Aspects of the mathematical standards of some 16+ school leavers in Gwent hoping to enter the engineering industry at craft and technician level and those of a sample of teachers

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"Aspects of the Mathematical Standards of some 16+ School Leavers in Gwent hoping to enter the Engineering Industry at Craft and Technician Level and those of a Sample of Teachers."

by


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Submitted for the Degree of M.Phil. to the Loughborough University of Technology. 1981

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ABSTRACT

"Aspects of the Mathematical Standards of some 16+ School Leavers in Gwent hoping to enter the Engineering Industry at Craft and Technician Level, and those of a Sample of Teachers."

by

John Maggs

CAMEST

(Centre for Advancement of Mathematical Education in Technology)

Loughborough University of Technology

The dissertation begins with a case study of the entrance examination for Craft and Technician Apprenticeships at a nationally known local firm. A critical examination was made of the selection test and a report, to the training officer concerned, is included. The Arithmetic ability of some who failed the test was compared with that of some who passed. The errors made by the candidates were scrutinised to see if a pattern would emerge, and which might add to that which was already known about errors made by the 16+ school leaver entering industry. The training officer was interviewed and, in the light of his professed requirements, a different kind of examination was proposed.

There were some Arithmetic processes that many of the school leavers could not do and it was decided to see how students training to be teachers would cope with these. Figures relating to the failure rate on different types of calculations by the 16+ school leavers in Wales were available from the C.B.I. (Wales) report, and a selection of these questions was made and an examination given to the students at the local college of education. Because of the sample of students at present at the college, it was possible to compare the scores and the errors made by those students taking the new route to teaching via the Diploma in Higher Education and those taking the older Certificate route. A comparison was also made of the scores and errors of the students in these categories with their mathematical level on entering college.
This same test was also administered to a sample of young teachers and their consequent scores and errors were determined. Comparisons were made of the scores and errors for the teachers, students and school leavers.

In order to find out more about the mathematical standards of the present day teaching force, who had been in colleges at some time during the period from about 1960 to 1980, the college mathematical records were examined. The 'basic' Mathematics scores for each year, in which students own elementary mathematical skills were examined, were compared with those of the year 1958, before the college had entered on its expansionist phase. A statistical 't' test was used in the comparisons. These 'basic' scores were also compared with the 'method' scores, in which the students were required to make an explanation, as if to the children, of a range of arithmetical processes. In making these comparisons, the mathematical level attained by each student before entering college was an integral factor.

Conclusions were drawn from the information and a set of recommendations made.

Key words: Mathematics, Craft, Technician, Industry, Standards, School-leavers, Teachers, Education.
ACKNOWLEDGEMENT

I wish to express my profound gratitude to my supervisor, Professor A.C. Bajpai, for the help and encouragement given to me in the preparation of this dissertation and the generosity of spirit with which he gave this help.
INTRODUCTION AND REVIEW OF SOME RELEVANT FACTORS INVOLVED IN THE PROBLEM OF MATHEMATICAL DEFICIENCIES IN SCHOOL LEAVERS.

METHODS USED IN THE ENQUIRY.

AN EXAMINATION OF A COMPANY APPRENTICE SELECTION EXAMINATION TAKEN BY SCHOOL LEAVERS IN GWENT IN JULY, 1979.

AN EXAMINATION OF MATHEMATICAL STANDARDS OF TEACHERS IN TRAINING AT A COLLEGE IN GWENT.

AN EXAMINATION OF THE MATHEMATICAL STANDARDS OF SOME YOUNG TEACHERS.

AN EXAMINATION OF THE MATHEMATICS RECORDS OF A COLLEGE IN GWENT FROM THE 1960'S AND 1970'S.

INTERPRETATION AND DISCUSSION OF THE RESULTS, INCLUDING RECOMMENDATIONS.

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6.4 Computer programmes in 'basic'. 't' tests on significance of a single mean. Each basic mathematics test compared with the 'method' test.
Introduction and review of some relevant factors involved in the problem of Mathematical deficiencies in school-leavers

The C.B.I. (Wales) working party report of 1977 (1) highlighted, for this part of the country, the concern felt by industry about what was regarded as falling standards in numeracy and literacy. This survey showed a decline in standards between 1966 and 1974. The percentage of the 1966 candidates, whose arithmetic standard was too low for them to be considered further, was 30%, whilst the figure had risen to 86% in 1974. Examples were given of the kind of arithmetic in which the apprentice-hopefuls were inadequate.

\[
\begin{align*}
\frac{3}{4} + \frac{3}{8} + \frac{1}{4} &= \frac{7}{16} \quad & \text{(corresponding digits were added)} \\
\frac{3}{4} \times \frac{2}{9} &= \frac{8}{27} \quad & \text{(cross multiplying - a common practice)} \\
13.27 + 29.9 &= 13.27 \quad & \text{(the position of the decimal point was ignored)}
\end{align*}
\]

The report found that it was in the case of only those of the lowest ability range that there was a failure to carry out the basic calculation processes once they had decided what to do. Mainly the mistakes arose because of a failure to make the correct decisions; there was a lack of comprehension of many of the fundamental concepts. Whilst holding the view that there had been a decline in standards, they nevertheless did admit a change in the school-leaving sector from which the apprentices were drawn. This is a factor which would make a conclusion about the decline in standards from these results above, rather difficult to make.
Gilbert (2) supports the view of a decline in standards but brings forth evidence of a more credible nature when he shows that between 1971 and 1975 the results of intelligence tests, (such as non verbal reasoning and mechanical comprehension), remained more or less constant, whilst the results of learned skills tests of English and Mathematics showed a serious decline. (See figure 1.1) Gilbert, who is a training executive for the Coventry and District Engineering Employers' Association, is concerned with a group training scheme which recruits between 100 and 150 apprentices each year. Several hundred applicants are tested each year using test papers selected from those designed by the National Institute of Industrial Psychology for an Engineering Apprentice Selection Battery.

Views concerning the dissatisfaction of industry with the numerical standards of Craft and Technician apprentices have been made by Carroll (1974). (3) When writing about the entrants below the '0' level threshold, he comments that,

"They come to us increasingly without the arithmetical ability to cope with the simple sums they must do during basic training."

The evidence for this brought forward by Carroll and others and reported as a summary of the discussions in the Institute of Mathematics and its Applications Symposium Proceedings Number 6, it was felt, remained uneroded by any arguments to the contrary.

Bajpai (1977),(4) reporting on the Royal Society/Council of Engineering Institutions Joint Education Committee's Working Party on School Mathematics in Relation to Craft and Technician Apprenticeships in the Engineering Industry, indicated that they could not ignore the vociferous criticisms coming from so many quarters of the engineering industry with regard to the effectiveness of Mathematics
Fig. 1.1 Average Range Score of M.G.T.S. Applicants V. Year of Leaving School

- 70B: Non-verbal Reasoning (x)
- 90.B: English (■)
- 90.E: Arithmetic (▲)
- V.H.D.: Mechanical Comprehension (●)

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</tr>
</thead>
<tbody>
<tr>
<td>No. Tests</td>
<td>213</td>
<td>356</td>
<td>466</td>
<td>419</td>
<td>597</td>
</tr>
</tbody>
</table>
teaching in schools. Bajpai, in the report outlining the problem, states:

"The full magnitude of the problem is not generally appreciated. Weaknesses which are typically found are shown by the performance of pupils in the selection tests currently given by firms, where their attainment in simple arithmetic, especially with decimal and vulgar fractions, is found to be low."

Appendix II of the report shows some of the common errors and the level of skills involved.

1) \[
\frac{56}{2} - \frac{2}{2} = \frac{54}{2} = 19
\]

in which there is an inadequate comprehension of the bonding concepts involved.

2) \[
\frac{2}{3} + \frac{3}{5} = \frac{5}{8}
\]

in which the concepts involved in the addition of fractions is not understood and there is direct addition of the corresponding digits involved.

3) The 1975 entrance tests for Plessey & Co. Ltd. asked the following questions. The percentage of correct responses is indicated.

<table>
<thead>
<tr>
<th>Question</th>
<th>% Correct</th>
</tr>
</thead>
</table>
| \[
\frac{5}{6} + \frac{2}{3}
\]                          | 30        |
| What % of 150 is 21?                     | 25        |
| What is the square of 0.07?                | 25        |
| What is \(\frac{3}{7}\) of \(10^1/9\)? | 0         |
It is interesting to see that Harrison, an apprentice supervisor with the British Aircraft Corporation, found that inadequacies in the mathematical capabilities of his apprentices were such that he had to institute additional evening classes to improve skills in, amongst other areas,

The four rules applied to whole numbers, fractions and decimals. Conversion of fractions to decimals and vice-versa.

This highlights a grave inadequacy at a very basic level. An inadequacy that industry has to try to overcome, albeit at quite a cost to itself.

"Many Companies are having to spend time and money on special tuition to bridge the gap." (6)

The C.B.I. is especially concerned that, whereas the Principality once had a high reputation for its educational standards, their presently considered inadequacy would have an adverse effect on the prosperity of the Welsh people.

In April, 1977, a survey was taken of the mathematical standards of British school children by the British Broadcasting Corporation, together with the National Foundation for Educational Research. (7) The results were compared, for several countries, with a UNESCO funded test which asked the same questions in 1964.

The thick line indicates in figure 1.2 the 1964 scores in the test in which Denmark did not take part. The results show a greater fall in the standards in England and Wales than any other nation except Germany. Japan was the only nation tested which actually had increased results.
Mathematics test April 1977

Score (%)

England and Wales
Scotland
Denmark
U.S.A.
Germany
France
Japan

Fig. 1.2
A great deal of the debate about standards is not aided by the lack of information. The report on the 1978 primary survey by the National Foundation for Educational Research in England and Wales to the Department of Education and Science will provide a basis on which future comparisons may be made. The Primary Survey Report No. 1 of the Assessment of Performance Unit (5) attempts to survey the mathematical performance of 11 year old pupils in England and Wales by the use of short printed tests administered to a representative national sample of 13,000 pupils. A sub-sample of over 1,000 pupils took practical tests and yet another, and separate, sample completed attitude questionnaires. Para. 6.6 of the results of the survey indicates that, whilst most 11 year olds can do mathematics involving the more fundamental concepts and skills to which they have been introduced, and are able to do simple applications of them, nevertheless they show a fairly sharp decline in performance if their understanding of concepts is probed more deeply. There is also a decline, if the basic knowledge has to be applied, in more complex settings or unfamiliar contexts. It goes on to say that,

"Pupils' grasp of the concept of decimal place value was shown by several items to be tenuous; placing decimals written to one place in order of size was achieved by 80% of pupils but the introduction in some of the numbers of a second place of decimals reduced the facility for the same process to 20%. Fractions could be added by 60% to 70% if their denominators were the same, but by less than 30% if they were not." (9)

Concern for the situation was being felt in high places and, in 1976, in a speech at Ruskin College, Oxford, the then Prime Minister, The Right Honourable James Callaghan, M.P., opened the Great Debate on Education in this country. (10) As part of this great debate, a conference was proposed by Mr. Barry Jones, M.P., Parliamentary Under
Secretary of State at the Welsh Office. This was held at the Centre for Educational Technology in Mold, Clwyd on 10th March, 1978, and a report was subsequently published. (11) A further conference was held and reported on the following year. (12)

At the 1978 Conference, particular reference was made to the C.B.I. (Wales) report on 'Standards of Numeracy and Literacy in Wales' and also to the pilot test of basic numeracy of fourth and fifth form secondary school pupils carried out by the Institute of Mathematics and its applications, (13) which was subsequently published in March, 1978, but which had received a great deal of publicity just before the conference. This showed a very low level of performance in dealing with some simple numerical calculations. Although the Mold Conference was mainly concerned with the unfavourable, (to Wales), comparison of the percentage of children leaving schools without a qualification, they were also concerned about standards needed for present day requirements. As was Callaghan, (12)

"Higher standards than in the past are required in the general education field. It is not enough to say that standards have or have not declined. With the increasing complexity of modern life we cannot be satisfied with maintaining existing standards, let alone observe any decline. We must aim for something better", this conference was concerned that though there remains, even after the improvement in educational provision and a broadening of the secondary curriculum, a substantial level of under-achievement amongst school leavers. There is a greater need to ensure that today's requirements are met rather than to engage in comparisons with the past.

"Society is making increasing demands on the mathematical and linguistic skills of school leavers. Whether there has or has not been a decline relative to standards in the past is of little importance compared with the generally accepted view that standards of
achievement are not satisfying present day requirements. Standards of numeracy and literacy can, and should, be raised." (15)

Following the initiative of the Prime Minister, the Secretaries of State for Education and Science and for Wales, under the aegis of the Minister of Education, Mrs. Shirley Williams, M.P., instituted a series of consultations and conferences which were followed by the publication in July, 1977 of the Green Paper 'Education in Schools'. (16) This paper does make the point that employers often fail to recognise that they are now drawing their recruits from a different and narrower range of school leavers than in the past and that they sometimes expect schools to have trained their pupils in very specific vocational skills which is more properly the task of employers themselves to impart through job-related training.

"There were many strongly expressed criticisms directed at industry: for instance, that employers often lay down unrealistic standards of attainment for school leavers well beyond what the job requires; that they have not made allowances for the fact that they are selecting from a group of school leavers which is more highly creamed by higher and further education." (17)

Nevertheless, the 1979 conference at Mold considered that though ....

"The expectations and needs of employers vary widely; ..... most would consider that they have a right to expect from potential recruits certain basic attainments in language and mathematics and personal attitudes and attributes." (18)

One might be tempted to think that there is a lack of attention given to basic skills in schools perhaps. The H.M.I. view, as expressed in Primary Education in England, (12) is quite to the contrary. Their findings did not support the view that
primary schools neglected the practice of basic skills in Arithmetic. In fact, considerable attention was paid to computation, though the results of the efforts were often disappointing. The first part of the statement, above, is supported by the H.M.I. Survey, "Primary Education in Rural Wales" (1978), in which they agree that considerable attention is given to computation. The average time spent on Mathematics is about 45-50 minutes each day and considerable emphasis is placed on computational skills. Indeed, they found that in some schools it was geared almost exclusively to that end.

The Green Paper stimulated a dialogue between comprehensive schools and their feeder primary schools, resulting in many cases in the production of a set of Mathematical guidelines 5-13. The H.M. Inspectorate found that Mathematics was supported by guidelines, whether or not produced in the above way, in 88% of the schools sampled. (20)

Some, like Kline (1976), were inclined to attribute the alleged lower levels of basic numeracy to the Modern Mathematics Movement, and Bond (1978) found that, in his survey of opinions of training officers in Tyne and Wear, 46% of them were of the opinion that the decrease in Mathematical ability of their intake, (in their opinion), was due to the teaching of Modern Mathematics. (21) This was the biggest single factor to which they attributed the decline. The figure for the questionnaire given to the training officers of Leicestershire and Warwickshire was 59%, again the largest single factor. This was not borne out in the findings of the Hampshire Education Committee Working Party (1974). This working party accepted as a fact that,
"computational skills have fallen among early school leavers" (22)

but found that the type of school course taken was not a significant factor.

"Tests conducted by Southampton Technical College and at Mullards suggest that the type of school course is not a significant factor in determining subsequent performance in basic skills at the level under consideration." (23)

They did, however, put forward two points which they thought were possible reasons for the decline.

"The problem of motivating pupils is taxing teachers of the fourth and fifth years of secondary education to an increasing extent."

"Uneven teaching standards, resulting especially from the national difficulty of recruiting adequately qualified teachers of Mathematics, play a highly significant role. Habits of mind are formed in the early years of education where the difficulty is no less acute than it is at secondary level." (24)

Research carried out by the Engineering Training Board at Chelsea College of Science and Technology (1977) found that there was no evidence to support the claim that Mathematical difficulties experienced by the students were more attributable to 'modern' than 'traditional' courses. There was a problem but, whatever the cause, it seemed to arise as a result of the way the methods were applied. (25)

In Wales, in Secondary Schools, the adoption of 'modern' syllabuses is to the least extent of anywhere in England and Wales, according to a Department of Education and Science Survey of Mathematics in Schools. Figure 1.3, below, shows that the swing from 'traditional' to 'modern' courses meant that, at its best, only one in three school leavers would have completed a modern course. (26)
<table>
<thead>
<tr>
<th>Year</th>
<th>South</th>
<th>Midlands</th>
<th>North</th>
<th>Wales</th>
<th>Overall</th>
</tr>
</thead>
<tbody>
<tr>
<td>First Year</td>
<td>72</td>
<td>58</td>
<td>58</td>
<td>33</td>
<td>59</td>
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<tr>
<td>Third Year</td>
<td>62</td>
<td>49</td>
<td>47</td>
<td>27</td>
<td>50</td>
</tr>
<tr>
<td>Fifth Year</td>
<td>48</td>
<td>36</td>
<td>36</td>
<td>19</td>
<td>38</td>
</tr>
<tr>
<td>3 Years</td>
<td>60</td>
<td>47</td>
<td>47</td>
<td>26</td>
<td>48</td>
</tr>
</tbody>
</table>

Fig. 1.3

No systematic study has been undertaken to measure the effect of changes in emphasis in primary education in the whole of Welsh Schools but there is some evidence in the Welsh Office Education Survey No. 6 1978.

"There is only limited evidence of a practical investigatory approach to Mathematics. Oral work and practical applications to concrete situations within the children's environment and experience tend to be under-emphasised in most of the schools so that children do not always fully understand what they are doing. Only in a minority of schools is sufficient consideration given to the stage the children have reached in Mathematics, and to experiences planned for a range of ability, in order to ensure understanding, consolidation and progress. The majority of the more able children reach what, for them, may be regarded as a fair level of performance only; the larger proportion of these work below their potential, and some well below it. In view of the under-achievement of the majority of the more able pupils and the rather narrowly conceived Mathematics curriculum in most schools, the general conclusion must be that most of the children are not fulfilling their potential in Mathematics as well as they might." (27)
This is a bleak picture of the non take-up of the splendid work which has gone on in recent years under the aegis of Miss Edith Biggs and Dr. Geoffrey Matthews. No lack of computational practice here but likelihood of the successful application of the skills to unknown situations is small. Hopefully the probability is that in the urban areas there may have been more communication and more drive towards a more broadly based Mathematical Education in the primary school. In any case, this would not in itself pre-suppose less of an emphasis on computation. A fact which Dr. Matthews has always maintained was a firm platform of the original Nuffield Mathematics Project.

Rappaport (1976),\(^{(28)}\) in the United States of America, was concerned about the abilities of the teaching force in meeting the needs of Mathematics teaching in primary schools. His concern was at the lack of sufficient understanding of Mathematics necessary to motivate the ablest children. Rees (1974)\(^{(29)}\) has shown that some of the concepts, usually considered to be very elementary, cause problems at all levels of educational attainment. Rees sought to define apparent regions of difficulty and tested a total of 861 students in Further Education, 138 in the first year of a University Engineering Course, 982 Secondary School pupils, (including G.C.E., C.S.E. and 'A' level candidates), and 601 trainee teachers. A common core of items was found for which the facility level was low. Figures 1.4 and 1.5 show the facility levels in this common core for school pupils and trainee teachers going into the Primary Sector. Whilst the mean score of the teacher trainees is not much less at 31.7 than the pupils at 33.1 on the test overall, nevertheless the scores on the common core items is rather less.
Fig. 1.4

Whole sample n=982
Mean score 33.1
S.D. 10.5

Fig. 1.5

Calculations Test, Colleges of Education. Facility-item distribution for weakest items.

Calculations Test, Schools. Facility-item distribution for weakest items with F<50%.
"The problem of innumeracy parallels that of illiteracy. It is at primary level that attitudes are set, possibly for life, and yet it is at this level that we have failed to use specialist forces. There appears to have been more concern over the appointment of specialist teachers for peripheral subjects. One Mathematics specialist teacher in a primary school could lead, advise, and hopefully generate enthusiasm amongst colleagues." (30)

It must be a serious matter if the Mathematical skills of the teacher in the primary school on 'common core' items are poor, the more so if, as Rees suspects, these topics form a learning-teaching cycle with the possible consequences of depressed standards. Rees’ hope that specialist teachers of Mathematics should be appointed to primary schools has an echo in the Gwent College of Higher Education's Academic Board sub-committee investigating the supply and training of those who have to teach Mathematics. (1979) The committee felt that a modified policy on who is to teach Mathematics in the primary schools should be adopted. They recommend that teachers should only teach Mathematics in primary schools if they themselves are competent and wish to do so. (31) This represents a very radical change from the present policy.

The Nuffield National Committee (1979) stresses that the most important factor in children's successful learning is still the teacher. They do not support the Caerleon view, in which only specified teachers would be able to teach Mathematics in the primary school, though they do highlight for consideration, by the Cockcroft Committee, the view that there should be specialist advice within primary schools; more perhaps, on the lines of Ruth Rees' thinking. Perhaps even a 'Head of Mathematics' in the primary school, as suggested
by the Schools Council (1979) in their submission to the Cockcroft Committee.

"....Primary schools are responsible for laying the foundations of Mathematics, and special attention must be paid to their needs: the appointment of a 'Head of Mathematics' is to be commended." (32)

Disquiet about being able to carry out in primary schools what is required in the present day teaching of Mathematics has been expressed by Boucher (1975). Discussing the foundations of numeracy at the primary school, he said,

"There is nothing wrong with what we are trying to do, but we have got to find the people to do it." (33)

The 1975 document by the Department of Education and Science H.M. Inspectorate showed that in secondary schools at that time there were 2,049 teachers of Mathematics and that, of these, only 625 were graduates. (This meant a graduate qualification, including Mathematics, Science and English.) (34) This is a factor highlighted by the Royal Society/Council of Engineering Institutions Joint Education Committee Working Party in its 1976 report, when it stated,

"There is still an acute shortage of able Mathematics' teachers. In many instances, teachers without formal Mathematics qualifications are finding themselves teaching Mathematics, sometimes reluctantly, as a second or third subject." (35)

As far as primary school teachers are concerned, a survey by the Mathematical Association in 1977 showed that about 60% of primary school teachers had passed Mathematics at 'O' level standard. (36) As Rees has shown, the ability of her sample of
future teachers to handle basic Mathematical skills, most of which are scheduled to be commenced in the primary schools, was not as good as that of the cross section of school pupils. (37)

At the Institute of Mathematics and its Applications Conference in July, 1964 at Nottingham, R.L. Lindsay, in his summing up, said,

"The horror stories of the engineers could seemingly be capped by those from the primary school; of teachers who 'taught' children how to subtract while being unable to do it themselves; of the grasping at straws, resulting in an unhealthy obsession with 'sets'; of the wishful thinking of calculators ousting calculation; of the realisation of personal inadequacy leading to much the same kind of breakdown in self-confidence, and to hysteria." (37)

Concern for the need of an adequate teaching force in order to ensure the realisation of the desire of the members of the Mold Conference to see a raising of standards, has been felt since the early years of the last decade. The D.E.S./A.T.C.D.E. Conference at Hereford (1972) was so concerned about the supply of an adequate teaching force in primary schools that it envisaged that 10% of the teachers recruited to primary schools should be those who had undertaken some study of Mathematics at specialist or semi-specialist level. (37)

A decline in the actual standards of school teaching was the second most significant factor in the decline of standards, according to the training officers of Tyne and Wear, and those of Leicestershire and Warwickshire who responded to Bond's questionnaire. (13)
The Nuffield National Committee (1979) is also concerned with teacher inadequacy when it comes to Mathematics in primary schools. They suggest that there is a basic feeling of insecurity in many members of the primary teaching force and that this insecurity lies in the area of computation. Records show that in the Nuffield Regional Meetings,

"the greatest demand still is for courses on computation and the Mathematics advisers on the National Committee would say a similar trend is seen locally." (1:1)

The need for a high degree of skill in computation is compounded, for the Engineering Industry apprentices, by the continuing need for Imperial units and by virtue of the fact that jobs started on a machine which operates in one set of units may have to be finished on another machine operating in a different set of units. The author found that this situation pertains in several engineering works in Gwent and especially with many of the older British Steel Corporation operations.

Mr. Fry, of the British Steel Corporation plant at 'Whiteheads', Newport, Gwent, told the author that,

"The need for conversion between metric units and Imperial units will remain in the foreseeable future because of the high capital investment in machinery which still has a productive life of 40 years." (1:2)

Carroll of the E.I.T.B. confirms this when he says that,

"The Imperial system will continue to be used jointly with the metric system for many years to come, not only because of the huge capital investment represented by existing Imperial machines, but because of the need to continue to manufacture spare parts for existing equipment." (1:3)
This is in strange contrast to the pronouncements which 
emanated from the D.E.S. in the way of statements made by various 
members of Her Majesty's Inspectorate. For example, in 1972 one 
such Inspector said,

"Undoubtedly the quickest way for us all 
to become familiar with the new units is 

to use them as frequently as possible. 
Conversion should be avoided wherever 

possible...... At the present time 
some of the examination boards plan to 
use S.I. units exclusively in 
Mathematics ...... To me personally, 
however, there appear to be two reasons 
why new and revised books should include 
metric measures only: because written 
practice in the four operations using 
Imperial measures is no longer necessary ......" (5)

Of course this has to be seen in the light of the current 
pronouncements of the Metrification Board that the metrification of 
most facets of industrial and commercial life was to be completed 
by 1975. Small wonder then that Colleges of Education ceased to 
work with Imperial units in the early 1970's. At Caerleon, 
Imperial units were abandoned in 1969 and, when Thyer and Maggs' 
'Teaching Mathematics to Young Children' was published in 1971, 
it was completely metric. (5) In the light of the above 
mentioned information from industry, the authors have felt obliged 
to reintroduce some Imperial units in the Second Edition now due 
to be published.

One result of the neglect of Imperial units has been the 
feeling that a thorough knowledge and skill in manipulation of 

fractions has not been needed.

Whatever contributory factors to lack of success which 
there may be lying outside the pupil, there may also be factors
inside the pupil; his motivation and interest in the task in hand. His performance will be affected by his interest and motivation and these in turn may be affected by his social background. This may not be because he has no vision of the rewards which may be gained as a result of endeavour, but rather that he may lack the necessary factors necessary for the implementation of his aspirations. (46)

The encouragement and expectation may not be forthcoming from the pupil's family. This motivation and encouragement may be more difficult to achieve in the schools where the aims of a more generalised education may not be appreciated. During the research programme carried out by Linda Dickson, (1977) she found that,

"most of the ten apprentices had suffered some serious shortcomings in their schooling which they attributed mainly to ineffective class control and low motivation through lack of practical application of the Mathematics encountered." (47)

During the first year of their apprenticeships, they were said to,

".... Seem to be enjoying a relatively high level of motivation." (48)

In a wider field, the Engineering Industries Training Board research of 1977 found that,

"Staff in the training centres included in the present study reported that, while they were often appalled at the standard of arithmetic of new trainees and while remedial teaching was at best inconvenient, they did overcome the problem during the first year training, because of the high motivation of the trainees once they understood the need for arithmetic skills as part of their job. It is likely that the motivation induced by perceiving the application of various aspects of Mathematics is a key factor in this change." (49)

If schools are to be able to motivate their pupils, then the teachers themselves must be aware of the applications of the Mathematics they
are teaching. There must be a greater link than there is at present between industry and schools. This may be something which could be implemented for primary schools as well as secondary schools. In order to facilitate children's handling of operations with numbers, and so that this may be linked with learning to use them in a variety of situations, Her Majesty's Inspectors (D.E.S. 1978) have expressed a desire that schools move in a direction of discovering Mathematics in everything. The author carried out some research for the Schools' Council in which he showed that it was possible to link many of the existing areas of the county schools' Mathematics guidelines with Environmental Studies. This does in itself bring in additional difficulties to which the H.M.I. Working Party for Primary Mathematics 5-13 years (1974) were sensitive.

"But this mode of working requires sensitivity to the Mathematical potential of a wide variety of situations, and this in turn demands more Mathematical knowledge than many teachers possess at present - so the opportunities for developing Mathematics from an integrated topic are under-developed." (52)

From the author's experience of working with children on Mathematics in integrated topics or environmental studies, he can say that it certainly did motivate children. They became more aware of Mathematics in its relationship to the lives we lead. Attempts have been made to motivate secondary school children to aim to achieve better skills in Mathematics.

Wright (1979) introduced certificates in basic numeracy in his schools. In the Oakdale Comprehensive School in Gwent, the headmaster has introduced his own 'School Certificate' for those children who would not be obtaining any C.S.E. examinations.
School-leavers having no graded result † at G.C.E. or C.S.E.

* The 1973 figures were distorted by a raising of the school-leaving age.

† Defined as G.C.E. grades A to E and C.S.E. 1 to 5.

Fitzgerald (1978) has suggested his 'Corridors of Power' along which almost all pupils should be able to proceed, albeit at their own pace and tackling those concepts and skills suitable to them.

"... there did seem to be a general pattern of progression (in some Arithmetic topics), and it is not unlikely that a similar phenomenon would be found in other areas of Mathematics. If this is so, then here is the possibility of arranging potentially useful Mathematics in some sort of crude hierarchy, which might aptly be described as a 'Corridor of power'." (55)

The further the pupils would be able to progress along this corridor the greater would be their potentiality to cope in earning a living, in using leisure time, in further studies, and in general in coping
with modern society. In any case, the problems of motivation could be attacked with such a scheme if the true relationship to needs can be brought home whilst the children are in school. The problem of motivation is one which Graham considers to be, "the major factor in the discussion over poor arithmetical standards in schools." (56)

Having considered these factors, the author decided to concentrate efforts on the alleged drop in standards in school teaching as indicated in Bond's questionnaires responses. It was decided to look at primary and especially that which was related to the local College of Education.

The main investigations of this thesis are into the attainments of apprentices (Ch.3), teachers in training (Ch.4,6), and some young teachers (Ch.5). Conclusions are given in Chapter 7. This following chapter contains some further background and an overview of the research together with some notes on its design methods.
CHAPTER 2

Methods used in the enquiry

The author firstly thought to look at a selection examination in Mathematics in one of the county industrial plants. In consequence of this, he sought the advice of a head teacher who had become well-known in the county for his institution and subsequent encouragement of Schools/Industry links. Mr. C. Lapham, Headmaster of Oakdale Comprehensive School, then suggested that the Chairman of his local Schools/Industry Liaison Committee would be the ideal Training Officer to approach. Mr. J. Winfield's company was a nationally known one and a large employer in the north of the county.

Each year this company received requests for Craft and Technician apprenticeships from over a hundred applicants. The apprentice-hopefuls were firstly required to pass a company selection test which was mainly of a Mathematical nature. The avowed intention was that the examination should select those candidates who were likely to make a success of their apprenticeship opportunities. In this case, the examination was being used as an indicator of potential for the future. Secondly, the examination had to find those candidates capable of accurate calculating work under stress conditions, i.e. on the shop floor. Thus the second purpose of this examination was to provide a stress situation in which to determine the candidates of whom the company would approve. Subsequent to the weeding out process in the examination, formal interviews would decide who would be taken on from those who were successful.
The author went to the plant on the first day of the examination process and, having firstly interviewed the Training Officer, then set about scrutinizing the papers finished by the candidates, and which had been marked by the Training Officer. It was decided to look at the ability of each candidate in terms of ability to calculate and thus to look at the errors which were made. A categorisation of errors was decided upon and each error made, where it could so be determined, was allocated into a category. The errors ranged from those where a lack of understanding of the essential concepts was involved to errors made due to a careless approach to the calculation.

The categories used were:

- **B₁** due to addition bond error
- **B₂** due to subtraction bond error
- **B₃** due to multiplication bond error
- **B₄** due to division bond error
- **C₁** calculation error in addition
- **C₂** calculation error in subtraction
- **C₃** calculation error in multiplication
- **C₄** calculation error in division
- **D** due to non-understanding of concept
- **E** due to incorrect formula
- **F** due to carelessness
- **P** place value error
- **R** rounding error
- **S** due to reversal of digits
- **N** due to a principle outside Mathematics
- **M** no working to tell why incorrect
Q inability to handle algebraic form

T inability to read necessary tables

A inability to quote \( \pi \)

As well as being assigned a category, each error was described and, where necessary, an example was given.

The Training Officer was rather concerned about the style of the papers given to the candidates and indicated that he would welcome comments. To this end a report on the examination was sent, in confidence, to Mr. Winfield. (see Appendix 3.2)

In this way it was to be seen what kind of selection procedure, involving Mathematics, was thought to be appropriate by a Training Officer who was keen on, and gave his time generously to, Schools/Industry liaison work.

Figures for the standard of performance on a Mathematics test by school-leavers seeking Craft apprenticeships with another large South Wales firm were available from the C.B.I. (Wales) Report (1977). Bearing in mind Bond's (1978) questionnaire in which Training Officers considered that the major factor in the decline in standards was the alleged decline in standards in teaching, the author next set out to look at some Arithmetic standards among teachers in training.

A selection of questions to use was made from the ones given in the C.B.I. (Wales) Report and which had been used in the Welsh survey. The report gave scores for forty-four items. This number was felt to be too great to use in the short length of time sessions that the author could persuade his colleagues to allow to him for the purpose of testing. In consequence, ten questions were selected from
the forty-four. The ten questions included,

(a) An addition of up to four figure numbers.
(b) A subtraction of two numbers, including a five figure number.
(c) A multiplication of a three figure number by a two figure number and further by another two figure number.
(d) Addition of a pair of simple mixed fractions.
(e) Division of a pair of simple fractions.
(f) Conversion of a simple fraction to a decimal.
(g) Finding the percentage, one number of another.
(h) Comparison of fractions with a decimal fraction worded in a 'problem' form. Orders of magnitude.
(i) Finding the area of a circle.
(j) A problem in screw sizes involving an Arithmetic progression.

All except (i) were items which were marked with an 'H' on Fitzgerald's (1976) list of Mathematical Knowledge and Skills required by pupils entering industry at the 16+ level. The assigned 'H' meant that these items were those in which a high level of competence was required. (i) was chosen so that a simplified element of question 7 on the local firm's test could be compared. At the college in 1979, were students preparing for teaching through the older Certificate Course and also on the newer Diploma of Higher Education Course leading to a Bachelor's degree. In that year, none of the students were required to have 'O' level Mathematics upon entry, nevertheless, with some students who did have this qualification, it was hoped to be able to make some kind of comparison with those who had not. The real difference in the two sets of students lay in the fact that for entry to the Dip. H.E. Course a student had to have at least two 'A' levels, which is the new requirement for Higher Education and which could mean that these students might be considered by the Universities. On the
surface at least, a better qualified student than the Certificate student. No time restriction was placed on the students by the author and so, apart from some 'faint hearts' who felt that they had to rush to join the protective crowd, most students had sufficient time in which to show whether they were capable of correctly answering the questions. It was required of the students that they showed all necessary working somewhere on their answer sheet. As for the apprentices, errors were observed and assigned categories. Further, each student's errors were logged and examples given.

Each student's score was taken on a right or wrong basis for each question. The mean and standard deviations were calculated using,

\[
\text{Mean} = \frac{\sum fX}{N} \quad \text{where} \quad f \text{ frequency} \quad X \text{ score by an individual} \quad N \text{ Number of students}
\]

\[
\text{Standard Deviation} = \sqrt{\frac{\sum d^2}{N-1}} \quad \text{where} \quad d \text{ is the deviation from the mean.}
\]

Each of these values was calculated for the sets.

1. Students taking the Diploma of Higher Education and who have 'O' level Mathematics or its equivalent.

2. Students taking the Diploma of Higher Education and who do not have 'O' level Mathematics or its equivalent.

3. Students taking the Diploma of Higher Education whether or not they have 'O' level Mathematics or its equivalent.

4. Students taking the Teacher's Certificate who have 'O' level Mathematics or its equivalent.
5. Students taking the Teacher's Certificate and who do not have 'O' level Mathematics or its equivalent.

6. Students taking the Teacher's Certificate whether or not they have 'O' level Mathematics or its equivalent.

These same questions were then set as a test, under the same conditions, for fifty-six young teachers. All of these teachers were taking Part I of the University of Wales Bachelor of Education degree. Twenty-three were taking a course leading to Part I at the Gwent College and the remaining thirty-three taking their course leading to Part I at University College, Cardiff. All of these teachers were non-graduates from Primary, Secondary and Further Education Sectors of the education service. Fifty per cent of the sample were from the primary service.

For these teachers, errors were observed and categorised. The errors themselves were analysed, recorded and examples given. The Mean and Standard Deviation of the scores was also calculated.

This was a sample of young teacher non-graduates and were of an age to have been at college during the late nineteen-fifties, the sixties or the early seventies.

In order to get an idea of the standard of more of such teachers who are now in the education service, and a great many of them teaching locally, the college mathematical records were examined.
The percentages of students, men and women taken separately, without '0' level Mathematics, was found and the figures compared throughout a period of fourteen years. It was also possible for some of the years to determine the percentage of students who had dropped Mathematics or Arithmetic even before their '0' level or C.S.E. year.

The scores made by these students were examined for the period of twenty years from 1958 to 1978. The Mean and Standard deviation for each set was calculated from the usual relationships for ungrouped data.

\[
\text{Mean} = \frac{\sum x}{N} \quad \text{and} \quad \text{Standard Deviation} = \sqrt{\frac{\sum d^2}{N-1}}.
\]

Using these Means and Standard deviations each year score was then compared with that of 1958.

The year 1958 was the first year of the records and also it was one of the last years of the 'old-order' in the college when the intake was all-male. A 't' test was applied using the difference between the Means of two samples taken from differing populations.

If we consider that the first is Sample A, with a Mean of \( m_1 \), a standard deviation of \( S \), and a number in the sample of \( n_1 \) and that the second is sample B with a mean of \( m_2 \), a standard deviation of \( S_2 \) and a number in sample of \( n_2 \), then the 't' test used was

\[
t = \frac{m_1 - m_2}{\sqrt{\frac{S_1^2}{n_1} + \frac{S_2^2}{n_2}}}.
\]

where \( n_1 \) and \( n_2 \) are large samples. For example, \( 61 \leq n_2 \leq 146 \) for the women and \( 43 \leq n_2 \leq 124 \) for the men with \( n_1 = 98 \).
This form was used throughout, since in only one case, namely that of the men who were students from 1976-1979, was \( n_2 < 30 \). It was felt that it was appropriate to be consistent throughout in the use of this form of the 't' test. There were so many of these tests that a programme was written in BASIC in order that the calculations could be run on the college computer.

The programme used was,

BASIC PROGRAM SIG OF DIFF BETWEEN MEANS

5 LET \( A=B=N=0 \)
10 LET \( C=D=M=0 \)
15 READ \( X \)
20 IF \( X = 0 \) THEN 45
25 LET \( A=A+X \)
30 LET \( B = B + X \times X \)
35 LET \( N = 1+N \)
40 GOTO 15
45 LET \( R = A/N \)
50 LET \( S = SQR(B/N - R^2) \)
55 DATA
---------------------
---------------------
90 READY
95 IF \( Y = 0 \) THEN 120
100 LET \( C = C+Y \)
105 LET \( D = D+Y\times Y \)
110 LET \( M = 1+M \)
115 GOTO 90
120 LET \( F = C/M \)
In each of these years in which there was a mark available from a basic Mathematics test, there was also one available from a test of 'Mathematics Method'. This was a test of whether the student could communicate to children some of the basic processes of Arithmetic. For each of the years the basic Mathematics score was compared with the score for Mathematics method. A 't' test was also used for this comparison, but this time using a single mean.

If \( X \) represents the 'basic' Mathematics scores and if \( Y \) represents the 'method' scores and \( d \) is the difference in the scores for each student then

\[
d = x - y \quad \text{and} \quad \bar{d} = \frac{\sum d}{n}
\]

that is \( \bar{d} \) is the mean of the differences, then the standard deviation

\[
\sigma = \sqrt{\frac{\sum d^2}{n} - \left(\frac{\sum d}{n}\right)^2}
\]

and the 't' test used was

\[
t = \frac{\bar{d}}{s/\sqrt{n}} \quad \text{where} \ s \ \text{is the Standard Deviation}.
\]
If there is no significant difference between the marks then \( \bar{d} \) should be zero, or close to zero. So if \( t = \frac{\bar{d} - 0}{s/\sqrt{n}} \) is applied, it tests whether \( \bar{d} \) differs significantly from zero or not. If it does, then the 'basic' scores will be significantly different from the 'method' scores. If \( \bar{d} \) is positive, then \( (X-Y) \) is positive and this indicates that the X marks will be higher than the Y marks. If \( (X-Y) \) is negative, on the other hand, then the Y marks will be higher than the X marks. These differences could be significantly so if the value of 't', calculated, exceeds the value quoted in the 't' table for the appropriate number of degrees of freedom.

So the inferences which might be made would be:

1. That the 'basic' marks will be significantly higher than the 'method' marks if \( d \) is positive, and if \( t \) is greater than the table value for the appropriate number of degrees of freedom.

2. That the 'method' marks will be significantly higher than the 'basic' marks if \( d \) is negative and if \( t \) is greater than the table value for the appropriate number of degrees of freedom.

3. That the 'basic' marks will be slightly higher than the 'method' marks, but not significantly so if \( d \) is positive but the value of \( t \) is less than the table value for the appropriate number of degrees of freedom.

4. That the 'method' marks will be slightly higher than the 'basic' marks, but not significantly so, if \( d \) is negative but the value of \( t \) is less than the table value for the appropriate number of degrees of freedom.
A computer programme was written in BASIC in order to carry out the calculations and tests. The programme written was:

BASIC PROGRAM SIGNIF OF SINGLE MEAN

5 LET A=0
10 LET B=0
15 LET N=0
20 READ X, Y
25 IF X=0, THEN 60
30 LET D=X-Y
35 PRINT "X="; X; " Y="; Y
40 LET A=A+D
45 LET B=B+D*D
50 LET N=1+N
55 GOTO 20
60 LET M=A/N
65 LET S=SQR(B/N-M*N)
70 LET T=M/S * SQR(N)
75 PRINT "N="; N; " M="; M; " S="; S; " T="; T
80 STOP
85 DATA
95 END

In the computer programme, \( N \) is equivalent to \( \bar{a} \). So we may, by taking into account the results of these enquiries, see the extent of any short-fall in the requirements which have been made by school-leavers, teacher-training students and teachers in the county. We may see the errors that they make and be able to judge some of the errors which may be common to all of the groups.
CHAPTER 3

An examination of a Company Apprentice selection examination taken by school-leavers in Gwent in July, 1979

This is an account of an examination set by a local branch of a National Company in the engineering industry, in order to select suitable future apprentices for Craft and Technician grades. The writer interviewed the training officer from this Company and from other Companies in Gwent, and it became clear that the examination was a stress situation from which the successful candidates were those who emerged with correct answers. A right or wrong method of marking was used.

The paper (see Appendix 3.1) consisted of a set of seven questions, some Mathematics, some English and a Science question which needed Mathematics in its solution.

The author was able to examine the marked papers and to analyse them for errors. In doing this, he was not assisted by the fact that the answers were very often written in a very brief and markedly untidy form which made the tracing of errors rather difficult.

No time limit was set for the answering of the paper, and the school-leavers left the room when they felt that they had done all they could. In spite of the fact that the rubric on the first sheet of the examination paper stated that extra marks would be awarded for 'layout, neatness and clarity of expression', the answer papers were, in general, messy and showed a lack of discipline in the
approach to answering a Mathematics paper.

One hundred and three would-be apprentices sat the paper and only seventeen were acceptable to the Company on the basis of their answers to this paper. Of course, one would not expect that the Company could take all the school-leavers who might pass such a paper, given that schools gave due attention to specific needs. Economic factors obviously will decide on the number to be taken on. Nevertheless it would be more satisfactory to those who have taught these pupils to find that more could be expected to pass at least this hurdle in the quest for an apprenticeship. The Company would benefit in that they would have more candidates to consider in the light of those factors of character not determined by an examination.

The Training Officer of this Company repeatedly pointed out that he was attaching great importance to the Mathematical ability of the candidates. He was interested in those who could provide correct answers under stress. Decisions on the shop floor or in planning were made often under stress conditions and incorrect answers could cost this Company, in particular, a great deal of money. Some of the materials being worked upon by the engineers was extremely expensive.

The answers given by the school-leavers were analysed to find the kind of errors made.

(For types of error refer to pp 24, 25)
Apprentice Examination. Successful Candidates.

<table>
<thead>
<tr>
<th>Candidate</th>
<th>Level of Mathematics</th>
<th>Qn.</th>
<th>Errors</th>
<th>Types of Error</th>
</tr>
</thead>
</table>
| 1         | Taking 'O' Level Maths. | 4   | a. Log. reading error.  
b. Error in subtraction with bar numbers. | F C3 |
| 2         | Has 8 'O' levels. Maths. 'B' | 4   | a. Uncertain of Trig. Ratios.  
b. Writes 2.66 to one place as 2.6. | D R |
| 3         | C.S.E. Maths. Grade 3. | 4   | a. Could not work out 3/0.8192 | D |
|           |                      | 6   | a. Could not do this question. | D |
| 4         | No Maths. at 'O' level, taking T.E.C. Course. | 5   | $\frac{1}{4} + \frac{3}{8} = \frac{2+3}{8}$ | F |
| 5         | 'O' level Maths. Grade'Bt | | No errors. | |
| 6         | Taking 'O' level Maths. | 2   | a. No idea of meaning of limits. | D |
|           |                      | 6   | a. Could not do this question. | D |
| 7         | Taking 'O' level Maths. | 5   | a. Cannot add $\frac{1}{4} + \frac{3}{8}$,  
$\frac{1}{4} + \frac{1}{10}$  
($\frac{1}{4} + \frac{3}{8} = \frac{2}{12}$) | D |
<p>|           |                      | 7   | a. All principles were correct. Was not successful at long division. Figures not carefully placed. | C4 |</p>
<table>
<thead>
<tr>
<th>Candidate</th>
<th>Level of Mathematics</th>
<th>Qn.</th>
<th>Errors</th>
<th>Types of error</th>
</tr>
</thead>
<tbody>
<tr>
<td>7 cont'd.</td>
<td></td>
<td>6</td>
<td>a. No clear ideas.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Could not work out 3/0.8192.</td>
<td>D</td>
</tr>
<tr>
<td>8</td>
<td>Taking C.S.E. Maths.</td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula. Writes V = 2\pi rh.</td>
<td>E</td>
</tr>
<tr>
<td>9</td>
<td>C.S.E. Maths.</td>
<td>2</td>
<td>a. No idea of meaning of limits.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Writes area of cross-section as 2\pi r. Incorrect formula.</td>
<td>D</td>
</tr>
<tr>
<td>10</td>
<td>Taking T.E.C. 1 Maths.</td>
<td>4</td>
<td>a. Incorrect reading of cosine.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. 3/1.937 was worked as 19/30.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. 8/3 = 2\frac{2}{3} also \frac{80}{18} = 4\frac{2}{9}.</td>
<td>D D.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Error in multiplication 3.142 x 20 = 61.84</td>
<td>F</td>
</tr>
<tr>
<td>11</td>
<td>T.E.C. level II Maths.</td>
<td>4</td>
<td>a. Works to one dec. place in one calculation and two dec. places in another.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Writes 2\frac{2}{3} = 2.6</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Errors due to not using negative sign for deceleration.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect multiplication 3.142 \times 2.25</td>
<td>C_3</td>
</tr>
<tr>
<td>12</td>
<td>Taking C.&amp;G. Foundation Course Maths.</td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula Writes V = 2\pi rh</td>
<td>E</td>
</tr>
<tr>
<td>Candidate</td>
<td>Level of Mathematics</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of error</td>
</tr>
<tr>
<td>-----------</td>
<td>----------------------</td>
<td>-----</td>
<td>--------</td>
<td>----------------</td>
</tr>
<tr>
<td>13</td>
<td>Taking 'O' Level Maths.</td>
<td>5</td>
<td>a. No idea of principle of adding resistances in parallel.</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Did not use negative sign in acceleration.</td>
<td>D</td>
</tr>
<tr>
<td>14</td>
<td>Taking 'O' Level Maths.</td>
<td></td>
<td>No errors.</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>C.S.E. Maths. Grade 3.</td>
<td></td>
<td>No errors.</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>Taking 'O' level Maths.</td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. Could not do this question.</td>
<td>N</td>
</tr>
<tr>
<td>17</td>
<td>Taking 'O' level Maths.</td>
<td>4</td>
<td>a. Could not work out $\frac{3}{0.9397}$</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. Confusion of Physics.</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Tried to subtract 4.44 from 2.66, ended in confusion with a bar number.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
</tbody>
</table>

Unsuccessful candidates

<table>
<thead>
<tr>
<th>Candidate</th>
<th>Level of Mathematics</th>
<th>Qn.</th>
<th>Errors</th>
<th>Types of error</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>C.S.E. Maths. Grade 1</td>
<td>2</td>
<td>a. Could not calculate $10%$</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. $\frac{8}{3} = 2.6$</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. $1.5 \times 1.5 = 20.5$. Carrying error. Place value error.</td>
<td>C3</td>
</tr>
<tr>
<td>Candidate</td>
<td>Level of Mathematics</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of errors</td>
</tr>
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<tr>
<td>19</td>
<td>Taking 'O' level Maths.</td>
<td>2</td>
<td>a. Could not calculate 10%.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Subtraction error $90 - 35 = 65$</td>
<td>$C_2$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Could not handle $\sin 65 = \frac{3}{AB}$</td>
<td>Q</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. No idea of relationship needed.</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula $V = 2\pi r h$.</td>
<td>E</td>
</tr>
<tr>
<td>20</td>
<td>Taking 'O' level Maths.</td>
<td>2</td>
<td>a. Cannot find 10% $\frac{10 \times 15}{100} = \frac{150}{100} = \frac{32}{2} = 1.2$</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. $\frac{10 \times 18}{100} = \frac{180}{100} = \frac{9}{5} = 1.4$</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Changing fraction to decimal.</td>
<td></td>
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<td></td>
<td></td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
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<td></td>
<td></td>
<td>5</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
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<td></td>
<td></td>
<td>7</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td>21</td>
<td>Taking C.&amp;G. Craft Course</td>
<td>2</td>
<td>a. Cannot find 10%. Subtracts 10 from each value.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. Does not know relationship needed.</td>
<td>N</td>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td>22</td>
<td>Taking C.S.E. Maths.</td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td>Candidate</td>
<td>Level of Mathematics</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of errors</td>
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<tr>
<td>23</td>
<td>Taking 'O' level Maths.</td>
<td>2</td>
<td>a. Cannot find 10%. Multiplies each number by 10.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4 a. No working to indicate why incorrect.</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6 a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7 a. Error in long multiplication.</td>
<td>C3</td>
</tr>
<tr>
<td>24</td>
<td>C.S.E. Maths. Grade 5.</td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>6 a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>7 a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td>25</td>
<td>Taking Maths. 'O' level.</td>
<td>4</td>
<td>a. Cannot handle the algebra of, ( \cos 20 = \frac{3}{\text{Hyp.}} ).</td>
<td>Q</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>5 a. Conversion ( 2\frac{2}{9} = \frac{20}{9} ).</td>
<td>F</td>
</tr>
<tr>
<td>26</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>4 a. Could not do this question.</td>
<td>D</td>
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<td></td>
<td></td>
<td></td>
<td>5 a. No idea of principles needed.</td>
<td>N</td>
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<td></td>
<td>6 a. Could not do this question.</td>
<td>D</td>
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<td></td>
<td></td>
<td></td>
<td>7 a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td>27</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. Cannot find 10%. Divides each by 2.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>4 a. Incorrect answers, no working.</td>
<td>M</td>
</tr>
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<td></td>
<td></td>
<td>5 a. Incorrect answers, no working.</td>
<td>M</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>6 a. Incorrect answers, no working.</td>
<td>M</td>
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<td></td>
<td></td>
<td></td>
<td>7 a. Incorrect answers, no working.</td>
<td>M</td>
</tr>
<tr>
<td>Candidate</td>
<td>Level of Maths.</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of errors</td>
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<tr>
<td>28</td>
<td>Taking 'O' level Maths.</td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
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<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Only outside volume calculated.</td>
<td>F</td>
</tr>
<tr>
<td>29</td>
<td>C.S.E. Maths. Grade 5.</td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Errors in multiplication 3.142 x 4 x 5 = 6.280.</td>
<td>C3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. 3.142 x 2.25 x 5 = 35.34 Rounding error.</td>
<td>P</td>
</tr>
<tr>
<td>30</td>
<td>Taking 'O' level Maths.</td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
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<td></td>
<td></td>
<td>6</td>
<td>a. Incorrect, no working.</td>
<td>M</td>
</tr>
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<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect, no working.</td>
<td>M</td>
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<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
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<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. No idea of principles connecting distance, velocity, accn. and time.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect long multiplication. Decimal point error, place value.</td>
<td>C3</td>
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<tr>
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<td>P</td>
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<tr>
<td>Candidate</td>
<td>Level of Mathematics</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of errors</td>
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<tr>
<td>32</td>
<td>Taking 'O' level Maths.</td>
<td>4</td>
<td>a. Writes Sine 70 = 5.736.</td>
<td>D T</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Error in long multiplication. 3.142 x 1.5 x 1.5 = 7.095. Untidy presentation.</td>
<td>C3</td>
</tr>
<tr>
<td>33</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. Cancelling problems in the fractions.</td>
<td>C4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
</tr>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula $V = \text{ht. } \times \text{diam.}^{3}$</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Incorrect formula $V = \text{Rad. } \times \text{diam.} \times \text{ht. }$</td>
<td>E</td>
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<td></td>
<td></td>
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<tr>
<td>34</td>
<td>Taking 'O' level Maths.</td>
<td>2</td>
<td>a. No idea of limits.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Multiplication error.</td>
<td>C3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Relationship of distance, accn. and time not known.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula $V = 2\pi \text{r}^{2}\text{h}$.</td>
<td>E</td>
</tr>
<tr>
<td>35</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. No idea of limits.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Could not do this question. Tried to use Pythagoras Thm.</td>
<td>D</td>
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<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula $V = \frac{1}{2} \text{area } \times \text{ht.}$</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Later wrote $V = 4\text{m } \times \text{5m } = 20\text{m}^{2}$.</td>
<td>D</td>
</tr>
<tr>
<td>Candidate</td>
<td>Level of Mathematics</td>
<td>Qn.</td>
<td>Errors</td>
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<tr>
<td>36</td>
<td>Taking 'O' level Maths.</td>
<td>4</td>
<td>a. Incorrect Trig relationship.</td>
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<td></td>
<td></td>
<td></td>
<td>b. Could not handle Algebra of relationships.</td>
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<td></td>
<td></td>
<td>5</td>
<td>a. Incorrect formula $R = \frac{1}{R_1} + \frac{1}{R_2}$</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>b. $\frac{1}{6} + \frac{1}{10} = \frac{9 + 4}{40}$ Tables Relation. B3</td>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td></td>
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<td></td>
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<td>7</td>
<td>a. $5.5 \times 5 = 27.2$ Reversal. C3 S</td>
<td></td>
</tr>
<tr>
<td>37</td>
<td>Taking 'O' level Maths.</td>
<td>2</td>
<td>a. No idea of limits.</td>
<td></td>
</tr>
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<td></td>
<td></td>
<td>4</td>
<td>a. Incorrect Trig relationship. E</td>
<td></td>
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<td></td>
<td></td>
<td>5</td>
<td>a. Misquote of relationship. E</td>
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<td></td>
<td>b. $\frac{1}{6} + \frac{1}{9} = \frac{1}{15}$. D</td>
<td></td>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question. D</td>
<td></td>
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<td></td>
<td></td>
<td>7</td>
<td>a. $1.5^2 = 2 \times 1.5$. D</td>
<td></td>
</tr>
<tr>
<td>38</td>
<td>Taking 'O' level Maths.</td>
<td>5</td>
<td>a. Subtraction error $10-9 = 2$. B2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Knows $V = \pi R^2h$ but cannot set about the question. D</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula, $V = 2\pi rh$. E</td>
<td></td>
</tr>
<tr>
<td>39</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. Errors in calculations but no working to show what they were. M</td>
<td></td>
</tr>
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<td></td>
<td></td>
<td>4</td>
<td>a. Could not do this question. D</td>
<td></td>
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<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed. N</td>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question. D</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Only inside volume calculated. F</td>
<td></td>
</tr>
<tr>
<td>Candidate</td>
<td>Level of Mathematics</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of errors</td>
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<tr>
<td>40</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. $\frac{5.6}{10} = \frac{4.4}{10} = \frac{2.2}{5} = 6.7$</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Incorrect Trig. relationship.</td>
<td>E</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>b. Cannot handle Algebra of relationship.</td>
<td>Q</td>
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<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Calculation error in Long Multiplication, $\frac{22 \times 8.75}{7} = 182$.</td>
<td>C₂</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Also not justified rounding.</td>
<td>R</td>
</tr>
<tr>
<td>41</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. Sometimes incorrect calculation of 10%. No working to show why.</td>
<td>M</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Vague in knowledge of relationships.</td>
<td>Q</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>b. Cannot handle Algebra of relationships.</td>
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<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
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<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula $V = H \times R_1 \times H \times R_2 - H \times R_1 \times H \times R_2$.</td>
<td>E</td>
</tr>
<tr>
<td>42</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. Cannot find 10%. Takes 10 away from each number.</td>
<td>D</td>
</tr>
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<td></td>
<td></td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td>Candidate</td>
<td>Level of Mathematics</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of error</td>
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<tr>
<td>43</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. Changing a fraction to a decimal $\frac{3}{2} = 1.2$</td>
<td>C_4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Changing fraction to a decimal $\frac{9}{5} = 1.2$</td>
<td>C_4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Incorrect Trig. relationship.</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Cannot handle Algebra of relationship.</td>
<td>Q</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. Changing fractions to decimals, $\frac{8}{3} = 2.2$</td>
<td>C_4 D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Could not relate acceleration to distance, speed and time.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula $V = \frac{4}{3} \pi r^3$.</td>
<td>E</td>
</tr>
<tr>
<td>44</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. No idea of limits.</td>
<td>D</td>
</tr>
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<td></td>
<td></td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
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<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula, $V = \pi r^2$.</td>
<td>E</td>
</tr>
<tr>
<td>45</td>
<td>Taking C.S.E. Maths.</td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<td></td>
<td></td>
<td>7</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td>46</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
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<td></td>
<td></td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula, $V = ht \times \text{rad}$.</td>
<td>E</td>
</tr>
<tr>
<td>Candidate</td>
<td>Level of Mathematics</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of error</td>
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</tr>
<tr>
<td>47</td>
<td>Taking 'O' level Maths.</td>
<td>2</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Incorrect formula. Tried to use Pythagoras' theorem.</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. In the calculation using logs., the logs. were rounded to two places.</td>
<td>R</td>
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<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
</tr>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td>48</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. No idea of limits.</td>
<td>D</td>
</tr>
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<td></td>
<td></td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td>49</td>
<td>Taking 'O' level Maths.</td>
<td>2</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Incorrect Trig. relationship.</td>
<td>E</td>
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<td></td>
<td></td>
<td></td>
<td>b. Could not handle Algebra of relationship.</td>
<td>Q</td>
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<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Long multiplication error</td>
<td>C,F,G</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$3.142 \times 2^2 \times 5 = 12.56$ Neglected to multiply by 5. Rounding error.</td>
<td>R</td>
</tr>
<tr>
<td>50</td>
<td>Taking 'O' level Maths.</td>
<td>2</td>
<td>a. Cannot find 10%, adds 10 to each number.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula, $V = \frac{22 \times l_r \times c_r \times h_t}{7}$</td>
<td>E</td>
</tr>
<tr>
<td>Candidate</td>
<td>Level of Mathematics</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of error</td>
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</tr>
<tr>
<td>51</td>
<td>Taking 'O' level Maths.</td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Changing fraction to a decimal, 80/15 = 5.4</td>
<td>C4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. 440/7 = 62.75</td>
<td>C4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Rounding error.</td>
<td>R</td>
</tr>
<tr>
<td>52</td>
<td>(C.S.E. Maths. 2) T.E.C. Al Maths Credit</td>
<td>4</td>
<td>a. Cannot handle Algebra of relationships.</td>
<td>Q</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. Error in changing fraction to a decimal.</td>
<td>C4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. ( \pi \times \frac{2}{4} = 7.067 ) Error lay in division.</td>
<td>C4</td>
</tr>
<tr>
<td>53</td>
<td>Taking 'O' level Maths.</td>
<td>2</td>
<td>a. No idea of limits.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. Misquote of formula ( R = \frac{1}{R_1} + \frac{1}{R_2} )</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. ( \frac{1}{4} + \frac{1}{8} = \frac{1}{12} )</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>c. ( \frac{1}{8} + \frac{1}{10} = \frac{1}{18} = 18 ) (Evidence that he knew it was 1)</td>
<td>D</td>
</tr>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula, ( V = 2\pi rh. )</td>
<td>E</td>
</tr>
<tr>
<td>54</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. No idea how to find 10%.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<td></td>
<td></td>
<td>7</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td>Candidate</td>
<td>Level of Mathematics</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of error</td>
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<tr>
<td>55</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. No idea of 10% doubles the number.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Added together 'inside radius', 'outside radius' and 'height'.</td>
<td>D</td>
</tr>
<tr>
<td>56</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. No idea of limits.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Cannot read sines from tables.</td>
<td>T</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>b. Cannot handle Algebra of relationships.</td>
<td>Q</td>
</tr>
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<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Diagram correct but could not proceed.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula ( V = \pi r_1^2 \times r_2^2 \times h )</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. ( \frac{220}{7} = 31.3 )</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Fraction to decimal: unit ( r^3 ) taken as 0.3</td>
<td>D</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>c. ( \frac{22 \times 1.5 \times 5}{7} = 33 \times 5 )</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Neglects to divide by 7.</td>
<td>F</td>
</tr>
<tr>
<td>57</td>
<td>C. &amp; G. Foundation Course in Engineering.</td>
<td>2</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula ( V = r_1 \times r_2 \times \pi \times h ).</td>
<td>E</td>
</tr>
<tr>
<td>Candidate</td>
<td>Level of Mathematics</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of error</td>
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</tr>
<tr>
<td>58</td>
<td>C.G.G. Foundation Course in Engineering</td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
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<td></td>
<td></td>
<td>6</td>
<td>a. Ideas very confused.</td>
<td>D</td>
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<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$V = \pi r^2 \times h$</td>
<td></td>
</tr>
<tr>
<td>59</td>
<td>Taking 'O' level Maths.</td>
<td>2</td>
<td>a. $18 - 1.8 = 17.2$</td>
<td>$\text{C}_2$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. $270 - 27 = 263$</td>
<td>$\text{C}_2$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Misconception of subtraction?</td>
<td></td>
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<td></td>
<td></td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Multiplication $1.5$</td>
<td>$\text{C}_4$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$\frac{1.5}{7.5}$</td>
<td>D</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>$\frac{15.0}{22.5}$</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Decimal Point as Place Value Problem.</td>
<td>$\text{P}$</td>
</tr>
<tr>
<td>60</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. $\frac{1}{10}$ of $5.6 = 5.6$</td>
<td>$\text{P}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Division of decimals.</td>
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<td></td>
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<td></td>
<td>Place value.</td>
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<td></td>
<td>$b. \ 270 - 27 = 253$.</td>
<td>$\text{C}_2$</td>
</tr>
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<td></td>
<td></td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula</td>
<td>E</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>$V = \pi \times \frac{1}{2}hx$.</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>$b. \ 0.5 \times 0.5 = 2.5$</td>
<td>$\text{P}$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$c. \ 3.142 \times 2.5 \times 2 = 15.110$</td>
<td>$\text{C}_3$</td>
</tr>
<tr>
<td>Candidate</td>
<td>Level of Mathematics</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of error</td>
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</tr>
<tr>
<td>61</td>
<td>'O' level Maths.</td>
<td>2</td>
<td>a. Where he could not work comfortably in fractions he did not do them.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>Grade B. (age bar to his getting an apprenticeship).</td>
<td>6</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>b. Could not handle Algebra of relationship.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula $V = \pi rh$ and $V = \pi r_1 r_2 x h$.</td>
<td>E</td>
</tr>
<tr>
<td>62</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. No idea of limits.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Incorrect formula in one part.</td>
<td>E</td>
</tr>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula $V = \pi rh$ and $V = \pi x r_1 x r_2 x h$.</td>
<td>E</td>
</tr>
<tr>
<td>63</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. Only one bound shown.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Incorrectly quoted relationship.</td>
<td>E</td>
</tr>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula $V = R_1 h - R_2 h$.</td>
<td>E</td>
</tr>
<tr>
<td>64</td>
<td>Taking 'O' level Maths.</td>
<td>4</td>
<td>a. $3/0.8192 = 3.5$</td>
<td>C4</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. $3.5 \times 0.8192 = 0.283475$ Error in multiplication and in place value.</td>
<td>C3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>c. Concept of sine rule incorrect.</td>
<td>D</td>
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<td></td>
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<td>d. Wants to calculate $0.283475$ but gives up.</td>
<td>D</td>
</tr>
<tr>
<td></td>
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<td>6</td>
<td>a. Knows some formulae but cannot proceed.</td>
<td>D</td>
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<tr>
<td></td>
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<td>7</td>
<td>a. Incorrect formula $V = \pi (r_1 - r_2)^2 h$.</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. $3.142 \times (0.5)^2 \times 5 = 0.7854$</td>
<td>C3</td>
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<tr>
<td>Candidate</td>
<td>Level of Mathematics</td>
<td>Qn.</td>
<td>Errors</td>
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<td>65</td>
<td>Not taking any exam-</td>
<td>2</td>
<td>a. Could not do this question.</td>
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<td>4</td>
<td>a. Could not do this question.</td>
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<td></td>
<td>At a young person's</td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
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<td>unit.</td>
<td>6</td>
<td>a. Could not do this question.</td>
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<td>7</td>
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<td>D</td>
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<tr>
<td>66</td>
<td>Taking 'O' level</td>
<td>2</td>
<td>a. $\frac{3}{2} = 1.5$</td>
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<tr>
<td></td>
<td>Maths.</td>
<td></td>
<td>b. $\frac{9}{5} = 1.8$</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Unsure about remainders and the decimal system.</td>
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<td></td>
<td></td>
<td>c. No idea of limits.</td>
<td>D</td>
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<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
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<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<td>7</td>
<td>a. Incorrect formula $V = \pi(r_1 - r_2) \times h$.</td>
<td>E</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td>b. $3.142 \times 0.5 = 15.71$</td>
<td>P</td>
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<tr>
<td>67</td>
<td>Taking 'O' level</td>
<td>2</td>
<td>a. No idea of 10%. Adds or subtracts 10 according to the bound required.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>Maths.</td>
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<td>b. Incorrect reading of antilog.</td>
<td>T</td>
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<td>6</td>
<td>a. $\frac{80}{15} = 4.75$</td>
<td>C4</td>
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<td></td>
<td>7</td>
<td>a. $27.4925 = 27.4$</td>
<td>R</td>
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<td></td>
<td>Rounding error.</td>
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<td>68</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. Upper bounds only given.</td>
<td>D</td>
</tr>
<tr>
<td></td>
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<td>4</td>
<td>a. Cannot handle Algebra of relationship.</td>
<td>Q</td>
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<tr>
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<td></td>
<td>b. Cosine $20 = 1.9397$</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula $V = (\pi r^2) h$.</td>
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<td>Types of error</td>
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<td>69</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. No idea of limits.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. ( \frac{9}{5} = 1.4 \neq 1.45 )</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>c. ( \frac{5.6}{10} = 0.56 )</td>
<td>D</td>
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<td>4</td>
<td>a. Incorrect formulae in some cases.</td>
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<td>b. Cannot handle Algebra of relationship.</td>
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<td></td>
<td></td>
<td>5</td>
<td>a. Treats all as if they were in parallel.</td>
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<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<td></td>
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<td>7</td>
<td>a. Thinks ( 1.5^2 = 2 \times 1.5 )</td>
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<td>70</td>
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<td>D</td>
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<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
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<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
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<td>6</td>
<td>a. Could not do this question.</td>
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<td>71</td>
<td>Taking 'O' level Maths.</td>
<td>2</td>
<td>a. Gives upper bounds only.</td>
<td>D</td>
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<td></td>
<td></td>
<td>5</td>
<td>a. Transcribing error ( 7\frac{1}{9} = 17/9 ) reversal.</td>
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<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<td></td>
<td></td>
<td>7</td>
<td>a. ( 3.142 \times 1.5 \times 1.5 \times 5 = 4.2427 ). Errors in multiplication and place value.</td>
<td>P</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>b. ( 3.142 \times 2 \times 2 \times 5 = 6.284 ) Place value error.</td>
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<td>Errors</td>
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<td>72</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. Gives upper bounds only.</td>
<td>D</td>
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<td></td>
<td></td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
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<td>a. Incorrect formula $A = 2\pi r$.</td>
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<tr>
<td>73</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. Gives upper bounds only.</td>
<td>D</td>
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<td>4</td>
<td>a. Incorrect formula.</td>
<td>E</td>
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<td>b. Cannot handle Algebra of relationship.</td>
<td>Q</td>
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<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. Incorrect principle $R = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Treats as if all were in parallel.</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>c. $\frac{1}{8} + \frac{1}{4} + \frac{1}{10} = \frac{1}{30}$</td>
<td>D</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>Addition of fractions.</td>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<tr>
<td>74</td>
<td>Taking C.&amp;G. Foundation Course in Engineering at an F.E. college</td>
<td>2</td>
<td>a. No idea of 10%. Takes 10% to be 1.</td>
<td>D</td>
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<td></td>
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<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<td></td>
<td></td>
<td>7</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<tr>
<td>75</td>
<td>Taking 'O' level Maths.</td>
<td>2</td>
<td>a. $\frac{11}{5} = 2.1$ - remainder and the decimal system.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Correctly calculates 10% of 18 but gives bounds as -1.8 to +1.8</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<tr>
<th>Candidate</th>
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<td>75 cont'd.</td>
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<td>5</td>
<td>a. No idea of principles needed.</td>
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<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
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<td></td>
<td>7</td>
<td>a. Incorrect formula $V = 2\pi rh$.</td>
<td>E</td>
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<tr>
<td>76</td>
<td>Taking 'O' level Maths.</td>
<td>2</td>
<td>a. Correctly calculates 10% but these quantities are given as limits.</td>
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<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Cannot handle Algebra of the relationships.</td>
<td>Q</td>
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<td></td>
<td></td>
<td>6</td>
<td>a. Neglects to divide by 2.</td>
<td>F</td>
</tr>
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<td>7</td>
<td>a. Correct relationship, but did not subtract 'inside' volume from 'outside' volume to get volume of metal.</td>
<td>F</td>
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<td>77</td>
<td>Taking 'O' level Maths.</td>
<td>2</td>
<td>a. No idea of principles in calculation of percentages. Writes $10 \times 100$.</td>
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<td>4</td>
<td>a. Incorrect formulae.</td>
<td>E</td>
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<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<td>7</td>
<td>a. Addition error in multiplication.</td>
<td>C_3 E_1</td>
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<td>78</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. No idea of 10%. Subtracts 10.</td>
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<td>4</td>
<td>a. Incorrect formulae.</td>
<td>E</td>
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<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<td></td>
<td></td>
<td>7</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<td>79</td>
<td>Taking 'O' level Maths.</td>
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<td>a. Could not divide 5.6 by 10.</td>
<td>D</td>
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<td></td>
<td></td>
<td></td>
<td>b. No idea of limits.</td>
<td>D</td>
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<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
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<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula, Base = Area x ht.</td>
<td>E</td>
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<td>Candidate</td>
<td>Level of Mathematics</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of error</td>
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<td>80</td>
<td>Taking 'O' level Maths.</td>
<td>4</td>
<td>a. Confuses ( \frac{1}{\cos} ) with Cosec.</td>
<td>F</td>
</tr>
<tr>
<td></td>
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<td>7</td>
<td>a. Incorrect quote of ( \frac{\pi}{\pi} = 3.42 )</td>
<td>( \pi )</td>
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<td></td>
<td>b. Thinks ( 1.5^2 = 2 \times 1.5 )</td>
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<tr>
<td>81</td>
<td>Taking C.S.E. Maths.</td>
<td>4</td>
<td>a. Writes ( \cos 35 = 1.8192 )</td>
<td>D</td>
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<td>b. Cannot handle Algebra of relationship.</td>
<td>Q</td>
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<td></td>
<td>c. Incorrect formula in one of them.</td>
<td>E</td>
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<td>6</td>
<td>a. Confused, some relationships correct.</td>
<td>D</td>
</tr>
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<td></td>
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<td>7</td>
<td>a. Incorrect formula ( V = \pi(R+r)(R-r)+h ) may be due to doing it in pieces rather than as a whole.</td>
<td>E</td>
</tr>
<tr>
<td>82</td>
<td>Taking 'O' level Maths.</td>
<td>2</td>
<td>a. No idea of limits.</td>
<td>D</td>
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<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
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<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
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<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<td></td>
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<td>7</td>
<td>a. Addition error in calculation long multiplication.</td>
<td>C_1</td>
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<td>83</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. Could not divide 5.6 by 10.</td>
<td>D</td>
</tr>
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<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Only the 'outer' volume found.</td>
<td>D</td>
</tr>
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<td>Candidate</td>
<td>Level of Mathematics</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of error</td>
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<td>84</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<td></td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
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<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
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<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
</tbody>
</table>
|           |                      | 7   | a. Nothing to show how he found  
Vol. of cyl. = 25 cm³  
Vol. of hollow cyl. = 75 cm³.  
He obviously did not find his results strange. | D |
| 85        | Taking 'O' level Maths. | 2   | a. No idea of concept in calculation of percentage.  
Writes $\frac{15}{2} \times 100$  
\[ \frac{10}{10} \] | D |
|           |                      | 4   | a. Incorrect formula. | E |
|           |                      | 5   | a. No idea of principles needed. | N |
|           |                      | 6   | a. Could not do this question. | D |
|           |                      | 7   | a. $\frac{22}{7} \times 1.5 \times 5 \times 1.5 = \frac{490}{7}$  
multiplication error. | C₃ |
|           |                      |     | b. $\frac{22}{7} \times 2 \times 2 \times 5 = \frac{440}{7}$  
72.85, division error and a rounding error. | B₄ |
<p>|           |                      |     | | R |</p>
<table>
<thead>
<tr>
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<th>Types of error</th>
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<tr>
<td>86</td>
<td>Taking 'O' level Maths.</td>
<td>2</td>
<td>a. Could not divide 5.6 by 10. The other could be handled in fractional form.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Could not handle addition and subtraction of fractions in the limits.</td>
<td>D</td>
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<tr>
<td></td>
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<td>4</td>
<td>a. Confused about Trig relationships, ( \tan \theta = \frac{0}{0.7002} (\tan 35) ) ( \frac{\tan 55}{1.4281} )</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. Incorrect relationship ( R = \frac{1}{R_1} + \frac{1}{R_2} )</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Incorrect relationship ( V = ut + at^2 )</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula ( V = 2\pi r_1 )</td>
<td>E</td>
</tr>
<tr>
<td>87</td>
<td>Taking 'O' level Maths.</td>
<td>2</td>
<td>a. Cannot handle division by 10 ( \frac{10 \times 5.6}{100} = 56 )</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. ( \frac{10 \times 270}{100} = 2.7 )</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Incorrect formula.</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Cannot handle Algebra of relationship.</td>
<td>Q</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. Incorrect formula ( R = \frac{1}{R_1} + \frac{1}{R_2} )</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. ( \frac{8}{3} = 2.6 ) Rounding error.</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Gives acceleration and distance both as areas under the graph.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Careless error in rewriting. Correct relationship.</td>
<td>F</td>
</tr>
<tr>
<td>88</td>
<td>Taking 'O' level Maths.</td>
<td>2</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Uses accn. for velocity.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. ( 1.5^2 \times 5 = 12.25 ) Carrying figure error.</td>
<td>C3 F</td>
</tr>
<tr>
<td>Candidate</td>
<td>Level of Mathematics</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of error</td>
</tr>
<tr>
<td>-----------</td>
<td>----------------------</td>
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<td>------------------------------------------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>89</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. Upper bounds only given.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Incorrect Trig relationship.</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Could not handle Algebra of relationship.</td>
<td>Q</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. Did not understand principle.</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td>90</td>
<td>Taking 'O' level Maths.</td>
<td>2</td>
<td>a. Incorrect Trig. relationship.</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Could not handle Algebra of the relationship.</td>
<td>Q</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. Incorrect relationship $R = \frac{1}{R_1} + \frac{1}{R_2}$</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. $\frac{1}{4} + \frac{1}{5} = \frac{1}{4} + \frac{2}{4} = \frac{3}{4}$</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Could not relate acceleration to distance and time.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula $V = (R + r) + (R - r) \times \pi h$.</td>
<td>E</td>
</tr>
<tr>
<td>91</td>
<td>Taking 'O' level Maths.</td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. $\frac{80}{15} = 5$</td>
<td>C4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula $V = \pi h(R_1 - R_2)^2$</td>
<td>E</td>
</tr>
<tr>
<td>Candidate</td>
<td>Level of Mathematics</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of error</td>
</tr>
<tr>
<td>-----------</td>
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<td>----------------</td>
</tr>
<tr>
<td>92</td>
<td>Taking 'O' level Maths.</td>
<td>2</td>
<td>a. No idea of limits.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Incorrect Trig. relationship.</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. Incorrect relationship ( R = \frac{1}{R_1} + \frac{1}{R_2} )</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Uses acceleration as velocity.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect long multiplication ( 3.142 \times 2.25 = 7.0085 ) Carrying figure error when multiplying by 0.05</td>
<td>F</td>
</tr>
<tr>
<td>93</td>
<td>No Maths. exams. being taken.</td>
<td>2</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. No idea of the principles needed.</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td>94</td>
<td>Taking C.S.E. Maths.</td>
<td>2</td>
<td>a. No idea of 10%. Multiplies by 10. Possibly 15 x 100.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula, ( V = R_1 h ).</td>
<td>E</td>
</tr>
<tr>
<td>95</td>
<td>Taking 'O' level Maths.</td>
<td>2</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. No idea of relationship needed.</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. No idea of relationships between accn. and distance, speed and time.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula, ( V = \frac{1}{2} R_1 x R_2 ).</td>
<td>E</td>
</tr>
<tr>
<td>Candidate</td>
<td>Level of Mathematics</td>
<td>Cn.</td>
<td>Errors</td>
<td>Types of error</td>
</tr>
<tr>
<td>-----------</td>
<td>----------------------</td>
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<td>--------</td>
<td>---------------</td>
</tr>
</tbody>
</table>
| 96        | Taking 'O' level Maths. | 2   | a. Subtraction error  
5.6 - 0.56 = 4.04 
Carrying figure error. | C₂  
F |
|           |                      | 4   | a. Could not do this question. | D |
|           |                      | 5   | a. No idea of principles needed. | N |
|           |                      | 6   | a. Correctly found deceleration 
but did not use negative sign 
subsequently. | F |
|           |                      | 7   | a. 3.142 x 2.25 x 5 = 35.247 
Carrying figure error. 
Rounding error. | C₃  
F |
| 97        | Taking 'O' level Maths. | 4   | a. Gives antilog of 0.5637 
and 5.637. | D |
|           |                      | 5   | a. No idea of principles needed. | N |
|           |                      | 7   | a. Incorrect formula 
\[ V = \frac{1}{3} \pi r_1^2 h - \frac{1}{3} \pi r_2^2 h \] 
b. \[ \frac{1}{3} \left( \frac{2}{7} \right) x \frac{22}{4} x 5 = \frac{7\times66\times84\times105}{21} \] 
Treats as in addition process. | E  
D |
| 98        | Taking 'O' level Maths. | 5   | a. No idea of principles needed. | N |
|           |                      | 6   | a. Could not do this question. | D |
| 99        | Taking C.S.E. Maths. | 2   | a. Gives upper bounds only. | D |
|           |                      |     | b. Addition error 270 + 27 = 290. | C₁  
F |
|           |                      | 4   | a. Could not handle Algebra of 
relationship. | Q |
|           |                      | 5   | a. Incorrect formula \( R = \frac{R_1 + R_2}{R_1 R_2} \) | E |
|           |                      | 6   | a. Could not do this question, 
only wrote \( V^2 - u^2 = 2as \) | D |
|           |                      | 7   | a. Error in the long multiplication, 6 x 2 = 18 | C₃  
B₃ |
<table>
<thead>
<tr>
<th>Candidate</th>
<th>Level of Mathematics</th>
<th>Qn.</th>
<th>Errors</th>
<th>Types of error</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>Taking 'O' level Maths.</td>
<td>2</td>
<td>a. $5.6 = \frac{2.8}{10} = 5.3$&lt;br&gt;Place value error.&lt;br&gt;Remainder and relationship with decimal system not understood.</td>
<td>C4, P, D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Only upper bounds given.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Incorrect relationship&lt;br&gt;Accn. = vt.</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Apart from addition the radii there was not further calculation.</td>
<td>D</td>
</tr>
<tr>
<td>101</td>
<td>'O' level Maths.&lt;br&gt;Grade 'D'</td>
<td>2</td>
<td>a. $15 - 1.5 = 14.5$, Carrying figure.</td>
<td>C2, F</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. $5.6 - 0.56 = 5.16$</td>
<td>C2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Incorrect Trig. relationship.</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Could not handle Algebra of relationship.</td>
<td>Q</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. $\frac{1}{4} + \frac{1}{8} = \frac{1}{12}$</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. $\frac{1}{8} + \frac{1}{10} = \frac{1}{18}$</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrectly substituted in the formula.</td>
<td>F</td>
</tr>
<tr>
<td>102</td>
<td>C.S.E. Maths.&lt;br&gt;Grade 4.&lt;br&gt;C.S.E. Arithmetic&lt;br&gt;Grade 2.</td>
<td>2</td>
<td>a. No idea of 10%.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Could not handle Algebra of relationship.</td>
<td>Q</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Used acceleration as velocity.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Thinks $1.5^2 = 2 \times 1.5$</td>
<td>D</td>
</tr>
<tr>
<td>Candidate</td>
<td>Level of Mathematics</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of error</td>
</tr>
<tr>
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</tr>
<tr>
<td>103</td>
<td>C.S.E. Maths.</td>
<td>2</td>
<td>a. Upper Bounds only given.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>Grade 2.</td>
<td>4</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. No idea of principles needed.</td>
<td>N</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Could not do this question.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Incorrect formula</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>( V = \text{length} \times \text{breadth} \times \text{height} )</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>( V = R_1 \times 2 \times H - R_2 \times 2 \times H ).</td>
<td>E</td>
</tr>
</tbody>
</table>
In view of the avowed intention of the Training Officer to select candidates who were mathematically good it therefore seems rather strange that a school-leaver could be taken on as an apprentice who could not do correctly questions 4, 5, 6 and 7. This candidate could only do one Mathematics question (No. 2) on the paper. This candidate, (No. 7), was taking 'O' level Mathematics, yet he could not, in question 4, work out \( \frac{3}{0.8192} \). In question 5, he could not add \( \frac{1}{2} + \frac{3}{4} \) (he made it \( \frac{2}{12} \), or \( \frac{3}{10} \) which he made to be \( \frac{2}{14} \). In question 6, he had no clear ideas and, in question 7, he was not successful in the long division because of the lack of care with the placing of the figures. He was, however, successful at picking up marks on the word comprehension question (\( \text{qn. 1} \)), and the stating of some required information of a scientific/technical nature in question 3.

Four others, of the successful candidates, had three of the five Mathematics questions incorrect.

Now we find amongst the unsuccessful candidates ten who also have three of the Mathematics questions incorrect, and two candidates who only have two Mathematics questions incorrect. One of these, (candidate No. 98), certainly had no real clue about the two questions on which he failed but, in mitigation, one of these was question 5, which depended upon a knowledge of something in the Physics syllabus. The other unsuccessful candidate, with only two Mathematics questions incorrect, was candidate No. 80. In question 4, he confused \( \frac{1}{\cos \theta} \) with cosec, and, in question 7, made a silly slip in quoting (3.42), but made one very bad error in writing \( 1.5^2 = 2 \times 1.5 \).
The author is still wondering why this candidate, in particular, is a worse risk than the successful candidate with grave errors in three of the four questions he had wrong. Indeed, would this candidate not have been very much more preferable to, for example, candidate No. 10 who was successful in the company's eyes, but who, (a) could not correctly read cosine tables, (b) worked \( 3/1.937 \) as \( 19/30 \), (c) made \( 8/3 = 2\frac{2}{3} \) and \( 80/18 = 4\frac{8}{90} \), (d) made an error in long multiplication \( 3.142 \times 20 = 61.84 \).

It seems to the author, that this school-leaver, (No. 80), may have been preferable to either candidates 9, 11 or 17. Candidate 9, for example, had no idea of limits in question 2, could not do question 6 at all, and, in question 7, wrote the area of the cross section as \( 2\pi r \). He might also have been considered to be a better risk than some of the successful candidates with only two of the Mathematics questions wrong. For example, candidate No. 8, who could not do question 6 and who, in question 7, wrote \( V = 2\pi rh \). Perhaps a closer look into why some candidates had the question wrong would be beneficial to the company in making its decision on whom to spend the training fees.

Candidate No. 22 is also a very interesting case. He does question 2 perfectly, as also he does in the case of question 7, where he performs lengthy calculations accurately. He simply does not understand the principles in questions 4, 5 and 6. As far as question 5 is concerned, he may not be taking any Physics. It might be that this boy was a good risk, but lacked the experience in those areas being tested. Again we must consider candidate 52, who had passed C.S.E. Mathematics with a grade 2 and was now taking a T.E.C. Al Mathematics course and for course work was given a 'credit' rating.
In spite of the kind of technically orientated course he was following, he was unprepared to take a paper set by an engineering company. He couldn't handle the algebra in question 4; in question 5 he failed to change a fraction to a decimal correctly. He could not do question 6 and, in question 7, he made an error in the long division. Candidate 57, who was taking a City and Guilds foundation course in Engineering, really had no idea at all about any of the questions, and candidate 58 was almost equally confused.

Candidate 74, also taking a City and Guilds Craft course at a College of Further Education and who received a 'good' in a Mathematics report, took 10% to be 1 in question 2 and then had no idea about any of the other questions. We might well wonder who is prepared adequately to sit this paper?

Of course, there is the problem here of not being able to compare like with like. Some of the candidates were pursuing or had passed C.S.E. courses in Mathematics, whilst others either had or were taking 'O' level Mathematics. At least one of the questions is, in the author's opinion, more suitable for the 'O' level candidates than the C.S.E. candidates, though only 18% of them could do the question. (Question 6) Only 7% of the C.S.E. candidates could do this question. There was again a very marked difference in the success rate for question 2, when 'C.S.E.' candidates are compared with 'O' level candidates. 80% of the C.S.E. candidates could not do this question compared with 59% of the 'O' level candidates. (see fig. 3.1)
These candidates are coming to the examination from very different backgrounds. Those who are teaching these pupils are often unaware of the type of examination the pupils have to meet. This paper is entirely in the hands of the Training Officer.

The comment made above would seem to be unfair to the Officer concerned. Let the writer say at once that he is a forward looking man who is very concerned to do the best he can, both for the company and for pupils in the local schools. So much is this so that very largely, by his doing, there has been instituted a school-industry liaison committee at one of the comprehensive schools in his area.

At the same time, he has been unable to make meaningful contact with
any of the other comprehensives in that area. Even given the good
will and frank discussions at the school-industry liaison committee
meetings, they have yet to discuss ideas about the constitution of
a reasonable examination paper. Perhaps a significant factor in
the good relations this school has with local industry is the fact
that its headmaster once worked in industry himself.

If we now turn our attentions to the answers to the
questions on the paper, we may be able to see what difficulties the
school-leavers had, and what malpractices they came to the paper with.

Question 2 "The following are a selection of preferred
values of resistors, each having a tolerance
of +10% of these marked values. What are
the possible limits of each of the resistance
values?"

This question caused a great deal of difficulty, especially
to the candidates with C.S.E. backgrounds. It seems to the author
that the technical nature of this question, and especially its wording,
may be the cause of a great deal of the difficulty. The word
'preferred' in this context must have been a source of great confusion
to the less linguistically able candidates. Many of the candidates,
including two of the successful ones, had no idea about the meaning of
limits. Perhaps pupils entering for such an examination should be
aware of such things. If so, then the teachers must be aware of their
needs and must keep these in mind when preparing pupils for this kind
of external examination as well as the ones set from within the
educational set-up. The report of the Royal Society/Council of
Engineering Institutions, Joint Education Committee commented that,

"C.S.E. syllabuses in Mathematics should reflect
the changing needs of society and industry.
For this to be possible and effective, there
needs to be a continuing dialogue between
industry and teachers" (57)
and further,

"The above comments also apply to the 'O' level syllabuses which are followed by most pupils intending to be technicians. (The majority of intending craft apprentices follow C.S.E. syllabuses.)" (58)

More needs to be known about the kind of questions thought to be pertinent to needs by various industries. More teacher industry links need to be forged so that teachers are aware of those needs. Perhaps even the questions could be prepared jointly by the teachers and the industrial representatives so that language may more reasonably be used in the asking of some of the questions.

Overall 66% of the 103 candidates failed this question. 59% of the candidates who were either taking or had passed 'O' level Mathematics failed, and 80% of the candidates with a C.S.E. background failed. (See fig. 3.1)

In many cases, part (iv) of this question was the only part to be done in decimals. The form of the question for part (iv) suggested decimals and so decimals it was. In the other parts of this question and, indeed, where calculations on percentages are in general done, the form suggests fractions. In this question fractions prevailed in parts other than part (iv) in spite of the fact that the figure was 10% and this would clearly leave a division by 10. So, in spite of the 10%, its meaning and its relationship to the decimal system, the overriding inertia of the use of fractions here cannot be overcome.

E.g. Typical of the finding of 10% of 18 was:

\[
\frac{3}{20} \times \frac{0}{100} = \frac{3}{2} = 1.6 \frac{1}{3}
\]
A thoroughly unsatisfactory way of doing this calculation and one which is liable, as it does in fact, to lead the unwary into errors. Surely this is a fitting matter for initial training and inservice training of teachers to be about. Surely also it is the duty of every teacher of Mathematics to discuss and even train children into good methods of affecting a calculation. This way of handling the calculation of percentages shows a great deal of inflexibility on the part of these candidates when dealing with fractions, decimals and percentages. Other errors abound in this calculation.

e.g. Candidate number 20, who was taking 'O' level Mathematics, wrote

\[
\frac{10 \times 18}{100} = \frac{9}{5} = 1.4
\]

The resulting conversion of the fraction to a decimal has been his downfall. This last type of error is fairly common, where the nature of the quantities are not appreciated either in fractional or decimal form. The remainder 4 after the first division is written as 0.4. The \(\frac{4}{5}\) and the \(\frac{4}{10}\) are not appreciated in this context. Many candidates could not get this far. Many basically could not attempt to find 10%. The meaning of 10%, or any other percentage for that matter, is not understood.

e.g. Candidate 27, who was taking C.S.E. Mathematics, thought he was finding 10% when he divided by 2.

Candidate 42, took 10 away from each number.

Candidate 50, added 10 to each number.

Candidate 55, doubled each number.

Candidate 67, added or subtracted 10 according to whether he required an upper or lower bound.

Some candidates (e.g. No. 77) remembered the 10, 100 and the 15 which were involved in finding 10% of 15, but had forgotten the arrangement.
This is the usual 'memory game' which lets the candidate down when he needs its help most. This one wrote $\frac{10}{15}$.

It seems surprising, but there were errors made by candidates in the operation of dividing by 10 in this question.

E.g. Candidate No. 100, who was taking 'O' level Mathematics, wrote

$$\frac{5.6}{10} = \frac{2.8}{5} = 5.3.$$ 

Thus he has made an error in place value in the division and, in addition, he treats the 3 tenths remainder after the first division as 3 hundredths. This writing of remainders as digits in the final decimal number occurs fairly frequently.

Candidate No. 69, who was taking C.S.E. Mathematics, wrote,

$$\frac{9}{5} = 1.\overline{4} = 1.45.$$ 

This lack of an understanding of the concepts in the relationship between fractions and decimals crops up again. Then we can get

$$\frac{5.6}{10} = 1.\overline{1}.$$ 

Where he showed a complete lack of understanding of the basic idea of the decimal system as well as a complete lack of skill in the process of division.

Candidate No. 66, who was taking 'O' level Mathematics, wrote,

$$\frac{3}{2} = 1.3 \text{ and } \frac{8}{5} = 1.4.$$ 

Here he clearly showed his lack of understanding of the division process when a decimal fraction resulted. The second of these is easier to explain than the first.

Even where the finding of 10% of the resistances is successfully done, other errors can creep in, as for example we see in the work of candidate No. 59, who was taking 'O' level Mathematics.
He made $18 - 1.8 = 17.2$ and also $270 - 27 = 263$, which, at best, showed a great weakness in the skill of subtraction. It may, though we cannot tell for certain, cloak a grave insufficiency in understanding of the concepts involved in his method of subtraction.

Note should be made of the candidate who understood the concept of $10\%$ as $\frac{10}{100}$, but, in trying to find the bounds, wrote,

$270 \pm 10\% = 270 \pm \frac{10}{100} = 263$, i.e. he firstly treated $10\%$ as an absolute value and then in the computation subtracted 10 and divided by 100.

His major error here was in the misunderstanding of the nature of the $10\%$. We cannot begin to unravel the tortuous processes followed by the candidate who wrote, $\frac{5.6}{10} = 1. \frac{4.4}{10} = 1. \frac{2.2}{5} = 6.7$.

The majority of the errors, in the judgement of the author, were errors in concept. Ideas have not been understood. Figures 3.2 and 3.3 show that 35 out of the 48 errors made by the candidates who had taken or were taking 'O' level Mathematics were of this type. 30 of the 38 made by the 'C.S.E. candidates' and all three of the errors made by the candidates taking Technical courses were these 'D' errors. Looked at as a whole, this meant a total of 70 out of 91 errors made were of the comprehension of ideas type. The errors due to calculation and to silly mistakes amounted to 16 out of 91.

Now, if one puts together the 'D' errors and the errors made in Place Value, which may or may not have been concept errors, these amount to 74 of the 91. In the question, many of the errors in concept were due to not understanding the meaning of $10\%$ in this context, though the point has already been made concerning the possible cloaking of meaning due to the choice of words.
### Fig. 3.2

#### Question No. 2

<table>
<thead>
<tr>
<th>Candidates with, or taking, 'O' level Mathematics</th>
<th>Types of Error</th>
<th>No. of Errors</th>
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48 Total Errors

#### Question No. 2

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38 Total Errors

#### Question No. 2

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</table>

3 Total Errors

### Fig. 3.3

#### Question No. 2

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<th>All Candidates</th>
<th>Types of Error</th>
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<td>1 6 5 70 4 4 1</td>
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</table>

91 Total Errors
Some students, possibly because of this, could not attempt the question at all, and other 'D' errors were due to related concept errors, e.g. as in the case of candidate 87 who was taking 'O' level Mathematics, but who could not handle division by 10,
\[
10 \times \frac{5.6}{100} = 56, \text{ or perhaps this was treated as multiplication by 10 and division by 100 and the difficulty lies in the concept of the decimal system and multiplication and division by powers of 10.}
\]

We see, finally, that even a school-leaver who has been right the way through an 'O' level course, (candidate No. 101 who obtained a grade D in the 'O' level Mathematics examination), could not calculate a simple subtraction in this question. He made a carrying figure error in \(15 - 1.5 = 14.5\) and seemed to be bemused by the figure placings in \(5.6 - 0.56 = 5.16\) or else his concept of subtraction, when it came to the extension into decimal fractions, was very shaky.

Here he had no corresponding figure in the hundredths column from which to try to take the 6 hundredths, 5.6
\[
\frac{0.56}{.}
\]
This would merit further investigation as a source of common error.

**Question 4.**

Three holes, with centres A, B and C are drilled in a terminal board as shown in the figure above. Calculate the lengths AB and BC using the Mathematical tables provided.
It is rather an irony, in view of the exhortations over the recent past to the educational world to make their questions more pertinent to the real world, that here we have from the world of work an unreal question. If the holes were bored, then the distances could have been measured! Perhaps it would have been more 'real' had it been about the location of the holes, given the distances that they were required to be apart, assuming there may be some reason for them to be that distance apart. It also may be an unfortunate question from another point of view. Children should not be allowed to have, though they may well have, learned by association in questions like this. Good teaching ensures that variables in the learning situation are applied. The author is aware of children who are able to apply the trigonometrical ratios correctly in this situation.

The rearrangement of the letters around the diagram can upset some children, and a fix takes place if they have always been presented with the triangle in the same form and with the same letter arrangements. We will not know how many may have been put-off by this presentation. It might have been better drawn with the A at the top of the diagram. The author is not, of course, suggesting that condoning of the lack of a true concept be made, but that if we are trying to make a fair selection from the group, then this may eliminate some we may want further to consider.
What we were able to see from this question was that it was found to be the second highest in failure rate. (See fig. 3.1)

There were no less than 85 incorrect answers or failure to answer the question, out of the 103 candidates. The percentage of the candidates either having or taking C.S.E. Mathematics who failed (85%) was only marginally greater than those with or taking 'O' level Mathematics and who failed (82%).

In this question, as with others, we are barred from knowing exactly what the difficulty was in many cases, because the school-leaver was unable to do the question at all, and so was entered as a 'D' error failure. That is, a failure to comprehend the concepts involved. Almost 50% of the errors made by each type of candidate were placed in the 'D error' class. (See figs. 3.4 and 3.5)

There were errors made by those who were able to tackle the question. About 17% of these were 'E errors', i.e. inability to quote the correct formula, though, in this case, that may not wholly be unconnected with the lack of understanding. Amongst these were candidates whose attempted quotation was so far from the mark as to leave no doubt that it was a lack of understanding. We could take as such an example candidate No. 86, who was taking 'O' level Mathematics. He wrote \[ \tan = \frac{0}{\tan 35} = \frac{0.7002}{0.4281} \]
i.e. he tried to find \[ \tan \frac{35}{\tan 55} \].

Candidate 47, who was taking 'O' level Mathematics, tried to effect a solution from a quotation of the theorem of Pythagoras. Perhaps he could only comprehend the situation in those terms and was lacking the time concepts involved.
There were many misquotations of the trigonometrical ratios and some candidates were not able to read the tables provided correctly.

**General Discussion.**

Actually, second to the 'D errors' in number, were the errors which could be ascribed to the candidate's inability to handle the Algebra of the relationships written. This occurred in some of the correct as well as the incorrect applications of the ratios. Typical of these was candidate 19, who was taking 'O' level Mathematics, who could not handle \( \sin 65^\circ = \frac{3}{AB} \). This may reflect a lack of practice in rewriting the expression in terms of the subject of the formula. The major difficulty seemed to be when the subject of the formula appeared as the denominator of a fraction.

In some cases, it would appear that the candidates were eager to apply that trigonometrical relationship which they knew best. Some applied the Tan relationship, and did it incorrectly. Others chose to find another angle and to use Sine instead of the most direct relationship (Cosine or Sec if it were known). The Cosine ratio was, for some candidates, not as familiar as the others and so more familiar ratios were thought of first. This would seem to be a case that the problem must fit the candidate's knowledge and not his knowledge fit the question. This has been noticed in other surveys where

"All too frequently the function most familiar to the individual is applied, regardless of whether or not it is appropriate." (59)

This would seem to be an indication that the candidate is unable to come to grips with the problem. Perhaps is unable to think about it, lacking both ideas and techniques.
### Question No. 4

#### Candidates with, or taking 'O' level Mathematics

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<tr>
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59 Total Errors

#### Candidates with, or taking, C.S.E. Mathematics

|   | B_1 | B_2 | B_3 | B_4 | C_1 | C_2 | C_3 | C_4 | D | E | F | P | R | S | N | M | Q | T | Π | Types of Error | No. of Errors |
|---|-----|-----|-----|-----|-----|-----|-----|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|   |     |     |     |     |     |     |     |     | 23| 9 |   |   |   | 2 | 13 | 1 |   |   |   |   |   |   |   |

48 Total Errors

#### Candidates taking 'technical' Courses

|   | B_1 | B_2 | B_3 | B_4 | C_1 | C_2 | C_3 | C_4 | D | E | F | P | R | S | N | M | Q | T | Π | Types of Error | No. of Errors |
|---|-----|-----|-----|-----|-----|-----|-----|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|   |     |     |     |     | 4   | 2   | 1   | 1   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |

8 Total Errors

### Fig. 3.5

#### All Candidates

|   | B_1 | B_2 | B_3 | B_4 | C_1 | C_2 | C_3 | C_4 | D | E | F | P | R | S | N | M | Q | T | Π | Types of Error | No. of Errors |
|---|-----|-----|-----|-----|-----|-----|-----|-----|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
|   | 1   | 3   | 1   | 53  | 20  | 5   | 13  | 3  | 24 | 3 |   |   |   |   |   |   |   |   |   |   |   |   |

117 Total Errors
Candidates 19 and 64 used what was most familiar to them, and that was the Sine Rule, in this case it would have effected a solution, but the choice of this may have been decided by familiarity due to it being the latest thing done in class, applied to the solution of triangles. It would not help, of course, if the Algebra could not be handled. The number of calculation errors compared with the total number of errors was few. What proportion they might be in an examination devoted to similar Mathematical ideas but gained from a paper written in such a way that the candidates could get further into the questions, could be looked into. Those Arithmetic errors which were made on this paper may serve to give us an indication of greater areas of difficulty than overtly appear here. e.g. Candidate 64, who was taking 'O' level Mathematics, failed to calculate $3/0.8192$ correctly, making it $3.5$. He then failed to multiply $3.5$ by $0.8192$ correctly. (There was a concept error in the Sine Rule also which led to this calculation.) $3.5 \times 0.8192 = 0.283475$ showed an error both in multiplication and in place value. Finally, this candidate arrived at $0.283475 \div 0.9397$ and, in spite of the availability of log. tables, he gave up. In fact, this candidate did not use tables anywhere in his calculations. Possibly he failed to understand these at one time and had since then, never been singled out for help in this matter. One of the candidates who actually applied the Sine Rule correctly then made $90-35 = 65$ and, since there was no evidence of decomposition, it must have been a case of a slipshod use of equal addition since a complementary addition method would seem hardly to have led to such an error. The author felt rather sorry for the candidate taking 'O' level Mathematics who confused $1/Cosine$ with $Cosec$. These inverses are most unfortunately named from the point of view of the learner.
There was, amongst the candidates, one who was taking T.E.C. 1 Mathematics and who was one of the successful candidates but who, nevertheless, when faced with \(3/1.937\) worked this as \(19/30\). This is not accurate to the first decimal place and so, even for practical purposes, would be an unacceptable answer. This candidate actually gave the answer to the nearest whole number.

In answering this question, there was very little to choose between the abilities of the various types of candidate. On the basis of the number in each category of candidate, (those with or taking 'O' level Mathematics, those with or taking C.S.E. Mathematics, those with or taking technical course Mathematics, and those taking no examinations at all), the 85 incorrect answers would be partitioned in the ratio \(51 : 41 : 9 : 2\) and so the incorrect solution for each category would be \(42, 34, 7, 2\). The actual numbers incorrect for each of the categories were \(42, 35, 6, 2\).

There was it seems very little difference in the ability of the differing classes of candidate to handle this question. So far as being able to start the question was concerned, \(31\%\) of the "O' level" candidates could not do the question and \(46\%\) of the "C.S.E. level" candidates could not do the question. So there was a marked difference in the percentage of the candidates who could not start the question. The 'C.S.E. candidates', as one might expect having had the greater percentage at this initial failure.

Question 5  (i) State Ohm's Law

(ii) Express it in symbols.

(iii) In the figure above, find the equivalent resistance

![Diagram](image-url)
of PQ and QR. Draw a circuit with the equivalent of PQ and QR in series. Find the resultant resistance between the terminals P and Q.

This question is one which cannot be tackled as it is written by candidates with little or no background in Physics. If a candidate could not start this question we have to ask if he has had the opportunity of a previous training in circuitry in his science course in school. There may not have been a science course for some of these candidates in their schools. This at once sorts out those with no relevant background or insufficient related background. Is this really fair to some candidates, or, more pragmatically, what is in the best interests of the company? Surely any candidate found to be suitable for training by the company will be taught the technicalities related to the particular industry when he is on his course at the apprentices' school or at related courses at Colleges of Further Education. More basic matters than this, and those which every candidate should have had the opportunity to study, would be more suitable in selecting candidates. On the other hand, schools, and in particular the teachers involved, should be aware of the possible needs of their pupils when entering for apprenticeship examinations.

"It is ........ important that teachers should be aware of the needs of their pupils, with special reference to local industry." (60)

The above may clearly be a case to be studied by the local teachers if the training officer feels that this is a vital question in his examination. This may be a special case when one bears in mind the shortage of science teachers in secondary schools and the possible consequences for the lesser ability groups within a school.
On the other hand, when one considers basic Mathematics,

"... virtually all the items on which school-leavers were found wanting by the industrialists are included in every syllabus ('O' and 'C.S.E.')" (61)

Although there should be consultations between local teachers and industrial companies, the Mathematical content of the papers set should, in the main, be that which is already being taught in the schools. In some cases, there may well be particular things required by local companies, which should be well borne in mind by the teachers concerned.

In this question, again, we are not likely to be able to get a true awareness of the Arithmetic errors of these pupils because of the number who simply could not do the question by reason of not knowing the concepts involved. These candidates who failed to tackle the question, were put in the error class 'N'. Those who did begin showed Arithmetic errors which must lead us to suppose that the numbers of these would have been much greater were it not for the initial inability to start the question. (see Fig. 3.7)

When one looks at the errors made by all the candidates, one sees that the conceptual error, outside the field of Mathematics, accounted for 55 out of the 88 errors made on this question. That is 62% of the candidates had insufficient idea of the concepts involved.

A substantially greater percentage (66%) of the C.S.E. level candidates failed to start the question than the 'O' level candidates, (43%). Four of the nine candidates taking technical courses were unable to start the question.
### Question No. 5

**Candidates with, or taking, O' level Mathematics**

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43 Total Errors

**Candidates with, or taking, C.S.E. Mathematics**

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35 Total Errors

**Candidates taking 'technical' courses**

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8 Total Errors

**All Candidates**

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83 Total Errors
The Mathematical solution to this question depends upon the use of the relationship \( \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} \) and this involved the addition of fractions and the finding of the reciprocal. In general, the setting out of this was not done in a very orderly way and so are found the lack of a logical thread running from the first statement to the last. The operations were done singly and with no regard to their relationship one with another.

\[ \frac{1}{R} = \frac{1}{4} + \frac{1}{8} \]
\[ \frac{1}{R} = \frac{2}{8} + \frac{1}{8} \]
\[ \frac{1}{R} = \frac{3}{8} \]
\[ R = \frac{8}{3} \]

was often written in this fashion

\[ \frac{1}{4} + \frac{1}{8} = \frac{2}{8} + \frac{1}{8} = \frac{3}{8} = \frac{8}{3}. \]

At least one might take comfort that in this lay-out at least all the parts in the calculation are connected, even if not all correctly.

Errors abounded in the addition of fractions. Candidate 5, for example, who was taking a technical course and who was successful in the selection, wrote \( \frac{1}{4} + \frac{1}{8} = \frac{2 + 3}{8} \), a careless error probably due to not working in a careful and unflustered way. His mind seemed to be ahead of his pen.

Much more serious was the error produced by successful candidate No. 7 who was taking 'O' level Mathematics. This candidate certainly seemed not to know the concept of the addition of fractions when he wrote, \( \frac{1}{4} + \frac{1}{8} = \frac{2}{12} \) and \( \frac{1}{8} + \frac{1}{10} = \frac{2}{18} \).
Surely something is radically wrong if an 'O' level candidate can make such an error. Why has this not been spotted earlier and put right? Have these skills been given attention and practised for long enough in this candidate's school life? Evidently this does cause concern at least in some quarters, for

"Many of the skills 1-13 should have been first acquired at Primary Schools (i.e. before the age of about 11), although more practice may be needed to achieve and retain the 'high degree of proficiency' which we deem to be desirable at the age of 16." (62)

(Author's note: the "Manipulation of simple Arithmetic fractions" comes in at number 2 in the list 1-13 of "Manipulative skills which should be acquired by the age of 16."

A glance at the influential guidelines in Mathematics for teachers of the county of West Sussex C.1970 will show that although the addition and subtraction of fractions is dealt with at the end of the Primary School, the explanation rests, as it should, on equivalence, but there is no following technique written in as being advisable to practise. Even in the later (1979) County of Avon Guidelines in Mathematics, 5-13 years, any "Manipulation" is left until the Secondary stage. There are other questions which should be asked as well as the length of time over which practice is carried out. Perhaps we should also ask when it is that children of the general ability of those involved in this examination are most receptive to ideas and skills which they need? How is it that with the accent upon individual learning we can allow an error of the kind illustrated above to survive, with a child of this intelligence, for so long?

Candidate No. 36, who was taking 'O' level Mathematics, wrote,

\[
\frac{1}{8} + \frac{1}{10} = \frac{9}{40},
\]

thus showing a weakness in the multiplication relationships needed here.
Candidate 37, also taking 'O' level Mathematics, had the same misconception of the addition of fractions as has already been illustrated when he wrote $\frac{1}{6} + \frac{1}{9} = \frac{1}{15}$, except that now this candidate only added denominators.

Candidate 53, also taking 'O' level Mathematics, made similar errors, $\frac{1}{4} + \frac{1}{8} = \frac{1}{12}$
This candidate wrote $R = \frac{R_1}{R} + \frac{1}{R_2}$ but evidently, 'deep down', he knew it to be $\frac{1}{R}$ for he made it $\frac{1}{5} + \frac{1}{10} = \frac{1}{18}$.

Candidate 73, who was taking C.S.E., also was not in possession of the concept of the addition of fractions. This candidate wrote, $\frac{1}{8} + \frac{1}{4} + \frac{1}{10} + \frac{1}{8} = \frac{1}{30}$. His ideas on the addition of resistances in parallel and in series were not well founded.

Careless errors could also be made by candidates who evidently knew better, for they were able to do one addition correctly.

For example, Candidate No. 90, taking 'O' level Mathematics, who wrote, $\frac{1}{4} + \frac{1}{8} = \frac{1}{4}$ + 2. The author assumes this to be a careless error, although the arrangement of the 1 + 2 makes it seem as if the error were really a major one. Had it been $\frac{1}{4} + \frac{1}{8} = \frac{2}{4}$, carelessness could the more readily have been assumed.

Even candidates who had been right through the 'O' level course, as candidate 101 had been, could also emerge without the concept of the addition of fractions. This candidate was capable also of writing $\frac{1}{4} + \frac{1}{8} = \frac{1}{12}$ as $\frac{1}{8} + \frac{1}{10} = \frac{1}{18}$. 
Even those who correctly added the fractions could go on to errors.

Candidate 10, who was taking a technical course, and, as a result of his marks on this paper, was acceptable to the company, wrote, \( \frac{8}{3} = 2\frac{2}{3} \) and \( \frac{80}{13} = 4\frac{8}{13} \). This candidate repeats the same error. Evidently this is not mere carelessness, but he is not understanding the concepts involved and this error may well be of long standing. Yet another candidate acceptable to the company, No. 17, made \( \frac{8}{3} = 2.66 \), and \( \frac{80}{13} = 4.44 \), then he tried to subtract the 4.44 from the 2.66. (He was confused about the physics as well.) His subtraction ended in confusion with a bar number.

Like the candidate mentioned above, candidate 18 also made a rounding error in making \( \frac{8}{3} = 2.6 \), an error which was also made by candidate 87.

Worse was the error made by candidate No. 43, who was taking C.S.E. Mathematics. He tried to change \( \frac{8}{3} \) to a decimal and made it 2.2, evidently writing the remainder 2 from the first division as the first place of decimal fractions. This would seem to be a case where the division could not be carried out accurately because of a lack of comprehension with regard to remainders, and the decimal system. This is by no means an isolated case, as we shall see in some of the later questions.

Question 6 A vehicle starts from rest and accelerates at 4 m/s\(^2\) for 20 seconds. Then it maintains its constant velocity for 15 seconds. It then decelerates to a stop in 15 seconds.

Find (i) The deceleration.

(ii) The total distance moved.
This question caused the greatest number of incorrect solutions out of the five Mathematics questions on the paper. 89 of the 103 candidates got this wrong (86%). In fact, 61% of the candidates had no real idea at all, either leaving the question undone or writing some totally irrelevant figures in the attempted solution. Perhaps it had no relevance to the doing of the question, but the last few words about finding the total distance moved is a rather flowery way of asking, 'How far did the vehicle go?'

The question could not truly be said to be germane to this industry. It might be argued, however, that it was there in order to serve to separate the Mathematical sheep from the goats and that this might be said to help decide who will be the future technical apprentices. It might in some other context but, on this paper, it would not seem to be used in that way.

Of the successful candidates, one who had C.S.E. Grade 3 Mathematics did this question; indeed he had no errors at all on the Mathematical questions, as also had one school-leaver who had a 'B' grade in 'O' level Mathematics. There were nine candidates in the successful group who had, or were taking, 'O' level Mathematics and, of these nine, four could not attempt this question. Of the successful C.S.E. level candidates (4), three could not attempt the question. Of the technical course candidates who were successful, the City and Guilds level candidates could not attempt the question but both of the T.E.C. level candidates could do the question, though one of them had it wrong. Success in this question was not confined to any particular level of Mathematical ability. 18% of the 'O' level category were successful, 7% of the C.S.E. category and 22% of the technical course candidates were successful.
### Fig. 3.8

<table>
<thead>
<tr>
<th>Question No. 6</th>
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<tbody>
<tr>
<td><strong>Candidates with, or taking, 'O' level Mathematics</strong></td>
</tr>
<tr>
<td>B₁ B₂ B₃ B₄ C₁ C₂ C₃ C₄ D E F P R S N H Q T</td>
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42 Total Errors

### Fig. 3.9

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38 Total Errors

### Question No. 6

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7 Total Errors

### Question No. 6

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<tr>
<td>3 78 2 2</td>
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87 Total Errors
The question is conceptually quite involved, and it is little wonder that the C.S.E. level candidates were the least successful group. The overall failure rate of 86% indicates it to be not one which is likely to tell the company very much about some of the candidates. Such a question, with involved relationships of acceleration, time, speed and distance, may not find those candidates who would be good at 'practical' Mathematics on the shop floor.

Not surprisingly, the errors by all candidates fell heavily in the 'D' category because of the number who could not attempt the question. Overall, 80 of the 89 errors were placed, by the author, in this category, (see fig. 3.9) because of the non-comprehension of the concepts involved. Of the errors made by the candidates with, or taking, C.S.E. Mathematics, 37 of the 38 errors were of this type (see fig. 3.8), the other error made by this group was one in which the answer was incorrect but there was no working from which it could be told where the error lay. Fig. 3.1 shows that 38 of the 41 candidates in the C.S.E. level category could not do this question. We do, however, see from the one C.S.E. candidate with a grade 3, that this question is not impossible at that level. Somebody had taught him to do questions like that. For the technical course candidates, all 7 of the errors were of the 'D' type, and, of the candidates who had taken or were taking 'O' level, 34 of the 42 errors were of the 'D' type. Overall, the high incidence of 'D' errors is naturally inhibiting to the display of any other types of errors. Of the 34 'D' errors made by the 'O' level category candidates, 24 were because the candidate had insufficient concepts to start the question, and the remainder were because the candidates had insufficient ideas about the relationships between acceleration, velocity, distance and time. Some failed because they did not observe the use of the
necessary negative sign in the deceleration. This happened also with one candidate taking T.E.C. level II Mathematics.

Candidate 51 got further than many, but made this division error when attempting to change a fraction to a decimal, \( \frac{80}{15} = 5.4 \). It seemed a pity that where understanding was of this level that the failure was due to such a fundamental calculation.

Candidate 67 made it, \( \frac{80}{15} = 4.75 \), clearly a problem with approximating 15's in 80.

Yet again, candidate 91, who was taking 'O' level Mathematics, made it, \( \frac{80}{15} = 5 \). He just took it to the nearest whole number and displayed his failure to recognise the degree of precision needed. Perhaps these candidates displayed the need for more class activity in terms of the practise of multiples of 15 and the differences between such multiples and a chosen number.

Some candidates, e.g. No. 88, were so unsure of the relationships between acceleration, velocity, distance and time, that they reverted to what they were more sure of. They used acceleration in the way in which they would have used a velocity. It seems unlikely that the candidates who were taking 'O' level Mathematics had not dealt with acceleration and its relationship to the others. It seems to be a case that has been noted before but this time at a higher level conceptually, that of reverting to the use of what was more familiar, whether or not it was appropriate.

This question did act as quite an effective filter on the successful candidates. In most cases, if they did this question, then they either had no errors, or, if they had, they were of a minor nature. Only in one case was there a serious lack of understanding...
of two other questions, one of which was the one needing concepts in Physics (No. 5). One of the candidates taking a T.E.C. level I Mathematics course had question 6 right but was capable of a rather slapdash attitude to the Arithmetic in the other questions, though substantially he understood them.

Question 7

A hollow metal cylinder is represented in the figure above. The dimensions are: Inner radius $R_2 = 1.5\text{m}$, Outer Radius $R_1 = 2\text{m}$ and the height $H = 5\text{m}$.

Derive a formula for the volume of a cylinder. Also, derive formula for the volume of metal in the hollow cylinder shown.

What is the cost of metal in the above cylinder if the metal costs £50 per cubic metre?

(This question is reproduced as presented to the candidates on the paper. See Appendix 3.1.)

There is a disturbing lack of clarity in the diagram, particularly as to $R_1$, though the text does tell us that $R_1$ is the outer radius. The use of the word 'drive' in two places is not what
the compiler intends. The use of the word 'give' or 'write' would be preferable.

Unlike the last question, this one is related to the industry. It is relevant to apprentices in this industry, of both kinds, but especially to the craft apprentices. It is a fairly traditional kind of question and one which should be common to all courses in Mathematics in schools, except the very 'modern' ones and such syllabuses are not used in this part of the country. The author would have expected a fair degree of competence in this question, especially by the candidates taking technical course Mathematics. He also expected to find a wider spread of errors in this case because of the number of candidates who could be expected to have enough concepts to start the question. It, in fact, did not turn out to be the case that a very much greater competence was shown in tackling this question.

Fig. 3.1 shows that 76% of the candidates with or taking 'O' level Mathematics failed this question, whilst the figure for the C.S.E. category candidates was 83%. Perhaps most surprising, though, of course, the number involved was very low, the candidates taking technical course Mathematics did least well; 89% of these candidates failed the question.

Not too much should be read into this last figure, since there were only nine candidates in this category. Nevertheless, if one considers these candidates alone, a greater percentage failed this question than any of the others. It was the second highest failure rate for the candidates in the 'O' level category and the third highest for the C.S.E. category.

In the case of this question, the error having the greatest frequency of occurrence was the 'E type' error. That is the quoting
of the incorrect formula. As might have been expected, some of the quotes were near misses, perhaps indicating a failure to memorise and recall. Others were well wide of the mark, perhaps more nearly indicating a lack of understanding of the concepts involved. Just under a third of all the errors made by all candidates were a failure to quote correctly the formula at the commencement of the question. The figures for each category were,

- Those with or taking 'O' level Mathematics: 23%
- Those with or taking 'C.S.E.' level Mathematics: 40%
- Those with or taking 'technical course' Maths: 33%

(See figs. 3.10 and 3.11)

The 'O' level candidates were those most likely to remember the correct form.

Some of the C.S.E. level candidates, for example, Nos. 3, 15, 22, etc., were quite capable of getting this question right. Even some who could not carry the question to a successful conclusion, correctly quoted the formula.

The errors due to the non-comprehension of the concepts in this question were there as ever. (See figs. 3.10 and 3.11) There were candidates who could not start the question. For example, one of the unsuccessful candidates, No. 24, with a C.S.E. grade 5 in Mathematics, was, for this failure, placed in the 'D' category. This applied also to candidates, No. 20 taking 'O' level Mathematics, No. 21 taking a City and Guilds course, and No. 26 taking a C.S.E. Mathematics course, and there were others besides.

The errors in calculation were a major factor in this question. 24 of the 118 total errors were due to either multiplication or division
### Question No. 7

**Candidates with, or taking, 'O' level Mathematics**

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60 Total Errors

**Candidates with, or taking, C.S.E. Mathematics**

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48 Total Errors

**Candidates taking 'technical' courses**

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9 Total Errors

**All Candidates**

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119 Total Errors
errors. (See fig. 3.11) Even amongst the successful candidates who knew what they had to do in order to effect a solution, the Arithmetic was not always correct. For example, see candidate No. 7 who was taking 'O' level Mathematics. All the principles were correct but he was not successful in the long division. In the main, this was because he was so untidy in the layout and, consequently, errors were made due to the careless placing of figures in the calculation. The two successful candidates, who were taking T.E.C. level Mathematics courses, both made errors in the multiplication elements of this question. The one was careless in producing $3.142 \times 20 = 61.84$. He neglected to multiply one of the digits. His concentration must have lapsed at that point. The other candidate was incorrect and there was no working which allowed the source of the error to be traced. It was interesting to note that three of the seventeen successful candidates could not quote the formula correctly.

In this question, several candidates, for example candidates 37, 69, 80 and 102 did not understand the meaning of $r^2$. They all wrote in their calculations $1.5^2 = 2 \times 1.5$. This error manifests itself also in other ways, indeed one might well ask whether the candidates who incorrectly quoted the formula and gave $V = 2\pi rh$ really thought they were giving an alternative and equivalent form to $V = \pi r^2h$. There were six cases of this kind of error in quoting the formula. One candidate, to be on the safe side, wrote $V = 2\pi r^2h$.

Errors in multiplication and division were due to many factors. As we have already seen, there were 24 candidates who were in error in these operations. Candidate No. 18 made a careless error due to the neglect of a carrying figure in the multiplication, in which he also made a place value error. Some errors in multiplication were due to
the result not being given correctly to two decimal places, as happened, for example, in the work of candidate No. 29. He made 3.142 x 2.25 x 5 = 35.34 instead of 35.35. Candidate 67 rounded off his result of 27.4925 as 27.4.

Untidy presentation and general lack of calculating discipline led to candidate No. 31 making 3.142 x 1.5 x 1.5 = 7.095 instead of 7.0695, and candidate No. 40 was also guilty of slapdash work and made \( \frac{22}{7} x 8.75 = 182 \), instead of \( \frac{192.5}{7} \).

In addition to the multiplication error, he had forgotten to divide by 7 and also perhaps unjustifiably and incorrectly have rounded off. Carelessness and lack of concentration at crucial times also figured in the causes of errors. Candidate No. 49, for example, neglected to multiply by 5 in the multiplication 3.142 x 2\(^2\) x 5 = 12.56 and also made a rounding error. Candidate 56, like candidate 31 above, neglected to divide by 7 in making \( \frac{22}{7} x 1.5 x 5 = 33 x 5 \).

An interesting case of the failure to be successful in multiplication is exhibited by candidate No. 59 who, in order to multiply 1.5 x 1.5, chose a method which involved the keeping of the decimal point throughout as a separator of whole numbers and fractions, and thus he calculated

\[
\begin{align*}
1.5 \\
1.5 \\
7.5 \\
15.0 \\
22.5
\end{align*}
\]

and, in doing so, made 1.5 x 1 = 15.0. This attempt, on the part of his teachers, to make the meaning of the magnification of numbers relative to a fixed separator clear, has not been successful. It has been followed as slavishly as any other method and, in this case, has not been successful.
This place value type of error we see in the work of candidate No. 60 who made \(0.5 \times 0.5 = 2.5\). Candidate 66, who made \(3.142 \times 0.5 = 15.71\), and candidate 71, who made \(3.142 \times 2 \times 2 \times 5 = 6.284\). This is yet another indication of where processes are carried out without a thought given to the magnitude of the numbers involved, and the magnitude of the number resulting. Perhaps we need more oral work on the approximation of numbers arising out of a calculation. Even those involved in such a calculation as this. There is encouragement to approximate now, but it is carried out if at all by the pupil and not necessarily communicated to anyone else. This results in a lack of pressure to be correct. The sharpening up of this kind of approximation may be helped by making it more public.

Rather weird, but hardly wonderful, were many of the incorrect quotations made by the candidates. As well as the confusion about \(2\pi r\) and \(\pi r^2\), we have candidate 33 in total confusion writing \(V = \text{rad.} \times \text{diam.}_1 \times \text{ht.} \times \text{rad.} \times \text{diam.}_2 \times \text{ht.}\). An error so wide of the mark that it might be more appropriately placed in the 'D' category than the 'E' category. He clearly does not comprehend the ideas needed in this question, even the simple one concerning the difference between two volumes.

A lack of understanding was also shown by candidate No. 35 who wrote \(V = \frac{1}{2} \times \text{Area} \times \text{ht.}\), and by candidate 41 who, though involving a difference, has not seen that he has reduced the right hand side to zero when he wrote \(V = H \times R_1 \times H \times R_2 - H \times R_1 \times H \times R_2\). Candidate 43, relying solely on his imperfect memory, quoted \(V = \frac{4}{3}\pi r^3\). Candidate 44 was in conceptual trouble when he wrote \(V = \pi r^2\), and candidate 46 was not at all near the correct idea when he wrote \(V = H \times \text{Rad.}\). Perhaps dimensionality had never been discussed with this candidate.
Candidates 50 (taking '0' level Mathematics), Candidate 57 (taking a City and Guilds foundation course), and candidate 62 (taking C.S.E. Mathematics), all wrote the form $V = \pi r_1 x r_2 x h$. It was curious that three from differing backgrounds should make the same kind of error in form. Again, with these candidates, there is no sign that they have the idea of removing one volume from another. This occurs also with the candidate, (No. 58), who wrote $V = \frac{\pi r^2 x h}{\pi r^2}$.

Candidate 63, however, has remembered that a difference must be found but had few other concepts which would enable him to solve the question, when he wrote $V = R_1 h - R_2 h$. Some errors actually get very close to the mark. For example, candidate 64, who was taking '0' level Mathematics, wrote $V = \pi (r_1^2 - r_2^2)h$. Here he is confused about $r_1^2 - r_2^2$ and $(r_1 - r_2)^2$. Candidate 66 was fundamentally more in error in writing $V = \pi (r_1 - r_2)h$; his really was a case of memory letting him down and not having a sufficient concept of the volume of this prism to assist him to correct his error.

Some of the candidates exhibited an arrest of the concept of volume in this case. For example, candidate No. 79, who was taking '0' level Mathematics, wrote Base = Area x Height. A real pot pourri of things involved. Candidate 63, who had a C.S.E. grade 2 in Mathematics, was nearer. He quoted $V = \text{length} \times \text{breadth} \times \text{height}$ on which to pin his ideas, and then he sought dimensions to fit this pattern, ending up with $V = R_1 x 2 x H - R_2 x 2 x H$, no $\pi$ and no squaring, but at least he did conceive of a difference to be used.

Then candidate 94, taking C.S.E. Mathematics and candidate 95, who was taking '0' level Mathematics, both made errors which showed their lack of any ideas of dimensionality on which to base their thinking.
Candidate 94 wrote $V = R_1 h$, Candidate 95 wrote $V = \frac{1}{2} R_1 \times \frac{1}{2} R_2$.

Gross errors in the relationship involved in this question came from the candidates regardless of the kind of course they were following.

An overall view showed that 83% of these school-leavers were unsuccessful at this industrial test. (See fig. 3.14)

If this particular set of results were bandied about in the press, of course it would give a very poor picture of the work of schools and would bring about anguished cries of justified horror from the general public. The author does not believe that it is wholly indicative of the Mathematical standards. The author is concerned about the paper itself, its structure and its presentation. Nevertheless, we cannot be complacent at the situation. There must be something wrong. Is it with the Mathematical standards of school-leavers seeking apprenticeships or is it that the candidates are very unprepared for the differences between work in schools and the papers set by local industries? As Carroll (1978) points out,

"If companies are going to test for arithmetical ability of this immediately useful kind, then their tests need to be much more carefully constructed than many of them are at present ... ..... Schools cannot reasonably be expected to prepare children to undertake tests of specific skills if they are given no indication of what those specific skills are." (63)

It seems to the author that there is not one cause of low levels of the results on such papers. It would be easier to judge how far a poor level of basic skills was involved if the paper were made up of questions such as those in the C.B.I. (Wales) report on Standards of Numeracy and Literacy in Wales. (64) It was selections from these questions and those on page 19 of the same report that the author gave to students training to be teachers, and whose results are discussed in Chapter 4.
Figures 3.12 and 3.13 show that of the 504 errors made, almost half were attributed, by the author, to the non-comprehension of some concept or other in these questions.

**Fig. 3.12**

<table>
<thead>
<tr>
<th>Questions</th>
<th>B₁</th>
<th>B₂</th>
<th>B₃</th>
<th>B₄</th>
<th>C₁</th>
<th>C₂</th>
<th>C₃</th>
<th>C₄</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>P</th>
<th>R</th>
<th>S</th>
<th>N</th>
<th>M</th>
<th>Q</th>
<th>T</th>
<th>Totals</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td></td>
<td></td>
<td>1</td>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td>70</td>
<td>4</td>
<td>4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>91</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td>1</td>
<td>53</td>
<td>20</td>
<td></td>
<td>5</td>
<td>1</td>
<td>3</td>
<td></td>
<td></td>
<td>3</td>
<td></td>
<td>24</td>
<td>3</td>
<td></td>
<td>117</td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td>2</td>
<td>12</td>
<td>10</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>55</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>88</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>3</td>
<td>80</td>
<td>2</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>89</td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>19</td>
<td>5</td>
<td>24</td>
<td>56</td>
<td>12</td>
<td>8</td>
<td>7</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>119</td>
</tr>
<tr>
<td>Totals</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>71</td>
<td>22</td>
<td>11</td>
<td>68</td>
<td>26</td>
<td>12</td>
<td>2</td>
<td>56</td>
<td>8</td>
<td>24</td>
<td>3</td>
<td>1</td>
<td>504</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Fig. 3.13**

<table>
<thead>
<tr>
<th>Most frequently occurring Type of Error</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>239</td>
</tr>
<tr>
<td>E</td>
<td>68</td>
</tr>
<tr>
<td>N</td>
<td>56</td>
</tr>
<tr>
<td>F</td>
<td>26</td>
</tr>
<tr>
<td>Q</td>
<td>24</td>
</tr>
<tr>
<td>C₃</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>With, or taking, 'O' level Mathematics</td>
</tr>
<tr>
<td>--------------------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td></td>
<td>Successful</td>
</tr>
<tr>
<td>Number</td>
<td>9</td>
</tr>
<tr>
<td>Percentage of each class</td>
<td>18%</td>
</tr>
</tbody>
</table>
The lack of a basic appreciation of the initial concept involved in a question often led to there being no solution offered. Due to this, it was impossible to say what the errors might have been in the Arithmetic skills, had the questions been tackled.

An intangible in the matter of the candidates' ability to start a question, was the degree to which the language proved to be an inhibiting feature. That is to say, if indeed it had been a major or a minor factor. But the conjecture that it might have been a factor is one which merits further consideration. It has been admitted that recruitment to engineering apprenticeships has not been made from the same strata of the school population as once it was.

The C.B.I. (Wales) report of 1977 states,

"In making comparison between the standard of applicants in 1966 and those of 1974, it is recognised that the sector of the school-leaving population from which they are drawn has changed. Better opportunities for sixth form and further education have taken a proportion of those who previously would have sought craft training." (65)

One of the concomitant problems arising from drawing from this new strata is the restricted comprehension of the written word which must add to the problems of assessing ability in Mathematics in a paper of this kind.
CHAPTER 4

An examination of Mathematical Standards of teachers in training at a College in Gwent

The C.B.I. (Wales), concerned at what they considered to be falling standards in school-leavers seeking apprenticeships in industry, set questions in Mathematics to would-be Craft apprentices in Wales. The author has made a selection of these and set them as a test to the 1979 entry Diploma of Higher Education and Teacher's Certificate courses at the college. The whole test questions could not be used because of the limited time which could be made available at the college for the test to be conducted.

The questions selected for the test were:

1. Add 4,532
   125
   7,609
   5,431
   892

2. Subtract 4,877 from 21,342.

3. Work out 625 x 57 x 16.

4. Add $1\frac{1}{2}$ and $2\frac{1}{3}$.

5. What is $\frac{5}{6} \div \frac{2}{3}$.

6. Write $\frac{3}{5}$ as a decimal.
7. What percentage of 150 is 21?

8. If in the store there were round steel bars of diameters $\frac{1}{4}$ inch, $1\frac{1}{16}$ inch, $1\frac{1}{8}$ inch, $1\frac{3}{16}$ inch, $1\frac{1}{2}$ inch, $1\frac{7}{16}$ inch and $1\frac{3}{4}$ inch, and you required one with a diameter as near as possible to 1.22 inch, which one would you choose?

9. Find the area of a circle $2\frac{1}{2}$ inch diameter to two decimal places.

10. A No. 0 woodscrew has a diameter of 0.050 inches, a No. 1 a diameter of 0.064 inches, and a No. 2 a diameter of 0.078 inches, and the larger sizes go on increasing by the same amount. Find the diameter of a No. 8.

In choosing these questions, the author wanted to have represented the usual four rules of number, work with fractions, especially changing fractions into decimals, since, from his experience with the school-leavers hoping to take an apprenticeship who were tested at a local factory, this was an area of especial difficulty. It was hoped that division, as an operation, could be observed in numbers 8, 9 and 10. Question No. 10 itself was included because it represented the idea of a progression, something which is likely to have received attention in schools in the last few years.

In the 1979 intake of students to the L.E.A. College in Gwent, there are 64 students with the necessary two 'A' levels to commence the two year Diploma in Higher Education course prior to the post-diploma B.Ed. course. In addition, there are 48 taking the three year Teacher's Certificate course. At the present time, it is not necessary for any of these students to have 'O' level Mathematics,
### Percentage of students with 'O' level Mathematics or its equivalent

Fig. 4.1

<table>
<thead>
<tr>
<th></th>
<th>With 'O' level Mathematics</th>
<th>Without 'O' level Mathematics</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diploma of Higher Education students</td>
<td>61%</td>
<td>39%</td>
</tr>
<tr>
<td>Teacher's Certificate students</td>
<td>35%</td>
<td>65%</td>
</tr>
<tr>
<td>All students</td>
<td>50%</td>
<td>50%</td>
</tr>
</tbody>
</table>
though some of them do. In fact, 50% of these students did have 'O' level Mathematics. 61% of the Diploma students and 35% of the Certificate students had passed 'O' level Mathematics. (See fig. 4.1)

Attention should here be focused upon the 39% of the students with two 'A' levels and the staggering 65% of the Certificate students who did not have 'O' level Mathematics. In this college, this intake of Certificate candidates will be the last, and all students taking teacher training will be obliged to have passed 'O' level Mathematics from 1980. This figure of 39% without 'O' level Mathematics was never reached by the men taking teacher training from 1960 to 1974; it was, however, exceeded by the women seven times between those years.

The largest percentage of students without 'O' level Mathematics during those years was the 63% of the women in the first year in which women were admitted to the college in 1962. Even with this high percentage of the women without 'O' level Mathematics the figure for all the students that year was 52%. The present 65% for the Certificate year is the highest figure since college Mathematics staff began to keep such records in 1960. (See fig. 4.1) Included in the students with 'O' level Mathematics were also those with C.S.E. Grade 1.

Three of the Diploma of Higher Education students had passed 'A' level Mathematics, whilst there was one student with additional Mathematics at 'O' level, amongst the Certificate students.

The errors made by the students are now analysed student by student.

(For types of error refer to pp 24, 25)
Diploma in Higher Education Students with
'O' level Mathematics or equivalent

<table>
<thead>
<tr>
<th>Student</th>
<th>Level of Maths</th>
<th>Qn.</th>
<th>Errors</th>
<th>Primary reason for failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>'O'</td>
<td>1</td>
<td>a. Errors in addition, probably due to untidy presentation. Not clearly in columns.</td>
<td>Cl</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>a. Multiplication bond error $6 \times 7 = 36$.</td>
<td>B3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. Attempts to compare in fraction form.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Incorrect formula $A = 2 \pi d$, though $A = \pi r^2$ was also put in to try to be correct hopefully with one of them.</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Though $A = \pi r^2$ is used it is treated as $2 \pi r$, i.e. $r^2$ is considered to be $2r$.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>c. Using diameter ($\frac{2}{3}d$) for radius.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>d. When $A = 2 \pi d$ is quoted, she writes $2d\pi = \frac{5}{2} \times \frac{5}{2} \times 22$. $2d$ is considered to be $d^2$.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>a. 8 intervals of 0.014 correct but this total was added to dia. of No. 2 screw.</td>
<td>D</td>
</tr>
<tr>
<td>2</td>
<td>'O'</td>
<td>8</td>
<td>a. Changes 0.22 to a fraction and tries to compare in fraction form.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. All working correct but gives answer to one decimal place and not two as was asked.</td>
<td>F</td>
</tr>
<tr>
<td>3</td>
<td>'O'</td>
<td>4</td>
<td>a. Misread the question.</td>
<td>A</td>
</tr>
</tbody>
</table>
|         |                | 8   | a. Conversion of fractions to decimals \[
\begin{align*}
\frac{3}{16} &= 1.9 \\
\frac{8}{10} &= 1.25.
\end{align*}
\] Lack of attention to place value in the long division. | C4_P |
<p>|         |                | 9   | a. $r^2$ considered to be $2r$. | D |
|         |                |     | b. Division of fractions $\frac{5}{2} \div \frac{2}{1} = \frac{5}{2} \cdot \frac{1}{2}$. | F |
|         |                |     | c. Division error $10.5 \div 2 = 5.42$. | C4 |</p>
<table>
<thead>
<tr>
<th>Student</th>
<th>Level of Maths</th>
<th>Qn.</th>
<th>Errors</th>
<th>Primary reason for failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>'O'</td>
<td>4</td>
<td>a. Adds numerators and multiplies denominators, $\frac{1}{4} + \frac{2}{3} = \frac{7}{12}$ Concepts of equivalence and addition of fractions not understood. Not learned as a skill either.</td>
<td>D</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>4</td>
<td>a. To divide fractions, she changes both to a percentage (in all probability thought she was changing to a decimal). She then divides the percentages.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. $\frac{5}{3} \div \frac{2}{3} = 83.3 \div 66.6$ (rounding error)</td>
<td>C₄</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>c. $\frac{13}{2}$ (error in the long division; did not change 167 units to tenths and have $667\text{ths} \div 667\text{ths}$ to give 2ths etc.)</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>4</td>
<td>a. Changing fractions to percentages not decimals. Probably due to lack of comprehension of the equivalence method taught, e.g. $\frac{1}{16} \times 100 = 6.2$ (rounding error) instead of $\frac{1}{16} \times 100 = \frac{100}{16} = \frac{6.25}{100}$</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. $\frac{3}{8} = 12.25$ (as above but now with a division error)</td>
<td>C₄</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>4</td>
<td>a. Diameter given as $2\frac{1}{2}$. Student multiplies by 2 instead of dividing in order to find the radius. $r^2 = \frac{5}{2}$.</td>
<td>F</td>
</tr>
<tr>
<td>5</td>
<td>C.S.E.</td>
<td>4</td>
<td>a. Incorrectly transcribed.</td>
<td>F</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>4</td>
<td>a. $\frac{210}{15} = 70$ Divides by 3, the numerator and the denominator to get the equivalent fraction. Reverses the factors of 15 when writing result.</td>
<td>S</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>4</td>
<td>a. Uses diameter ($2\frac{3}{2}$) for the radius.</td>
<td>F</td>
</tr>
<tr>
<td>Student</td>
<td>Level of Maths</td>
<td>Qn.</td>
<td>Errors</td>
<td>Primary reason for failure</td>
</tr>
<tr>
<td>---------</td>
<td>---------------</td>
<td>-----</td>
<td>--------</td>
<td>---------------------------</td>
</tr>
<tr>
<td>6</td>
<td>C.S.E.</td>
<td>4</td>
<td>a. Not understanding equivalence of fractions, $\frac{2}{4} + \frac{7}{3} = \frac{2}{12} + \frac{7}{12}$.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>a. Not understanding the meaning of $\frac{3}{5}$ when changing to a decimal.</td>
<td>D</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td></td>
<td>1.66 = $\frac{3}{5.0}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$\frac{3}{20}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$\frac{18}{20}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Rounding error above.</td>
<td>R</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td>a. Not understanding concept in percentage calculation. Writes $\frac{21}{100} x 150$.</td>
<td>D</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td>a. Changing fractions to decimals. Lack of attention to place value in the division.</td>
<td>C₄ P</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$\frac{1}{16} = 0.66 \frac{16}{100}$ Error in division.</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. $\frac{3}{16} = \frac{0.17}{16/30}$ In the calculation, 8 was rejected because $16 \times 8 = \frac{144}{140} 6 \times 8 = 64$.</td>
<td>C₄ 3₃</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td>a. Incorrect formula $A = \pi d$.</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Could not quote $\pi$ as a decimal. Found converting fraction to decimal.</td>
<td></td>
</tr>
<tr>
<td>7 '0'</td>
<td></td>
<td>3</td>
<td>a. Multiplication bond error in long multiplication.</td>
<td>C₃ B₃</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. A series of corrections were made throughout as the result of spotting this error. Not all were corrected. Student did not spot that $10,000 \times 57 = 57,000$.</td>
<td>F</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td>a. Not understanding concept in percentage calculation. Writes $\frac{21}{100} x 150$.</td>
<td>D</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td>a. Division error in changing a fraction to a decimal $\frac{3}{6} = 0.185$. When dividing the hundredths 20 hundredths. $= 8$. Writing $\frac{3}{3}$ reversal figure.</td>
<td>C₄ S</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td>a. Error in long multiplication. Place value error.</td>
<td>C₃ P</td>
</tr>
<tr>
<td>Student</td>
<td>Level of Maths.</td>
<td>Qn.</td>
<td>Errors</td>
<td>Reasons for failure</td>
</tr>
<tr>
<td>---------</td>
<td>----------------</td>
<td>-----</td>
<td>--------</td>
<td>--------------------</td>
</tr>
<tr>
<td>8</td>
<td>'O'</td>
<td>8</td>
<td>a. Changing fractions to decimals, not rounding.</td>
<td>R</td>
</tr>
<tr>
<td>9</td>
<td>'O'</td>
<td>5</td>
<td>a. Reverses first fraction instead of second. $\frac{5}{6} \div \frac{2}{3} = \frac{5 \times 3}{6} = \frac{15}{6} = \frac{5}{2}$.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Using diameter $(2\frac{3}{4})$ as the radius.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Error in long division $275 \div 14 = 11.64$. In calculation the unit figure was 9 but was so poorly written, he himself took it for a 1.</td>
<td>C4</td>
</tr>
<tr>
<td>10</td>
<td>'O'</td>
<td>5</td>
<td>a. $\frac{5}{6} \div \frac{2}{3} = \frac{5 \times 3}{6} = \frac{15}{6} = \frac{5}{2}$. Conceptual error. Possibly due to the one denominator method.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Transcribing error.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Incorrect formula $A = \pi d$.</td>
<td>E</td>
</tr>
<tr>
<td>11</td>
<td>'O'</td>
<td>5</td>
<td>a. Error in changing fraction to a decimal. $\frac{1}{6} = 0.16$ due to not rounding.</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. $\frac{5}{6} \div \frac{4}{6} = 0.8 \div 0.64 = \frac{80}{64} = \frac{10}{8} = 1\frac{1}{4}$. In spite of rounding errors, the final fraction could lead to correct result but there is a reversal of factors.</td>
<td>S</td>
</tr>
<tr>
<td>12</td>
<td>'A'</td>
<td>9</td>
<td>a. Error in long division due to a multiplication error. $56 \times 9 = 494$ his working $50 \times 9 = 450$ and $6 \times 9 = 54$, the 4 of the 4 units is added in, instead of the 5 of the 5 tens. May be a reversal.</td>
<td>C4, C3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>10 a. Multiplication error, $1 \times 8 + 3 = 14$ in $0.014 \times 8 = 0.112$. Possibly due to adding in the 'carrying' number twice.</td>
<td>C3</td>
</tr>
<tr>
<td>13</td>
<td>'A'</td>
<td>8</td>
<td>a. $\frac{1}{8} = 0.12$. Rounding error.</td>
<td>R</td>
</tr>
<tr>
<td>Student</td>
<td>Level of Maths</td>
<td>Qn.</td>
<td>Errors</td>
<td>Reasons for failure</td>
</tr>
<tr>
<td>---------</td>
<td>---------------</td>
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<td>------------------------------------------------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>14</td>
<td>'A'</td>
<td>3</td>
<td>a. Neglected to complete question by multiplying by 16.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. ( \frac{a}{b} = 0.12, \frac{3}{16} = 0.18 ), Rounding Errors.</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Incorrect formula ( A = \frac{1}{2} \pi r^2 ).</td>
<td>E</td>
</tr>
<tr>
<td>15</td>
<td>C.S.E. 1</td>
<td>5</td>
<td>a. ( \frac{5}{6} - \frac{2}{3} = \frac{5}{6} \times \frac{4}{6} = \frac{24}{36} ) Does invert in his head, but inverts first fraction instead of the second.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. Converts 1.22 to a fraction and attempts to compare the fractions.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>b. ( 1.22 \approx 1\frac{1}{2} ). Willing to use this gross approximation in this comparison.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>a. Uses diameter ( (2\frac{1}{2}) ) for radius.</td>
<td>F</td>
</tr>
<tr>
<td>16</td>
<td>'O'</td>
<td>9</td>
<td>a. Uses diameter ( (2\frac{1}{2}) ) for radius.</td>
<td>F</td>
</tr>
<tr>
<td>17</td>
<td>'O'</td>
<td>5</td>
<td>a. ( 5 \div 4 = 1\frac{1}{4} ) Reversal.</td>
<td>S</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. ( \frac{1}{2} ) of ( 2\frac{1}{2} ) = 1.75</td>
<td>C1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. ( 1.75 \times 1.75 ) in this calculation neglects to multiply by the 5 hths.</td>
<td>F</td>
</tr>
<tr>
<td>18</td>
<td>C.S.E. 1</td>
<td>7</td>
<td>a. Not understanding concept in percentage calculation. ( \frac{21}{100} \times 150 ).</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Result not given to 2 d.p. as required.</td>
<td>F</td>
</tr>
<tr>
<td>19</td>
<td>C.S.E. 1</td>
<td>9</td>
<td>a. Result not correct to 2 d.p. Rounding off too early in calculation.</td>
<td>R</td>
</tr>
<tr>
<td>20</td>
<td>'O'</td>
<td>1</td>
<td>a. ( 1 + 9 + 3 + 0 + 2 + 3 = 20 ).</td>
<td>C1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. ( 1\frac{1}{2} = 1\frac{3}{4} ) Transcribing error, because the other fraction was correct.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Not understanding concept in percentage calculation. ( \frac{21}{100} \times 150 ).</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. ( \frac{3}{16} = 0.18, \frac{5}{16} = 0.312 ) Not rounding off.</td>
<td>R</td>
</tr>
<tr>
<td>Student</td>
<td>Level of Maths.</td>
<td>Qn.</td>
<td>Errors</td>
<td>Reasons for failure</td>
</tr>
<tr>
<td>---------</td>
<td>----------------</td>
<td>-----</td>
<td>-----------------------------------------------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>21</td>
<td>'0'</td>
<td>2</td>
<td>a. Using equal addition. Forgot to add in the bottom amount on one of the subtractions.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$\frac{5}{6} \div \frac{2}{3} = \frac{5}{6} \div 4 = 1.25$</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Not comprehending the concept, made worse perhaps by the one denominator syndrome.</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>2</td>
<td>a. No understanding the concept in percentage calculation. Writes $21 \times \frac{150}{100}$</td>
<td>D</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>2</td>
<td>a. $\frac{22}{7} \times 1.56 = \frac{2200}{7} \times 156$</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Not understanding the concept of equivalence of fractions. Magnifies by a factor $10^4$.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. The rounding of 1.5625 to 1.56 would lead to error in result. Rounding too early.</td>
<td>R</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>2</td>
<td>a. Only sees 5 steps of 0.014 from No. 2 screw to No. 8 screw.</td>
<td>D</td>
</tr>
<tr>
<td>22</td>
<td>'0'</td>
<td>3</td>
<td>a. Neglects to multiply by 7 in 57.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$\frac{5}{6} \div \frac{2}{3} = \frac{5}{6} \div 4 = \frac{1}{6}$</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>The one denominator syndrome again plus a possible transcribing error leads to a familiar pattern and so he completes it.</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>2</td>
<td>a. Changes 1.22 to $1\frac{11}{50}$ and tries to compare the fractions.</td>
<td>D</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>2</td>
<td>a. Incorrect formula $A = 2\pi r$.</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Uses diameter ($2\frac{2}{4}''$) for radius.</td>
<td>F</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>2</td>
<td>a. Gives result as 8 intervals of 0.014. Does not add to first screw diameter.</td>
<td>D</td>
</tr>
<tr>
<td>23</td>
<td>'0'</td>
<td>4</td>
<td>a. Misread the question.</td>
<td>A</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>2</td>
<td>a. Not understanding the concept in percentage calculation, writes $21 \times 150$.</td>
<td>D</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>2</td>
<td>a. Writes both $\frac{1}{4}$ and $\frac{1}{3}$ as 0.25.</td>
<td>D</td>
</tr>
<tr>
<td>Student</td>
<td>Level of Maths</td>
<td>Qn.</td>
<td>Errors</td>
<td>Reasons for failure</td>
</tr>
<tr>
<td>---------</td>
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<td>---------------------</td>
</tr>
<tr>
<td>24 'O'</td>
<td>7</td>
<td>a. Not understanding the concept in percentage calculation, writes ( \frac{21}{100} \times 150 ).</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>1( \frac{3}{4} )</td>
<td>a. Conversion of a fraction to a decimal ( \frac{13}{16} = 19% = 1.125 ) Error due to initial division ( 19 \div 16 = 1 \text{ rem. } 2 ). Subtraction error.</td>
<td>C4, B2</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>a. Incorrect formula ( A = \pi D ).</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td>25 'O'</td>
<td>8</td>
<td>a. Writes ( \frac{3}{4} = 0.12, \frac{5}{4} = 0.25 ) ( \frac{21}{64} = 0.18 ). In two cases a rounding error. In one case a division error.</td>
<td>R, C4</td>
<td></td>
</tr>
<tr>
<td>26 'O'</td>
<td>7</td>
<td>a. Not understanding the concept in percentage calculation. Writes ( \frac{21}{100} \times 150 ).</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>a. Error in long division ( \frac{47}{56} = 4.92 ). Error was in dealing with ( 4 ) thdths. rem. This was changed to 40 thdths., this is entered in the thdths. col. giving 0.917, which is then rounded to 0.92.</td>
<td>C4, P</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>a. Attempts the comparison in fraction form.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>27 'O'</td>
<td>8</td>
<td>a. Conversion of fractions to decimals by long division. ( \frac{1}{16} = 0.0625, \frac{3}{16} = 0.2775, \frac{5}{16} = 0.4625 ). Error was in the initial division to change ( \frac{1}{6} ) to a decimal.</td>
<td>C4, P</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>a. Incorrect formula ( A = 2\pi r ).</td>
<td>E</td>
<td></td>
</tr>
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<tr>
<td>Student</td>
<td>Level of Maths.</td>
<td>Qn.</td>
<td>Errors</td>
<td>Reasons for failure</td>
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<td>---------</td>
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<td>---------------------</td>
</tr>
<tr>
<td>28 'O'</td>
<td></td>
<td>7</td>
<td>a. Mishandles the 'Cancelation' process. 7 \times \frac{3}{100} \Rightarrow \frac{12}{100} \Rightarrow \frac{3}{10} \Rightarrow \frac{3}{10} R \Rightarrow \frac{1}{10}.</td>
<td>C_4 \ R</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. Only converts some fraction to decimals and considers the others in fraction form.</td>
<td>D</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>9</td>
<td>a. $1.25 \times 1.25 = 1.5625$. Rounds off to 1.56 too early in the calculation. b. $22 \times \frac{143}{3}$ rounds off again. c. In consequence gets an inaccurate answer of 4.84.</td>
<td>R</td>
</tr>
<tr>
<td>29 'O'</td>
<td></td>
<td>6</td>
<td>a. Changes to a percentage and not a decimal. $\frac{3}{5} \times 100 = 60%$.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. Changing fractions to decimals, $\frac{1}{2} = 0.175$. All other decimals based on this. Calculation was to find $\frac{1}{2}$ of $2^{\frac{1}{2}}$ $2^{\frac{1}{25}}$ $2 \div 2$ and gets a rem. 1 and so 15 hths.</td>
<td>C_4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Long division $275 \div 56 = 4.09$ The changing of 51 units to 510 tenths is not understood.</td>
<td>C_4</td>
</tr>
<tr>
<td>30 'O'</td>
<td></td>
<td>5</td>
<td>a. Changes both fractions to decimals. Divides and gets 1.238. Rounding error. b. Answer is left as a decimal.</td>
<td>R \ D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Changes to a percentage and not a decimal, $\frac{3}{5} \times 100 = 60%$.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Neglects to square the radius after substitution. Thinks $r^2 = 2r$.</td>
<td>D</td>
</tr>
<tr>
<td>Student</td>
<td>Level of Maths</td>
<td>Qn.</td>
<td>Errors</td>
<td>Reasons for failure</td>
</tr>
<tr>
<td>---------</td>
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<td>-----------------------------------------------------------------------</td>
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</tr>
<tr>
<td>31 'O'</td>
<td>7</td>
<td></td>
<td>a. Not understanding the concept in percentage calculation. Writes ( \frac{150 \times 21}{100} )</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. Changing fractions to decimals.</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Gives result as ( \frac{7}{16} ) or ( 1\frac{1}{4} ).</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Difference between 1.22 and 1.25 = 0.03</td>
<td>C_2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Difference between 1.187 and 1.22 = 0.033</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Neglects to square the radius after substitution. Thinks ( r^2 = 2r ).</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>a. Not attempted.</td>
<td>D</td>
</tr>
<tr>
<td>32 'O'</td>
<td>5</td>
<td></td>
<td>a. ( \frac{5}{6} \div \frac{2}{3} = \frac{5 \times 3}{2} = \frac{15}{2} \times \frac{3}{6} = \frac{5}{2} ) The one denominator syndrome.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. Changing fractions to decimals.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>( 1\frac{7}{16} = 1\frac{7}{16} = 1\frac{7}{16} \times \frac{25}{4} = \frac{445}{4} = 1.1125 )</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Error in equivalence of fractions.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Does not write it correctly.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Error in multiplication ( 17 \times 25 = 445 ).</td>
<td>C_3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. ( 1\frac{7}{16} = 21 \times 100 = \frac{525}{4} = 1.06 ) Method as before, but now error lies in the division by 4. The carrying figure (rem.) is forgotten.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. To this student ( \pi r^2 = \pi d ).</td>
<td>D</td>
</tr>
<tr>
<td>33 'O'</td>
<td>8</td>
<td></td>
<td>a. Changing fractions to decimals, not rounding off.</td>
<td>R</td>
</tr>
<tr>
<td>34 'O'</td>
<td>9</td>
<td></td>
<td>a. ( \pi = 3.143 ) quoted.</td>
<td>( \pi )</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Rounding off to 3.14 lead to inaccurate result.</td>
<td>R</td>
</tr>
<tr>
<td>Student</td>
<td>Level of Maths</td>
<td>Qn.</td>
<td>Errors</td>
<td>Reasons for failure</td>
</tr>
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<td>---------</td>
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<td>------------------</td>
</tr>
<tr>
<td>35 '0'</td>
<td>I</td>
<td>8</td>
<td>a. Errors in changing fractions to decimals. ( \frac{1}{5} = 0.10, \frac{7}{16} = 0.30, \frac{9}{3} = 0.30 )</td>
<td>C₄</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Both ( \pi ) and 1.5625 rounded off to two places too early. &lt;br&gt;b. ( 3.14 \times 1.56 = 6.594 ). Error in multiplication. ( 314 \times 100 = 31400 ). &lt;br&gt;c. Error in multiplication, ( 314 \times 50 = 1570 ).</td>
<td>R &lt;br&gt;P</td>
</tr>
<tr>
<td>36 '0'</td>
<td>I</td>
<td>9</td>
<td>a. Multiplication error, ( 1.25 \times 1.25 = 1.5725 ), error lay in ( 1.25 \times 0.05 = .0725 ) carrying figure error.</td>
<td>C₃</td>
</tr>
<tr>
<td>37 C.S.E.</td>
<td>1</td>
<td>5</td>
<td>a. ( \frac{5}{6} \div \frac{2}{3} = \frac{5}{6} \times \frac{3}{2} = \frac{5}{2} \times \frac{1}{2} = \frac{5}{2} = 2\frac{1}{2} ) &lt;br&gt;One denominator syndrome.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. Changing fractions to decimals, not rounding off when using to 2 d.p.</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Inaccurate result due to rounding off 1.5625 to 1.56 early in the calculation.</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>a. Could not see a constant difference. &lt;br&gt;Actual error was in transcribing his own figures. 0.086 was written as 0.068. &lt;br&gt;A reversal.</td>
<td>S</td>
</tr>
<tr>
<td>38 '0'</td>
<td>Arith.</td>
<td></td>
<td>No errors.</td>
<td></td>
</tr>
<tr>
<td>39 '0'</td>
<td></td>
<td>2</td>
<td>a. Starts by adding instead of subtracting and then moves into subtraction.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. Does not round off when using decimals to two places.</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. ( 3.142 \times 1.25 = 3.9265 ). A carrying figure error. &lt;br&gt;b. Rounds off to 3.92</td>
<td>C₃ &lt;br&gt;R</td>
</tr>
</tbody>
</table>
### Dip. H.E. Students without 'O' level

**Mathematics or Equivalent**

<table>
<thead>
<tr>
<th>Student</th>
<th>Level of Maths</th>
<th>Qn.</th>
<th>Errors</th>
<th>Reasons for failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>No 'O' level</td>
<td></td>
<td>No errors.</td>
<td></td>
</tr>
<tr>
<td>41</td>
<td>No 'O' level</td>
<td></td>
<td>No errors.</td>
<td></td>
</tr>
</tbody>
</table>
| 42      | No 'O' level   | 3   | a. Error in long multiplication.  
            Error due to neglect of a carrying figure. | C3 |
|         |                | 8   | a. Not always rounding off when using to two places of decimals. | R |
|         |                | 9   | a. Wrote $r^2 = \frac{25}{4}$, i.e. neglected to square the denominator of the fraction as well as the numerator. | D |
|         |                | 10  | a. Intervals seen as 0.014 but diameters given only as far as the No. 3 screw. | D |
| 43      | No 'O' level   | 1   | a. Addition error. Lost the 4th in the top number in scanning the numbers in the thousands column. | F |
|         |                | 3   | a. $625 \times 57$. Only the multiplication by 50 was carried out. | C3 |
|         |                | 8   | a. Conversion of fractions to decimals, some not rounded off when using to 2 d.p. | R |
|         |                |     | b. $1\frac{1}{2}$ as 1.75 | C4 |
|         |                | 9   | a. $\frac{1}{2}$ of $2\frac{1}{2} = 1.75$  
            Error in division, used rem. when there wasn't one. | C4 |
|         |                |     | b. Misquote $\frac{4}{4} = 3.172$ | H |
|         |                |     | c. Error in long multiplication.  
            Error $7 \times 7 + 3 = 51$. | C3 |
|         |                | 10  | a. Error in transcribing his own script  
            $0.112 = 0.122$ | F |
<table>
<thead>
<tr>
<th>Student</th>
<th>Level of Maths</th>
<th>Qn.</th>
<th>Errors</th>
<th>Reasons for failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>44</td>
<td>No 'O' level</td>
<td>3</td>
<td>a. Calculation not completed. Multiplication by 16 was not carried out.</td>
<td>F</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td>a. In the long division, there was a multiplication error, $16 \times 8 = 144$. He clearly knew it was 9 since he calculated $16 \times 8 = 128$, $128 + 16 = 144$ but did not acknowledge the 9 in the answer and so obtained $78.55 + 16 = 4.808$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. He repeats the error when he has $150$ thdths, $\div 16 = 8$ thdths. in answer instead of 9 thousandths.</td>
<td>F</td>
</tr>
<tr>
<td>45</td>
<td>No 'O' level</td>
<td>4</td>
<td>a. $\frac{7}{4} + \frac{7}{3} = \frac{14}{7}$ No concept of addition of fractions.</td>
<td>D</td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td>a. Tries the comparisons in fraction form. Does change all the fractions to sixteenths, but does not do anything with the 1.22</td>
<td></td>
</tr>
<tr>
<td>46</td>
<td>No 'O' level</td>
<td>4</td>
<td>a. Calculation not completed. The necessary long division was not carried out.</td>
<td>F</td>
</tr>
<tr>
<td>7</td>
<td></td>
<td></td>
<td>a. Not understanding concept in percentage calculation. Writes $150 \times 21$.</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td>a. Changes decimal to a fraction and tries to compare fractions.</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td>b. $1.22 = 1^{22/100} = 1^{11/50} = \text{approx} 1^{1/2}$.</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td>a. Incorrect formula $A = \pi d$.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Gets result 7.857 and writes this to two places as 7.85</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>a. Correctly gets intervals of 0.014 but does not add these to an existing screw diameter.</td>
<td></td>
</tr>
<tr>
<td>Student</td>
<td>Level of Maths</td>
<td>Qn.</td>
<td>Errors</td>
<td>Reasons for failure</td>
</tr>
<tr>
<td>---------</td>
<td>---------------</td>
<td>-----</td>
<td>------------------------------------------------------------------------</td>
<td>---------------------</td>
</tr>
</tbody>
</table>
| 47      | C.S.E. 2      | 3   | a. In long multiplication $625 \times 7 = 5075$. The carrying figures were correct. 
Error is in $6 \times 7 = 49$. | C3                  |
|         |               | 4   | a. $\frac{3}{4} + \frac{1}{3} = \frac{6 + 8}{12} = \frac{14}{12}$  | B3, D               |
|         |               | 5   | a. $\frac{5}{6} + \frac{2}{3} = \frac{5 \times 2}{6} = \frac{5 \times 2}{6}$ = $\frac{5}{3}$  
One denominator syndrome. | D                   |
| 48      | No 'O' level  | 3   | a. In long multiplication, neglects a carrying figure, hundreds to thousands. | C3                  |
|         |               | 4   | a. Converts each fraction to a decimal, adds and tries to convert result back to a fraction.  
$1\frac{1}{2} + 2\frac{1}{2} = 1.75 + 2.33 = 4.08 = 4\frac{1}{8}$ | D                   |
|         |               | 5   | a. Not attempted.                                                      | D                   |
|         |               | 6   | a. $\frac{3}{7} = 0.35$. No understanding of the value of these quantities. No working. | D                   |
|         |               | 8   | a. Tried to convert $1.22$ to a fraction and could not do it.           | D                   |
|         |               | 9   | a. $r^2 = \frac{72}{7} = \frac{700}{7} = \frac{88}{7}$ = $8.4$  
The second 'equals' sign is meant to be a multiplication sign. | F                   |
<p>|         |               |     | b. Cannot square $2.5$ if that is what the $200$ represents.            | D                   |
|         |               |     | c. Division error $88 \div 7 = 8.4$                                   | C4                  |
| 10      |               |     | a. Addition error $0.078$ $\frac{0.084}{1.62}$                       | P                   |
|         |               |     | All very neatly written.                                               |                     |</p>
<table>
<thead>
<tr>
<th>Student</th>
<th>Level of Maths.</th>
<th>Qn.</th>
<th>Errors</th>
<th>Reasons for failure</th>
</tr>
</thead>
</table>
| 49      | No 'O' level   | 5   | a. $\frac{5}{6} \div \frac{2}{3} = \frac{5}{6} \times \frac{3}{2}$ neglects to invert.  
|         |                |     | a. Not understanding the concept in percentage calculation, writes $\frac{21}{100} \times 150$. | D |
|         |                | 8   | a. Guesses result. | D |
| 50      | No 'O' level   | 5   | a. Transcribing error.  
|         |                |     | b. $\frac{5}{16} \div \frac{3}{2} = \frac{24}{5}$  
|         |                |     | Inverts first fraction instead of second and does not change the sign. | D |
|         |                | 7   | a. Finds 1% is 1.5. Then finds 6% is 9.  
|         |                |     | Seems to realise he needs to make the 21 but he adds 15 and 9 to make 21 and thus the % total is 16%. | B1 |
|         |                | 8   | a. Tries to change the fractions to decimals but uses the same basic techniques as converting fractions to percentages and is confused, e.g.  
|         |                |     | $\frac{1}{5} \times \frac{100}{5} = \frac{25}{2}$ | D |
|         |                |     | b. $\frac{17}{16} \div \frac{5}{16}$ are merely left in a muddle after the 'cancellation' process. | D |
|         |                | 9   | a. Long multiplication, $1.25 \times 1.25$  
|         |                |     | $1.25$  
|         |                |     | $1.25$  
|         |                |     | $.625$  
|         |                |     | $2.50$  
|         |                |     | $1.25$  
|         |                |     | $3.375$  
<p>|         |                |     | Multiplying by 0.05 means a shift of 2 places to the right. Here we have only one. | P |
|         |                |     | b. Multiplying by 0.2 means a shift of one place to the right. Here we have no shift. | P |
|         |                |     | c. In the multiplication above there is a neglect of the carrying figure from tenths to units. | F |
|         |                |     | d. In long multiplication $3.375 \times 3.14$ similar errors to those above. | P |</p>
<table>
<thead>
<tr>
<th>Student</th>
<th>Level of Maths.</th>
<th>Qn.</th>
<th>Errors</th>
<th>Reasons for failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>51</td>
<td>No 'O' level</td>
<td>4</td>
<td>a. $3\frac{2}{5} = 1\frac{2}{5}$ Not adding in the $\frac{2}{5}$.</td>
<td>F</td>
</tr>
</tbody>
</table>
|         |                | 8   | a. Conversion of fractions to decimals. 
|         |                |     | $\frac{3}{16} = \frac{3}{5} \times \frac{5}{16} = \frac{15}{80} = \frac{9}{48}$ 
|         |                |     | Lack of understanding of the meaning of $\frac{5}{16}$. Did get $\frac{3}{5}$ correct in No. 6 but only after two attempts. She is obviously not sure. | D |
|         |                | 9   | a. Incorrect formula, $A = \frac{1}{4}$. | E |
|         |                |     | b. Gives her answer in fraction form in spite of being asked for it to two places of decimals. | F |
| 52      | No 'O' level   | 4   | a. $1\frac{2}{3} + 2\frac{1}{3} = 1 \times 4 + 3 = \frac{7}{4}$ 
|         |                |     | $2 \times 3 = 6 + 1 = \frac{7}{3}$ 
|         |                |     | Carefree sprinkling of equals signs. | F |
|         |                |     | b. $\frac{7}{4} + \frac{7}{3} \neq \frac{7}{4} \times \frac{7}{3} = \frac{49}{12}$ | D |
|         |                |     | c. $\frac{49}{12} = 4.08 \neq 4\frac{1}{12}$. | D |
|         |                | 6   | a. $\frac{3}{5} \neq \frac{3}{5} \times \frac{25}{1} = \frac{75}{1}$ 
|         |                |     | Using an equivalence idea but error is in $100 \div 5 = 25$. | C4 |
|         |                | 7   | a. Not understanding the concept in the calculation of percentages. 
<p>|         |                |     | Writes $\frac{150}{100} \times 21$. | D |
|         |                | 8   | a. No idea of how to proceed. | D |
|         |                | 9   | a. No idea of how to proceed. | D |</p>
<table>
<thead>
<tr>
<th>Student</th>
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<th>Qn.</th>
<th>Errors</th>
<th>Reasons for failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>53</td>
<td>No 'O' level</td>
<td>4</td>
<td>a. $1\frac{1}{2} + 2\frac{1}{4} = 3\frac{1}{4}$. No concept of the addition of fractions.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. $\frac{5}{6} - \frac{2}{3} = \frac{5}{6} \times \frac{3}{2} = \frac{5}{4}$ Ans. $\frac{4}{5}$. Inverts the answer.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Conversion of a fraction to a decimal. $\frac{2}{5} = 0.35$. No concept of conversion. No concept of place value.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Not understanding the concept in percentage calculation. Writes $\frac{21}{100} \times 150$.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. No attempt made.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Incorrect formula $A = \pi D$. b. $3\frac{1}{2} \times 2\frac{1}{2} = 6\frac{1}{4}$. No concept of multiplication of mixed fractions - distributive Law.</td>
<td>E, D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>a. Adds the first three sizes to get No. 8. Basically has no idea of the progression.</td>
<td>D</td>
</tr>
<tr>
<td>54</td>
<td>No 'O' level</td>
<td>2</td>
<td>a. Tries to subtract $4877 - 21342$</td>
<td>-23525</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. $\frac{7}{4} + \frac{7}{3} = \frac{14}{7} = 2$. No concept of addition of fractions.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. $\frac{5}{6} - \frac{2}{3} = \frac{5}{6} \times \frac{3}{2} = \frac{5}{2}$ No concept of division of fractions.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Made no attempt.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Not understanding the concept in percentage calculation. Writes $\frac{150}{100} \times 21$.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. $1.22 = 1\frac{22}{100} = 1\frac{11}{12}$ No concept of conversion decimals to fractions. Place value. b. Tries to compare in fraction form.</td>
<td>D, P</td>
</tr>
<tr>
<td>Student of Maths</td>
<td>Level</td>
<td>Qn.</td>
<td>Errors</td>
<td>Reasons for failure</td>
</tr>
<tr>
<td>-----------------</td>
<td>-------</td>
<td>-----</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>---------------------</td>
</tr>
<tr>
<td>54 cont'd. 'O'</td>
<td>9</td>
<td>a. Incorrect formula $A = \pi D$.</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Had to multiply $\frac{3}{2} \times \frac{1}{2}$ and did not do it. No concept of multiplication of fractions.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>a. Recognises the correct progression but there are two addition errors in the calculation of No. 8. 0.078 + 0.014 = 0.082</td>
<td>C₁</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Carrying figure error. Similar error later.</td>
<td>C₁</td>
<td></td>
</tr>
<tr>
<td>55 No 'O' level</td>
<td>1</td>
<td>a. Addition error. Error lies in 'carrying' figure.</td>
<td>C₁</td>
<td></td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>a. Transcribing error.</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. $\frac{1}{2} + \frac{2}{4} = 3 \frac{3}{4} + \frac{1}{2} = \frac{43}{8}$. No concept of addition of fractions and equivalence.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>a. $\frac{5}{6} \div \frac{2}{3} = \frac{5}{2} \times \frac{3}{2} = \frac{5}{2}$</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>Poor layout, but seems to have forgotten the other 2 in the denominator.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Knows $\frac{1}{7}$ as $0.25$ but is unable to convert the other fractions to decimals.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Believes $\pi r^2$ is equivalent to $2 \pi r$.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>56 No 'O' level</td>
<td>3</td>
<td>a. Error in addition in this long multiplication. Error probably lies in the inclusion of a 'carrying' figure from 10 thousands to 100 thousands when there wasn't one.</td>
<td>C₃</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Changing fractions to decimals, careless about the expression to 2 d.p. No rounding off.</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Error in long multiplication. Uses the counting of places way of locating the decimal point and is inaccurate. $1.25 \times 1.25 = 158.25$, (does not see she is incorrect).</td>
<td>C₃</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. 'Carrying' figure error also.</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. 'Carrying figure errors in a second long multiplication.</td>
<td>C₃</td>
<td></td>
</tr>
<tr>
<td>Student</td>
<td>Level of Maths</td>
<td>Qn.</td>
<td>Errors</td>
<td>Reasons for failure</td>
</tr>
<tr>
<td>---------</td>
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<td>-------------------</td>
</tr>
<tr>
<td>56</td>
<td></td>
<td>10</td>
<td>a. Insufficient intervals of 0.014 for the No. 8 screw.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>57</td>
<td>No '0' level</td>
<td>3</td>
<td>a. Neglects to complete the multiplication. Does not multiply by the 7 units of 57.</td>
<td>C3 F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Not understanding the concept in calculation of percentage. Writes 150x21 ÷ 100</td>
<td>D</td>
</tr>
</tbody>
</table>
|         |                | 8   | a. Conversion of fractions to decimals. \[
|         |                |     | \[\frac{17}{16} = 0.94 \quad \frac{9}{8} = 0.88\] |        |
|         |                |     | \[\frac{5}{4} = 0.8\] Rounding error. |
|         |                |     | Division is made of numerator into denominator. Concept of these amounts is lacking. | D     |
|         |                | 9   | a. Believes that \[\pi r^2\] is equivalent to \[2\pi r\]. | D     |
|         |                |     | b. In the division 55 ÷ 7 error. Error lies in multiplication and 7 x 7 = 35. | C4 B3 |
|         |                | 10  | a. Correct intervals are observed. Errors in addition, 0.078 + 0.014 = 0.112 Bond error 1 + 1 + 7 = 11. | C1 H1 |

<p>| 58      | No '0' level   | 5   | a. [\frac{5}{2} \div \frac{10}{8} = \frac{1}{6} \div \frac{12}{12} = \frac{1}{12}] No concept of division of fractions. | D     |
|         |                | 7   | a. Confusing the number with the percentage. Finds that 1% is 1.5 and then finds 21 x 1.5 instead of finding the number of 1.5's in 21. | D     |
|         |                | 8   | a. Guessing the result. | D     |
|         |                | 9   | a. [3.14 \times 1.25^2 = 490.47] Place value error. | C3 P  |
|         |                |     | b. Rounding too early results in inaccurate result to 2 d.p. | R     |</p>
<table>
<thead>
<tr>
<th>Student</th>
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<th>Errors</th>
<th>Reasons for failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>59 No 'O' level</td>
<td>5</td>
<td>a. $\frac{5}{6} \div \frac{2}{3} = \frac{15}{6} \times \frac{6}{4} = \frac{60+36}{12} = 8$. Transcribing error.</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. One denominator syndrome with multiplication of fractions not understood. The transcribing of x to + may have added to the confusion.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Clearly thinks of the denominator as $6 \times 4$ and works to this, but writes 12.</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>60 No 'O' level</td>
<td>4</td>
<td>a. $1\frac{1}{2} + 2\frac{3}{4} = 1.75 + 2.33 = 4.08 = \frac{408}{66}$. No concept of division of fractions.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Place value concept poor. $0.08 = \frac{1}{8}$.</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>a. $\frac{5}{6} \div \frac{2}{3} = \frac{15}{6} \times \frac{6}{4} = \frac{60+36}{12} = 8$. Converted to decimals and used equivalence of fractions. Rounding error.</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. $\frac{83}{66} = 1.2$ Division not continued and so there is a rounding error.</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>a. Not understanding the concept in calculation of percentages. Writes $150 \times \frac{21}{100}$.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. $17 = 0.88$ Numerator is divided into denominator. Concept of these amounts is lacking.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Error in long division $16 \div 17$. Lies in a multiplication band error $7 \times 8 = 64$.</td>
<td>B3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. $2 = 0.88$. Has not seen that both $\frac{8}{9}$ fractions cannot be same decimal.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. Rounding error.</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Incorrect formula $A = 2\pi r$.</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Multiplication of fractions not carried out.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>a. Did not give No. 8 screw but No. 7. Counted 8 screws but forgot the start screw 0.</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>Student No</td>
<td>Level of Maths</td>
<td>Qn.</td>
<td>Errors</td>
<td>Reasons for failure</td>
</tr>
<tr>
<td>------------</td>
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<td>-------------------</td>
</tr>
<tr>
<td>61</td>
<td>No '0' level</td>
<td>4</td>
<td>a. $\frac{1}{2} + \frac{2}{3} = \frac{7}{9}$</td>
<td>C3</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Multiplication error $2 \times 3 = 8$</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>or, still thinking of quarters from the first fraction.</td>
<td>B3</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>a. Did not attempt this question.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>a. Gets down to $1%$ 1.5. Multiplies 1.5 by 21 and thinks this is a $%$ instead of finding how many 1.5's in 21 to give percentage.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>a. Changes 0.22 to 11 and tries to compare in fraction form.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>a. Incorrect formula $A = \pi r$.</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. $\frac{22 \times 1\frac{4}{7}}{110} = \frac{110}{28}$ i.e. neglects the 1.</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. In long division $110 \div 28$</td>
<td>C4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$28 \times 6 = 158$. Carrying error.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. In long division $110 \div 28$</td>
<td>B2</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$110 - 84 = 16$. Bond error $11 - 9 = 1$.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>e. In long division $110 \div 28$</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>division 2ths are changed to 20 hths. 20 hths. $\div 28 = 7$, i.e. he changed to thdths. but did not enter zero in hths. col.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>f. In long division $110 \div 28$</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$36.71$. Place value error.</td>
<td></td>
</tr>
<tr>
<td>10.</td>
<td></td>
<td>a. $0.092 + 0.014 = 0.0106$.</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Place value error.</td>
<td></td>
</tr>
<tr>
<td>62</td>
<td>No '0' level</td>
<td>3</td>
<td>a. $625 \times 57$, neglects to multiply by the 7.</td>
<td>F</td>
</tr>
<tr>
<td>5</td>
<td></td>
<td>5</td>
<td>a. $\frac{5}{6} + \frac{2}{3} = 1$ after crossing out correct value of $\frac{15}{12}$.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a. Converting a fraction to a decimal $\frac{35}{30} = 0.06$</td>
<td>P</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>No indication is made of the value of the three, nought. Place value error.</td>
<td></td>
</tr>
<tr>
<td>Student</td>
<td>Level of Maths.</td>
<td>Qn.</td>
<td>Errors</td>
<td>Reasons for failure</td>
</tr>
<tr>
<td>---------</td>
<td>----------------</td>
<td>-----</td>
<td>----------------------------------------------------------------------</td>
<td>---------------------</td>
</tr>
</tbody>
</table>
| 62 (cont'd.) |                | 8   | a. Attempts to change 1.22 to a fraction.  
\[
\frac{22 \times 100}{100} = \frac{22}{12} = \frac{11}{6}
\]
and  
\[
\frac{22 \times 12}{100 \times 100} = \frac{42}{125}
\]
No idea of the concept, especially place value. | D                   |
|         |                |     | b. Tries to compare them as fractions.                                | D                   |
| 9       |                |     | a. Thinks $\pi r^2$ is equivalent to $2\pi r$.                       | D                   |
| 63      | No '0' level   | 7   | a. Not understanding the concept in calculation of percentages.      | D                   |
|         |                |     | Writes $\frac{150 \times 21}{100}$.                                  |                     |
|         |                | 8   | a. Not rounding off quantities when considering them to 2 decimal places. | R                   |
|         |                |     | b. $\frac{3}{8} = 0.33$. Division error.                            | C                  |
|         |                | 9   | a. Quotes $\pi$ as 3.1                                              | A                   |
|         |                |     | b. $\frac{5 \times 5}{4 \times 4} = \frac{25}{20}$. Reversal of 4 and 5 in thinking. | S                   |
|         |                |     | c. He has $1\frac{1}{2} \times 1\frac{1}{2} = 1\frac{1}{4}$. Does not see error. | F                   |
| 64      | No '0' level   | 9   | a. In the long multiplication. Error due to a number bond error $5 + 2 = 5$. Lost the 2 in the scan. | G                  |
|         |                |     |                                                                       | F                   |
Teacher's Certificate Students with 'O' level Mathematics or equivalent

<table>
<thead>
<tr>
<th>Student</th>
<th>Level of Maths</th>
<th>Qn.</th>
<th>Errors</th>
<th>Reasons for failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>'O' level</td>
<td>1</td>
<td>a. Addition error, neglected to add in the carrying figure.</td>
<td>C1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. Tries to compare in fraction form.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Thinks ( r^2 = 2r ).</td>
<td>D</td>
</tr>
<tr>
<td>2</td>
<td>'O' level</td>
<td>8</td>
<td>a. Tries to compare in fraction form</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Incorrect formula ( A = \sqrt{d} ).</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Quotes ( \sqrt{9} = 22.37 ).</td>
<td>( \text{As} )</td>
</tr>
<tr>
<td>3</td>
<td>'A' level</td>
<td>8</td>
<td>a. Conversion of fraction to a decimal. ( 1\frac{11}{16} = 1.625 ). Division error. Place value.</td>
<td>C4 P</td>
</tr>
<tr>
<td>4</td>
<td>'O' level</td>
<td>8</td>
<td>a. Not attempted.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Did not complete the calculation.</td>
<td>F</td>
</tr>
<tr>
<td>5</td>
<td>C.S.E. level</td>
<td>3</td>
<td>a. Addition errors in the long multiplication. C1</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. Tries to compare as fractions.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Writes ( \frac{11}{30} = \frac{1}{5} ) for comparison purposes.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Thinks ( \pi r^2 ) means ( (\pi r)^2 ).</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Rounding error.</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>c. In long multiplication addition error a number lost in the scan. Untidy layout.</td>
<td>C1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>a. Addition error. Lost carrying figure.</td>
<td>C1</td>
</tr>
<tr>
<td>6</td>
<td>'O' level</td>
<td>1</td>
<td>a. Addition error.</td>
<td>C1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. Tries to compare in fraction form.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Equates ( 1\frac{1}{4} ) with 1.22</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Makes ( 1\frac{1}{4} \times 1\frac{1}{4} = 1\frac{1}{16} ) Distribution law for fractions.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Rounding too early in calculation.</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>c. Error in long multiplication calculation.</td>
<td>C3</td>
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<tr>
<td>Student</td>
<td>Level of Maths.</td>
<td>Qn.</td>
<td>Errors</td>
<td>Reasons for failure</td>
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<tr>
<td>7</td>
<td>C.S.E. 1</td>
<td>3</td>
<td>a. Error in long multiplication. Neglected to enter a figure.</td>
<td>C3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Not understanding the concept in percentage calculation. Writes $150 \times \frac{21}{100}$</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. Guessing at the result.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Not attempted.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>a. Not attempted.</td>
<td>D</td>
</tr>
<tr>
<td>8</td>
<td>'O' level</td>
<td>8</td>
<td>a. Changing a fraction to a decimal $\frac{1}{16} = 0.05125$</td>
<td>C4</td>
</tr>
<tr>
<td></td>
<td>and Addl. Maths.</td>
<td></td>
<td>Incorrect division $100 \div 16 = 5$.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Incorrect formula $A = \frac{1}{11} d$.</td>
<td>E</td>
</tr>
<tr>
<td>9</td>
<td>'O' level</td>
<td>1</td>
<td>a. Addition error.</td>
<td>C1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. Cannot deal with this, many indistinct attempts, scribbled out.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. Not attempted.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Conversion of fraction to a decimal $\frac{3}{5} = 0.005$</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Not comprehending the idea of $\frac{3}{5}$ or of $0.005$.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Starts correctly, then cannot calculate $21 \times 100$. Divides $2100 \div 150 = 6$.</td>
<td>C4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. Guesses result incorrectly.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Scribbled attempts with no form to them.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>a. Counts only 6 screws and does not arrive at number 8.</td>
<td>D</td>
</tr>
<tr>
<td>10</td>
<td>'O' level</td>
<td>2</td>
<td>a. Error in equal addition. The 1 ten not added in.</td>
<td>C2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. Not attempted.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Not attempted.</td>
<td>D</td>
</tr>
<tr>
<td>Student Level of Maths.</td>
<td>Qn.</td>
<td>Errors</td>
<td>Type of Error</td>
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<td>----------------------------------------------------------------------</td>
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</tr>
<tr>
<td>11 'O' level</td>
<td>5</td>
<td>a. ( \frac{5}{6} \div \frac{4}{6} = \frac{1\frac{3}{6}}{6} ). Lacks understanding of meaning here.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. ( \frac{1\frac{3}{6}}{6} = \frac{5}{6} ). Does not understand how to handle this fractional form.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>a. Only converts ( \frac{1}{2} ) to a decimal, guesses other relationships incorrectly.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>a. Incorrect formula ( d ).</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Writes ( d = 1\frac{1}{2} ).</td>
<td>F</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td>c. Writes ( = \frac{7}{22} ) or 0.33</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. ( 1\frac{1}{2} \times 1\frac{1}{2} = 16.5^2 )</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>e. ( 66 + 16.5^2 = 82.5^2 ). Adds first.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>12 C.S.E. 1</td>
<td>7</td>
<td>a. Not understanding the concept in percentage calculation. Writes ( \frac{150 \times 100}{21} ).</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>a. Answer not given to 2 d.p.</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>13 'O' level</td>
<td>6</td>
<td>a. Does not know how to change a fraction to a decimal. Nor perhaps equivalence to see ( \frac{9}{10} ) in this case.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>a. Not understanding the concept in percentage calculation. Writes ( \frac{21}{100} \times 150 ).</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>a. Incorrect form. Area ( = l \times b ).</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>a. Understands constant difference of 0.014 but adds 8 of these to 8 times the diameter of the No. 0 screw.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>14 C.S.E. 1</td>
<td>5</td>
<td>a. ( \frac{5}{6} \div \frac{2}{3} = \frac{6 \times 2}{5 \times 3} ) Changes sign and inverts first fraction.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. ( \frac{6 \times 2}{5 \times 3} = \frac{18 \times 10}{15} ) One denominator syndrome.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td></td>
<td>a. No idea at all.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td>a. Compares as fractions.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>a. Incorrect formula ( A = 2d ).</td>
<td>E</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. ( 2 \times 2.5 = 4.25 )</td>
<td>C3</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td></td>
<td>a. Addition error. Carry number missed.</td>
<td>C1</td>
<td></td>
</tr>
<tr>
<td>Student</td>
<td>Level of Maths.</td>
<td>Qn.</td>
<td>Errors</td>
<td>Type of Error</td>
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<td>---------</td>
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<td>------------------------------------------------------------------------</td>
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<tr>
<td>15</td>
<td>'O' level</td>
<td>3</td>
<td>a. Addition error in long multiplication.</td>
<td>C₁</td>
</tr>
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<td></td>
<td></td>
<td>8</td>
<td>a. Compares in fraction form.</td>
<td>D</td>
</tr>
<tr>
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<td></td>
<td>9</td>
<td>a. Incorrect formula $A = dr^2$.</td>
<td>E</td>
</tr>
<tr>
<td>16</td>
<td>'O' level</td>
<td>4</td>
<td>a. In changing $1\frac{1}{2}$ to a fraction in 12ths. Divides 12 by 4</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>and then multiplies the whole number by that 3 and adds in the other 3</td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>and so gets $1\frac{1}{2} = \frac{9}{12}$.</td>
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<td></td>
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<td>7</td>
<td>a. Not understanding the concept in percentage calculation. Writes</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$150 \times \frac{21}{100}$</td>
<td></td>
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<td></td>
<td></td>
<td>8</td>
<td>a. Not attempted.</td>
<td>D</td>
</tr>
<tr>
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<td>9</td>
<td>a. Error in long multiplication.</td>
<td>C₃</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>$3.9275 \times 1.25 = 1.02115$. Error lay in the treating of the 1.25</td>
<td>P</td>
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<td></td>
<td></td>
<td></td>
<td>as 125 and multiplying by the 100. The placing of the numbers was</td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td>incorrect by two places to the right.</td>
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<tr>
<td>17</td>
<td>'O' level</td>
<td>7</td>
<td>a. Not understanding the concept in percentage calculation. Writes</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$150 \times \frac{21}{100}$</td>
<td></td>
</tr>
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<td></td>
<td></td>
<td>9</td>
<td>a. Long division $275 \div 56 = 1.91$</td>
<td>C₄</td>
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<tr>
<td>18</td>
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<td>9</td>
<td>a. Not attempted.</td>
<td>D</td>
</tr>
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<td></td>
<td>Maths. SP</td>
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<td></td>
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<td></td>
<td>Arith. 'O'</td>
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<td>Qn.</td>
<td>Errors</td>
<td>Type of Error</td>
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<tr>
<td>19 'O' level</td>
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</tr>
<tr>
<td>3</td>
<td>a.  Carrying figure error.</td>
<td>C3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>a.  $\frac{1}{2} + \frac{2}{4} = \frac{3}{4}$. Addition of corresponding numbers. No concept of addition of fractions.</td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>a.  $\frac{5}{6} \div \frac{2}{3} = \frac{1}{6} \div \frac{2}{3} = \frac{1}{6}$ No concept of division of fractions.</td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>a.  $\frac{3}{5} = 0.35$. No concept of conversion of fractions or of meaning of $\frac{3}{5}$ in relation to denary system.</td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>a.  Not attempted.</td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>a.  Not attempted.</td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>a.  Not attempted.</td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>a.  Not attempted.</td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20 'O' level</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>a.  No concept of addition of fractions.</td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>a.  $\frac{5}{6} \div \frac{2}{3} = \frac{5}{6} \cdot \frac{3}{2}$ Inverts second fraction but does not multiply.</td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>a.  Rounding errors.</td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.  Place value errors in converting fractions to decimals by division.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\frac{1}{2} = 0.025$</td>
<td>DP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\frac{1}{16} = 0.03$</td>
<td>DP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>$\frac{1}{8} = 0.03$</td>
<td>DP</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>c.  Division error in converting fraction to a decimal.</td>
<td>C4</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>a.  Not attempted.</td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>a.  Not attempted.</td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21 'O' level</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>a.  Thinks $r^2 = 2r$.</td>
<td>D</td>
<td></td>
<td></td>
</tr>
<tr>
<td>b.  Changing fraction to a decimal $\frac{6}{7} = 0.09$ Place value error in division.</td>
<td>C4 P</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>a.  Only finds diameter of the seventh screw. Not seen that screw 0 is the 1st.</td>
<td>F</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Student</td>
<td>Level of Maths</td>
<td>Qn.</td>
<td>Errors</td>
<td>Type of Error</td>
</tr>
<tr>
<td>---------</td>
<td>----------------</td>
<td>-----</td>
<td>--------</td>
<td>---------------</td>
</tr>
<tr>
<td>22</td>
<td>No 'O' level.</td>
<td>8</td>
<td>a. Guessing the result.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>No 'O' level.</td>
<td>9</td>
<td>a. Incorrect formula $A = \pi d$.</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td>Failed 'O'</td>
<td></td>
<td>b. Changing fraction to a decimal $\frac{6}{7} = 0.08$&lt;br&gt;Place value error in division.</td>
<td>C₄</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>c. Rounding error when given to two places of decimals.</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>a. Calculation error in multiplication.&lt;br&gt;$0.014 \times 6 = 0.104$&lt;br&gt;$1 \times 6 + 2 = 10$</td>
<td>C₃</td>
</tr>
<tr>
<td>23</td>
<td>No 'O' level.</td>
<td>3</td>
<td>a. In multiplication.&lt;br&gt;Bond error $6 \times 5 = 35$</td>
<td>C₃</td>
</tr>
</tbody>
</table>
|         | Failed 'O'     | 7   | a. Correct concept.<br>\[
\frac{27}{130} \times \frac{102}{130} = \frac{9}{130} \\
\frac{12}{130}
\]
Add instead of multiplies. | F |
<p>|         |                | 8   | a. Not attempted. | D |
|         |                | 9   | a. Not attempted. | D |
| 24      | No 'O' level.  | 4   | a. No concept of addition of fractions,&lt;br&gt;adds corresponding elements. | D |
|         | No Maths. after 14 yrs. | 5   | a. Not attempted. | D |
|         |                | 6   | a. Not attempted. | D |
|         |                | 7   | a. A jumble of figures headed by 150 is 21. | D |
|         |                | 8   | a. Not attempted. | D |
|         |                | 9   | a. Not attempted. | D |
|         |                | 10  | a. Not attempted. | D |</p>
<table>
<thead>
<tr>
<th>Student Level of Maths.</th>
<th>Qn.</th>
<th>Errors</th>
<th>Type of Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>25 C.S.E. 3 Grade 2</td>
<td>5</td>
<td>a. No concept of division of fractions.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>a. Not understanding the concept in percentage calculation. Writes ( \frac{21}{100} \times 150 ).</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Guessing the result. No method.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Not attempted.</td>
<td>D</td>
</tr>
<tr>
<td>26 C.S.E. 4 Grade 5</td>
<td>5</td>
<td>a. No concept of division of fractions.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>a. No concept of converting fraction to a decimal or of value of the fraction in relation to the denary system ( \frac{3}{5} = 3.5 ).</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>a. Not understanding the concept in percentage calculation. Writes ( \frac{150}{100} \times \frac{21}{100} ).</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Not attempted.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Not attempted.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>a. Not attempted.</td>
<td>D</td>
</tr>
<tr>
<td>27 C.S.E. 1 Grade 2</td>
<td>1</td>
<td>a. Error in result due to addition. A carrying figure error.</td>
<td>C_1 F</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Thinks ( r^2 = 2r ).</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Converting fraction to a decimal ( \frac{67}{100} = 0.09 ). Place value error.</td>
<td>C_4 P</td>
</tr>
<tr>
<td>Student</td>
<td>Level of Maths</td>
<td>Qn.</td>
<td>Errors</td>
</tr>
<tr>
<td>---------</td>
<td>----------------</td>
<td>-----</td>
<td>-----------------------------------------------------------------------</td>
</tr>
<tr>
<td>28</td>
<td>C.S.E. 4</td>
<td>2</td>
<td>a. Tries to take the larger number from the smaller. Subtracts individual digits. Is confused by the 2 ten thousands.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. (\frac{13}{12} = \frac{17}{13}) Reversal.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. This division of decimals is in working treated as an addition.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Not understanding the concept in the calculation of a percentage.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. Writes (\frac{12}{2} = 1.22) and makes that reason for choice.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. No concept.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Changing fraction to a decimal (\frac{5}{2} = 2.5)</td>
</tr>
<tr>
<td>29</td>
<td>C.S.E. 2</td>
<td>5</td>
<td>a. (\frac{5}{6} : \frac{2}{3} = \frac{5 \times 2}{3 \times 2} = \frac{5}{2} = \frac{9}{6} = \frac{45}{6}) The one denominator syndrome.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. Writes 1.22 in fraction form (\frac{11}{50}) and tries to compare in fraction form.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Incorrect formula (A = L \times B).</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>a. Addition error in series. Added in a carrying figure when there was not one.</td>
</tr>
<tr>
<td>30</td>
<td>Failed '0' level</td>
<td>7</td>
<td>a. Not understanding concept in the calculation of percentages.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Writes (\frac{21}{100} \times 150)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. Tries to compare in fraction form.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Tries to compare through a sketched diagram of fractions.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Incorrect formula (A = d \times r)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Rounding error in giving result to 2 decimal places.</td>
</tr>
<tr>
<td>Student</td>
<td>Level of Maths.</td>
<td>Qn.</td>
<td>Errors</td>
</tr>
<tr>
<td>---------</td>
<td>----------------</td>
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<td>--------</td>
</tr>
<tr>
<td>31 C.S.E. 3</td>
<td>7</td>
<td>a. Not understanding concept in the calculation of percentages. Writes ( \frac{21 \times 150}{100} ).</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Compares in fraction form.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Equates 1.22 and ( 1\frac{3}{10} ).</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. After crossing out ( A = \pi r^2 ) writes diameter = ( \frac{1}{2} ) area.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Writes area = ( 2\frac{1}{4} ), hence diameter ( 1\frac{1}{4} ).</td>
<td>D</td>
</tr>
<tr>
<td>32 C.S.E. 3</td>
<td>1</td>
<td>a. Addition errors. Lost the top 4 thousands in the scan.</td>
<td>C1</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. In the long division we have ( 56 \times 9 = 494 ). The 4's and 5's in the multiplication are reversed.</td>
<td>C4</td>
</tr>
<tr>
<td>33 Only Arith. to age of 15.</td>
<td>4</td>
<td>a. No idea of equivalence.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. No idea of distributive law. ( \frac{2 + 1}{4} ) writes ( \frac{2}{4} ).</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>a. No concept of division of fractions.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>a. Not attempted conversion of fraction to a decimal.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>a. Not understanding the concept in the calculation of percentages. ( 150 \times \frac{21}{100} ).</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Guesses incorrectly. No method.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Not attempted.</td>
<td>D</td>
</tr>
<tr>
<td>Student</td>
<td>Level of Maths</td>
<td>Qn.</td>
<td>Errors</td>
</tr>
<tr>
<td>---------</td>
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<td>--------</td>
</tr>
<tr>
<td>34</td>
<td>No 'O' level</td>
<td>4</td>
<td>a. Addition bond error $9 + 4 = 12$.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. Writes $1.22 = 1\frac{1}{2}$.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Not attempted.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>a. Multiplication $0.014 = 1.12$&lt;br&gt;Place value error.&lt;br&gt;b. Answer was given as the sum of the differences.</td>
</tr>
<tr>
<td>35</td>
<td>Failed C.S.E.</td>
<td>3</td>
<td>a. Neglected to multiply by the 10 when multiplying by 16.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>4</td>
<td>a. No concept of addition of fractions.&lt;br&gt;Adds corresponding parts.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. No concept of conversion of fractions to decimals or of the value of the fraction in relation to the denary system. $\frac{3}{6} = 56, \frac{2}{7} = 23$.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Attempts the division $56 \div 23$ but has little idea of how to proceed.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$24$&lt;br&gt;$23 \div 56$&lt;br&gt;$46 \times 1$&lt;br&gt;$100$&lt;br&gt;$92$&lt;br&gt;$8$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Not attempted.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Not understanding the concept in the calculation of percentages.&lt;br&gt;Writes $21 = 150$.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. Not attempted.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Not attempted.</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>a. Transcribing error $0.078 = 0.78$</td>
</tr>
<tr>
<td>Student</td>
<td>Level of Maths</td>
<td>Qn.</td>
<td>Errors</td>
</tr>
<tr>
<td>---------</td>
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<td>------------------------------------------------------------------------</td>
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<tr>
<td>36</td>
<td>C.S.E. 2</td>
<td>8</td>
<td>a. Changing fractions to decimals.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>In the division place value errors.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>e.g. $\frac{31}{16} = 62.8$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$\frac{1}{8} = 124.8$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$\frac{3}{16} = 187.$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$\frac{1}{2} = 25.$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$\frac{5}{16} = 31.$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$\frac{1}{3} = 3.$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. In the above there are calculation errors also in the division, e.g.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>$\frac{4}{16} = 62.8$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>remainder 8 at the end is written as .8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>and $\frac{4}{5} = 124.8$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>c. Rounding not observed.</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td></td>
<td>a. Incorrect formula $A = \pi d$.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. Quotes $\pi = 3\frac{1}{3}$.</td>
</tr>
<tr>
<td>10</td>
<td></td>
<td></td>
<td>a. Correctly sees steps but does not take sufficient to get screw No. 8</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Does not see that screw No. 0 is the first.</td>
</tr>
</tbody>
</table>

<p>| 37      | C.S.E. 3       | 4   | a. Long multiplication $2 \times 6 + 3 = 21$.                          | G3            |
|         |                |     | The carrying figure is 3 and so the 2 gets thought of as 3 and is     |               |
|         |                |     | multiplied by the 6. Reversal error.                                   | S             |
|         |                |     | a. This addition is treated as a multiplication and, in view of the   | D             |
|         |                |     | overall lack of understanding of fractions, must be taken as a concept |               |
|         |                |     | error.                                                                |               |
|         |                |     | 5. writes $\frac{5}{6} = \frac{30}{6}$ and $\frac{2}{3} = \frac{6}{3}$. | D             |
|         |                |     | 6. $\frac{3}{5} = 0.35$, no concept of changing to a decimal.         | D             |
|         |                |     | 8. Guessing result, no method.                                         | D             |
|         |                |     | 9. Incorrect formula $A = \pi d$.                                      | E             |
|         |                |     | b. Quotes $\pi = 3\frac{1}{3}$.                                       | $\pi$         |
| 10      |                |     | a. Correctly sees the steps but does not take sufficient to get screw No. 8. Does | F             |</p>
<table>
<thead>
<tr>
<th>Student</th>
<th>Level of Maths</th>
<th>Qn.</th>
<th>Errors</th>
<th>Type of Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>38 C.S.E. 3</td>
<td>7</td>
<td>a. Division error, $42 \div 3 = 16$.</td>
<td>C4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. $\frac{14}{7} = 1.18$. Conversion fraction to decimal. No problem with previous one ($\frac{3}{5}$) because it was changed to tenths. No other fractions considered.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. $\frac{17}{9} = 1.14$. Changing fraction to a decimal. Concept error.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. In long multiplication, an addition error $4 \times 4 + 1 = 8$.</td>
<td>C3</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. $\pi$ quoted as 33.</td>
<td>B1</td>
<td></td>
</tr>
<tr>
<td>39 C.S.E. 4</td>
<td>9</td>
<td>a. Thinks $r^2 = 2r$.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Conversion $\frac{6}{7}$ to decimal = 0.08 Division error of place value nature.</td>
<td>C4</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Rounding error to 2 decimal places.</td>
<td>R</td>
<td></td>
</tr>
<tr>
<td>40 No qual.</td>
<td>5</td>
<td>a. No idea of division of fractions.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>a. $\frac{3}{5} = 0.35$ No concept of changing a fraction to a decimal or of relation of this fraction to denary system.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>a. Not understanding the concept when calculating a percentage. Writes $\frac{21}{150} \div \frac{150}{100}$</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Guessing, incorrectly.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Not attempted.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>a. Not attempted.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td>41 No 'O' level</td>
<td>6</td>
<td>a. Not attempted.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>a. Not understanding concept when calculating a percentage. Writes $150 \times \frac{21}{100}$</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Guessing result. No method.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Answer not given to 2 decimal places but left as $\frac{275}{3}$.</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td>Student</td>
<td>Level of Maths.</td>
<td>Qn.</td>
<td>Errors</td>
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<tr>
<td>---------</td>
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<tr>
<td>42</td>
<td>R.S.A. Arith. Stage 1</td>
<td>3</td>
<td>a. In long multiplication addition error. $14 + 3 = 18$.</td>
<td>$G_3$</td>
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<tr>
<td></td>
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<td>5</td>
<td>a. Not attempted beyond putting them both in sixths.</td>
<td>$D$</td>
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<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. No concept of percentage when related to quantities other than 100.</td>
<td>$D$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. Correct working and method but neglects to give a result.</td>
<td>$F$</td>
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<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Not attempted.</td>
<td>$D$</td>
</tr>
<tr>
<td>43</td>
<td>Failed 'O' level</td>
<td>4</td>
<td>a. Transcribing error.</td>
<td>$F$</td>
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<tr>
<td></td>
<td></td>
<td>6</td>
<td>b. No concept of addition of fractions. Adds corresponding elements.</td>
<td>$D$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>a. $\frac{3}{5} = 0.60$ No concept of size of fraction and relationship to denary system.</td>
<td>$D$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. Guesses result incorrectly.</td>
<td>$D$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Answer not given to 2 decimal places.</td>
<td>$D$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>a. Not attempted.</td>
<td>$D$</td>
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<tr>
<td>44</td>
<td>C.S.E. 3</td>
<td>3</td>
<td>a. Long multiplication when multiplying by 50 the digits were placed in incorrect columns. Place value error.</td>
<td>$G_3$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>b. As above: when multiplying by 16, a place value error.</td>
<td>$G_3$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>a. $\frac{5}{6} \div 2 = \frac{5}{6} \div \frac{4}{6} = \frac{1}{2}$</td>
<td>$D$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Partial comprehension of the idea.</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>a. Not attempted.</td>
<td>$D$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>7</td>
<td>a. Not understanding concept in the calculation of percentages.</td>
<td>$D$</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Writes $\frac{21}{150} \times 150 = \frac{100}{4}$.</td>
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<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. Not attempted.</td>
<td>$D$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Not attempted.</td>
<td>$D$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>10</td>
<td>a. Not attempted.</td>
<td>$D$</td>
</tr>
<tr>
<td>Student</td>
<td>Level of Maths</td>
<td>Qn.</td>
<td>Errors</td>
<td>Type of Error</td>
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<tr>
<td>45 C.S.E. 4</td>
<td>4</td>
<td>a. Lacking in the idea of equivalence when attempting to change fractions to twelfths.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>a. No idea of division of fractions. Writes $\frac{3}{76}$</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>a. $\frac{3}{5} = 3.5000$ No concept of converting this fraction to a decimal.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>a. Not understanding concept in the calculation of percentages. Writes $\frac{21}{100} \times 150$.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Guesses result incorrectly.</td>
<td>D</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Thinks $r^2 = 2r$. b. Incorrectly quotes $A = r^2d$.</td>
<td>F</td>
<td></td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>a. Failure to observe that the first diameter was No. 0</td>
<td>F</td>
<td></td>
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</tbody>
</table>

| 46 C.S.E. II | 5 | a. $\frac{5}{6} \div \frac{2}{3} = 5 \times \frac{3}{2}$, but not completed. | F |
| | 7 | a. Not understanding concept in the calculation of percentages. Writes $150 = \frac{21}{100}$. | D |
| | 8 | a. Guessing at result. No method. | D |
| | 9 | a. $4\sqrt{56} = 1.91$ Transcribing error. | F |
| | 10 | a. Failure to observe that the first diameter was No. 0 | F |

<p>| 47 No Maths, beyond form 3 | 7 | a. Not understanding concept in the calculation of percentages. Calculates $150 \div 21$. | D |
| | 9 | a. Not attempted. | D |</p>
<table>
<thead>
<tr>
<th>Student</th>
<th>Level of Maths</th>
<th>Qn.</th>
<th>Errors</th>
<th>Type of Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>48</td>
<td>Failed 'O' level</td>
<td>5</td>
<td>a. No concept of division of fractions.</td>
<td>D</td>
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<td></td>
<td></td>
<td>7</td>
<td>a. Not understanding concept in the calculation of percentages.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8</td>
<td>a. Compares as fractions. Incorrect result.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>9</td>
<td>a. Thinks $r^2 = 2r$. b. Tries to calculate $r$ and gets $1\frac{1}{2}$.</td>
<td>$C_4$</td>
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</tbody>
</table>
Failure Rates on the 10 selected questions

<table>
<thead>
<tr>
<th>Question</th>
<th>School leavers</th>
<th>Students in Training</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>66%</td>
<td>7%</td>
</tr>
<tr>
<td>2</td>
<td>34%</td>
<td>4%</td>
</tr>
<tr>
<td>3</td>
<td>75%</td>
<td>21%</td>
</tr>
<tr>
<td>4</td>
<td>70%</td>
<td>27%</td>
</tr>
<tr>
<td>5</td>
<td>73%</td>
<td>36%</td>
</tr>
<tr>
<td>6</td>
<td>41%</td>
<td>19%</td>
</tr>
<tr>
<td>7</td>
<td>86%</td>
<td>43%</td>
</tr>
<tr>
<td>8</td>
<td>13%</td>
<td>63%</td>
</tr>
<tr>
<td>9</td>
<td>94%</td>
<td>88%</td>
</tr>
<tr>
<td>10</td>
<td>99%</td>
<td>34%</td>
</tr>
</tbody>
</table>

Fig. 4.2

Comparing the failure rates on these particular questions, we see that (in fig. 4.2) whilst the failure rates amongst the students only once exceeds that of the school-leavers, nevertheless the rates amongst the students is high. Failure rates in excess of 30% on half the questions, and over double that figure on two of the questions. When one considers that of the school-leavers,

"... only those of the lowest ability failed to add, divide, subtract and multiply correctly – once they had decided what to do", (66)

even the 7% of the students failing to correctly add in question 1 seems a very high figure indeed. From this situation we must, I
think, justly be concerned that many of these students will have to teach Mathematics in primary schools where the all important foundations are laid. We may well ask what kind of foundations will be laid, the circumstances being as they are. A much greater percentage of the future teachers were unable to cope with question 8 than the school-leavers. It would seem unlikely that the question is made harder for the students by being associated with an industrial procedure. It may be that if rote learning figures highly in Mathematics lessons in schools, then the students have had more time to forget 'what we do'. Even two of the three students with 'A' level Mathematics were unable to get questions 8 and 9 correct.

Where the questions involved the handling of fractions, there were a large number of failures amongst the students, e.g. No. 4 (27%), No. 5 (36%), No. 8 (63%), (see fig. 4.2). The percentage of errors is not so great where the fraction is more easily identified with the decimal system, as in question 6. The author well remembers expressed feelings in educational circles in the early days of the pressing for metrication, when attention to fractions was given a very low priority indeed. In view of this, it is, perhaps, not surprising that

"The notion of a fractional part was introduced when discussing everyday things in over half the 7 year old classes, four-fifths of the 9 year old and nearly all 11 year old classes, although in many classes this was only touched on and the work was not fully developed."

(67)

This was written by H.M. Inspectors about English Schools. In a similar report of some of the schools in Wales, the point was made that

"The Mathematics curriculum in most of the schools lays considerable emphasis on computational skill and, in some schools,
the course is geared almost exclusively towards this end. There is no evidence that this aspect of the work is being seriously neglected in any school." (69)

The inspectors making this latter report were very concerned to see a broader Mathematics curriculum to replace the narrow concentration upon Arithmetic skills. So there is a wide disparity between what is seen in one area of the country and another. One might suppose that the Welsh rural schools pattern would be much more acceptable to those industrialists looking for a narrow range of skills but, to judge from the C.B.I. report, these schools have not been altogether successful in providing the candidates industry seeks. The report sought evidence of the ability of candidates from Mid., West and South Wales. The only comment made by the Welsh Inspectorate on the teaching of fractions was that

"In some schools the children perform complex computation with very little understanding of the processes involved - for example long division, complicated work involving the four rules in fractions and long multiplication of decimals." (69)

Just what is the content of Mathematics in the primary school is a vexed question. Until fairly recently such a matter has been left to headteachers to decide. Even now it is their decision but, in many areas of England and Wales, Mathematics Guidelines have been produced. In the county of Gwent most Comprehensives have met with their feeder schools and have produced, or are in the process of producing, Mathematics Guidelines for the teachers of children between the ages of 4 years and 13 years in those schools. In some areas, e.g. Wiltshire, Somerset and Avon, etc. the guidelines have been produced by teacher working parties on a county basis. Even within the area served by a Nuffield Continuation
programme committee, as all counties just mentioned are, there is no real agreement as to the content of the primary syllabus. The author is secretary of the Western Regional Mathematics Council, which has been responsible for initiating such work on guidelines in the region, and has served on local committees drawing up guidelines. It is only too well obvious that establishing guidelines in this way, involving local teachers, whilst it gives them an identification with the objectives of the guidelines, it does not lead to a well agreed upon set of topics throughout the region and throughout the country. For example, in the guidelines for Newport, Gwent schools Block 7, (for the pupil in the last year of the primary school), has two items, (a) the division of fractions and (b) simple problems in percentages. Both of which indicate that considerable attention had already been given to these areas in previous years. In the guidelines for the Abergavenny schools, in the same county, Stage 7, although it includes a statement about dealing with the four rules of fractions, only mentions an introduction to percentages. In the guidelines for the County of Somerset, in work for children in the last year of the primary school, it gives (a) division of a whole number by a fraction, and (b) to introduce percentage by comparison with fractions and decimals. No division of a fraction by a fraction, and only an introduction to percentages.

In a similar document produced a few years ago by Southend-on-Sea L.E.A., we have work on fractions up to the multiplication of a fraction by a fraction, but no mention of division at all and no mention of percentages either. The guidelines produced by West Sussex, and used as a model by other working parties throughout the country, contains no mention of multiplication or of division of
fractions and only introduces percentages related to fractions for simple cases. Generally, there is less attention given to fractions and percentages in the older guidelines.

Today, teachers are becoming concerned about the neglect of basic processes. A recent survey of schools, some of which were in Wales, reports that teachers were asked to outline any reservations they had about primary Mathematics as taught today. (Headteachers' and teachers' questionnaire.)

"29% of teachers reported their reservations about the neglect of basic processes."

It is interesting that this survey shows that for the only questions involving a computation with a fraction, the children's performance was 85% and the teachers' rating of importance (1.45) was 24. These two fraction questions were placed 98th and 99th in order of the 'questions liked best', but they were only placed about half way in the list for questions needing most thought. Here is the issue of a challenge to teachers. They are, at present, evidently not taught very well, even though teachers think they are important. It is also interesting that the children did not have them on their 'hate' list. So, with the teachers thinking them quite important, the children not absolutely disliking work in that area, the problem with fractions would seem to be either a difficulty on the part of the children in grasping the necessary concepts, or the lack of an adequate teaching programme, or the lack of a sufficient grasp of the concepts by the teachers themselves.

The Nuffield Mathematics National Committee recently submitted a report to the Cockcroft Committee in which they incorporated areas of concern submitted to them by the various regional councils. In this document, concern is shown that the
<table>
<thead>
<tr>
<th>Dip. H.E. Students with 'O' level Mathematics or equivalent</th>
<th>Mark</th>
<th>Dip. H.E. Students without 'O' level Mathematics or equivalent</th>
<th>Mark</th>
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</thead>
<tbody>
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<td>39</td>
<td>70</td>
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</tbody>
</table>

Fig. 4.3
'Matherate' child should

"have computational skills", (74)

but they do not suggest anywhere where they discuss areas of
difficulty that these should include computation with fractions.
They do highlight generally accepted areas of difficulty, such as
long division and place value, though there is by no means an
agreement as to whether long division should appear in Mathematics
guidelines for primary schools.

As we have seen above, there is some difference of opinion
and a great variance in the attitude of bodies and individuals to
the teaching of fractions in the primary school. In some guidelines,
where the intention is clearly to provide children with the
opportunity to become competent at manipulating fractions whilst
understanding what they are doing, it is included in the primary
schools' Mathematics work. Others feel that this, to them, is so
difficult for children that they do not give it attention.

On the other hand, in the report of the working party for
the review of the Educational Needs of the 14-19 year olds, sponsored
by Coventry Education Committee, it lists amongst the Mathematical
skills needed by the technician apprentice and the craft apprentice,
all four operations involving fractions. Indeed, in their frequency
ratings, 'very frequent', 'frequent', and 'limited use', all these
operations with fractions, including conversions to decimals, are
given the 'frequent' rating. One wonders whether it is possible to
achieve the standards necessary with the eventual craft apprentice
applicant if they are not given a higher prominence in the primary
school than has been the case in many schools during the last
fifteen years or so.
<table>
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<tr>
<th>T.Cert Students with 'O' level Mathematics or equivalent</th>
<th>Mark</th>
<th>T.Cert Students without 'O' level Mathematics or equivalent</th>
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<td>24</td>
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</tr>
<tr>
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<td></td>
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</tr>
<tr>
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</tr>
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<td></td>
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<td>47</td>
<td>80</td>
</tr>
<tr>
<td>31</td>
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</table>

Fig. 4.4
Mean and Standard Deviation Calculations

(a) Dip. H.E. Students with 'O' level Mathematics or equivalent

<table>
<thead>
<tr>
<th>f</th>
<th>x</th>
<th>fx</th>
<th>d</th>
<th>d²</th>
<th>fd²</th>
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<tbody>
<tr>
<td>4</td>
<td>50</td>
<td>200</td>
<td>-23.59</td>
<td>556.4740</td>
<td>2225.8960</td>
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<tr>
<td>7</td>
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<td>420</td>
<td>-13.59</td>
<td>184.6800</td>
<td>1292.7600</td>
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<tr>
<td>10</td>
<td>70</td>
<td>700</td>
<td>-3.59</td>
<td>12.8859</td>
<td>128.8590</td>
</tr>
<tr>
<td>8</td>
<td>80</td>
<td>640</td>
<td>+6.41</td>
<td>41.0919</td>
<td>328.7352</td>
</tr>
<tr>
<td>9</td>
<td>90</td>
<td>810</td>
<td>+16.41</td>
<td>269.2980</td>
<td>2423.6820</td>
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<tr>
<td>1</td>
<td>100</td>
<td>100</td>
<td>+26.41</td>
<td>697.5040</td>
<td>697.5040</td>
</tr>
</tbody>
</table>

\[ fx = 2870 \]
\[ \frac{fd^2}{39} = 7097.4362 \]
\[ \text{Mean} = \frac{2870}{39} = 73.5977 \]
\[ \text{S.D.} = \sqrt{\frac{7097.4362}{38}} = 13.67 \]

(b) Dip. H.E. Students without 'O' level Mathematics or equivalent

<table>
<thead>
<tr>
<th>f</th>
<th>x</th>
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<th>d²</th>
<th>fd²</th>
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<td>20</td>
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<td>-19.6</td>
<td>384.16</td>
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<td>350</td>
<td>-9.6</td>
<td>92.16</td>
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<td>4</td>
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<tr>
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<td>80</td>
<td>80</td>
<td>+20.4</td>
<td>416.16</td>
<td>416.16</td>
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<td>2</td>
<td>90</td>
<td>180</td>
<td>+30.4</td>
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<tr>
<td>2</td>
<td>100</td>
<td>200</td>
<td>+40.4</td>
<td>1632.16</td>
<td>3264.32</td>
</tr>
</tbody>
</table>

\[ fx = 1490 \]
\[ \frac{fd^2}{25} = 10696.00 \]
\[ \text{Mean} = \frac{1490}{25} = 59.6 \]
\[ \text{S.D.} = \sqrt{\frac{10696.00}{24}} = 21.11 \]
### (c) All Dip. H.E. Students

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<thead>
<tr>
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<th>fd²</th>
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<tr>
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<td>40</td>
<td>80</td>
<td>-28.125</td>
<td>791.0156</td>
<td>1582.0312</td>
</tr>
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<td>50</td>
<td>550</td>
<td>-18.125</td>
<td>328.1563</td>
<td>3609.7193</td>
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<tr>
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<td>60</td>
<td>660</td>
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<td>727.7193</td>
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<td>14</td>
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<td>980</td>
<td>+1.875</td>
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<td>49.2184</td>
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<td>9</td>
<td>80</td>
<td>720</td>
<td>+11.875</td>
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<td>11</td>
<td>90</td>
<td>990</td>
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<td>3048.0468</td>
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</table>

\[
\text{fx} = 4360 \\
\text{fd}^2 = 20772.5938
\]

Mean = \( \frac{4360}{64} \)

S.D. = \( \frac{\sqrt{20772.5938}}{63} \)

\[
= 68.125 \\
\text{S.D.} = 18.16
\]

### (d) Certificate Students with 'O' level Mathematics or equivalent

<table>
<thead>
<tr>
<th>f</th>
<th>x</th>
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<th>d</th>
<th>d²</th>
<th>fd²</th>
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<td>2214.5307</td>
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<tr>
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<td>100</td>
<td>-17.0588</td>
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<td>49.8267</td>
<td>149.4801</td>
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<td>5</td>
<td>70</td>
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<td>+2.9412</td>
<td>8.6507</td>
<td>43.2535</td>
</tr>
<tr>
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<td>167.4747</td>
<td>837.3735</td>
</tr>
<tr>
<td>1</td>
<td>90</td>
<td>90</td>
<td>+22.9412</td>
<td>526.2987</td>
<td>526.2987</td>
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</tbody>
</table>

\[
\text{fx} = 1140 \\
\text{S.D.} = \frac{\sqrt{4352.9419}}{16}
\]

Mean = \( \frac{1140}{17} \)

S.D. = 16.49

\[
= 67.0588 \\
\text{S.D.} = 16.49
\]
(e) **Certificate Students without 'O' level Mathematics or equivalent**

<table>
<thead>
<tr>
<th>f</th>
<th>x</th>
<th>fx</th>
<th>d</th>
<th>d^2</th>
<th>fd^2</th>
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<td>2199.3436</td>
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<td>103.2520</td>
<td>309.7560</td>
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<td>50</td>
<td>250</td>
<td>- 5.1613</td>
<td>26.6390</td>
<td>133.1950</td>
</tr>
<tr>
<td>5</td>
<td>60</td>
<td>300</td>
<td>+ 4.8387</td>
<td>23.4130</td>
<td>117.0650</td>
</tr>
<tr>
<td>5</td>
<td>70</td>
<td>350</td>
<td>+14.8387</td>
<td>220.1870</td>
<td>1100.9550</td>
</tr>
<tr>
<td>4</td>
<td>80</td>
<td>320</td>
<td>+24.8387</td>
<td>616.9610</td>
<td>2467.8440</td>
</tr>
</tbody>
</table>

\[
\begin{align*}
\text{fx} &= 1710 \\
\text{fd}^2 &= 11437.8376 \\
\text{Mean} &= \frac{1710}{31} = 54.8387 \\
\text{S.D.} &= \sqrt{\frac{11437.8376}{30}} = 19.53
\end{align*}
\]

(f) **All Certificate Students**

<table>
<thead>
<tr>
<th>f</th>
<th>x</th>
<th>fx</th>
<th>d</th>
<th>d^2</th>
<th>fd^2</th>
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<td>1550.3906</td>
<td>4651.1718</td>
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<tr>
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<td>30</td>
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<td>-29.375</td>
<td>862.8906</td>
<td>4314.4550</td>
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<td>375.3906</td>
<td>1126.1718</td>
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<td>50</td>
<td>350</td>
<td>- 9.375</td>
<td>87.8906</td>
<td>615.2342</td>
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<td>8</td>
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<td>480</td>
<td>+ 0.625</td>
<td>0.3906</td>
<td>3.1248</td>
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<td>1128.9060</td>
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<td>270</td>
<td>+30.625</td>
<td>937.8906</td>
<td>2813.6718</td>
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</tbody>
</table>

\[
\begin{align*}
\text{fx} &= 2850 \\
\text{fd}^2 &= 18481.2488 \\
\text{Mean} &= \frac{2850}{48} = 59.375 \\
\text{S.D.} &= \sqrt{\frac{18481.2488}{47}} = 19.83
\end{align*}
\]
The overall marks gained by the students may be seen in figs. 4.3 and 4.4. There is a considerable difference shown in these mean scores between the students with 'O' level Mathematics or its equivalent and those without. The Diploma of Higher Education students with 'O' level Mathematics or its equivalent had a mean score of 73.59 with a standard deviation of 13.67, compared with the 59.6 mean and 21.11 standard deviation of the Diploma students without 'O' level Mathematics or its equivalent. The second group had a much lower mean and a much wider spread. It was also the case that the Certificate students with 'O' level Mathematics or its equivalent had a higher mean at 67.06 than that of the Certificate students without 'O' level Mathematics or its equivalent (55.16). The order of the difference in the means was roughly the same in each set at 13.99 and 11.9.

There was also a considerable difference in the mean scores of all the Diploma of Higher Education students and the Certificate students. The Diploma students, at a mean of 68.13, were 8.75 ahead of the mean of 59.38 of the Certificate students.

In terms of these measures, the possession of 'O' level Mathematics or its equivalent is significant, as also is the fact of being a more highly qualified student in other areas. (Two 'A' level entry requirement of the Diploma students.)

Let us now examine the students' attempts to answer the questions which were originally set to school-leavers. The author has placed the types of errors into sixteen categories.
A  Misread the question
B1  Bond error - addition
B2  Bond error - subtraction
B3  Bond error - multiplication
B4  Bond error - division
C1  Calculation error - addition
C2  Calculation error - subtraction
C3  Calculation error - multiplication
C4  Calculation error - division
D  Concept error
E  Incorrect formula
F  Lack of attention to detail
P  Place value error
R  Rounding error
S  Reversal error
Π  Misquote Π

The questions of the test (See Appendix 5.1) taken in order

<table>
<thead>
<tr>
<th>Question Number 1</th>
<th>4532</th>
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</thead>
<tbody>
<tr>
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<td>125</td>
</tr>
<tr>
<td></td>
<td>7609</td>
</tr>
<tr>
<td></td>
<td>5431</td>
</tr>
<tr>
<td></td>
<td>892</td>
</tr>
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</table>

Of the 112 students, 7% did not calculate this correctly.
5% of the students taking Dip.H.E. and who had 'O' level Mathematics, failed to do this correctly, and the figure was 13% of the Certificate students with 'O' level Mathematics. One would expect there to be a higher percentage of failures amongst the Dip.H.E. students without 'O' level, and that was the case (8%).
The figure was 8% for the Certificate students without 'O' level Mathematics also. Indeed, 9% of the students overall with 'O' level Mathematics failed this question, whilst only 5% of the students without 'O' level failed it. (See fig. 4.5)

<table>
<thead>
<tr>
<th>Question Number 1</th>
<th>Students with 'O' level Maths.</th>
<th>Students without 'O' level Maths.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>%</td>
<td>18%</td>
</tr>
<tr>
<td></td>
<td>9%</td>
<td>5%</td>
</tr>
<tr>
<td></td>
<td>7%</td>
<td></td>
</tr>
<tr>
<td>Diploma of Higher Education</td>
<td>6%</td>
<td>Teacher's Certificate</td>
</tr>
</tbody>
</table>

It seems strange that anyone who gets as far as higher education should fail to carry out such an addition correctly. If we look at the errors, we see that 11 were made in total. Of these, 3 students because of lack of attention to detail; they were careless in some way. Either they did not add in a carrying figure, or, in the scan of the 'thousands' column, the 4 thousands was overlooked. The majority of these 11 errors, (8), were failure to add the individual numbers correctly. It was not possible to determine which bonds were the ones in which errors were made. Seven of the errors were made by Certificate students and four Dip. H.E. students. Although in only one case could the error be reasonably attributed to an untidy presentation, a review of the answer papers as a whole makes one conscious of the slovenly presentation of the answers by
many students. This lack of discipline in the way the answers were presented was not confined to the students without 'O' level Mathematics.

Question Number 2  Subtract 4,877 from 21,342.

The overall percentage of students who could not subtract these numbers correctly was 4%, a figure both surprising and of great interest to the author. Nearly double the percentage failed with the addition, and yet it is with subtraction that most students have trouble when it comes to giving an explanation of what they are doing in the process. We see that for this question, 34% of the school-leavers, taking pre-apprenticeship examinations, failed and only 4% of the students failed. It was only second from the bottom 9/10 (see fig. 4.2) for the school-leavers and 10/10 for the students. Evidently it is not quite the major hurdle that it has always been considered to be. Again there was a higher percentage of the students with 'O' level Mathematics who failed this question, 5%, whilst only 4% of those without 'O' level Mathematics failed. The students who were most successful with this question were the Teacher's Certificate students without 'O' level Mathematics (3%), and the Teacher's Certificate students were overall more successful than the Dip.H.E. students, a reversal of the situation from that of Question 1.

We are dealing with a small number of errors, only five in total. In only 13 cases out of 112 was decomposition used. Only one error was in the decomposition method and the others were all in the equal addition, but, considering the larger number of the equal addition, this is not surprising. It is rather surprising
## Question Number 1

### Diploma of Higher Education Students

<table>
<thead>
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<th>A</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>B4</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>P</th>
<th>R</th>
<th>S</th>
<th>( n )</th>
<th>Types of Errors</th>
<th>Nos. of Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
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</table>

### Question Number 1

### Teacher's Certificate Students

<table>
<thead>
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<th>B2</th>
<th>B3</th>
<th>B4</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>P</th>
<th>R</th>
<th>S</th>
<th>( n )</th>
<th>Types of Errors</th>
<th>Nos. of Errors</th>
</tr>
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<tbody>
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</tbody>
</table>

### Question Number 1

### All Students

<table>
<thead>
<tr>
<th>A</th>
<th>B1</th>
<th>B2</th>
<th>B3</th>
<th>B4</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>P</th>
<th>R</th>
<th>S</th>
<th>( n )</th>
<th>Types of Errors</th>
<th>Nos. of Errors</th>
</tr>
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<tbody>
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<td></td>
<td></td>
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</tbody>
</table>

## Question Number 2

### Students with 'O' level Maths.

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</tr>
</thead>
<tbody>
<tr>
<td>Teacher's Certificate</td>
<td></td>
<td>4%</td>
</tr>
</tbody>
</table>

### Students without 'O' level Maths.

<table>
<thead>
<tr>
<th>Diploma of Higher Education</th>
<th>Certificate</th>
<th>5%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher's Certificate</td>
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<td>4%</td>
</tr>
</tbody>
</table>
### Question Number 2

### Diploma of Higher Education Students

<table>
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<th>B1</th>
<th>B3</th>
<th>B4</th>
<th>C1</th>
<th>C2</th>
<th>C3</th>
<th>C4</th>
<th>D</th>
<th>E</th>
<th>F</th>
<th>P</th>
<th>R</th>
<th>S</th>
<th>N</th>
<th>Types of Error</th>
<th>Nos. of Errors</th>
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3 Total Errors

### Teacher's Certificate Students

<table>
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<th>Nos. of Errors</th>
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2 Total Errors

### All Students

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<td>2</td>
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</tbody>
</table>

5 Total Errors
that, with all that has been said and written about the wisdom of teaching children in the primary school the method of decomposition, there was not a greater percentage in this sample. Perhaps the secondary schools superimpose equal addition, indeed it is their intention to do so in this county, e.g.

"It was agreed, (by the working party), that subtraction is best taught in the first place by the method of decomposition, while at secondary level, average and above average pupils will need to know the equal addition method." (75)

If this has been done, the effect has not been disastrous on these above average pupils. Where there was a subtraction to perform on the paper set by the engineering company, it was not generally possible to tell what method was in use, so little was actually worked on the answer papers.

We may not generally infer, but we may conjecture that, since the students in training are able to do subtraction but not explain it, they are more successful than the lower ability range in retaining rote learning. Perhaps a greater attention to comprehending the process in the students would be beneficial to those they teach and thus to those who will sit apprenticeship examinations. As far as the actual errors were concerned in this question, two were the result of lack of attention to detail, one to a calculation error and two to concept errors.

According to the report given in the Schools Council Working Paper No. 61, when evidence is brought on the errors made by children,

"two themes crop up again and again in the completed questionnaires: subtraction and notation." (76)
Forty per cent of the teachers said that subtraction caused the greatest number of errors, and that the commonest mistake is taking the top number from the bottom when this means taking the smaller number from the larger. In the author's survey, only one student made that error and, in his case, it was the subtraction of the larger number from the smaller (they were set out in a line: see above). This student did not have 'O' level Mathematics and his total of correct answers to the questions was only two out of the ten. The author feels that in this case the error is not one due to a reversal but more due to a lack of the initial idea. It is interesting to note that he had occasion to reflect on his error when he got to the subtraction of the two - ten thousands and realised

\[
\begin{array}{c}
4877 \\
21542 \\
3535 \\
\end{array}
\]

he could not deal with this as he had the others. He entered the two in the answer and removed it. It is interesting to note that this student is enrolled as a Dip.H.E. student and is taking 3-dimensional Studies, i.e. a course which will prepare him for teaching the workshop crafts in a secondary school. Presumably many of the school-leavers who seek apprenticeships in the engineering industries will have taken such courses in schools. One would have thought that this student's previous acquaintance with engineering/workshop Mathematics would have enabled him to overcome these grave weaknesses in the comprehension of Arithmetic processes allied to the engineering industry.
Question Number 3

Work out 625 x 57 x 16

The failure rate for question 3, as cited in the C.B.I. (Wales) report on questions given to pupils hoping to take up an apprenticeship, was very high at 7.5%, but this was not very much of a rise from the 66% incorrect of question 1. In the case of the students, for the same question, (No. 3) there was a considerable rise from 7% to 21% (see fig. 4.2).

Fig. 4.9

Failure Rates

<table>
<thead>
<tr>
<th>Question Number 3</th>
<th>Students with 'O' level Maths.</th>
<th>Students without 'O' level Maths.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>10%</td>
<td>1%</td>
</tr>
<tr>
<td></td>
<td>32%</td>
<td>26%</td>
</tr>
<tr>
<td></td>
<td>13%</td>
<td>29%</td>
</tr>
</tbody>
</table>

| Diploma of Higher Education | 1% |
| Teacher's Certificate      | 23% |

As may be seen in Fig. 4.9, 13% of the students with 'O' level Mathematics did not do this correctly and 29% of those without 'O' level Mathematics failed the question. There was not a great deal of difference shown in the ability to succeed on this question by the Dip. H.E. students (1%) over the Certificate students (23%). This question is a more hopeful indicator that the new regulation, that students may enter teacher training with two 'A' levels and an
### Question Number 3

#### Diploma of Higher Education Students

|   | A | B1 | B2 | B3 | B4 | C1 | C2 | C3 | C4 | D | E | F | P | R | S | \( \overline{\text{m}} \) | Types of Error |
|---|---|----|----|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|
| No. of Errors | 3 | 7 | 7 | | | | | | | | | | | | | | | | | |
| Total Errors | 17 | | | | | | | | | | | | | | | | | | | |

#### Teacher's Certificate

|   | A | B1 | B2 | B3 | B4 | C1 | C2 | C3 | C4 | D | E | F | P | R | S | \( \overline{\text{m}} \) | Types of Error |
|---|---|----|----|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|
| No. of Errors | 1 | 2 | 2 | 9 | 4 | 2 | 2 | | | | | | | | | | | | | |
| Total Errors | 21 | | | | | | | | | | | | | | | | | | | |

#### All Students

|   | A | B1 | B2 | B3 | B4 | C1 | C2 | C3 | C4 | D | E | F | P | R | S | \( \overline{\text{m}} \) | Types of Error |
|---|---|----|----|----|----|----|----|----|----|---|---|---|---|---|---|---|---|---|
| No. of Errors | 1 | 4 | 2 | 16 | 11 | 2 | 2 | | | | | | | | | | | | |
| Total Errors | 38 | | | | | | | | | | | | | | | | | | | |
'O' level in Mathematics, may mean more capable Mathematics teachers. The Dip.H.E. students with Mathematics 'O' level were the group with fewest failures (%) on this question.

The actual percentage failures at 32% for the Dip.H.E. students without 'O' level Mathematics represented the highest failure rate. If we look at fig. 4.10, we see that seven of the errors could be ascribed to a lack of attention to detail. A lack of care, a lack of concentration perhaps, an equal number of errors were due to calculation, and some of these errors were even due to a deficiency in the ability of the student to recall the multiplication bonds accurately. If we look at the actual analysis of the students' errors, we see that the errors which arose as a result of this lack of attention to detail consisted very often of a failure to complete the multiplication, e.g. when multiplying by 57, the student may have forgotten to multiply by the 5 tens or by the 7 units. It is a lengthy calculation and perhaps many are over-anxious to complete it. It does demand a goodly measure of concentration to ensure that all parts of the process are completed. The calculation errors (23) outweighed other types of errors when all students were considered. Some of them were carrying figure errors and were counted as lack of attention to detail, but others were bond errors. Some seemed to be the old problem of 'reversal' errors, e.g. the T. Cert. students without 'O' level who made $2 \times 6 + 3 = 21$. The carrying figure is 3 and the 2 gets thought of as a 3 and is multiplied by the 6. It was gratifying to see that, amongst these students, and for this question, only one error was due to place value not being correctly observed. The student in question was multiplying by 50 and did not enter the amount in the correct columns. (See student T.Cert. No. 44.)
The major errors, it seems in this question, were the ones of not completing the multiplication, (7 of the 11 carelessness errors were due to this), and the calculation errors where multiplication bonds were not recalled correctly, additions were incorrect, there was the neglect of carrying figures. Sometimes these latter were added in when they were not there, and neglected when they were. In this question, only 6 errors out of the total of 38 errors were, in fact, bond errors. That is, about 16% were due directly to bond errors. This should be contrasted with the evidence in the returned questionnaire by teachers in the Schools' Council Survey, in which only 3% of calculation errors were accorded as being due to "tables and number bonds". (77)

We see that the students have double this percentage. Is this because they are further away from their last Arithmetic calculation? Items such as these committed to memory in early school life do not usually disappear so soon. In the author's examination of the papers of the pupils seeking apprenticeships with a national engineering company in Gwent, the errors in multiplication seemed more often to be due to place value errors than due to multiplication bonds. However, the high percentage of school-leavers who were incorrect on this question (75%) and the 44% who were in error with 267 x 6, (78) must surely indicate a possible lack of multiplication bond certainty.

There is, however, some comment in the C.B.I. report when it comes to the addition of fractions, as in Question 4. Add 1\frac{1}{4} and 2\frac{1}{3}, where, for example, the students made errors of the type \( \frac{7}{4} + \frac{7}{3} = \frac{14}{7} = 2 \). See for example the Dip. H.E. student with 'O' level Mathematics No. 4.
The C.B.I. Wales' report states that

"In the case of the addition of simple fractions, a common practise was to add together all the numerators and then add together all the denominators."

Certainly, the author's investigation shows that, in this question, 65% of the errors could be directly ascribed to a lack of understanding of one concept or another in the process of addition of fractions. (see fig. 4.11)

<table>
<thead>
<tr>
<th>Question Number 4</th>
<th>Diploma of Higher Education</th>
<th>Teacher's Certificate</th>
<th>All Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>B1</td>
<td>B2</td>
<td>B3</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>23 Total Errors</td>
<td>17 Total Errors</td>
<td>40 Total Errors</td>
<td></td>
</tr>
</tbody>
</table>

In this there was little to choose between the Dip.H.E. students and the Teacher's Certificate students.
When we look at the percentages failing this question, (see fig. 4.12), we see that the greater percentages failing, as one would expect, are amongst the students without 'O' level Mathematics. The percentage (44%) failing from amongst the Dip.H.E's. without 'O' level Mathematics was actually greater than the percentage (35%) of the Teacher's Certificate students without 'O' level Mathematics. Having 'O' level Mathematics or its equivalent certainly makes an enormous difference in this question. Nevertheless it is still unacceptable that 14% of the students with 'O' level Mathematics should fail this question and that, amongst their errors, were some of the kind shown above already.

70% of the school-leavers seeking apprenticeships, as shown by the C.B.I. (Wales) report, also failed this question and, although we do not know in any detail of the individual errors, the comments made in the report suggest that a large number of them must have been of the concept type. Indeed, 64% of the errors made by the students with 'O' level Mathematics were of this type and so, with the much
larger percentage of failures amongst the school-leavers, we can safely assume a percentage of errors greater than this, due to concept difficulties. Since most of the guidelines now being produced would include addition of fractions in the primary school, it would seem that the pupils will have considerable attention in this area in the future. It is not easy to determine whether it has had the same attention in the past. The working party report to Hampshire Education Committee feels that it is necessary to state

"Contrary to popular opinion, computation lies at the heart of the Nuffield Mathematics project, which has played a major role in the development of Mathematics teaching in primary schools." (30)

Their feeling evidently is that computation has not been given the role it deserves, due to a misunderstanding of the place of computation in the Nuffield Mathematics project. A misunderstanding exacerbated by the misunderstandings created in the teachers' minds by the various pronouncements of the Metrication Board. Six out of the 26 'D' errors could be directly ascribed to not understanding the concept of equivalence in fractions, and many of the others could be due to this if only we could tell. Equivalence of fractions is a crucial area, demanding considerable attention before one proceeds in a teaching programme to addition and subtraction of fractions. A few students clearly knew nothing at all about the handling of these quantities in this form. They had to change them into decimals first. Perhaps their teachers greatly influenced by the publicity given to the need to metrificate and abandon Imperial Units and with it the accompanying work on fractions. These decimal quantities were added together and the result was 4.08, which was then changed back into fraction form as \( \frac{47}{12} \). The students have changed fractions to decimals to do this question and yet they in all seriousness give
0.08 = \frac{1}{12}$. Apparently anything goes in Mathematics! Another student showed a complete lack of understanding of converting fractions to decimals and place value when she wrote $4.08 = \frac{4\frac{2}{5}}{10}$. Someone in the same school must have seen this way of tackling these questions and have approved of it, unless little is done to diagnose failure in the performance of a Mathematical technique in schools. There is concern that this may be the case, for

"Good teachers learn to identify the nature of error and to know what steps to take, but too often wrong answers to 'sums' are still being marked with a cross with little or no attempt being made to pin-point what has gone wrong and why. Consequently, there are many children who go from year to year and from one school to another making the same mistakes without corrective action being taken." (81)

Question 5. What is $\frac{5}{6} \div \frac{2}{3}$?

The failure rate for the school-leavers, as indicated in the C.B.I. Wales report, is 73% for this question, and, whilst the students do not reach this rate, theirs is a very serious 36%. Nearly half of the students without 'O' level Mathematics could not do this extremely simple calculation. It seems not possible, but the figure is 25% of the Dip.H.S. students with 'O' level Mathematics who failed at this question. (See fig. 4.13) For the future, we could anticipate, as a result of these figures, that in spite of the hopeful expectations of future students with two 'A' levels and 'O' level Mathematics, the likelihood is that a quarter of them will need remedial work on this type of question. Yet, in the new Dip.H.S. course situation, the provisions for remedial work is now not very great. In the future, remedial work will still be
### Fig. 4.13

#### Failure rates

<table>
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<tbody>
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<td>Students with 'O' level Maths.</td>
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<tr>
<td>Diploma of Higher Education</td>
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<tr>
<td>Teacher's Certificate</td>
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### Fig. 4.14

#### Question Number 5

**Diploma of Higher Education**

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<th>R</th>
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**Total Errors:** 33

#### Question Number 5

**Teacher's Certificate**

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**Total Errors:** 22

#### Question Number 5

**All Students**

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</table>

**Total Errors:** 55
very necessary, but the fact that the students are seen to have a higher qualification in Mathematics may mean that even less time may be allocated by the course planners who are not necessarily interested in Mathematics. In this question, 55 errors were made, 40 of which were errors in comprehension of necessary concepts, e.g. see Student 9 who has 'O' level Mathematics -

$$\frac{5}{6} \div \frac{2}{3} = \frac{5}{6} \times \frac{3}{2} = \frac{6}{5} \times \frac{2}{3} = \frac{12}{15}$$

and Student 10 who also has 'O' level Mathematics -

$$\frac{5}{6} \div \frac{2}{3} = \frac{5-4}{6}.$$ 

It seems to be a memory game and they cannot remember the rules.

Some students have been taught an equivalence method of dealing with this calculation, e.g. $\frac{5}{6} \div \frac{2}{3} = \frac{10}{12} \div \frac{8}{12}.$

The major error associated with this method is the expression of the result in twelfths. More understanding is required of this method than of the inverted second fraction method which may be approached from the $\frac{1}{2}$, the number of 'halves in' method. This was apparent in the case of one student with 'O' level Mathematics who wrote -

$$\frac{5}{6} \div \frac{2}{3} = \frac{5 \div 4}{6} = \frac{1 \cdot 25}{6} \quad \text{(another wrote } \frac{12}{6})$$

and yet another student, one with two 'A' levels but without 'O' level Mathematics wrote: $\frac{5}{6} \div \frac{2}{3} = \frac{10}{12} \div \frac{8}{12} = \frac{1}{12}$

must have been bemused by the mysteries of the possibility of a fractional numerator and a fractional denominator. Of course, the inversion method is not free from its difficulties, especially if it has been learned by rote, e.g. as in the case of a student on the Teacher's Certificate course with a C.S.E. Grade 1 Mathematics.

This student could not remember which fraction to invert and so made it: $\frac{5}{6} \div \frac{2}{3} = \frac{6}{5} \times \frac{2}{3} = \frac{18 \times 10}{15}.$
The eventual confusion with the one denominator expression in the addition and subtraction of fractions happened in several cases.

A student with 'O' level special Arithmetic remembers to invert the second fraction but leaves the operation as it was, \( \frac{5}{6} \div \frac{2}{3} = \frac{5}{6} \div \frac{3}{2} \). Even students with 'O' level Mathematics were capable of inverting the first fraction instead of the second.

Perhaps the most surprising and disturbing way of tackling this question, both by some students with 'O' level Mathematics and some without, was by conversion to decimals, e.g. the Dip. H.E. student with 'O' level Mathematics Number 4 -

\( \frac{5}{6} \div \frac{2}{3} = 83.3 \div 66.6 = 1.02 \), additional errors appearing in the rounding of the 66.6 and in the long division.

Dip. H.E. student Number 60, without 'O' level Mathematics, converts to decimals and uses the equivalence of fractions to produce (with rounding errors), \( \frac{5}{6} \div \frac{2}{3} = \frac{83}{66} = 1.2 \). Either that explanation, or this student converted to percentages. There was a great deal of confusion in the methods of some students when they attempted to convert fractions to decimals. An equivalence method was in use which they failed to comprehend and so deal with correctly, e.g. \( \frac{50}{8} \times \frac{600}{3} = \frac{250}{3} = 83.3 \), instead of \( \frac{50}{6} \times \frac{100}{100} = \frac{500}{6} \times \frac{100}{100} \)

\( = \frac{83.3}{100} = 0.833 \). It seems very sad that these students have been taught to deal with fractions by changing them to decimals, perhaps as a result of the demise of fractions in some quarters in latter years. It is very unlikely that, unless such students have considerable remedial work, they will be able to teach these things. The whole
situation with regard to such parts of the Mathematics syllabus will get steadily worse. Whether the students have 'O' level Mathematics will not make the situation suddenly much better.

We have, in the past, set great store by the imposition of an 'O' level Mathematics pass for students in teacher training, just as there is such a regulation with respect to 'O' level English. In some areas of the Mathematics curriculum, at least, we cannot expect that this will obviate the necessity for the diagnosis of areas of weakness and the application of necessary remedial work. Many students had such a lack of understanding of this question that they could not tackle it at all.

Question Number 6  Write \( \frac{75}{100} \) as a decimal.

This question presented less difficulty to the school-leavers than the last three questions; even so, 41% of them were not able to write \( \frac{75}{100} \) as a decimal. In this particular case, it seems to point to a great deal of lack of understanding of this quantity and its relation to the denary system, rather than an inability to convert a fraction to a decimal. Of the intending teachers, 19% could not accurately do this. Many, of course, did not write the relationship immediately but used a process of conversion of a fraction to a decimal. Is this an indication of a lack of thought which attends students' application to Mathematical questions? It seems that they are not concerned about 'meaning' so much as getting on with a 'process' which will enable them to reach the required goal. Even 11% of the students with 'O' level Mathematics could not achieve this very simple relationship. In the case of the Dip. H.S. students, about 40% of the errors were concept errors, but, for the Teacher's
Certificate students, all the errors were of the concept kind. (see fig. 4.16)

**Fig. 4.15**

### Failure Rates

<table>
<thead>
<tr>
<th>Question Number 6</th>
<th>Students with 'O' level Maths.</th>
<th>Students without 'O' level Maths.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>8%</td>
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</tr>
<tr>
<td></td>
<td>11%</td>
<td></td>
</tr>
</tbody>
</table>

| Diploma of Higher Education | 11% |
| Teacher's Certificate      | 29% |

One Dip. H.E. student with 'O' level Mathematics (Student No. 6), carried on in a regardless fashion in trying to change \( \frac{3}{5} \) to a decimal by division, e.g. \( \frac{3}{5} = 3 \div 5 \)

\[
\begin{array}{c}
\frac{3}{5} \\
\frac{20}{20} \\
\frac{18}{20}
\end{array}
\]

Either this student did not have a full grasp of the meaning of such a fraction, or this was a reversal error. Note that this student also found it necessary to use 'long' division for this, and also the rounding error in its accomplishment. Student No. 29 actually changed the fraction to a percentage and wrote in the percentage sign, \( \frac{3}{5} \times \frac{20}{100} = 60\% \).
### Question Number 6

#### Diploma of Higher Education

<table>
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10 Total Errors

#### Teacher's Certificate

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13 Total Errors

#### All Students

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23 Total Errors
Again, perhaps, the result of an equivalence method applied incorrectly. Student No. 30 made an identical error. Concept errors abounded amongst the students without 'O' level Mathematics, e.g. Dip. H.E. student No. 48 could write $\frac{3}{5} = 0.35$. This type of error reveals a lack of comprehension on the part of the student about the nature of the fraction and the nature of the place value in the decimal quantity. This was by no means an isolated example of this error, both in this question and in others on the paper. One Teacher's Certificate student without 'O' level, (Student No. 26 with a C.S.E. grade 5) could even make $\frac{3}{5} = 3.5$, and Teacher's Certificate student No. 43 made it 0.8.

When one considers it a great likelihood that these two students will eventually teach Mathematics in the primary school, and that they are not isolated examples, but there have been many such students since the expansion of teacher training which carried on in the 60's and up to the mid 70's, it is hardly surprising that there is criticism of the mathematical prowess of some of the school-leavers.

There are other errors also which are revealed by this question, e.g. place value errors revealed in the division process. The Dip. H.E. student, without 'O' level Mathematics, who can attempt to do the division thus,

\[
\frac{3}{5} = \frac{06}{30} = \frac{3}{5} = 0.06.
\]

The bad habits which this student has been allowed to get away with during his school life are to be deplored. How poorly disciplined this student has been. The lack of attention to place value and the entry of leading zeros could be avoided by observing errors like these and,
"... once correctly diagnosed, can often be simply and quickly remedied." (82.)

All this, provided, of course, the teacher himself or herself is sufficiently capable of seeing these errors and remedying them. It is not asking too much that someone paid to do the job should be able to do it, but is this truly the case. There are many grave weaknesses in the ability of these and former students entering the primary sector of education. There is an amount of in-service training in Mathematics but it is almost never devoted to the end of ensuring that primary school teachers are fully armed with these skills and, what is more important, are fully capable of dealing with all the concepts necessary for these skills, so that their teaching will be effective.

Question 7. What percentage of 150 is 21?

In spite of the fact that 86% of the school-leavers got this question wrong, it is hard to credit that of this small sample of the future teaching force, 43% should not be able to do so simple a calculation. Moreover, 32% of the students with 'O' level Mathematics, or its equivalent, also could not do this question. One would expect that the percentage of students without 'O' level Mathematics, and not being able to do this question, would be higher. That it should be 54% does not, therefore, put the school-leavers, even at 86%, in such a bad light. If the teachers are not able, how will the pupils be able? If one looks in addition to these figures, at the types of errors, one sees again that in the author's opinion they are mostly concept errors. (see fig. 4.18)

For example, 9 of the errors out of the 12 made by the Dip. H.E. students with 'O' level Mathematics, showed a lack of
Fig. 4.17

Failure Rates

<table>
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<tr>
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<tr>
<td>Students with 'O' level Maths.</td>
<td>Students without 'O' level Maths.</td>
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<tr>
<td>28%</td>
<td>41%</td>
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<tr>
<td>32%</td>
<td>54%</td>
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</table>

Diploma of Higher Education 34%
Teacher's Certificate 54%

understanding of the concept involved in the calculation of percentages, e.g. to take that of only one of these 9 - Student No. 20 made \( \frac{21 \times 150}{100} \) as the basis of the calculation. The rest of these 9 errors were some similar attempt to juggle the order of these quantities. They knew the quantities involved but did not appreciate the relationship one had with the others. That 75% of the errors made by Dip. H.E. students with 'O' level Mathematics should be of this kind shows the grave lack of understanding of percentages. The overall 86% of the errors being ones of gross incomprehension of the principles makes the matter very serious indeed. Equally serious was the incomprehension of the principles where a direct proportion method was used. 150 was correctly seen to be 100% and by proportion 1.5 was deduced to be 1%, but, from then on, confusion reigned. Actual numbers and percentages were compared one with the other, e.g. Dip. H.E. student No. 58, without 'O' level Mathematics, writes 1% is 1.5. Then he seems to realise that he needs to make 21, so he makes 21% by multiplying
<table>
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<tr>
<td><strong>All Students</strong></td>
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<td>A</td>
<td>B1</td>
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</table>
1.5 x 21 instead of finding the number of 1.5's in 21.

Of all the errors made by the students who have 'O' level Mathematics or its equivalent, 79% are of the non comprehension of the concept \( \frac{15}{7} \) kind, whilst of the students without 'O' level Mathematics, the figure is \( \frac{27}{30} \) 90%. Again the fact that some students have 'O' level Mathematics has not made a very great difference to their ability to handle this question. In the future, remedial work in some areas of Mathematics will still be a very important feature of teacher training.

In the Schools Council's survey, (Working paper No. 61), the only kind of question on percentage is one where the children are asked to find a given percentage of a number, not to find what percentage one quantity is of another. Nevertheless, in this question, 52% got it correct and 48% either got it wrong or did not attempt it. The figure not attempting it (31%) was quite high, which may show that it is a difficult concept for a lot of children or perhaps that it is not given a great deal of attention.

The N.I.'s survey (Primary Education in England), does not, in fact, mention work on percentages. It does suggest, however, that ideas encountered in say Mathematics and Geography are sometimes common but they are rarely linked. Indeed,

"The responses to the N.F.E.R. Mathematics test 32 show that the efforts made to teach children to calculate are not rewarded by high scores in the examples concerned with the handling of everyday situations. Learning to operate with numbers may need to be more closely linked with learning to use them in a variety of situations than is now common." (53)

In respect of the work on percentages, this would be extremely beneficial. Environmental Studies is not given a mention in the
report, but here would be an area where integration of Mathematics with 'everyday situations' would be encountered. The author was instrumental in carrying out a research project under the Aegis of the Schools Council in Wales to determine the possible involvement of Mathematics in Environmental Studies in Primary Schools in Gwent. Work was carried out on a Topic basis and it was shown possible in, for example, one Topic to involve Mathematics in a hundred separate items connected with the Topic, with work for children from six to eleven years. (8s)

Question Number 8

If in the store there were round steel bars of diameter 1 inch, \(1\frac{1}{16}\) inches, \(1\frac{1}{8}\) inches, \(1\frac{3}{16}\) inches, \(1\frac{1}{4}\) inches, \(1\frac{5}{16}\) inches, and you require one with a diameter as near as possible to 1.22 inches, which one would you choose?

The disparity in the percentage incorrect answer figures between the school-leavers and the students is very wide indeed. School-leavers 13%, Students 63%. It must be said here that there may very well have been a very different attitude on the part of the markers involved in this question. The training officers are concerned with correct answers, indeed, in the author's interviews with several in this county, they stressed this aspect again and again. In this question, there was undoubtedly a great deal of guessing on the part of the students. The author had asked the students to include all their working on the answer sheets and so was looking for a justification for the answer given. The school-leavers could have
been marked correct and yet it might have been a guess. In the author’s examination and marking of the pre-apprenticeship examinees' papers, he found it extremely difficult to tell whether the candidate could repeat his correct answer with other questions in the same field, because of the lack of working in many cases, on which to base a judgement.

This being said, the author judged 61% of the students with 'O' level were not accepted as being correct and 64% of those without 'O' level Mathematics.

It might be argued that the technical nature of the question made it more appropriate to the pupils who were being prepared for apprenticeship examinations. The inability of pupils to apply their Mathematics successfully to everyday situations was noted by the H.M.I's. in their report. Perhaps this situation, being more specialised, makes it worse. This did not really seem to be the case with these students; they seemed to lack the ability to handle the Arithmetic situation.

Difficulties with the concept of comparing the quantities in this question were evident. Of the Dip.H.E. students, 30 out of the 74 errors were rooted in the lack of their appreciation of the concept involved. For the Teacher's Certificate students, 42 out of the 58 errors were of this nature. When all students were considered, 54% of the errors were attributable to the inability of the students, due to not understanding the concepts involved.

There were in all 19 rounding errors which, although they did not in themselves invalidate the conclusions, showed a very sloppy technique and a lack of discipline which might well invalidate
judgements of a similar kind in any possible future questions.

Errors in concept were those where the students tried to compare the diameters in fraction form without making a common family of fractions or changing them to decimals. In this context it is interesting to note that this kind of comparison of the size of fractions is the type of question set by the 'Maths. and the 10-year-old' survey.

It also appears in N.F.E.R. tests which are set in this county in order to put pupils into sets or bands for Mathematics in the comprehensive schools. In Working Paper Number 61, some unitary fractions are given and the children are asked to put them in order of size starting with the largest in one case and the smallest in the other. This kind of question is very well if one wishes to find out the level of comprehension of the concept here with regard to the size of a unitary fraction. Perhaps it encourages an intuitive approach to this kind of situation in children at the formative age, especially if they
### Question Number 8

#### Diploma of Higher Education

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#### All Students

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133 Total Errors
never encounter any particular Arithmetic technique which may be used to make such a comparison in general. As was stated in the working paper, this test, of course,

"did not expect that any one class would have covered all the topics, but that every child should have encountered the majority of them" (85)

and

"questions finally given to the 10 year olds included the majority of topics considered appropriate to this age." (86)

This does suggest a level of question aimed at considerably less than the ablest children, but the majority of topics are considered appropriate for this age group. The same attitude is taken by other tests in use in schools and where the tests themselves influence the teacher in the kind of work he or she does. It might be worthwhile including questions designed to focus attention on some of the common Arithmetic manipulations, especially fractions, with a view to giving the teaching of these a little more impetus in schools.

About 25% of the students with 'O' level Mathematics or its equivalent made Arithmetic errors which were crucial in this question, e.g. Student No. 6, of the Dip. H.E. students, tried to change $\frac{1}{16}$ to a decimal - $\frac{1}{16} = 0.66$ $\frac{16}{100}$ $\frac{96}{96}$

The above manner of the calculation shows a disregard for the discipline needed in this question. There is a lack of attention to place value and the technique of long division. This student also made a division error as well as the place value error - 40 thdths. $\frac{7}{16} = 6$ thdths.

Student No. 3, amongst the Dip. H.E. students, and one who has 'O' level Mathematics, made $\frac{3}{16} = 1.9$ and $\frac{8}{10} = 1.25$. 
In one case, one student actually wrote that $\frac{1}{4}$ and $\frac{1}{2}$ were both equal to 0.25. There were errors due to the execution of the division which were not of a place value nature, e.g. \( \frac{19}{16} = 1.125 \) in which the error was due to the subtraction involved in the initial division - \( 19 \div 16 = 1 \text{ rem.} 2 \). It is hard to excuse these students with 'O' level Mathematics or its equivalent for these calculation errors. This is especially true when one student has to find $\frac{3}{4}$ of $\frac{1}{2}$, finds it necessary to divide thus - $\frac{2}{0.25}$ and, in so doing, calculates $2 \text{ths.} \div 2 = 1 \text{ th.} \text{ with a remainder of } 1 \text{ th.}$

This would seem to be a case of not concentrating during the process, just as in the case where a student multiplies $17 \times 25$ and makes it $445$. There is no working to tell how this was accomplished but it would have been due to a simple bond error when adding the tens, $3\text{ tens} + 4\text{ tens} = 14\text{ tens}$. 

Of the candidates without 'O' level Mathematics or its equivalent, 21 of the 33 errors were, in the author's opinion, due to a lack of comprehension of the concept of the comparison of this kind of fraction. The bulk of these being by students who thought they could compare the diameters in fraction form, often changing or trying to change, the 1.22 to fraction form in order to do so. In one case, a student in this category did understand that he could compare the fractions if they were all expressed in terms of the same 'family' of fractions but he did not know what to do with the 1.22. There were also errors of concept made by, for example, the student who was aware that a comparison could be made most easily if all were expressed in decimal form and then in order to change $\frac{7}{16}$ to a decimal divided 16 by 3.
There were in fact a number of errors of this kind in this and other questions. Either here there is a lack of comprehension of the meaning of the fraction, or slipshod work leads to a reversal of the numbers. Another student showed a lack of comprehension of the decimal system when he wrote $1.22 = \frac{122}{100}$. The examples of lack of understanding of the basic quantities involved and the way they are written get quite bizarre. With no comprehension of what he/she was going, a student wrote $\frac{22}{100} \times \frac{100}{12} = \frac{22}{12} = \frac{11}{6}$

and $\frac{22}{100} \times \frac{12}{100} = \frac{42}{125}$. In the first case, this student may have had some acquaintance at one time with equivalent fractions and was seeking to write $\frac{22}{100} \times \frac{12}{12}$. Had he tried to convert to a family in which all the fractions could have been expressed he could have made his comparison. The second expression written just below the first illustrates his confusion, and the quantity he obtains is most odd. Yet there is a student who correctly changes $1.22$ to $\frac{122}{100}$ and then simplifies this to $1\frac{13}{50}$, but then for the comparison makes this quantity, as he says 'approx. $1\frac{1}{2}$' (see Dip. H.E. student No. 46). For the same approximation, Dip. H.E. student No. 15 could write $1\frac{22}{100} \approx 1\frac{1}{2}$.

This use of approximation in what should be a tight calculation procedure recurs in other questions also, e.g. the students who can write $4.08 = 4\frac{1}{12}$, without even the abbreviation 'approx.' this time. This seems again, to the author, to demonstrate a rather cavalier attitude towards some of these calculations.

There were many errors in this question (133), some were the not fully expressing of a fraction as a decimal, or rounding it off to
two places when considering it in comparison with others, some were
calculation errors involving division and subtraction, whilst others
were concerned with place value. The majority of the errors,
however, were due to the lack of the idea of how to compare quantities
when expressed in fraction form.

Question 9  Find the area of a circle $2\frac{3}{4}$ inches diameter to
two decimal places.

As reported in the C.S.I. Wales survey, 94% of the school-
leavers taking examinations for apprenticeships failed this question.
It is almost unbelievable but it is a statistic which is supported by
the failure rate amongst the students, (see fig. 4.21), 88% of the
students also failed this question, 81% of the Diploma of Higher
Education students and 98% of the Teacher's Certificate students.
The figure was even 84% of the students with 'O' level Mathematics or
its equivalent. For the students taking a Teacher's Certificate
Course and without 'O' level Mathematics, the failure rate was 100%.
This is really a story of the blind leading the blind.

The types of errors, (see fig. 4.20), in this case showed a
different picture from that of many of the previous questions. This
time there was not so great a percentage of concept errors. 50 out
of 186 (27%) were concept errors when the errors made by all the
students was considered. The percentage was down to 1% ($\frac{16}{107}$) for
the errors made by the two 'A' level Dip. H.E. students, but 43% for
the Teacher's Certificate students. The concept error rate was much
lower for those with 'O' level Mathematics or its equivalent (20%) than
for the students without 'O' level Mathematics (31%). The biggest
single type of error amongst the Dip. H.E. students was that kind of
error due to lack of attention to detail.
Fig. 4.21

Failure Rates

<table>
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<tr>
<th>Question Number 9</th>
<th>Students with 'O' level Maths.</th>
<th>Students without 'O' level Maths.</th>
</tr>
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<td>79%</td>
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<td>84%</td>
<td>100%</td>
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<td>88%</td>
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Diploma of Higher Education 81%
Teacher's Certificate 98%

e.g. the many students who used the diameter (2\(\frac{3}{2}\)) as the radius. Teachers know that this is likely to happen in many instances in the classroom. The successful teacher makes sure that the children become alive to the fact that it might happen. They then guard against it. Then there is Dip. H.E. student No. 3 who, when he wants to divide 2\(\frac{3}{2}\) by 2, writes it as \(\frac{5}{2} \div \frac{2}{1} = \frac{5}{2} \div \frac{1}{2}\), an error purely due to carelessness, because in question number 5, he has already demonstrated his ability to divide fractions.

The third highest factor overall (13%) was due to not quoting the relationship between area and radius or diameter correctly. Some gave it as \(A = d\) (\(\frac{17}{112}\) students). It was quoted by others in a variety of ways -

\[
A = 2d, \quad A = dr^2, \quad A = dr, \quad d = \frac{1}{4} \text{ area}
\]

\[
A = \pi r, \quad A = 1xb, \quad A = \frac{3}{4} \pi r^2
\]
Fig. 4.22

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107 Total Errors

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79 Total Errors

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<td>No. of Errors</td>
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186 Total Errors
The author thinks that concept error is at the bottom of those who quote it as $\pi d$. One would hope that the two forms $A = \pi r^2$ and $C = 2\pi r$ would have been developed in a way which was meaningful and which drew attention to the dimensionality inherent in the forms of these formulae. Further concept errors were exhibited by those students who thought that $\pi r^2 = \pi d$ or $2\pi r$, in fact that $r^2 = 2r$. There were in fact 10 of the students who did this, and one is tempted to conjecture that this is at the heart of the concept errors giving rise to many of the other quotes of $A = \pi d$. In the minds of many of the students, the two things are in fact the same because $r^2 = 2r$ to them. There were so many errors in this question, in fact a greater number (186) than in any of the other questions.

The author suspects that there would be a great deal of lack of understanding about the concept of $\pi$, but, in this test, we can only see that many students could not quote $\pi$ accurately. We had $\pi$ quoted as a fraction and then the student had to convert the fraction to a decimal. Then we had

- $\pi = 3.143$
- $\pi = 3.172$
- $\pi = 3.1$
- $\pi = 22.37$
- $\pi = \frac{7}{22}$ or $0.33$
- $\pi = 3\frac{3}{34}$
- $\pi = 3$.

Some are so far from the mark that these ideas must to them be totally meaningless.

Calculation errors also abounded in this question. There were skills needed for this question which were identified in previous
questions, some of the students made these errors for the first time in this question, e.g. Place value errors, Multiplication errors, Division errors.

Student No. 9 of the Dip. H.E. students, had to divide 275 by \(14 = 11.64\). In the calculation, the units figure was a 9 but was so poorly written that he himself took it for a one.

Student No. 12, who has 'A' level Mathematics, has to multiply 56 by 9 and makes it 494. He correctly gets \(50 \times 9 = 450\) and \(6 \times 9 = 54\) but then he adds in the 4 of the units instead of the 5 of the tens. A lack of concentration it seems in this question, for this is his first error so far on the paper.

Student No. 17 of the Dip. H.E's. exhibits an error which we have seen before but which he commits for the first time. In the multiplication 1.75 by 1.75 he neglects to multiply by the 5 hundredths.

Student No. 21 of the Dip. H.E's. exhibits an error which he has not previously made, but his methods have not, until this time, called for it. He writes \(\frac{22}{7} \times 1.56 = \frac{2200}{7} \times 156\) thus magnifying the amount by a factor of \(10^4\). Perhaps his concept of the equivalence of fractions is shaky, or again, may be he lacks the concentration and discipline to carry this calculation out without error.

Yet again we have an error in this question which Dip.H.E. student No. 26 has not made previously. This student employs long division and makes \(\frac{57}{56} = 4.92\). The error occurred when dealing with the 4 hundredths remainder. When changed to thousandths, a
division still could not be made and a zero should have been entered in the thousandths column and was not. Consequently there was a rounding up in the hundredths column.

The errors in calculation seem to be precipitated in this question.

Student No. 36 of the Dip. H.E's. makes his only errors on this question. He makes a multiplication error, $1.25 \times 1.25 = 1.5725$. The error actually lay in $1.25 \times 0.05 = .0725$ which involved a carrying figure error. Here we see an extremely able student making his only error and it is an error due to lack of concentration.

Some students, in attempting this question, expressed the quantities in decimals and then rounded them off far too early in the calculation to be accurate to two places of decimals. There were 15 rounding errors in the question.

Student No. 37 of the Dip. H.E. students has a C.S.E. grade I and, in her calculation, rounds off 1.5625 to 1.56; other students rounded off both 1.5625 to 1.56 and 3.142 to 3.14 and thus an answer, which should have been 4.91 sq. miles, now becomes 4.90.

Student No. 39 of the Dip. H.E's. makes $3.142 \times 1.25 = 3.9265$ and has a carrying figure error. He then rounds 3.9265 to 3.92. One I suppose is not surprised but rather ashamed to find amongst the students with two 'A' levels those who can make mistakes when dividing by 2, e.g. $\frac{1}{2}$ of $2\frac{1}{2} = 1.75$, $10.5 \div 2 = 5.42$. So many of these errors do seem to be either due to gross incomprehension of the concepts involved or are due to a lack of discipline in the settling down to answer an Arithmetic paper.
One student with 'O' level Mathematics, had to divide 275 by 56 and made it $4.09$, $275 \div 56 = 4$ units, remainder 51 units. In this case there is no indication that the 51 units are then converted to 510 tenths and divided accordingly. The working was set out merely in fraction form, $\frac{275}{56} = 4.09$. The lack of a disciplined use of a method has here been his downfall, but the error is a Place Value error and, whether careless or not, a concept error is made.

It is interesting to see that there were three students without any errors at all, three of them did not have 'O' level Mathematics, one of them had an 'O' level in Arithmetic and was from India.

There were the few calculation errors, e.g. $7 \times 7 + 3 = 51$. In this one, the author thinks the weakness lies in the addition bond. Not that the student does not know or that he could not count on, but that he is not sufficiently familiar with all the addition bonds.

It is hard to see why a student, in carrying out a long division, $78.55 \div 16$, correctly calculates $16 \times 8 = 128$ and sees that $128 + 16 = 144$, should then write 8ths in the answer,

\[
\begin{array}{c}
\text{16/78.55} \\
\text{64} \\
\text{145} \\
\text{144} \\
\text{1 50}
\end{array}
\]

Indeed, the error is repeated when dealing with the 150 thousandths. The $16 \times 8 = 144$ is evidently still present in the mind, and he writes 8 thousandths in the answer. All the rationale is there, but the concentration does not seem to be there.
It is even harder to understand the thinking of a student who writes, 
\[
\frac{11}{7} = \frac{2 \times 8}{7} = \frac{2 \times 88}{7} = 8.4.
\]

The second 'equals' sign he intends should be a multiplication sign since he multiplies the fractions together. The \( \frac{200}{50} \) is an enigma.

If one looks back at his previous questions (Dip. H.E. student No. 48 who has no 'O' level Mathematics or its equivalent), he is in trouble with the concepts involved in fractions all along. One wonders if the \( \frac{200}{50} \) represents a mistaken way of writing \( 2 \frac{1}{2} \) where this student has seen fractions and wholes represented upon a metre ruler. This student is also capable at one moment of correctly relating \( 11 \times 8 = 88 \) and, in the next moment, in the situation \( \frac{88}{7} \), relating 88 and 7 with 8.

Dip. H.E. student No. 50 had been taught a method of long multiplication which depended upon keeping the decimal point in a fixed position and moving the digits to appropriate positions, thus multiplying by 0.05 means multiplying by 5 and using a shift of two places to the right. In each case in the multiplication by the 0.2 and the 0.05 there was an error in the shift. In a later multiplication, these types of error were repeated. This is a Dip. H.E. student without 'O' level Mathematics or its equivalent who may one day teach Mathematics, certainly will if he is engaged to teach in a primary school. He himself at this stage shows that he cannot multiply two decimal quantities together, something which is in many Mathematics guidelines for primary schools.

It is no surprise to meet, in this question, the error previously met with in the multiplication of fractions, \( \frac{3}{2} \times 2 \frac{1}{4} = 6 \frac{1}{4} \).
The concept of multiplication of fractions is not part of this student's Mathematical armoury.

Within the set of students without 'O' level Mathematics is one who distinguishes herself by getting errors in numbers 2, 4, 5, 6, 7, 8, 9 and 10, i.e. she could only do two questions correctly, the addition and the multiplication of whole numbers. As may be seen throughout, especially question No. 9, she has not the least idea of how to handle fractions.

The counting of places in a long multiplication of decimals, to locate the decimal point, is a usual way of proceeding. Some inaccuracies will occur in this if there is a lack of care and concentration.

One student makes $1.25 \times 1.25 = 158.25$, having an addition error $5 + 5 + 6 = 18$ as well as the place value error. It seems clear that she is merely going through a routine procedure without any proper regard to the value of the numbers involved.

A similar occurrence appeared in the answers of a student who was multiplying $3.14 \times 1.25^2$ and made it $490.47$. Place value errors abound, both in multiplication and division as we have seen.

When one looks at the slovenly way the work is carried out on paper by many of the students, there is little wonder that such errors occur. There is with a certainty, amongst these students at least, insufficient attention to good practice in layout.

The student who made the error quoted above, also contrived to add together $0.092$ and $0.014$ and make it $0.0106$. 

Question 10

A No. 0 wood screw has a diameter of 0.050 inches. A No. 1, a diameter of 0.064 inches, and a No. 2 a diameter of 0.078 inches, and the diameter of the larger sizes goes on increasing by the same amount.

Find the diameter of a No. 8.

The author, seeing that 99% of the school-leavers got this question wrong, rather feared the worst. In fact, 34% of all the students got this wrong, far fewer than expected. The students with 'O' level had a failure rate of 20% against the failure rate of 48% for those without 'O' level Mathematics or its equivalent. Even so, for the Dip. H.E. students, one quarter of them could not do this question without error. The massive difference in the percentages between school-leavers and students could possibly be explained in this question by the probable superiorcy of the students in their use of English. Certainly the most well qualified of the students, 2 'A' levels and 'O' level Mathematics, make them the best fitted to tackle this question. One would think that mathematically, any difficulty that lay in this question would lay in the idea of a series. Comprehension errors accounted for 40% of those made overall, though, as one would expect, it was a greater percentage (42%) for the Teacher's Certificate students than the Dip. H.E. students (37%) but not by so very much.

Lack of care was the cause of the next most frequent set of errors and the remainder were calculation errors and place value errors in the main, e.g. in addition

\[
\begin{align*}
&0.078 \\
&0.014 \\
\hline
&0.092
\end{align*}
\]

a 'carrying figure' is dropped and a similar error is made by the
same student in a later calculation in the same question.

It was good to see the idea of a progression was understood here, most of the problems came in actually linking the intervals to the No. 8 screw. One student gave the sum of the intervals alone as the answer, another could not find the correct number of steps (intervals) from the number 2 screw to the number 8 screw. One student found the correct number of intervals but added this sum to the No. 2 screw size and not to the No. 0 screw size.

Fig. 4.23

Failure Rates

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<th>Students without 'O' level Maths.</th>
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Diploma of Higher Education | 2%
Teacher's Certificate     | 46%
### Question Number 10

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Notes on methods employed

A great variety of methods were demonstrated by these students in tackling these questions which aptly demonstrated the lack of a widely taught and accepted best method of approach to calculation and the belief expressed by many in the '60s and early '70s that children should not be restricted to one method in a calculation but should be allowed to experiment and should be shown a variety of methods.

"We make a special plea for the avoidance, even in 'practice' in computation, of the imposition of a closed situation. Such a closed situation exists, for example, where children are drilled in only one method of carrying out a particular method of calculation until they come to regard this as the only way to arrive at the required answer." (87)

In a few of the cases, the students have been taught to do, or perhaps have been allowed to do, division by a single digit number by the 'long' method. One student carried this out for division by 2 and yet another one used long division layout when he wanted to divide by 10! There are teachers, (certainly some in Gwent, as the author can verify, having had discussions on this point when compiling guidelines), who advocate the teaching of the long division layout even when dealing with single digit division. This would be on the grounds that it better prepares children for division when the divisors are outside those which are in the learned 'tables'. It is true that long division does present a major hurdle, but to base the whole of early division by a single digit divisor on this layout is to give, in the author's opinion, pupils a bad calculation pattern. It is quicker and more economical to use 'short' division and it seems so unnecessary to use a steam hammer to crack a nut.
Really to be deplored are the cases where the student has either been taught or allowed to deal with the operations on fractions by changing them into decimals. At the heart of this may well lie the swing away from fractions due to metrication publicity, but it also shows the lack of appreciation, of those who advocate changing fractions into decimals in order to operate upon them, of the relationship of the quantities expressed in fraction form and the quantities expressed in decimal form, and the limitations of accuracy so imposed.

If one looks at the overall errors made by Dip. H.E. students and Teacher's Certificate students, (see fig. 4.25), it would appear at first glance that the Dip. H.E. students had made more errors and had failed more questions. In fact, in all questions except numbers 2 and 8 they either had a lesser percentage of failures or, as in the case of question No. 4, had the same percentage of failures (see fig. 4.26). Where the Teacher's Certificate students had a reduced overall error total, this was due to the fact that if they did not comprehend the question then they could only be given that as an error. The students who tackled the questions may have made more than one error in carrying out the possible solution. Certainly there were more 'D' errors made by the Certificate students (see fig. 4.25). There was a greater lack of comprehension of concepts amongst the Teacher's Certificate students. Excluding question 1 and 2, the Teacher's Certificate students without 'O' level Mathematics or its equivalent were in such a relative position that a greater percentage of them failed the questions than the percentage of the Teacher's Certificate students with 'O' level. This would act as a factor which would inflate the number of errors made by the Teacher's Certificate students and would influence the figure for the 'D' errors. If one examines in fig. 4.26 the percentage figures of the various categories of student who failed each question, the Certificate
### Totals of Types of Error

**Diploma of Higher Education**

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Total Errors: 514

**Teacher's Certificate**

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Total Errors: 271

**All Students**

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Total Errors: 585

Fig. 4.25
students with 'O' level Mathematics or its equivalent, in questions 4, 5 and 8, and even when one compares the Dip. H.E. and the Certificate students, both of whom do not have 'O' level or its equivalent, the Certificate students do relatively better on questions 4 and 8, whilst they do as well on question 5. Supplementary to this, they do better on questions 1, 2, 3. In fact, their percentage of students failing is only worse on questions numbers 6, 7, 9 and 10. Looking at the Diploma students as a whole and the Certificate students as a whole, then the Certificate students have a greater percentage failure on all but questions 2 and 8, and have an equal percentage on question 4.

What one must take to be the greater intellectual quality of the Dip. H.E. students has not been a telling factor in these questions. The Certificate students are not much behind in question 5. So, for the questions on fractions, numbers 4, 5 and 8, the superior intellectually have not been able to score significantly more. The greater ability to comprehend is not a significant factor. The Dip. H.E. students show their superiority in questions 6, 7, 9 and 10. In 6 and 7, the comprehension of the concept is crucial and, in number 10, it is always the higher level of attainment in education that counts, e.g. School-leavers 99% failure rate See fig. 4.24.

Certificate students 46% failure rate
Diploma students 25% failure rate

A superior linguistic ability surely plays a part in being successful with this question. As for question 9, there are many pitfalls in the successful execution of this question. It is significant that far more errors are made in this question than any other, and that this figure of 186 is suppressed by the number of students who could not start it and thus only made the 'D' error. Had they been able to start, then the figure might well have been much greater. Though the biggest single factor in the concept error in
this question which could be magnified also by the 'E' errors (the failure to quote the correct formula), there were a host of other errors, quite a few in the calculation itself.

Some students attempted to carry out this calculation such as, \[ \frac{22}{7} \times \left( \frac{24}{2} \right)^2 \] where the problems of comprehending processes of multiplication and division of fractions are met.

Others tried it as decimals, i.e. \( 3.142 \times 1.25 \times 1.25 \) with the attendant problems of comprehension skill and concentration necessary for a lengthy 'long' multiplication of decimals.

Either way of doing it calls for skill in calculation and the concentration and discipline necessary. In meeting these challenges, the students with two 'A' levels were more successful than the Teacher's Certificate students.

The greatest number of errors made overall, (see the errors in order of frequency, fig. 4.28), were concept errors and these mostly occurred in questions 5, 7, 8 and 9. For many years, and under the aegis and encouragement of Miss Biggs, The Nuffield Project, The Schools Council, the Mathematical Association, many interested in Mathematics' education have striven against rote learning. They have tried in their own teaching and in the encouragement of others to ensure that children learn Mathematics with understanding. For example, in the report on Mathematics in primary schools, by a committee of the Mathematical Association, a great emphasis is placed on understanding,

"We have emphasised the importance of what we call understanding, ....... What is important is that we should recognise and foster its growth, and that we should be ready, as far as we are able, to relate children's experience and their growing power of understanding to Mathematical ideas ......." (88)
## Percentages with Questions Incorrect

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**Fig. 4.26**
### Totals of Errors

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<th>P</th>
<th>R</th>
<th>S</th>
<th>Σ</th>
<th>Total Errors</th>
</tr>
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<tbody>
<tr>
<td>1</td>
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<td>133</td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>14</td>
<td>19</td>
<td>50</td>
<td>24</td>
<td>30</td>
<td>16</td>
<td>15</td>
<td>3</td>
<td>9</td>
<td></td>
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<td></td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td>8</td>
<td>3</td>
<td>18</td>
<td>11</td>
<td>3</td>
<td>1</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>585</td>
</tr>
</tbody>
</table>

**Fig. 7.27**
We see here how much a lack of understanding has led to the downfall of so many students. What we must be on our guard against is so called teaching or learning for understanding which excludes the necessary Arithmetic skills.

"Nor does the development of understanding through 'an individual organisation of experience' exclude the acquisition of skill in the use of accepted rules of procedure." (89)

Somehow a garbled message got to teachers concerning the emphasis on understanding. Somehow we concentrated, for example, on proving what we were doing by constructing multiplication tables and then ignored the fact that they should be available, hopefully, for instant recall.

Though this area of 'understanding' is the one for our most serious consideration, the second highest reason for error also presents us with a problem for consideration. This is the set of errors which have been made due to lack of attention to details, to carelessness, to lack of concentration, due, perhaps, to a lack of that essential disciplined attitude towards Mathematical activity. Some of the work was extremely careless, both from a mental and a written point of view. Carrying figures were 'forgotten' and the layout of various processes were conducive to errors being made. Clearly the attitude of the teacher is an important factor in remedying this situation.

The third largest set of errors were those of rounding and calculation involving division. The rounding errors could reflect a lack of understanding about quantities expressed to the nearest kind of unit, or it also could reflect a lack of a disciplined approach once again. Division has always been an area of some difficulty for pupils in primary schools but it does appear as a process which teachers think
Errors in order of frequency

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>267</td>
<td>46%</td>
</tr>
<tr>
<td>F</td>
<td>76</td>
<td>13%</td>
</tr>
<tr>
<td>R</td>
<td>41</td>
<td>7%</td>
</tr>
<tr>
<td>C4</td>
<td>41</td>
<td>7%</td>
</tr>
</tbody>
</table>

Fig. 4.28

Most commonly occurring errors

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
<th>Percentage of Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>267</td>
<td>46%</td>
</tr>
<tr>
<td>F</td>
<td>76</td>
<td>13%</td>
</tr>
<tr>
<td>R</td>
<td>41</td>
<td>7%</td>
</tr>
<tr>
<td>C4</td>
<td>41</td>
<td>7%</td>
</tr>
</tbody>
</table>

Fig. 4.29
could and should be taught to primary school children, in many
guidelines, e.g. see: Syllabus for Mathematics 4-13 years for the
R.C. schools in Gwent. It is included in the work for the third
year of the junior school. Clearly, if we think it is to be
taught, then we must exercise our minds for finding the most
beneficial way of presenting experiences and teaching which will
lead to the concepts and the skills being learned.
CHAPTER 5

An examination of the Mathematical Standards
of some young teachers

The ten selected questions from the report on numeracy and literacy in Wales by the C.B.I. Working Party, having been given to a group of students in training in 1979, were also given in 1980 to a group of fifty-six young teachers who were taking an in-service B.Ed. course at the college and at University College, Cardiff, and 50% of whom were teachers in primary schools. The author felt that he was fortunate indeed to get the willing co-operation of teachers for such a test and, consequently, the group were promised anonymity. No names were written at the top of the answer sheet.

As previously, an attempt has been made to ascertain the kind of errors which were made and the frequency of occurrence of such errors.

The following pages show the kinds of errors made by these teachers.

(For types of error refer to pp 24,25.)
<table>
<thead>
<tr>
<th>Teacher</th>
<th>Qn.</th>
<th>Errors</th>
<th>Types of error</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>4</td>
<td>a. No concept of addition of fractions $\frac{7}{4} + \frac{7}{3} = \frac{14}{12}$</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. No attempt made.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. No attempt made.</td>
<td>D</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>a. Tried to compare by changing decimal to a fraction. No basis for result.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Multiplication error $1.25^2 = 1.5725$</td>
<td>C3</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>a. Error in multiplication $5 \times 7 = 30$.</td>
<td>C3B</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Error in multiplying by 16. Multiplied by 10 and then by 6. No appreciation of the distributive law.</td>
<td>D</td>
</tr>
<tr>
<td>4</td>
<td></td>
<td>a. No concept of addition of fractions. Adding corresponding elements, $\frac{7}{4} + \frac{7}{3} = \frac{14}{7} = 2$.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a. 'Cancellation' within $\div$ operation.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Multiplication of corresponding elements within the $\div$ operation.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Changed decimal to fraction to try to compare. Incorrect result.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Incorrectly quoted $\pi = 3\frac{1}{3}$.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Conversion of mixed fraction to vulgar fraction incorrect twice, $1\frac{3}{4} = 6$.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>a. No attempt made.</td>
<td>D</td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>a. A digit missed in the scan.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Tried to compare by changing the decimal to a fraction. No basis for the conclusion.</td>
<td>D</td>
</tr>
<tr>
<td>Teacher</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of Error</td>
</tr>
<tr>
<td>---------</td>
<td>-----</td>
<td>--------</td>
<td>----------------</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>a. No concept of addition of fractions[\frac{7}{4} + \frac{7}{3} = \frac{14}{7}]. Adds corresponding elements.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Incorrect result. No working to show basis for conclusion.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. In division calculation, $6 \times 9 = 54$. Digits reversed in recording.</td>
<td>C4, F</td>
</tr>
<tr>
<td>6</td>
<td></td>
<td>No errors</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>5</td>
<td>A. Changed operation from division to addition.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>a. Error in concept of percentage calculation. [150 \times \frac{21}{100}]</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Errors in changing fractions to decimals. Concept error since $\frac{1}{16} = .016, \frac{2}{16} = .08, \frac{3}{16} = .24$.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Area incorrectly quoted as $\pi$ D.</td>
<td>E</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>a. Changes decimal to fraction to try to compare. Incorrect result.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Correctly writes $A = \pi r^2$ but treats as $A = (\pi r)^2$.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Division error $55 \div 14 = 3.92$</td>
<td>C4</td>
</tr>
<tr>
<td>9</td>
<td>5</td>
<td>a. No concept of division of fractions. Correctly inverts second fraction but multiplies numerators and adds denominators.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Changes decimal to a fraction to try to compare.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Rounds 1.5625 (i.e. $1.25^2$) to 1.6 too early in calculation. No further calculation done.</td>
<td>R</td>
</tr>
<tr>
<td>Teacher</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of Error</td>
</tr>
<tr>
<td>---------</td>
<td>-----</td>
<td>------------------------------------------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>10</td>
<td>3</td>
<td>a. Carrying figure error in the multiplication.</td>
<td>C&lt;sub&gt;3&lt;/sub&gt; F</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>a. No concept of division of fractions after using equivalence to convert to same 'family'.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. No attempt made.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. No concept of changing fraction to a decimal.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>451/56 = 100% 1/3 = .56. Nothing further.</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>3</td>
<td>a. Error in multiplying by 7. Place value error.</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>a. Converts fractions to decimals, adds. Does not convert back to fractions.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>a. Changed operation from division to subtraction.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Derives 4/7 from 7/16 x 4 and makes an error in multiplication. Incorrect result.</td>
<td>C&lt;sub&gt;3&lt;/sub&gt;</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Error in rounding 1.5625. Rounds to 1.5.</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>a. No attempt made.</td>
<td>D</td>
</tr>
<tr>
<td>12</td>
<td>7</td>
<td>a. Error in concept of percentage calculation. Writes 21 x 150.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>100</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Errors in converting fractions to decimals.</td>
<td>C&lt;sub&gt;4&lt;/sub&gt;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1^{1/2}<em>{16} = 1.00  1^{1/3}</em>{3} = 1.01  1^{1/3}_{16} = 1.01</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>1^{1/2}<em>{2} = 1.02  1^{5}</em>{16} = 1.05  1^{3}_{2} = 1.04</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Misquote of π  π = 2.17</td>
<td>π</td>
</tr>
<tr>
<td>13</td>
<td>2</td>
<td>a. Neglect of addition figure in equal addition method.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>a. Three carrying figure errors in the multiplication. C&lt;sub&gt;3&lt;/sub&gt; F</td>
<td></td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>a. Not attempted.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>a. Not attempted.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Answer given as &quot;1/3?&quot;. No basis for conclusion.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Misquote of π.  π = 3.75</td>
<td>π</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Carrying figure error in multiplication.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>a. No concept. Multiplies No. 2 screw by 2 to get D</td>
<td></td>
</tr>
<tr>
<td>Teacher</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of Error</td>
</tr>
<tr>
<td>---------</td>
<td>-----</td>
<td>-----------------------------------------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>14</td>
<td>1</td>
<td>a. Addition error.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>a. Place value error in multiplication by 57, 625 x 57 = 356250.</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. This then multiplied by 6 and not 16.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>a. Cannot handle multiplication of fractions after correctly inverting second fraction, ( \frac{5}{6} \times \frac{3}{2} = \frac{5 \times 9}{6} ). The one denominator syndrome!</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Decimal changed to fraction to compare. Incorrect result.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Uses diameter instead of radius.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Multiplication error, ( 3.14 \times 6.25 = 19.63 ). In calculation ( 3 \times 6 = 18 ).</td>
<td>C4, B3</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>a. Diameters written as 0.50, 0.64, 0.78 etc. In consequence difference is 0.14. Incorrect result with these figures. Incorrect transcribing.</td>
<td>F</td>
</tr>
<tr>
<td>15</td>
<td>1</td>
<td>a. 5431 omitted in transcribing.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>a. &quot;Cancellation&quot; carried out with division operation ( \frac{5}{2} \div \frac{2}{3} = \frac{5}{9} ).</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Incorrect quotation of area, ( A = \pi d ).</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>a. Incorrect addition led to result 1.162.</td>
<td>C1</td>
</tr>
<tr>
<td>16</td>
<td>3</td>
<td>a. Carrying figure error in multiplication.</td>
<td>F C3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Neglected to multiply by 16.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Changes decimal to a fraction to compare. No other working. No basis for conclusion.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Not attempted.</td>
<td>D</td>
</tr>
<tr>
<td>Teacher</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of Error</td>
</tr>
<tr>
<td>---------</td>
<td>-----</td>
<td>------------------------------------------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>17</td>
<td>7</td>
<td>a. Error in concept of percentage calculation.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Writes $\frac{21 \times 150}{100}$</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Changes decimal to a fraction to compare.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No other working. No basis for conclusion.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Correctly quotes $\pi r^2$. Calculates $r^2$ correctly.</td>
<td>$\pi$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No other working. Seems as if could not quote $\pi$.</td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>1</td>
<td>a. Addition error.</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>a. When multiplying by 57, started multiplying by 7u and changed to multiply by 5u.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>a. Correctly obtained $\frac{3}{4} + \frac{1}{3} = \frac{9}{12} + \frac{4}{12} = \frac{13}{12}$. Crossed this out. Very uncertain. Wrote $\frac{33}{12}$ as result.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. No basis for result. No working.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Incorrectly uses form $\Pi D$.</td>
<td>E</td>
</tr>
<tr>
<td></td>
<td>b.</td>
<td>Error in place value in calculation $3.142 \times 2.5 = \frac{\pi}{2}$. When multiplying $3.142 \times 0.5 = 15.710$. Calculation then not completed.</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>a. Not attempted.</td>
<td>D</td>
</tr>
<tr>
<td>19</td>
<td>3</td>
<td>a. To multiply by 16, firstly multiplies by 6 and then by 10. Not using distributive law.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>a. Makes $\frac{49}{12} = 4\frac{1}{2}$.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>a. In calculation $\frac{1}{5} \times \frac{1}{2} = 2\frac{1}{2}$, has neglected one of the twos in the denominator.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>a. Not attempted.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>a. Error in concept of percentage calculation.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>What is written amounts to $\frac{150 \times 21}{100}$.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Tries to compare by changing decimal to a percentage. No basis for the conclusion.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Place value error in division, $275 \div 56 = 40.9$</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>b.</td>
<td>Error in the digits also.</td>
<td>$C_4$</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>a. Makes No. 6 screw twice diameter of the No. 3 screw.</td>
<td>D</td>
</tr>
<tr>
<td>Teacher</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of Error</td>
</tr>
<tr>
<td>---------</td>
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<td>--------</td>
<td>---------------</td>
</tr>
<tr>
<td>20</td>
<td>7</td>
<td>a. Error in concept of percentage calculation. Finds 21%% .</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Makes 1% = 1.25 and this leads to choice of 1% or 1%%. Careless and lack of thinking.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Carrying error in the multiplication.</td>
<td>C_3 F</td>
</tr>
<tr>
<td>21</td>
<td>2</td>
<td>a. Incorrect result and no working to indicate method used.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>a. Error in concept of percentage calculation. Writes 150 x 21. \frac{150}{100}</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Incorrect result and no working.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Correctly takes A = π r² but thinks π r² means (π r)². b. Uses d for r in calculation. c. Calculates ((7^2)^2 = (7 + 6)^2 = (49 + 36)) No concept of ((a + b)^2 = a^2 + 2ab + b^2). d. Calculates (\frac{(6)^2}{7}) as 36.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>a. Addition error in calculation.</td>
<td>C_1</td>
</tr>
<tr>
<td>22</td>
<td>7</td>
<td>a. Error in concept of percentage calculation. Writes 150 x 21. \frac{150}{21}</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Incorrect result, and no working.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Correctly quotes π r² but thinks π r² means (π r)². b. ((3\frac{3}{7} x 1\frac{1}{4}) = (2\frac{2}{7} + \frac{3}{4})) The several attempts made at this led to another concluding that it could not be handled.</td>
<td>D</td>
</tr>
<tr>
<td>23</td>
<td></td>
<td>No errors</td>
<td></td>
</tr>
<tr>
<td>Teacher</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of Error</td>
</tr>
<tr>
<td>---------</td>
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<td>--------</td>
<td>----------------</td>
</tr>
<tr>
<td>24</td>
<td></td>
<td>a. Multiplying by 57. Instead of multiplying by 5 x 10, multiplied by 7 x 10.</td>
<td>C3 F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. In multiplication (1 x 6) + 1 = 9.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>a. ( \frac{5}{2} \times \frac{1}{2} = \frac{5}{2} )</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. No basis for conclusion shown.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. ( 1\frac{3}{4} = 6 )</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. 8 correct intervals not added in to initial size.</td>
<td>D</td>
</tr>
<tr>
<td>25</td>
<td></td>
<td>a. 35625 x 10 = 35620.</td>
<td>C3 F</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>a. Changed operation from ( \div ) to -.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>a. Division, ( 42 \div 3 = 7 ).</td>
<td>C4</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Curious answer given as 11 ft. 4 ins.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Area of circle quoted as ( \pi D ).</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. ( \pi ) quoted as ( \frac{33}{7} ).</td>
<td>( \pi )</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Diameter used is 254.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>d. Division error, ( 83 \div 7 = 7, \quad \frac{797.42}{7/8382} )</td>
<td>C4</td>
</tr>
<tr>
<td>26</td>
<td>8</td>
<td>a. No attempt made.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Correct quote of ( A = \pi r^2 ) and no further attempt.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>a. No attempt made.</td>
<td>D</td>
</tr>
<tr>
<td>Teacher</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of Error</td>
</tr>
<tr>
<td>---------</td>
<td>-----</td>
<td>------------------------------------------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>27</td>
<td>4</td>
<td>a. (1\frac{3}{4} = \frac{15}{12})</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Factor not taken from both components in equivalence calculation, (\frac{15 + \frac{3}{4}}{\frac{12}{4}})</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>a. Nature of division of fractions not understood.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Incorrect answer (\frac{17}{6}) given with no working.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Correct quote of (\pi r^2) for area. Correct substitution (\pi (1\frac{1}{2} \text{ in.})^2) but could not work further.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>a. Constant difference noted, but given as (14).</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Only 5 intervals taken from the chosen screw size when 6 were needed.</td>
<td>D</td>
</tr>
<tr>
<td>28</td>
<td>8</td>
<td>a. Changes decimal into fraction. No basis for decision.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Writes (r^2 = 2r).</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Division error, (220 \div 28 = 4 \times 8)</td>
<td>C_4</td>
</tr>
<tr>
<td>29</td>
<td>9</td>
<td>a. Uses (d) for (r) in calculation.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Multiplication error. Error in placing of D.P. (3.142 \times 6.25 = 196.375)</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>a. Correctly saw 8 intervals of 0.014 but did not add in to screw No. 0.</td>
<td>D</td>
</tr>
<tr>
<td>30</td>
<td>3</td>
<td>a. Addition error in multiplication.</td>
<td>G_3 B_1</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>a. Wrote incorrectly one of two factors in equivalence calculation.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. No attempt made.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Incorrectly quoted (A = \pi d).</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Addition error in multiplication.</td>
<td>G_3 B_1</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>a. Took 7 intervals instead of 6 from chosen screw size.</td>
<td>D</td>
</tr>
<tr>
<td>Teacher</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of Error</td>
</tr>
<tr>
<td>---------</td>
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<td>----------------</td>
</tr>
<tr>
<td>31</td>
<td>7</td>
<td>a. Lacks concept of percentage when calculating. Writes $\frac{21}{100} \times 150$.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Converts decimal to fraction. No basis for comparison.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. In calculation $A = 4\frac{51}{56}$ is changed to a decimal as 4.00.</td>
<td>D</td>
</tr>
<tr>
<td>32</td>
<td>4</td>
<td>a. In division $\frac{12}{49} = 6\frac{3}{12}$</td>
<td>$C_4, B_3$</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Incorrectly thought it was something to do with the application of the Theorem of Pythagoras.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>a. No attempt made.</td>
<td>D</td>
</tr>
<tr>
<td>33</td>
<td>8</td>
<td>a. Errors in changing fractions to decimals $\frac{1}{8} = 0.135$.</td>
<td>$C_4$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. $\frac{1}{16} = 0.00625$.</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Error in multiplication $1.25 \times 1.25$.</td>
<td>$C_3$</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Addition error in multiplication.</td>
<td>$C_3$</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>a. Addition error in adding on 0.014.</td>
<td>$C_1$</td>
</tr>
<tr>
<td>34</td>
<td>4</td>
<td>a. Error in changing $2\frac{1}{2}$ to vulgar fraction.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>a. Changes $\div$ to operation of $\div$.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>a. Writes $\frac{3}{2} = 0.03$.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. No attempt made. Confesses to not knowing how to do it.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. No attempt made. Confesses to not knowing how to do it.</td>
<td>D</td>
</tr>
<tr>
<td>Teacher</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of Error</td>
</tr>
<tr>
<td>---------</td>
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<td>----------------</td>
</tr>
<tr>
<td>35</td>
<td>3</td>
<td>a. Error in addition in multiplication.</td>
<td>C3</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>a. Cannot add these.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>a. Multiplies each corresponding element together as it stands.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>a. No attempt made other than writing down what has to be done.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>a. Working amounts to $\frac{150}{21}$ without even to 100 being included. Answer given as 7.3%.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Writes 3 remainder from division as 0.3.</td>
<td>D P</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. No real basis for conclusion.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. No attempt made.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>a. Difference written as 14.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Incorrect size taken for 5 intervals.</td>
<td>D</td>
</tr>
<tr>
<td>36</td>
<td>2</td>
<td>a. Neglected the addition on one of digits in bottom line using equal addition method.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. No attempt made. Confesses to having no idea.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Writes $A = \pi r^2$ but cannot proceed.</td>
<td>D</td>
</tr>
<tr>
<td>37</td>
<td>3</td>
<td>a. Tries to compare by changing decimal to a fraction.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Writes 5 x 5 as 55 in calculation.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Division error involving place value.</td>
<td>C4 P</td>
</tr>
<tr>
<td>38</td>
<td>1</td>
<td>a. Error in transcribing from paper.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>a. Error in concept of percentage calculation, writes $\frac{150}{121}$.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Tries to compare them in fraction form. Uses sixteenths but then cannot handle 1.22.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. In attempting to multiply $\frac{1}{2} \times \frac{3}{4}$ makes it $\frac{1}{2} \times \frac{3}{4}$, i.e. multiplies corresponding parts individually. Not using distributive law.</td>
<td>D</td>
</tr>
<tr>
<td>Teacher</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of Error</td>
</tr>
<tr>
<td>---------</td>
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<td>--------</td>
<td>---------------</td>
</tr>
<tr>
<td>39</td>
<td>3</td>
<td>a. Error in multiplication calculation.</td>
<td>C3</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>a. Writes $\frac{6}{10}$ as 0.66.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>a. Error in concept of percentage calculation. Writes $21 \times 150$.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. No attempt made.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Correctly writes $A = \pi r^2$ but cannot proceed.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>a. Error in subtraction to find step difference.</td>
<td>C2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Also place value error in difference calculation.</td>
<td>P</td>
</tr>
<tr>
<td>40</td>
<td>5</td>
<td>a. Cannot handle $\frac{5}{6}$</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Changes decimal to a fraction and then cannot proceed.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Multiplication error. Added in a non existent carrying figure.</td>
<td>C3</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>a. Addition error. Added in non existent carrying figure.</td>
<td>C1</td>
</tr>
<tr>
<td>41</td>
<td>5</td>
<td>a. Changes operation from $\div$ to $\cdot$.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Writes $\pi = 3.143$.</td>
<td>π</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Rounding too early in calculation leads to inaccuracy.</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Answer not given to 2 decimal places.</td>
<td>R</td>
</tr>
<tr>
<td>42</td>
<td>7</td>
<td>a. Error in concept of percentage calculation. Writes $150 \times 21$.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Error in multiplication, $0 \times 1 = 1$.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. No working to indicate why the incorrect result of 1.16 was given.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Writes statements to indicate that he thinks $2r = \pi$.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Also thinks $A = \pi r$.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>c. Calculation $1\frac{1}{2} \times 5 = 6 \times 6 = 36$.</td>
<td>D</td>
</tr>
<tr>
<td>Teacher</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of error</td>
</tr>
<tr>
<td>---------</td>
<td>-----</td>
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<td>----------------</td>
</tr>
<tr>
<td>43</td>
<td>4</td>
<td>a. Writes ( \frac{7}{4} + \frac{7}{3} = \frac{14}{7} ) Direct addition of corresponding elements.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>a. Error in concept of percentage calculation. Writes ( \frac{150 \times 21}{100} )</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. No method employed to indicate a reasoned choice.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Uses ( D ) instead of ( r ).&lt;br&gt;b. In equivalence uses ( 4 \times 4 = 18 ).&lt;br&gt;c. Multiplication ( 25 \times 25 = 675 ).&lt;br&gt;d. Multiplication ( 675 \times 22 = 13750 ).&lt;br&gt;e. Division ( \frac{13750}{700} = 19.34 ).</td>
<td>D, B, C, C, C</td>
</tr>
</tbody>
</table>

| 44      | 3   | a. Addition errors in multiplication due to neglect of carrying figure. | C, F |
|         | 7   | a. No idea of concept of percentage calculation. | D |
|         | 8   | a. Tries to express the decimal as a fraction and cannot do it. | D |
|         | 9   | a. Knows \( A = \pi r^2 \) but cannot proceed. | D |
|         | 10  | a. Thinks this is something to do with the circle. | D |

<p>| 45      | 8   | a. Tries to compare by changing the decimal to a fraction. | D |
|         | 9   | a. Result given in fraction form. | F |</p>
<table>
<thead>
<tr>
<th>Teacher</th>
<th>Qn.</th>
<th>Errors</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>46</td>
<td>2. a. Neglect of an addition figure in the method of equal addition.</td>
</tr>
</tbody>
</table>
|         |     | 4. a. No idea of the addition of fractions, $\frac{2}{3} + \frac{1}{3} = \frac{3}{3}$.
|         |     | 5. a. Straight multiplication of the corresponding elements $\frac{2}{6} - \frac{2}{3} = \frac{10}{18}$.
|         |     | 7. a. Error in concept of percentage calculation.
|         |     | 9. a. Result written as $2\frac{1}{2}$. No other working.
|         |     | 10. b. Wrote No. 0 screw as No. 1 screw and so did not get to No. 8.                                                                                                                                                                                                       |
|         | 47  | 4. a. Equivalence of fractions $\frac{1}{3} = \frac{3}{12}$.
|         |     | 8. a. Changes decimal to a fraction and tries to compare. Does not know how to proceed.
|         |     | 9. a. Wrote $A = 2\pi r$.
|         |     | b. Wrote $\pi = \frac{21}{7}$.
|         | 48  | 1. a. Error in addition.
|         |     | 6. a. Writes $\frac{3}{5} \times 100$ to change $\frac{3}{5}$ to a decimal and gives answer as 60%.
|         |     | 7. a. Error in concept of percentage calculation.
|         |     | 8. a. No basis for the conclusion.
|         |     | 9. a. Thinks $\text{Area} = \pi r$. No calculation.
<p>|         |     | 10. a. Error in transcribing from own paper $0.092 = 0.92$.                                                                                                                                                                                                             |
|         | 49  | 9. a. Error in division $51 \div 56$ and in multiplication $56 \times 9 = 494$.                                                                                                                                                                                                  |</p>
<table>
<thead>
<tr>
<th>Teacher</th>
<th>Qn.</th>
<th>Errors</th>
<th>Types of Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>50</td>
<td>8</td>
<td>a. Tries to compare in fraction form. Incorrect result.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. No attempt made.</td>
<td>D</td>
</tr>
<tr>
<td>51</td>
<td>8</td>
<td>a. Error in changing fraction to decimal, ( \frac{15}{16} = 1.03125 ).</td>
<td>C, P</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Size ordering incorrect, ( 1.03125 &gt; 1.22 ).</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Uses diameter as radius.</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. In calculation ( 5 \times 5 ) treated as ( 55 ).</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>a. Error in transcribing from own paper ( 0.078 = 0.074 ).</td>
<td>F</td>
</tr>
<tr>
<td>52</td>
<td>8</td>
<td>a. No attempt made.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. No attempt made.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>a. No attempt made.</td>
<td>D</td>
</tr>
<tr>
<td>53</td>
<td>1</td>
<td>a. Addition error.</td>
<td>C</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>a. No concept of addition of fractions. Adds corresponding elements, ( \frac{7}{4} + \frac{7}{3} = \frac{11}{7} ).</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>a. Error in concept of percentage calculation. Writes ( \frac{150}{100} \times 21 ).</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. Incorrect rounding of ( 1.0625 ).</td>
<td>R</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Writes ( 1\frac{3}{4} = 1.25 ).</td>
<td>F</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. Thinks ( R^2 = 2R ).</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td></td>
<td>b. Answer given as a fraction.</td>
<td>F</td>
</tr>
<tr>
<td>54</td>
<td>8</td>
<td>a. Incorrect answer of ( 1\frac{3}{4} ) given, with no working to support it.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. In calculation, ( 4 \times 4 = 8 ).</td>
<td>F</td>
</tr>
<tr>
<td>Teacher</td>
<td>Qn.</td>
<td>Errors</td>
<td>Types of Error</td>
</tr>
<tr>
<td>---------</td>
<td>-----</td>
<td>-------------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>55</td>
<td>7</td>
<td>a. No attempt made.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>a. No attempt made.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>9</td>
<td>a. No attempt made.</td>
<td>D</td>
</tr>
<tr>
<td></td>
<td>10</td>
<td>a. No attempt made.</td>
<td>D</td>
</tr>
<tr>
<td>56</td>
<td>10</td>
<td>a. Addition error in calculation.</td>
<td>C₁</td>
</tr>
</tbody>
</table>
Only two teachers out of the fifty-six got all the ten questions correct. The modal number correct was seven (see fig. 5.3). The cumulative frequency graph (fig. 5.4) shows that 18 teachers, (32%), got five or less questions right. Thirty-two per cent of the teachers could not get half marks.

The performance of the teachers was better than that of the school-leavers (see fig. 5.1), as one should hope, but it still should be a cause of grave concern that on six of the ten questions, over a quarter of the teachers got the question wrong.

In the case of question 9, the percentage of the school-leavers who got this wrong was 94% and the teachers were not far behind with 93%.

The percentage who got question 8 wrong amongst the young teachers was equally deplorable at 86%. This time, however, the way in which this question was marked must have had a considerable bearing upon the marked difference in the failure rates of 13% for the school-leavers and 86% for the teachers. Since the avowed intention of industry, with respect to these tests, is for a right or wrong marking, one must suspect that this failure rate is abnormally low.

"I am only interested in whether the school-leaver can get the right answer under stress conditions."

(Statement made to the author by the training officer for 'South Wales Switchgear' during an interview.)

The author found that the failure rate for the students, on this question, was also high at 63%. Admittedly the author, in marking this question, was trying to find those who could substantiate a claim to the right answer. The question is wide open to a guess and, for many of the students and teachers, there was no real basis for their conclusions, and the author got the impression that, for many of them, the only resort was
Comparison of percentages incorrect
by apprentices and by teachers

<table>
<thead>
<tr>
<th>Question</th>
<th>Percentages incorrect Apprentices</th>
<th>Percentages incorrect Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>66%</td>
<td>13%</td>
</tr>
<tr>
<td>2</td>
<td>34%</td>
<td>7%</td>
</tr>
<tr>
<td>3</td>
<td>75%</td>
<td>25%</td>
</tr>
<tr>
<td>4</td>
<td>70%</td>
<td>25%</td>
</tr>
<tr>
<td>5</td>
<td>73%</td>
<td>30%</td>
</tr>
<tr>
<td>6</td>
<td>41%</td>
<td>9%</td>
</tr>
<tr>
<td>7</td>
<td>86%</td>
<td>38%</td>
</tr>
<tr>
<td>8</td>
<td>13%</td>
<td>86%</td>
</tr>
<tr>
<td>9</td>
<td>94%</td>
<td>93%</td>
</tr>
<tr>
<td>10</td>
<td>99%</td>
<td>45%</td>
</tr>
</tbody>
</table>

See also p. 255 for student figures

Fig. 5.1
was to a guess. All credit was given to those who made the basis of their answer a comparison in decimal form even though they did not write down the completed calculation of the change of the fraction to a decimal.

The school-leavers must have included a great many guessors. In actual fact, if one were to look at the correct answers only, and not enquire into whether the answer was a guess or not, the percentage of wrong answers for the teachers was 70%. This is staggeringly higher than that of the school-leavers, judged on the same basis.

Calculation of the Mean and Standard Deviation

<table>
<thead>
<tr>
<th>f</th>
<th>x</th>
<th>fx</th>
<th>d</th>
<th>d²</th>
<th>fd²</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>20</td>
<td>40</td>
<td>-43.0357</td>
<td>1852.0715</td>
<td>3704.1430</td>
</tr>
<tr>
<td>2</td>
<td>30</td>
<td>60</td>
<td>-33.0357</td>
<td>1091.3575</td>
<td>2182.7150</td>
</tr>
<tr>
<td>6</td>
<td>40</td>
<td>240</td>
<td>-23.0357</td>
<td>550.6435</td>
<td>3183.8610</td>
</tr>
<tr>
<td>8</td>
<td>50</td>
<td>400</td>
<td>-13.0357</td>
<td>169.2947</td>
<td>1354.3576</td>
</tr>
<tr>
<td>7</td>
<td>60</td>
<td>420</td>
<td>-3.0357</td>
<td>9.2155</td>
<td>64.5085</td>
</tr>
<tr>
<td>17</td>
<td>70</td>
<td>1190</td>
<td>+6.9643</td>
<td>48.5015</td>
<td>824.5255</td>
</tr>
<tr>
<td>10</td>
<td>80</td>
<td>800</td>
<td>+6.9643</td>
<td>287.7875</td>
<td>2877.8750</td>
</tr>
<tr>
<td>2</td>
<td>90</td>
<td>180</td>
<td>+6.9643</td>
<td>727.0735</td>
<td>1454.1470</td>
</tr>
<tr>
<td>2</td>
<td>100</td>
<td>200</td>
<td>+6.9643</td>
<td>1366.3595</td>
<td>2732.7190</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>fx = 3530</td>
<td>fd² = 18378.8516</td>
</tr>
</tbody>
</table>

\[
\text{Mean} = \frac{fx}{N} = \frac{3530}{56} = 63.0357
\]

\[
\text{S.D.} = \sqrt{\frac{fd²}{N-1}} = \sqrt{\frac{18378.8516}{55}} = 18.28
\]

The teachers' scores on the ten questions had a mean of 63.04% and a standard deviation of 18.28. Figs. 5.2 and 5.3 will show, however, that two of the teachers could only score 20 and two others only 30 on these ten questions.
### Fig. 5.2

<table>
<thead>
<tr>
<th>Teacher</th>
<th>Mark</th>
<th>Teacher</th>
<th>Mark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>70</td>
<td>29</td>
<td>80</td>
</tr>
<tr>
<td>2</td>
<td>80</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>3</td>
<td>40</td>
<td>31</td>
<td>70</td>
</tr>
<tr>
<td>4</td>
<td>80</td>
<td>32</td>
<td>70</td>
</tr>
<tr>
<td>5</td>
<td>70</td>
<td>33</td>
<td>70</td>
</tr>
<tr>
<td>6</td>
<td>100</td>
<td>34</td>
<td>50</td>
</tr>
<tr>
<td>7</td>
<td>60</td>
<td>35</td>
<td>20</td>
</tr>
<tr>
<td>8</td>
<td>80</td>
<td>36</td>
<td>70</td>
</tr>
<tr>
<td>9</td>
<td>70</td>
<td>37</td>
<td>80</td>
</tr>
<tr>
<td>10</td>
<td>60</td>
<td>38</td>
<td>60</td>
</tr>
<tr>
<td>11</td>
<td>40</td>
<td>39</td>
<td>40</td>
</tr>
<tr>
<td>12</td>
<td>70</td>
<td>40</td>
<td>60</td>
</tr>
<tr>
<td>13</td>
<td>30</td>
<td>41</td>
<td>80</td>
</tr>
<tr>
<td>14</td>
<td>40</td>
<td>42</td>
<td>70</td>
</tr>
<tr>
<td>15</td>
<td>60</td>
<td>43</td>
<td>60</td>
</tr>
<tr>
<td>16</td>
<td>70</td>
<td>44</td>
<td>50</td>
</tr>
<tr>
<td>17</td>
<td>70</td>
<td>45</td>
<td>80</td>
</tr>
<tr>
<td>18</td>
<td>40</td>
<td>46</td>
<td>30</td>
</tr>
<tr>
<td>19</td>
<td>20</td>
<td>47</td>
<td>70</td>
</tr>
<tr>
<td>20</td>
<td>70</td>
<td>48</td>
<td>40</td>
</tr>
<tr>
<td>21</td>
<td>50</td>
<td>49</td>
<td>90</td>
</tr>
<tr>
<td>22</td>
<td>70</td>
<td>50</td>
<td>80</td>
</tr>
<tr>
<td>23</td>
<td>100</td>
<td>51</td>
<td>70</td>
</tr>
<tr>
<td>24</td>
<td>50</td>
<td>52</td>
<td>70</td>
</tr>
<tr>
<td>25</td>
<td>50</td>
<td>53</td>
<td>50</td>
</tr>
<tr>
<td>26</td>
<td>70</td>
<td>54</td>
<td>80</td>
</tr>
<tr>
<td>27</td>
<td>50</td>
<td>55</td>
<td>60</td>
</tr>
<tr>
<td>28</td>
<td>80</td>
<td>56</td>
<td>90</td>
</tr>
</tbody>
</table>
Fig. 5a

Cumulative Frequency of Correct Answers by Teachers

Cumulative Frequency

0  5  10  15  20  25  30  35  40

Number of questions answered correctly

1  2  3  4  5  6  7  8  9  10
A closer examination of the answers to each question may allow us to see where the errors made by the teachers lay.

Question 1. Add 4532
125
7609
5431
892

It must be a cause of some concern that as great a percentage as thirteen were in error on this simple addition in the denary system. Teacher No. 4 missed the 5 thousands, in the second line from the bottom, in the scan. In the case of this teacher, the presentation was not too badly done, but the digits were not carefully written in columns, and the error may well have been due to this fact. As far as the presentation was concerned, the work of some of the teachers was appalling in some of the later questions. The answers were written with a total disregard of the lines on the paper, and the answers spread obliquely down the page. (See Appendix 5.1) If discipline has not been nurtured in these teachers and a proper regard engendered towards these calculations, we can hardly expect that such a discipline and regard will be transferred to the pupils. Teachers 14, 18, 48 and 53 each made an addition error in one of the columns, whilst teachers 15 and 38 were careless in rewriting the question before doing it. Fig. 5.4 shows that the seven errors made were almost equally divided between addition errors and errors due to carelessness.

Question 2. Subtract 4,877 from 21,342

Rather strangely, perhaps, fewer teachers got this wrong than were wrong on the addition question (see fig. 5.1).
**Fig. 5.5**

| B₁ | B₂ | B₃ | B₄ | C₁ | C₂ | C₃ | C₄ | D | E | F | P | R | S | $\frac{1}{n}$ | Question |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----------|----------|
|    |    |    |    | 4  |    |    |    |    |    |    |    |    |    |    |          | 1        |

**Total Errors 7**

**Fig. 5.6**

| B₁ | B₂ | B₃ | B₄ | C₁ | C₂ | C₃ | C₄ | D | E | F | P | R | S | $\frac{1}{n}$ | Question |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----------|----------|
|    |    | 4  |    |    |    |    |    |    |    |    |    |    |    |    |          | 2        |

**Total Errors 4**
As we have previously seen, teachers are aware that errors occur in subtraction, and thus they may have given this question a little more in concentration. Usually, teachers take addition to be an area which presents little difficulty to pupils, and so it is interesting to see that when one compares questions 1 and 2 for each of the groups who have taken the test, in each case there was a worse score on question 1 than on question 2 (see fig. 5.7).

**Fig. 5.7**

<table>
<thead>
<tr>
<th>Group</th>
<th>Question 1</th>
<th>Question 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>School-leavers</td>
<td>66%</td>
<td>34%</td>
</tr>
<tr>
<td>Students</td>
<td>7%</td>
<td>4%</td>
</tr>
<tr>
<td>Teachers</td>
<td>13%</td>
<td>7%</td>
</tr>
</tbody>
</table>

From the evidence of the kind of errors on question 1, it would seem that there is no problem about understanding what to do. The problems lie in insecure number bonds and a careless attitude to the calculation. Fig. 5.6 shows that 7% of the teachers got question 2 wrong, but it is rather gratifying to see from Fig. 5.5 that the four errors made were not concept errors on this question. They were, in fact, all errors due to carelessness. One was an error which happened as a result of the equal additions in the bottom number, not all being taken into account. A lack of care, rather than any serious misunderstanding seems to be obvious. A second error gave an incorrect answer but with no marks made on the answer to indicate the method which was employed. This error was made by teacher number 21 when he or she
wrote,

\[
\begin{array}{c}
21,342 \\
4,877 \\
15,565
\end{array}
\]

If it were an equal addition method, then it was due to the neglect to add 1 hundreds to the 8 hundreds in the 4877 and hence getting 13h-8h = 5h. This same argument cannot be used about the error in the thousands column, unless there was also a subtraction error of the bond kind. The author is inclined to think that the likeliest method used was that of equal addition for, without the 'props', decomposition could probably not have been sustained in the mind.

The other possible explanation may be that a form of complementary addition was used. Where the digit for the answer line was chosen so that the sum of that digit and the digit in the corresponding column of the second line should make the corresponding digit in the top line. That is, for the units 7u + 5u will give a 2 in the units column, thus making the last 2 digits in the second line 82, since 4877 + 5 = 4882. 6 would now be the digit needed in the tens column in order to get 4882 + 60 = 4942. This would be continued in changing the digits in the remaining columns. Perhaps, in this attempted solution, only the digits up to the tens column were changed correctly and the one hundred, carried in the process, was forgotten, and hence 4842 + 500 = 5342. This is a possible explanation, as would be a complementary subtraction method. Whichever method was employed, the author is inclined to think that a carrying figure error was involved here. The error made by teachers number 36 and 46 were similar to that described in the former of the two possible explanations just made.
Question 3: Work out $625 \times 57 \times 16$

One quarter of the teachers, as compared with 75% of the school-leavers shown in the C.B.I. Wales report, got this wrong. (See fig. 5.1) A total of twenty-five errors were made on this question. (See fig. 5.2) Ten of these were calculation errors in multiplication, two only were errors in understanding, but nine careless errors were made. The remaining errors were due to insecure number bonds and to place value errors.

Some teachers made more than one error. For example, teacher number 3 made two errors. The first was made in a multiplication due to a bond error ($5 \times 7 = 30$), and the second, made also by teacher number 19, concerned a grave misconception of the nature of 16 and its relationship to multiplication using the distributive law. Instead of $35625 \times (10 + 6)$, these teachers used $35625 \times (10 \times 6)$. That is to say, they used the associative law of multiplication and thus multiplied by 60 and not 16. The manner in which this was carried out was not that as shown above, but rather as $35625 \times 16 = 356260 \times 6$. The long multiplication caught out some of these teachers in terms of their concentration. Teachers 10, 13, 16 and 44 all made carrying figure errors due to lack of attention to detail. Teacher number 13, in fact, made not one but three such errors in this question, suggesting that in
his/her case it was endemic. Teacher number 11 displaced the digits one place to the left when multiplying by 7 units. Teacher number 14 seemed not to know where to place the digits when multiplying by 57.

In his/her case we had

\[
\begin{array}{c}
625 \\
\times \ 57 \\
\end{array}
\]

\[
\begin{array}{c}
3225 \\
4375 \\
356250 \\
\end{array}
\]

The multiplications by the 7 units and the 5 tens are correct in relation to one another, but we end up with them being displaced one place to the left. There is no evidence here that place value has been really appreciated with respect to this question.

Teacher number sixteen made an error which was also made by some of the students. He, like them, in the author's view, was not concentrating on the job in hand and forgot to multiply by the 16.

Teacher number eighteen got into a real pickle when, in one line, he/she started to multiply by 7 and then switched to multiplying by 5. Again an example of a lack of concentration. Teacher number twenty-four may well have been careless in multiplying by 57, or he/she may have become very confused. Instead of multiplying by 5 x 10, he/she multiplied by 7 x 10. What one can be sure about is that this teacher's confusion will be transmitted to the children. Some teachers basically used the correct method but were unable to bring it to a successful conclusion because of errors made on the way. Errors were made in not adding in carrying figures, multiplication bond errors and addition bond errors.

Question 4: Add $1\frac{2}{4}$ and $2\frac{3}{4}$

Whereas 70% of the school-leavers, according to the C.B.I. Wales survey, could not get this right, 25% of the teachers could not,
for one reason or another, satisfactorily do this question. (See fig. 5.4) That one quarter of the teachers could not add together two simple mixed fractions does not seem to bode well for the chances of the pupils in schools. It must be remembered that it is quite possible that such teachers have the mathematical welfare of thirty or more children a year in their hands. If one of these teachers who had a grave misunderstanding of the concept of the addition of fractions had been appointed to schools in the mid '60's, he/she may well have had charge of the Mathematics of over 500 children in that time. In a life-time of primary school teaching, the figure might well be around 1400 children. The seriousness of this could have been compounded by organisational factors. In a traditional 'box' arrangement, one teacher might well follow his/her class on up through the school and the children may well have had that teacher for at least two years. If the teacher had been placed in a country school, then the likelihood is that the children would have had that teacher for four years. For all the formative junior school years in fact. In the sixties and seventies, with the expansion of primary education, so many teachers who were inadequate Mathematically were appointed to schools. It could have been the case that some unfortunate children had one Mathematically poor teacher after another. With the advent of open plan schools, many difficulties of this kind could have been alleviated with an efficient introduction of team teaching; something which did not happen in Gwent. A factor which could well have worsened the situation in some cases was the introduction of vertical grouping, which effectively meant the same teacher for more than one year. Such situations as these would be particularly serious as far as the addition of fractions was concerned for, in fig. 5.9, we see that of the sixteen errors that were made, no fewer than eleven were errors of understanding of the concepts involved.
Fig. 5.9

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</table>

Total Errors 16

Teacher number 1 lacked the concept and, in making $\frac{7}{4} + \frac{7}{3} = \frac{14}{12}$ showed that presumably he/she had learned part of the mechanics of the process and has 'put them over the same denominator' but showed no evidence that a pair of fractions equivalent to the originals but of the same family was sought. The family of twelfths has been arrived at by a purely mechanical process. With teachers numbers 3, 5, 43, 46 and 53, what occurred was that which we have observed amongst the students, and what was complained of in the C.B.I. Wales report of 1977, namely that of having a total lack of the true concept, they reverted to 'doing what comes naturally' when they saw a + sign. They added the corresponding components, e.g. $\frac{7}{4} + \frac{7}{3} = \frac{14}{7} = 2$. Rather serious also was the manner in which the addition was carried out by teacher number 11. Each fraction was changed to a decimal and then the addition was carried out. Evidently no doubts were experienced by this teacher in writing that 4.08 was exactly equal to $4\frac{1}{12}$. Teacher number 18, rather curiously, added the whole numbers but multiplied the fractions, and thus made $1\frac{1}{4} + 2\frac{1}{2} = 3\frac{3}{12}$. Teacher number 35 had no idea at all of how to proceed and teacher number 27 displayed an insecurity in ideas of number bonding when he/she wrote $\frac{15}{12} + \frac{3}{4}$. 

This teacher also failed to find the equivalent fractions in twelfths to each of the fractions to be added and so \( 1\frac{1}{2} \) became \( \frac{15}{12} \) and \( 2\frac{1}{2} \) became \( \frac{3}{12} \). We see here that the teacher is not thinking about the quantities, for the larger \( 2\frac{1}{2} \) on changing to twelfths, becomes the smaller of the fractions.

It would seem to be a very serious situation when 11% of a sample of teachers simply did not know how to add a pair of fractions.

Question 5: What is \( \frac{5}{6} \div \frac{3}{8} \)?

We now see a 5% increase in the teachers who could not do this question and the teachers who could not do the previous fractions question (see fig. 5.1).

If we look at fig. 5.10, we see once again that the great majority, (16 out of 18), of errors are of the non-understanding of the concept type. Looking at the teachers' attempts in detail, we see that teachers numbers 3 and 15, and 35 and 46 treated the question as if it were a multiplication, e.g. \( \frac{1}{3} \div \frac{2}{3} = \frac{3}{5} \div \frac{1}{3} = \frac{3}{5} \). These teachers totally obscure in their minds, the fact that somewhere a division has to take place. This again may be the substitution of a known process for an unknown one, a fact which the C.B.I. Wales report highlights. It may well have been that the teaching programme which these teachers underwent paid minimal attention to the fact that a division had to be made. After all, if the first statement made is that the division be replaced by a multiplication, then all the attention subsequently focuses on that multiplication. If, however, a reasonable amount of attention is given to the meaning of the division of fractions, and the reason for the transformation to a multiplication,
difficulties like this may perhaps be avoided.

There are further examples of teachers substituting known processes for ones which are unknown. Teachers 7 and 41 changed the division operation to that of an addition, and teachers 11, 25 and 34 changed it to a subtraction.

A partial remembering of the process was exhibited by teacher number 9. Here, the second fraction was inverted and the operation changed to a multiplication, but then the numerators were multiplied together but the denominators were added together.

A method in which a conversion to equivalent fractions of the same family had been taught to teachers 10 and 40, e.g.

\[ \frac{5}{6} \div \frac{2}{3} = \frac{5}{6} \div \frac{4}{6} \]. Then, unfortunately, for teacher number 10, the one-denominator syndrome got involved in it and, as a consequence, the teacher wrote the result as \( \frac{5}{6} \div \frac{4}{6} \) and then proceeded to try to find a value for this. The result was given as \( \frac{17}{6} \). Teacher number 40 got as far as the statement \( \frac{5}{4} \) and then could not proceed further. This misuse of the one denominator idea, which has stuck after its use in addition and multiplication, causes a great deal of difficulty for some learners when they are trying to get to grips with the other operations of multiplication and division. For example, teacher number 14 wrote

\[ \frac{5}{6} \times \frac{3}{2} = \frac{5}{6} \times \frac{9}{6} = \frac{45}{6} \]. Teacher number 13 was not able to do this question at all. One teacher (No. 19), who was able to proceed, could not bring the calculation to a satisfactory conclusion because of the neglect of a factor 2 in one of the denominators, and made \( \frac{5}{6} \times \frac{1}{2} = \frac{5}{2} \) which displayed a lack of care and working discipline once again. Teacher number 27 gave the following sequence,
syndrome intervenes in the understanding of the process and also the bonding relationships are not appreciated.

Fig. 5.10

| B₁ | B₂ | B₃ | B₄ | C₁ | G₂ | C₃ | C₄ | D | E | F | P | R | S | \( \frac{m}{n} \) | Question |
|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|----|-------|
|    |    |    |    |    |    |    |    | 16 | 2  |    |    |    |    |    | 5     |

Total Errors 18

Question 6: Write 3/5 as a decimal.

Only two out of the 56 teachers were unable to do this question, though it is interesting that a great majority had to work it out. Most could not quote it directly and thus this does reflect upon their understanding of fractions with denominator five and the relationship of these to decimal fractions.

There were various confusions about the conversion of fractions to decimals. For example, teacher number 39 made \( \frac{6}{10} = 0.66 \) and it seems had divided 10 by 6 and not 6 by 10 and, in the process, had not realised that the division would yield 1.66, which should have been 1.67 given to two decimal places. Clearly here he/she really had little idea about fractions with denominators in powers of ten and their relationship to the decimal fractions. Teacher number 34 exhibited an error which has been previously noted, in that he/she wrote the numerator of the fraction in a selected position in the decimal system, regardless of the involvement of the denominator of the fraction.
Yet again we have a case where one teacher expresses the answer as a percentage, \( \frac{3}{5} \times 100 = 60\% \). Perhaps in the Teacher's school life percentages were always closely related to decimal fractions and this was the means by which the decimal fraction would eventually have been found. This teacher has neglected to complete the conversion perhaps.

It might have been better to have treated this as a conversion to an equivalent fraction whose denominator was a power of 10, \( \frac{3 \times 100}{100} = 60 \) and then converted this to the decimal fraction. Since this works in only those cases where the denominator of the fraction is a factor of 100, the more general method of division is to be preferred.

Again, in another case, a teacher had used this method and had written \( \frac{3}{5} \times 20 = \frac{60}{100} = 0.60 \) which is full of incorrect statements due to the misuse of equals signs and a poor realisation of equivalence.

**Question 7:** What percentage of 150 is 21?

Fig. 5.1 shows that we have a situation here where well over one-third of all the teachers in this sample are unable satisfactorily to do this question. A total of 24 errors were made and, of these, no less than 21 were due to not understanding the concepts involved (see fig. 5.12).
25% of the teachers in this group sufficiently lacked the concepts involved in the calculation of percentages that they each wrote statements of the kind, $150 \times \frac{21}{100}$. These were trying to calculate $21\%$ of $150$; a different question. If one takes into account the teacher who wrote, $150 \div 21$ and gave the answer as $7.3\%$ and the two who could not do the question at all, the total percentage of the same not sufficiently comprehending the idea involved was $30\%$. There were other conceptual errors. For example, the teacher quoted above who divided $150$ by $21$ gave the remainder $3$ units from the division as $0.3$, again an error noted in other places. There were some careless errors, but one notable conceptual error of $0 \times 1 = 1$.

Question 8: If in the store there were round steel bars of diameters $1$ inch, $1\frac{1}{16}$ inches, $1\frac{1}{8}$ inches, $1\frac{3}{16}$ inches, $1\frac{1}{4}$ inches, $1\frac{5}{16}$ inches, $1\frac{3}{8}$ inches, and you require one with a diameter as near as possible to $1.22$ inches, which one would you choose?

There is a very marked discrepancy in the number of teachers who were judged not to be able to do this question and the number of school-leavers who were judged not to be able to do it. As has been commented
upon previously in this chapter, the question is wide open to a guess,
unfounded upon any consideration of the relationship between the
quantities. The author was concerned that the evidence should show
that the consideration took such a form that a true assessment could
be made of the relevant sizes. The instructions to the teachers and
to the students who took this test were that all working should be
clearly shown on the answer paper. In such a way the author could
decide on whether the judgement had been properly made. Fig. 5.1
shows that the percentage of teachers who were judged as being
incorrect or as presenting an answer on an unsound basis was 86%, a
very high figure indeed.

Many of these teachers, (32%), tried to consider the
diameters in fractional form and without ensuring that all of them,
including the $1\frac{22}{100}$, were in the same family of fractions. Few of
the teachers seemed to be in possession of a true concept of the
comparison of quantities like this. If one takes together as a class
those who tried considerations in fractional form, together with those
who made no attempt, this amounts to 48% of the same. If one also
includes those who were incorrect and in whose answers there was no
working in justification, the number swells to 59% of the sample.
So 59% of these teachers did not really know what they were doing.

Amongst the others who were attempting a proper comparison
in decimal form, there were a number of errors in the conversion of
fractions to decimals.

Teacher number 7 clearly lacked the concepts involved as
could be seen by his/her writing of $\frac{1}{16} = 0.016$, $\frac{3}{16} = 0.048$,
$\frac{2}{8} = 0.08$, $\frac{3}{8} = 0.24$. The denominators of the unitary forms have merely
been written into some selected places in the decimal format.
Teacher number 12 seems to have place value and division problems, and the conversions came out as

\[
\begin{align*}
1 \frac{1}{16} &= 1.00 \\
1 \frac{3}{4} &= 1.01 \\
1 \frac{5}{16} &= 1.01 \\
1 \frac{1}{2} &= 1.02 \\
1 \frac{3}{16} &= 1.05 \\
1 \frac{5}{8} &= 1.04.
\end{align*}
\]

This teacher seems to have problems with a proper regard for these numbers and has a consequent rounding problem. Perhaps this teacher really thinks that \(1 \frac{3}{8}\) and \(1 \frac{3}{16}\) are both the same.

**Fig. 5.13**

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Total Errors 53

As far as not perceiving that what is written is a nonsense, teacher number 20 is outstanding. This teacher writes,

\[
\begin{align*}
l_1 &= 1.25 \\
l_2 &= 1.25
\end{align*}
\]

result is either \(l_1\) or \(l_2\).

Changing fractions to decimals, as we have seen previously amongst the students, is not a process which many can do with success. Thus one finds calculation and place value errors, for example like those of teacher number 33, who makes \(\frac{1}{8} = 0.135\) and \(\frac{1}{16} = 0.00625\) and those of teacher number 51, who makes \(\frac{5}{16} = 1.03125\). This latter teacher also had a difficulty in the ordering of decimal fractions and so made \(1.03125 \gt 1.22\). A real minority of the errors made were as a result of calculation or of carelessness. Fig. 5.13 shows that 46 of the 53 errors were due to a lack of understanding of the necessary
ideas, a figure of 87%.

Question 9: Find the area of a circle 2 \( \frac{1}{2} \) inches in diameter, to two decimal places.

This question represents the highest failure rate amongst the teachers. Fig. 5.1 shows that at 93% failure rate the teachers were only one point behind the school-leavers at 94%.

There was a much wider spread of types of error on this question, though 39% were of the comprehension of concepts and place value type (see Fig. 5.14).

![Fig. 5.14](image)

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Total Errors 89

This question seems to have caused many and varied errors. Eleven of the errors were due to an inability to quote the correct formula and to quote 'pi' correctly. The incidence of calculation errors increased in this question so that 24% of the errors were due to this. Some teachers were driven to a plethora of such errors, as was teacher number 21. This teacher correctly quoted \( A = \pi r^2 \) but then used \( \pi r^2 \) to mean \((\pi r)^2\), d was used for \( r \) in the subsequent calculation, and then \((7\frac{6}{7})^2\) was worked as \( (7 + \frac{6}{7})^2 = (49 + \frac{36}{7}) \)
and we see that within this is \((\frac{6\pi}{2})^2 = 36\pi^2\). Missing for this teacher are some of the concepts more often used in algebra, e.g. \((a+b)^2 = a^2 + 2ab + b^2\). For this teacher \((a+b)^2\) means \(a^2 + b^2\) and, instead of \((a)^2\) meaning \(a^2\), this teacher has it as \(a^2\). Similarly, instead of \((\frac{b}{a})^2\) he/she has taken this to mean \((ab)^2\), i.e. the square of both.

Teacher number 22 had difficulty with this and also had little idea of how to tackle \(3\pi x \frac{1}{2}\) and so he or she changed the operation for one which was more familiar. Thus we got \(3\pi x \frac{1}{2} = 2\pi + \frac{\pi}{4}\). This teacher had several false attempts at this and led the author to suppose this to be a genuine 'D' error and not just a careless mistake.

Teacher number 38 had a similar difficulty but 'solved' it differently. This teacher made it, \(1\frac{1}{2} x 1\frac{1}{2} = 1\frac{1}{4}\), that is, he/she multiplied the whole numbers together and then separately the fractions together. In the separation, the distributive law was ignored.

Many of the teachers made no attempt at all, or else, after correctly quoting \(A = \pi r^2\), made no further attempt. This group amounted to 21% of the sample.

The misquotations of 'pi' previously mentioned were as varied as, \(3\frac{1}{2}, 2.17, 3.75, 3\frac{3}{4}, 3.143, 2\frac{1}{4}\) with one teacher correctly quoting \(A = \pi r^2\) and correctly calculating \(r^2\), so it seems that the stumbling block was the inability to remember the value of 'pi'.

There were six incorrect quotations of \(A = \pi D\) for the area and one incorrect quotation of \(A = \pi r\), all of which indicate a lack of comprehension of the dimensionality of \(D\) and \(r^2\). The lack of understanding, after the correct quotation of \(A = \pi r^2\), exhibited itself in the cases of teachers 8 and 21 as a failure to differentiate between \(\pi r^2\) and \((\pi r)^2\), as it was in the cases of teachers 28 and 53 who used
This fact led the author to wonder whether those who misquoted \( A = \pi r^2 \) really thought there was no difference between that and \( \pi r^2 \). As a teacher, one is aware that the use of diameter for radius is a great source of error in these questions. It transpired that there were just four teachers, numbers 14, 29, 43 and 51, who were careless enough to do this.

Carelessness could not have been the cause of the error exhibited by teachers numbers 3 and 24. Each of these teachers, in converting a mixed fraction to a vulgar fraction, wrote \( 1\frac{2}{3} = \frac{9}{4} \) and repeated the error. It seems that, in doing this, they made a sum of the digits as they were written regardless of their values. Neither of them did this in the previous questions where this conversion may have occurred. There were calculating errors as, for example, in the work of teacher number 5. Here an error occurred in the division because of a lack of concentration when handling \( 6 \times 9 = 54 \). Four was written down and 'four' was carried. Teacher number 8 made a division error in making \( \frac{55}{14} = 3.92 \), the error occurring in the hundredths.

Place value errors occur in these calculations. Teacher number 18, in multiplying \( 3.142 \times 0.5 \), made it 15.710, and teacher number 19 made a place value error in the division of 275 by 56,

\[
\begin{align*}
56 \Big) 275 \\
\underline{224} \\
409 \\
\underline{275} \\
224
\end{align*}
\]

The division, as can be seen above, was carried out without good calculating discipline. The layout is incomplete and so an incorrect result is obtained from that and the careless placements made. The relationships of the remainders to a unit would not be clear. This kind of calculation, if carried out in decimal quantities, very often leads to errors due to rounding.
Teacher number 9 rounds 1.5625 to 1.6 too early in the calculation to have led to an accurate result. As it was, no further calculation was carried out. Teacher number 11 rounds 1.5625 incorrectly to 1.5, and teacher number 41 rounds the quantities off too early in the calculation to lead to two decimal place accuracy.

Those teachers who kept their calculations in fraction form were faced with having to express the result to two decimal places. Teacher number 10 was faced with changing $\frac{45}{56}$ to a decimal form and was all at sea. He/she wrote $56 = 100\%$, $1\% = 0.56$ and then nothing further. This teacher clearly had no idea of how to proceed. This was the same teacher who had misused equivalence to convert a fraction firstly to one with a denominator of 100 in question 5 and then could not handle question 8 at all, and clearly has problems with changing fractions to decimals.

Teacher number 31, faced with the same problem, carried out a division and made $\frac{45}{56} = 4.00$ with no working to indicate how this had been arrived at. Once again it seems that he had no clear idea of how to change a fraction to a decimal.

Teachers numbers 45 and 53 settled for leaving the answers in a fractional form. Serious though these are, they represent, the author supposes, a far less serious state of affairs than that exhibited by teacher number 32, who thought the solution might have something to do with the theorem of Pythagoras, and that of teacher number 42, who thinks that $\pi = 2\pi$. Though which might be the more easily redeemable in remedial work is open to conjecture.

It seems such a pity that, in the case of teacher number 29, a fatal error in place value should appear in otherwise impeccable work,
3.142 \times 6.25 = 196.375. One wonders whether quick checks are insisted upon by teachers. This is surely a matter of discipline and training.

Many simple bond errors occurred in these calculations, and teacher number 43 epitomises what happens when basic bonding is not secure. These are the calculations, \(4 \times 4 = 18, 25 \times 25 = 375, 675 \times 22 = 1375\) and \(13750 - 700 = 19.34\). Here we see typified bonding errors such as that made by teacher number 14 (6 \times 3 = 12), carrying figure errors in calculations as made by teachers 13, 20 and 40, and division errors which, in the above case, was probably due to a subtraction error.

Teacher number 25 made a division error because of a multiplication bond error, \(83 \div 7 = 7\), whilst the error made by teacher number 28 was probably due to thinking of 220 as 120, \(220 \div 28 = 4.28\). Bonding errors, (in these cases addition), led to the incorrect result of multiplication in both the case of teacher number 30 and teacher number 33, who made two such errors.

Question 10: A number 0 woodscrew has a diameter of 0.050 inches, a number 1 a diameter of 0.064 inches, and a No. 2 a diameter of 0.078 inches, and the diameter of the larger sizes goes on increasing by the same amount. Find the diameter of a No. 8.

In contrast to the very large percentage of the school-leavers who could not do this, the percentage of teachers who failed the question was 4.5\% (see Fig. 5.1).
In all 29 errors were made and over 50% of them (15) were errors due to not understanding the concepts involved. (see Fig. 5.15)

Not being able to understand the concepts involved was judged to be the source of error for teachers 3, 11, 18, 26, 32, 52 and 55, all of whom did not attempt the question.

Most of the concept errors made by those who did tackle the question were those where intervals were related to a datum screw size. For example, teachers numbers 24 and 29 obtained 8 correct intervals but did not add them in to the initial screw size. Teacher number 27 added in only 5 intervals from the chosen screw diameter, when 6 were needed, which was the kind of error made by teacher number 30. Teacher number 35 selected the incorrect screw size on to which to add the eight intervals, whereas teacher number 46 wrote the No. 0 screw size as the No. 1 screw size and hence did not get the correct number of intervals. Complete misconception about the intervals were made by teacher number 13 who multiplied the No. 2 screw diameter by 2 to try to get the No. 8, and teacher number 19 who multiplied the No. 3 diameter screw by 2 to try to get No. 6 diameter. Three teachers made errors in transcribing the sizes from the question sheet on to their answer sheet. Incorrect addition of
the intervals led to a final error for teachers 15, 21, 33, 40 and 56, whilst incorrect place value involvement led to teachers 27 and 35 getting the difference to be 0.14 and teacher 39 not even getting the same digits because of a subtraction bond error. The case of the attempt made by teacher number 15 is interesting. The interval is correctly seen to be 0.014 and the first few additions proceed correctly, but then 0.092 + 0.014 is made to be 1.106. The several attempts made at this showed that there was great uncertainty in the addition, involving as it does, the making of a 9 into a 10 within the decimal system. The uncertainty was shown where 0.1 6, with a space between the 1 and the 6 was crossed out in favour of the answer 1.106.

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<td></td>
<td>5</td>
<td></td>
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</tr>
<tr>
<td>7</td>
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<td></td>
<td></td>
<td></td>
<td>1</td>
<td>21</td>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1</td>
<td>3</td>
<td>43</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>9</td>
<td>1</td>
<td>2</td>
<td></td>
<td></td>
<td>10</td>
<td>8</td>
<td>31</td>
<td>4</td>
<td>18</td>
<td>4</td>
<td>4</td>
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<td>6</td>
<td>1</td>
<td></td>
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</tr>
<tr>
<td>Total Errors</td>
<td>2</td>
<td>4</td>
<td>9</td>
<td>1</td>
<td>2</td>
<td>13</td>
<td>14</td>
<td>5</td>
<td>4</td>
<td>8</td>
<td>11</td>
<td>5</td>
<td></td>
<td>7</td>
<td>270</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 5.16
Fig. 5.17

Errors in order of frequency

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
<th>Percentage of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>145</td>
<td>54%</td>
</tr>
<tr>
<td>F</td>
<td>48</td>
<td>13%</td>
</tr>
<tr>
<td>C3</td>
<td>21</td>
<td>8%</td>
</tr>
<tr>
<td>C4</td>
<td>13</td>
<td>5%</td>
</tr>
<tr>
<td>P</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td>9</td>
<td></td>
</tr>
<tr>
<td>π</td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>R</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>E</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>B3</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>B1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>C2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>S</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>B2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>B4</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Fig. 5.18

Most commonly occurring errors

<table>
<thead>
<tr>
<th>Type</th>
<th>Number</th>
<th>Percentage of total</th>
</tr>
</thead>
<tbody>
<tr>
<td>D</td>
<td>145</td>
<td>54%</td>
</tr>
<tr>
<td>F</td>
<td>48</td>
<td>13%</td>
</tr>
<tr>
<td>C3</td>
<td>21</td>
<td>8%</td>
</tr>
<tr>
<td>C4</td>
<td>13</td>
<td>5%</td>
</tr>
</tbody>
</table>
Fig. 5.18 shows that by far the most commonly occurring errors even amongst this sample of teachers were those resulting from a lack of understanding of the concepts involved, with the second most commonly occurring being those which were caused by carelessness and a lack of mind given to the job in hand. Nearly three-quarters of all the errors fell into these two categories.

Fig. 5.19

Failure Rates on the 10 Questions

<table>
<thead>
<tr>
<th>Question</th>
<th>School-leavers</th>
<th>Students in training</th>
<th>Teachers</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>66%</td>
<td>7%</td>
<td>13%</td>
</tr>
<tr>
<td>2</td>
<td>34%</td>
<td>4%</td>
<td>7%</td>
</tr>
<tr>
<td>3</td>
<td>75%</td>
<td>21%</td>
<td>25%</td>
</tr>
<tr>
<td>4</td>
<td>70%</td>
<td>27%</td>
<td>25%</td>
</tr>
<tr>
<td>5</td>
<td>73%</td>
<td>36%</td>
<td>30%</td>
</tr>
<tr>
<td>6</td>
<td>41%</td>
<td>19%</td>
<td>9%</td>
</tr>
<tr>
<td>7</td>
<td>86%</td>
<td>43%</td>
<td>38%</td>
</tr>
<tr>
<td>8</td>
<td>13%</td>
<td>63%</td>
<td>86%</td>
</tr>
<tr>
<td>9</td>
<td>94%</td>
<td>88%</td>
<td>93%</td>
</tr>
<tr>
<td>10</td>
<td>99%</td>
<td>34%</td>
<td>45%</td>
</tr>
</tbody>
</table>

Fig. 5.19 shows a comparison of the failure rates on the ten questions between the school-leavers, students in training to be teachers, and a sample of serving teachers. Generally the teachers and students' performances were better than the school-leavers, though the percentage
of failures on some of the questions was extremely high, e.g. 88% by students on number 9, and 93% by the teachers on the same question; almost as great a degree of lack of proficiency as that of the school-leavers with 94%. The percentages of failures on question number 8 was also very high for students (63%) and for teachers (86%). In fact, this is far higher than that of the school-leavers at only 13%. Mention has been made earlier about the possibility of a high incidence of guessing in this question and the relation to the marking. It is, however, rather remarkable that the teachers at an 86% failure rate should do so much worse than the students at a 63% failure rate, the marking in these cases being made on the same basis.

It is perhaps also remarkable that on no less than six of the ten questions the teachers' failure rates were greater than those of the students at present in college. These teachers had learned, what mathematics they had learned, within the system and perhaps had themselves been victims of poor teachers of mathematics who had never inspired them or taught them meaningfully. For example, one of these teachers commented that her recollections had been of the "regimented drilling of formulae, which I could never quite see the relation to ordinary life". (Diane).

Another found that, as so often happens in schools, she was at odds with the teacher and complained of the, "personality clash with the teacher--- I hated him, and he apparently detested me so therefore I took little interest and did not try particularly hard". (Linda). This is a cry one often hears from pupils about their maths teachers, and perhaps less often about teachers of other subjects. It would be interesting to know whether this is as widespread as one sometimes is circumstantially
led to believe.

In their comments about their learning experiences in mathematics it is good to report that not all had bad experiences. One teacher reported that, "the subject was made interesting, more by the enthusiasm of the teacher, than by the types of books and practical equipment provided. The teacher is so important in the learning process. The use of organisational patterns and of good books are of themselves helpful of course, but much more so when in the hands of a perceptive teacher who is able to enliven his pupils to the potentialities of his subject. Here was the case of a teacher who had been happy with his experiences of learning mathematics because of the enthusiasm of his teacher. It does seem that mathematics is a subject, more than others, in which learning can be gravely affected by the attitudes and skills of the teacher. Perhaps the teaching of mathematics should only be carried out by the skilled and enthusiastic, if this were at all possible in manpower terms. The abiding memory of Eric was of work and classroom atmosphere, and not with much admiration either.

"Work was very much routine, consisting of learning by rote and copying examples from the blackboard...not stimulating". (Eric).

This was not entirely so for Jane, who did find some of the things she did interesting but was just not successful.

"I found some aspects of mathematics interesting but never seemed really to come to terms with them". (Jane).

Perhaps this was a deficiency with the learner rather than the teacher who had, at least in part, interested her in mathematics. Skilled and imaginative teachers can do a great deal with interested pupils though any success would have to be measured in terms of the improvement in the individual understanding and performance. It is, however, hard to accept that since Jane attained the level which made her acceptable for teacher training, she should have been unable to reach a satisfactory level
in mathematics.
Several of the teachers complained about not having had a choice of
taking, or not taking, mathematics.

"Maths was compulsory so I studied it
without real interest or understanding.
The only aim being to pass my 'O' level". (Christine).

Advocate of a core curriculum had better be warned that the insistence
on the inclusion of maths in that core will not of itself solve the
problem. There has to be a proper atmosphere of interest and enjoyment
engendered by a skilled and stimulating teacher. Even someone fairly
dedicated to the successful impartation of skills could go wrong. One
wonders how successful Alan's teacher was, who gave him, "a good grounding
in the 'basics', with an emphasis on work and not enjoyment". Clearly
here he had some reservations and, perhaps, some regrets about his
maths tuition.

Of course there are many gifted maths teachers who have the ability
to interest and help all of their pupils, but here we have been seeing
some teachers whose own standards of mathematics is poor and whose
personal experiences of their leaning of mathematics leaves a lot to be
desired.
CHAPTER 6

An examination of the Mathematics' Records of a College in Gwent from the 1960's and 1970's

In the last chapter, we saw how a group of young teachers fared as they tackled an Arithmetic paper previously given to school-leavers and to some students in training to be teachers. All of these teachers were of an age to have been trained in the sixties and early seventies.

In those days, colleges were bursting at the seams with students in training. Many colleges had practically to double their intake of students overnight, at the request of the Department of Education and Science. At this time, little was heard about an adequate initial qualification in Mathematics for entrants into teacher training. Many students did not have 'O' level Mathematics and, indeed, a substantial minority had given up Mathematics by the time they were fourteen years of age. The college was, in the main, training these students to teach in primary schools. Most of these students then would have been eventually responsible for the Mathematical education of children in their most formative years. If one looks at the records for the middle sixties at the college, one sees that, in 1965, there were 95 men taken on for the Certificate course, 24% of whom were without 'O' level Mathematics. Of the 133 women taken on in that year, 34% were without 'O' level Mathematics. Monitoring of this position was conducted by college lecturers in the University Area training organisation.
For example, in another college in Wales the figures were:

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>1965</td>
<td>30%</td>
<td>54%</td>
</tr>
<tr>
<td>1966</td>
<td>37%</td>
<td>58%</td>
</tr>
<tr>
<td>1967</td>
<td>41%</td>
<td>55%</td>
</tr>
</tbody>
</table>

(90)

and for Caerleon College of Education:

<table>
<thead>
<tr>
<th></th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>1965</td>
<td>2%</td>
<td>34%</td>
</tr>
<tr>
<td>1966</td>
<td>2%</td>
<td>36%</td>
</tr>
<tr>
<td>1967</td>
<td>1%</td>
<td>37%</td>
</tr>
</tbody>
</table>

(91)

At this college in Gwent, the figures had reached as high as 50% of the women students without 'O' level Mathematics in 1970 and 1974. The highest level for the Gwent college was in 1962 when 47 men and 65 women were admitted. 34% of the men were without 'O' level Mathematics and 62% of the women. (see Fig. 6.1)

Great concern was felt about figures like these, and forcibly expressed at 'Boards of Study' held by the University of Wales. Lecturers at the various colleges expressed the opinion that a minimum requirement for entry into teaching in primary schools should include 'O' level Mathematics. It was felt at the time that, beyond voicing fears concerning the possible consequences of such a situation, little could be done to improve the figures substantially in view of the pressure to reach target figures in the output of teachers. Subsets of the figures already quoted show that, in 1962 at the Gwent college, 4% of the men and 23% of the women had dropped Mathematics or Arithmetic before the 16+ examinations, with some even dropping them one or two years before.

The figure for the women students who had dropped Mathematics or Arithmetic before the 16+ examinations was 17% by the 1968 intake.
Except for the year 1965, the figure for the women was always in excess of 7% (92).

Some comparison between the attempts made at Arithmetic questions for those years and that of the present survey may be made as the result of an examination of the results of questions set in basic Mathematics to the new intake in 1962.

Question 10 on the paper was: \( \frac{3\frac{1}{2}}{2\frac{3}{4}} \)

This question is arguably slightly more difficult than Question 5 on the present paper \((\frac{5}{6} \div \frac{2}{3})\).

The intake in 1962 had a very large percentage of both men and women without 'O' level Mathematics, as we have seen. Indeed, the percentage of men and women below 'O' level Special Arithmetic standard was 6.4% and 32.7% respectively. (Below Special Arithmetic meant, not having taken or failed any Mathematics or Arithmetic at the 'Ordinary' level. These students did include the ones with C.S.E's.) The results show that despite of this, 89% of the students got this question right. 4% could not do it and 7% of the intake were wrong. (33) The present survey shows that on the similar, but slightly easier question, (No. 5), 61% of the teachers tested could not do it and 64% of the students in training could not do it.

In 1962, 34% of the students failed to get half marks on the paper but, even so, they were quite successful at this question.

Question 3 on the 1962 paper asked the students to put in order of magnitude the following fractions: \( \frac{4}{7}, \frac{7}{13}, 0.55, \frac{27}{50}, \frac{19}{33} \).
**Percentage of students without 'O' level Mathematics**

<table>
<thead>
<tr>
<th>Year</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td>1960</td>
<td>28%</td>
<td></td>
</tr>
<tr>
<td>1962</td>
<td>34%</td>
<td>62%</td>
</tr>
<tr>
<td>1963</td>
<td>27%</td>
<td>50%</td>
</tr>
<tr>
<td>1964</td>
<td>25%</td>
<td>34%</td>
</tr>
<tr>
<td>1965</td>
<td>24%</td>
<td>33%</td>
</tr>
<tr>
<td>1966</td>
<td>23%</td>
<td>35%</td>
</tr>
<tr>
<td>1967</td>
<td>19%</td>
<td>36%</td>
</tr>
<tr>
<td>1968</td>
<td>28%</td>
<td>53%</td>
</tr>
<tr>
<td>1969</td>
<td>33%</td>
<td>48%</td>
</tr>
<tr>
<td>1970</td>
<td>31%</td>
<td>50%</td>
</tr>
<tr>
<td>1972</td>
<td>31%</td>
<td></td>
</tr>
<tr>
<td>1974</td>
<td>19%</td>
<td>50%</td>
</tr>
</tbody>
</table>

**Fig. 6.1**
Here we see that, compared with the fractions to be dealt with in
Question 8 on the present paper, these fractions were considerably
more difficult to deal with. In 1962, 32% of the students got it
right, 31% could not do it and 37% were wrong. Concern was shown
at the time about the 68% who were unsuccessful on this question,
and yet it compares favourably with the 87% of the sample of
teachers who were unsuccessful on the rather easier question of
the C.B.I. paper. Admittedly Question 8, as given to the teachers,
was in a rather 'wordy' form.

If one compares the percentage questions of the 1962
student paper and the paper given in 1969 to the students and
teachers, one sees that again the 1962 question is arguably slightly
harder.

Question 14 on the 1962 paper was: 12% of a sum of money is £30.

What is the sum?

25% of the 1962 students either could not do this question or got it
wrong, compared with the 35% of the 1979 sample of teachers who
failed Question 7 of the school-leavers' test. The figure was
higher still at 43% of the students admitted for training in 1979
who failed this question.

But Question 15 on the 1962 paper was very like Question 7
on the C.B.I. school-leavers' test. 75% of the 1962 students were
correct, 14% were wrong and 11% could not do the question. This
compares with the 35% of the sample of teachers in 1979 who got this
wrong, and thus the 65% who were correct. It could also be compared
with 57% of the students in training to be teachers in the college in
1979. So a very similar question produces a decline in the
percentage of teachers or intending teachers through the years from
There were questions on which the 1962 intake were less successful than the figures shown so far indicate. For example, Question 9 on the 1962 paper was: \[ \frac{3}{4} - \frac{1}{4} \times \frac{5}{4} - 1 \]. 75% of the students were wrong and 2% were unable to do this question. If the trend we have seen were to continue, then we might conjecture that the present day teachers and students would be less successful still at this kind of question. If this were so, it would be serious, for this is one of the types of question which Bajpai and Bond (1979) consider to be essential for the Mathematical training of Craft Apprentices.

"Determine the value of \(1\frac{7}{15} \times 2\frac{3}{11} - 4\frac{4}{7} \div 2\frac{2}{5}\)" (24)

An even smaller percentage (24%) were able to handle, successfully, a question on ratio in 1962.

"The sides of a triangle are in the ratio 2 : 2.5 : 3.5, If the perimeter is 12", find the sides." (25)

71% of the students at that time could not do this question at all and 5% got it wrong. There was no comparable question on the present paper, but since this again is in that area of work which includes, fractions, percentages, decimal fractions and ratios, we should be very concerned indeed if this figure also worsened since 1962. Especially so since this again is the kind of Mathematical expertise needed by the Craft Apprentice, according to Bajpai and Bond (1979).

"A substance is made from:-
34 parts lead, 26 parts copper,
30 parts iron, 35 parts water.
(a) How much water is there in 7kg of the substance?
(b) How much substance could be made with 78kg of copper?" (26)

The author decided to look at the scores in the first year Mathematics tests over the whole period of the expansion in teacher training.
Knowing the kind of questions and the students' results in 1962, the author felt that it might be possible to see whether the results during those years were of a uniform pattern. The means of the scores were plotted for men and women, where that was appropriate, from 1958 until 1978. (See fig. 6.2)

In addition to test for any significance in the difference between the mean score in each year and the mean score for 1958, a student 't' test was carried out. The result of a basic Mathematics test in 1958 represented the earliest available score from the old order of teacher training at the college. Previous to the expansion in teacher training, the college took only men students and the earliest records the author could find were from 1958. This was taken as a basis for comparison for subsequent sets of scores.

Here the author is trying to compare two samples each time, taken from differing populations and thus the statistical technique employed is that of a 't' test carried out on the difference between the means of the two samples.

<table>
<thead>
<tr>
<th>Sample A</th>
<th>Mean</th>
<th>$M_1$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Standard Deviation</td>
<td>$S_1$</td>
</tr>
<tr>
<td></td>
<td>Number in sample</td>
<td>$N_1$</td>
</tr>
<tr>
<td>Sample B</td>
<td>Mean</td>
<td>$M_2$</td>
</tr>
<tr>
<td></td>
<td>Standard Deviation</td>
<td>$S_2$</td>
</tr>
<tr>
<td></td>
<td>Number in sample</td>
<td>$N_2$</td>
</tr>
</tbody>
</table>

The formula for computing 't' in this case was taken to be

$$ t = \frac{M_1 - M_2}{\sqrt{\frac{S_1^2}{N_1} + \frac{S_2^2}{N_2}}} $$

where $n_1$ and $n_2$ are large.

It was thought by the author to be inappropriate to use any of the modified forms of this for small groups, since in only one case (that
A Comparison of Basic Mathematics
Mean Scores for Men and Women
Students at Oregon College of
Education 1958-78

Fig. 6.2

75% LEVEL

50  60  70  80  90

Men
Women

1958  '60  '62  '64  '66  '68  '70  '72  '74  '76  '78
of the men 1976-1979), was $n_2 < 30$. In all other cases $n_1$ and $n_2$ were each greater than thirty.

$$n_1 = 98$$

$$43 \leq n_2 \leq 124$$ in all other cases for the men and for the women, $61 \leq n_2 \leq 146$. There were so many of these tests to make over the twenty year period that the author wrote a programme in BASIC and ran the Tests on the college computer. (See Appendix 6.3)

We see from the fig. 6.2 that the means for the years 1960, 1963, 1965 and 1974 for the men students fell below that of the 1958 mean and considerably below that of the 1962 mean. In these years, the percentages of the men students not having 'O' level Mathematics was 28%, 27%, 24% and 19% respectively. For all the other years, the mean scores were above that of the 1958 level. In the cases of the twelve years in which the mean score for the men was above the 1958 level, there were four of these years in which the percentage of the men students not having 'O' level Mathematics was greater than the greatest percentage when the means were below the 1958 level.

In 1969, for example, when the mean score for the men was within 0.1% of being the highest level attained, the percentage of men without 'O' level Mathematics was only 1% less than the greatest percentage recorded in those years. From 1962 and the advent of the real expansion in student numbers in the college, a mark of 75% had to be reached on a paper in order to satisfy the internal examiners.

Where students were diagnosed to be weak, a remedial programme was undertaken and subsequent papers tested them by a range of questions within the weak areas.

In 1969, (see fig. 6.3), almost the highest mean score for the men students was recorded. In this year, the mean was 82.8
### Fig. 6.3

Scores on basic Mathematics papers 1958-1978

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean</th>
<th>Range</th>
<th>S.D.</th>
<th>% &lt; 75</th>
<th>Mean</th>
<th>Range</th>
<th>S.D.</th>
<th>% &lt; 75</th>
</tr>
</thead>
<tbody>
<tr>
<td>1958</td>
<td>59.1</td>
<td>100-20</td>
<td>16.7</td>
<td>69%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1960</td>
<td>46.2</td>
<td>84-9</td>
<td>15.9</td>
<td>93%</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1962</td>
<td>68.1</td>
<td>100-30</td>
<td>15.8</td>
<td>57%</td>
<td>51.7</td>
<td>90-0</td>
<td>22.9</td>
<td>80%</td>
</tr>
<tr>
<td>1963</td>
<td>56.1</td>
<td>90-16</td>
<td>16.0</td>
<td>89%</td>
<td>55.7</td>
<td>100-10</td>
<td>21.0</td>
<td>72%</td>
</tr>
<tr>
<td>1964</td>
<td>68.7</td>
<td>95-4</td>
<td>19.0</td>
<td>49%</td>
<td>67.5</td>
<td>100-31</td>
<td>15.6</td>
<td>65%</td>
</tr>
<tr>
<td>1965</td>
<td>52.1</td>
<td>97-18</td>
<td>16.2</td>
<td>90%</td>
<td>48.6</td>
<td>89-10</td>
<td>16.7</td>
<td>95%</td>
</tr>
<tr>
<td>1966</td>
<td>62.6</td>
<td>100-1</td>
<td>20.7</td>
<td>71%</td>
<td>71.0</td>
<td>100-19</td>
<td>17.3</td>
<td>56%</td>
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<tr>
<td>1967</td>
<td>71.1</td>
<td>100-7</td>
<td>18.2</td>
<td>53%</td>
<td>71.9</td>
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<td>1968</td>
<td>75.0</td>
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<td>12.7</td>
<td>42%</td>
<td>66.8</td>
<td>97-18</td>
<td>15.9</td>
<td>63%</td>
</tr>
<tr>
<td>1969</td>
<td>82.8</td>
<td>97-5</td>
<td>15.0</td>
<td>16%</td>
<td>79.3</td>
<td>96-36</td>
<td>11.8</td>
<td>22%</td>
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<tr>
<td>1970</td>
<td>73.9</td>
<td>97-34</td>
<td>13.5</td>
<td>54%</td>
<td>71.4</td>
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<td>10.2</td>
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<td>75.1</td>
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<td>14.3</td>
<td>36%</td>
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<td>1973</td>
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<td>98-15</td>
<td>17.7</td>
<td>75%</td>
<td>63.1</td>
<td>100-10</td>
<td>19.9</td>
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<td>95-32</td>
<td>15.1</td>
<td>89%</td>
<td>53.7</td>
<td>100-4</td>
<td>16.5</td>
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<tr>
<td>1975</td>
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<td>92-51</td>
<td>11.8</td>
<td>28%</td>
<td>81.7</td>
<td>100-40</td>
<td>11.8</td>
<td>25%</td>
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<tr>
<td>1976</td>
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<td>90-65</td>
<td>7.2</td>
<td>15%</td>
<td>76.5</td>
<td>96-43</td>
<td>11.1</td>
<td>39%</td>
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</tbody>
</table>

### Men and Women

<table>
<thead>
<tr>
<th>Year</th>
<th>Mean</th>
<th>Range</th>
<th>S.D.</th>
<th>% &lt; 75</th>
</tr>
</thead>
<tbody>
<tr>
<td>1977</td>
<td>81.1</td>
<td>99-49</td>
<td>11.8</td>
<td>26%</td>
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<tr>
<td>1978</td>
<td>78.4</td>
<td>94-41</td>
<td>11.5</td>
<td>31%</td>
</tr>
</tbody>
</table>
with a standard deviation of 15. In that year, only 16% of the men students failed to satisfy the examiners. Even with these good figures, there must have been a few cases which gave cause for great concern, since the range of marks was from 97 down to 5.

In 1960, the first of the years in which the mean was below the 1958 level, it was 46.2. On comparing these, using a 't' test involving the difference in the means, the calculated 't' is seen to be 5.62472, and from 't' tables

\[ t_{0.01} < 2.66 \quad \text{d.f.} = 97 \quad n_1 = 98 \quad \text{and} \]
\[ t_{0.01} < 2.66 \quad \text{d.f.} = 103 \quad n_1 = 104. \]

The 't' value we have found should be compared with the average of the two values shown above, but, since the sizes of the degrees of freedom is large and high in the table, the averaging of the values makes no difference to the calculation, so we have that

\[ |t| = 5.62472 > 2.66. \]

Thus we can reject the Null Hypothesis with regard to these two populations, and deduce that there is a significant difference between them at the 1% level. That is, there is less than a 1% probability that this could have occurred by chance. In that year, 93% of the men students failed to satisfy the internal examiners. (See fig. 6.3)

In 1963, the percentage of men students who failed to satisfy the internal examiners was almost as great. In this year, it was 89% of the men students. The mean was 56.1 with a standard deviation of 16 and a range of scores from 90 to 16. Fig. 6.3 shows that, for this year, \( n_1 \) being 98 and \( n_2 \) being 56, the calculated |t| = 1.12549 < the 'average' of \( t_{0.05} < 2.00 \) df = 97 and \( t_{0.05} < 2.021 \) df = 55 and hence there is no significance at the 5% level. The mean is lower than the 1958 level but not
significantly so. With this kind of low mean value and the low percentage of passes, (11%), the lack of any significant difference leads the author to conclude that the 1958 level was also most unsatisfactory. There must have been many very unsatisfactory students Mathematically in those years when the mean was below the 1958 level.

If we now look at 1965, we see another year in which the mean score is below the 1958 level. This time significantly so, for the calculated 't' for the men for this year is 2.87078 and thus $t = 2.87078 > 2.66$ since $t_{0.01} < 2.66$ and $t_{0.01} < 2.66$ for 83 degrees of freedom. In this year, the mean of the men's scores was 52.1 with a standard deviation of 16.2 and a range of 97 to 18. The failure rate this time went up to 90%. This being significantly different from the 1958 level and lower than that level we may conclude that this was another bad year in which many of the men students were poor at Mathematics. Most of these were through remedial work brought to a point where they could score sufficient marks on a basic Mathematics paper in order to pass the course, but one wonders whether any remedial work over so short a period could adequately make up for the so obvious lack of ability, much of it, as we have seen, stemming from a lack of comprehension of the fundamental concepts.

The graph, Fig. 6.2, also suggests that 1974 was a year when many students were very limited Mathematically. In that year, the mean score was only 54.2 with a standard deviation of 15.1 and a range of 95 to 32. The failure rate, (see Fig. 5.3) was 89%. The calculated 't' value as a result of the comparison made with
1958 was 1.84859. From the tables we see that,
\[ t_{0.05} < 2.00 \text{ for } d.f. = 97 \]
\[ t_{0.05} < 2.021 \text{ for } d.f. = 52 \]
and thus \(|t| = 1.84859 < \text{average of these.} \]
Although the mean is below that of 1958, it is not significantly different judged at the 5% level. The 89% failure rate again helps confirm the previous judgement concerning the low level of that of 1958.

The figures for the years in which the mean for the men was above that of the 1958 level should also be examined.

The first of these occurred in 1962. In that year, the mean was 68.1, nine points higher than that of 1958, with a standard deviation roughly the same. There was a decrease of twelve points in the percentage of failures, though the range of from 100 to 30 showed that there was a cause for grave concern about some of the students.

Fig. 6.4 shows that in comparison with 1958, the calculated t value was \(-3.02905\). The 't' tables show that
\[ t_{0.01} < 2.66 \text{ for } d.f. = 97 \]
\[ t_{0.01} < 2.704 \text{ for } d.f. = 41 \]
Thus \(|t| > \text{average of these values and hence there is a significant difference at the } 1\% \text{ level.} \]
The mean score now is significantly higher than the 1958 level, but with a 57% failure rate to reach the required standard of a mark of 75%.

This mark of 75% may, to many looking superficially at this, be taken to be abnormally high a requirement. The internal examiners had on many occasions to battle with administrators who wished the mark to be associated with the usual 40% pass rate set by the university for final certificate examinations. The internal
Fig. 6.4

't' values calculated from difference in means - each year compared with 1958

<table>
<thead>
<tr>
<th>Year</th>
<th>Men</th>
<th>Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>'t'</td>
<td></td>
</tr>
<tr>
<td>1960</td>
<td>5.62472</td>
<td></td>
</tr>
<tr>
<td>1962</td>
<td>-3.02905</td>
<td>2.03467</td>
</tr>
<tr>
<td>1963</td>
<td>1.12549</td>
<td>1.2911</td>
</tr>
<tr>
<td>1964</td>
<td>-3.1515</td>
<td>-3.81085</td>
</tr>
<tr>
<td>1965</td>
<td>2.87078</td>
<td>4.7128</td>
</tr>
<tr>
<td>1966</td>
<td>-1.22534</td>
<td>-5.21932</td>
</tr>
<tr>
<td>1967</td>
<td>-4.81211</td>
<td>-5.72891</td>
</tr>
<tr>
<td>1968</td>
<td>-7.42267</td>
<td>-3.52018</td>
</tr>
<tr>
<td>1969</td>
<td>-10.2238</td>
<td>-10.2772</td>
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<tr>
<td>1970</td>
<td>-6.59501</td>
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<td>1971</td>
<td>-9.77891</td>
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</tr>
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<td>1972</td>
<td>-7.55228</td>
<td>-5.02842</td>
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<td>1973</td>
<td>-1.25064</td>
<td>-1.69254</td>
</tr>
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<td>1974</td>
<td>1.84859</td>
<td>2.5062</td>
</tr>
<tr>
<td>1975</td>
<td>-6.72222</td>
<td>-11.2154</td>
</tr>
<tr>
<td>1976</td>
<td>-10.2073</td>
<td>-8.02285</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Year</th>
<th>Men and Women</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<tr>
<td>1977</td>
<td>-8.68572</td>
</tr>
<tr>
<td>1978</td>
<td>-8.00402</td>
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examiners argued that, since these students were to be the eventual teachers, their ability at least to get the right answer ought more properly to be nearer the 100% mark than the zero per cent mark.

The view was not popular. Thus in 1962 we are looking at a significant improvement, but one which still does not inspire great confidence in the ability of many of the students to teach Mathematics in the primary school.

We must always remember that in so wide a spread of marks there will be some serious deficiencies in Mathematical ability. For example, in 1962 there was the case of Miss X who was admitted as a first year student on the Certificate course. On the basic Mathematics papers taken during the course in her three years she scored, 0, 16, 22, 32, 35, 58, 45. The 45, final mark, was gained when the examination was the final Certificate examination held under the aegis of the University and when the pass mark was 40%. Miss X became an infant teacher, and now holds a very high position in the educational world.

In 1964 we see that the mean score was increased by a small amount, but there is a greater spread about the mean, the standard deviation now was up to 19. The range of marks has also increased, and was now from a top mark of 95 to a bottom mark of just 4. The calculated 't' of -3.1515, when compared with the tables, shows

$$|t| = 3.1515 > \text{the average of } t_{0.01} < 2.66 \text{ d.f.} = 97$$

and

$$t_{0.01} < 2.704 \text{ d.f.} = 56,$$

and so the change is significant at the 1% level. A highly significant change then from the 1958 mean, and with a failure rate further decreased to 49%. This situation is obviously a desired improvement upon some of the previous ones but, with marks deviating
from a mean of 68.7, (standard deviation 19), but nearly twenty points and a bottom mark of 4, there were again a considerable number of students who at that time were not going to be able to satisfactorily teach Mathematics.

In 1966, the mean fell by some 6 points over the 1964 level and was now only 3.5 points above the 1958 level. The standard deviation from the mean of 62.6 was 20.7. This was the largest standard deviation, from a mean, recorded. The spread of marks was very wide as was seen from this deviation and also from the practically maximum spread from 100 down to just 1 mark. 71% of the students did not satisfy the internal examiners and the rise in the mean from the 1958 level was not significant since, 

\[ t = -1.22534 \text{ and thus } |t| = 1.22534 < 'average' \text{ of } t_{0.05} < 2.0 \]

\[ \text{d.f.} = 97 \text{ and } t_{0.05} < 2.0 \text{ d.f.} = 83. \] Hence the 1966 intake for the men should also be regarded as not very satisfactory in terms of basic Mathematics.

In the years we have examined so far, the percentage of men without 'O' level Mathematics has usually been in excess of 25%, except in 1974. In that year, the percentage of men without 'O' level Mathematics dropped to 19. As we have seen previously, the evidence does not suggest that one could have a great deal of faith, Mathematically, in these students. Now, in 1967, the percentage of men without 'O' level Mathematics was again at the 19% level. In this year, there was a rise of over nine points in the mean from the 1966 level, though the spread was almost as wide as indicated by a standard deviation of 18.2 and a range of from 100 to 7. Then there was a drop of nearly 20% in the failure rate, (53%, see Fig. 6.3). The calculated 't' value for 1967 compared with 1958
was -4.81211. Comparing this with the 't' tables, $|t| = 4.81211 > \text{the 'average' of } t_{0.01} < 2.66 \text{ d.f.} = 97$ and $t_{0.01} < 2.66 \text{ d.f.} = 97$. The upward move from 1958 was highly significant. Here we are able to compare the scores for two years, 1967 and 1974, when the percentage of the men without 'O' level Mathematics was the same at 19%.

We see the scores in 1967 as significantly higher than in 1958, and the scores in 1974 not significantly so, but lower than that of 1958. A significant difference then in these two years. There would seem to be a possibility that having 'O' level Mathematics has not made a significant difference to the ability of these students to do simple Arithmetic.

In 1969, the mean score for the men students reached 82.8 with a standard deviation 15.0 and a range of 97 down to 5. The failure rate for this year was almost the lowest recorded, at 16%. This was the situation in spite of the fact that at 33%, the percentage of men without 'O' level Mathematics was one of the highest in the records. The calculated 't' value when the scores were compared with 1958 showed that the difference was very highly significant, $t = -10.2238$. $|t| = 10.2238 > \text{the 'average' of } t_{0.01} < 2.66 \text{ d.f.} = 97$, and $t_{0.01} < 2.66 \text{ d.f.} = 89$. This we must conclude, was a very good set of students as far as basic Mathematics was concerned.

In 1968, there was a movement, less marked, upward in the mean Mathematics score and against the fall in the percentage of those men with 'O' level Mathematics. 81% of the men had 'O' level Mathematics in 1967 against only 72% in 1968. The mean of the Mathematics scores went up by almost 4 points from the 1967 level.
The marks were not so widespread, there being a standard deviation of 12.7 and a range of 96 to 28. The percentage of failures in the eyes of the internal examiners fell from 53% in 1967 to 42% in 1968. That there was a more highly significant different set of scores, as demonstrated by the difference in the means when 1967 and 1968 were compared with 1958, is shown by the 1968 calculated 't' of -7.42267, and so $|t| = 7.42267 > t_{\text{average}}$ of $t_{0.01} < 2.66 \text{ d.f.} = 97$ and $t_{0.01} < 2.66 \text{ d.f.} = 91$. This is more highly significant than the 1967 results, and yet there was a drop in the percentage of men with 'O' level Mathematics in 1968 from the 1967 level. The ranges of marks for 1968 and 1969 show that in spite of a more satisfactory all round situation, there were still students who were very weak at Arithmetic.

From the peak at 1969, there then began a decline until 1974, when the mean fell to below the 1958 level again. This fall took place in spite of the fact that in 1970 the percentage of students without 'O' level Mathematics was down from the almost peak figure of 33% in 1969 to one of the lowest levels at 21%. The figure dropped further to the lowest level in 1974 when only 19% of the men were without 'O' level Mathematics.

After this time, the means climbed again and were each one of them higher, and significantly so, when viewed against the 1958 level, though too much reliance should not be placed on the calculated 't' value for that year. The numbers the scores were 98 and 20. According to Guilford and Fruchter (1973) one should hesitate to use 't' formulas if the N's differ markedly, though no indication of what to 'differ markedly' might mean. Both the values of N are 'large' if $N > 10$. This was the situation at 1978.
Each year for which we have records, the percentage of women without 'O' level Mathematics greatly exceeds that of the men (see Fig. 6.1). In six of the ten years in which there were men's and women's records taken separately, the figure for the women is approximately twice that for the men. In spite of this, we see, if we look at the graph, (Fig. 6.2), that the mean scores for the women, for the most part, closely follow that of the men and, in some of the years (1966, 1967, 1973, 1975) actually exceeds that of the men.

In those years in which the mean scores for the women students are below the 1958 level, (1962, 1963, 1965 and 1974), in only one year is the calculated 't' figure great enough to show a significant difference at the 1% level. That is to say, in only one year, (1965), is the mean score for the women such that we see a highly significant fall in the score from the 1958 level.

1962 \[|t| = 2.03467 > \text{'average'} \text{of } t_{0.05} < 2.0 \text{ d.f.} = 97\]
and \[t_{0.05} < 2.021 \text{ d.f.} = 58\]

1963 \[|t| = 1.2911 < \text{average of } 1.98 < t_{0.05} < 2.0 \text{ d.f.} = 97\]
and \[1.98 < t_{0.05} < 2.0 \text{ d.f.} = 108\]

1965 \[|t| = 4.7128 > \text{average of } t_{0.01} < 2.66 \text{ d.f.} = 97\]
and \[t_{0.01} < 2.617 \text{ d.f.} = 128\]

1974 \[|t| = 2.5062 > \text{average of } t_{0.05} < 2.0 \text{ d.f.} = 97\]
and \[t_{0.05} < 1.98 \text{ d.f.} = 140.\]

In only 1965 is \(|t|\) greater than the average of the values at the 1% level. There is a significance at the 5% level, however, in 1962 and 1974. The 1963 level is not significantly different from the 1958 level, as is shown by the \(t\) table figures for the 5% level.
For these years, the percentage of women students without 'O' level Mathematics is least for 1965, in fact the year in which the drop below the 1958 level is most significant. Thus we see that with 33% of the women without 'O' level Mathematics compared with figures of 62% for 1962, 50% for 1963 and 50% for 1974, the failure rate was the highest at 93%.

Where the mean scores for the women students exceeds the 1958 level, the difference between that and the 1958 level is highly significant except in 1973. In 1973, we find a higher level of performance than in 1958, but not significantly so.

1964 \(|t| = 3.81085 > 'average' \text{ of } t_{0.01} < 2.66 \text{ d.f. = 97}
\text{ and } t_{0.01} < 2.617 \text{ d.f. = 125}

1966 \(|t| = 5.21932 > 'average' \text{ of } t_{0.01} < 2.66 \text{ d.f. = 97}
\text{ and } t_{0.01} < 2.617 \text{ d.f. = 132}

1967 \(|t| = 5.72891 > 'average' \text{ of } t_{0.01} < 2.66 \text{ d.f. = 97}
\text{ and } t_{0.01} < 2.617 \text{ d.f. = 123}

1968 \(|t| = 3.52018 > 'average' \text{ of } t_{0.01} < 2.66 \text{ d.f. = 97}
\text{ and } t_{0.01} < 2.617 \text{ d.f. = 135}

1969 \(|t| = 10.2772 > 'average' \text{ of } t_{0.01} < 2.66 \text{ d.f. = 97}
\text{ and } t_{0.01} < 2.617 \text{ d.f. = 137}

1970 \(|t| = 6.1778 > 'average' \text{ of } t_{0.01} < 2.66 \text{ d.f. = 97}
\text{ and } t_{0.01} < 2.617 \text{ d.f. = 142}

1971 \(|t| = 7.79524 > 'average' \text{ of } t_{0.01} < 2.66 \text{ d.f. = 97}
\text{ and } t_{0.01} < 2.617 \text{ d.f. = 142}

1972 \(|t| = 5.02842 > 'average' \text{ of } t_{0.01} < 2.66 \text{ d.f. = 97}
\text{ and } t_{0.01} < 2.617 \text{ d.f. = 140}

1973 \(|t| = 1.69254 < 'average' \text{ of } 1.98 < t_{0.05} < 2.0 \text{ d.f. = 97}
\text{ and } 1.96 < t_{0.05} < 1.98 \text{ d.f. = 144}
1975 \( |t| = 11.2154 \) 'average' of \( t_{0.01} < 2.66 \) d.f. = 97
\[ \text{and} \quad t_{0.01} < 2.66 \quad \text{d.f.} = 113 \]

1976 \( |t| = 8.02285 \) 'average' of \( t_{0.01} < 2.66 \) d.f. = 97
\[ \text{and} \quad t_{0.01} < 2.66 \quad \text{d.f.} = 65. \]

This significantly higher level than 1958 was achieved when, in some of the years, the percentage of students without 'O' level Mathematics was running at its highest level (see Fig. 6.1).

In 1970 for example, the percentage of women students without 'O' level Mathematics was 50%, in 1968 it was 53%, and in 1969 48%.

In spite of these seemingly good performances there are causes for concern yet. The spread of marks in 1964 was from 100 to 31 with a mean at 67.5 and a standard deviation of 15.6. The failure rate for that year was 65%. Some of these failures must have had quite low marks. The range in 1968 was from 97 down to 18 with a mean of 66.8 and a standard deviation of 15.9. In this year, the failure to reach the required standard was 63%. In this year, amongst the women students, 17.1% of them were below the level of 'O' level special Arithmetic, whilst that figure was only 12.2% in 1966.

In 1969, the mean score for the women students was the second highest at 79.3, with a range of 96 down to 36, and with a standard deviation of only 11.8. In this year, the failure rate was 22%, and yet the percentage of women without 'O' level Mathematics was 48%, quite a high value. In that year also, 30.5% of the women were below ordinary level special Arithmetic standard.

As well as the students' ability to do simple Arithmetic, must be borne in mind the need for them to be able to communicate to others the processes involved. On one of the Mathematics 'Method'
papers taken each year at Caerleon, the students were required to explain particular Arithmetic processes. For example, they were required to explain a method of subtraction relative to a particular example.

The author has examined college records and has applied 't' tests to examine the relationship between the basic Mathematics marks and the Mathematics 'Method' marks for each year from 1962 until 1978.

An examination of the results given in Fig. 6.5 shows that, in 1962 for the men students, the calculated value of t was 6.9515 and so \( |t| = 6.9515 > t_{0.01} < 2.704 \) d.f. = 43. This indicates that, since \( M \) is positive, the method marks are significantly lower than the 'basic' marks. There is less than a 1% probability that this could have occurred by chance. So we see that the chances that these men could explain to others what it was they were doing was not high. For the women of that same year, the calculated value of 't' was 0.75745 and hence \( |t| = 0.75745 < t_{0.05} = 2.0 \) d.f. = 60. Though the 'Method' marks are slightly lower than the 'basic' marks, they are not significantly so. In only two cases are the 'method' marks not significantly lower for the men. These are

\[
1965 \quad |t| = 0.03205 \leq (1.98 < t_{0.05} < 2.0) \quad \text{d.f.} = 83 \\
1976 \quad |t| = 0.702461 < t_{0.05} = 2.093 \quad \text{for d.f.} = 19.
\]

In all other cases, the method marks are significantly lower, though this does include years 1970 and 1974 when the difference was only significant at the 5% level. In all the other cases, the method marks were lower at the highly significant 1% level.

For the women, in these years we actually have seven occasions when the 'method' marks exceed those of the 'basic' marks.
Fig. 6.5

Comparison of 'basic' marks and 'method' marks (1962-1978)

't' test using single mean

<table>
<thead>
<tr>
<th>Year</th>
<th>Men 't' Value</th>
<th>Women 't' Value</th>
<th>Men Tables</th>
<th>Women Tables</th>
<th>Men d.f.</th>
<th>Women d.f.</th>
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</thead>
<tbody>
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<td>60</td>
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<td>57</td>
<td>&gt; t&lt;sub&gt;0.01&lt;/sub&gt; &lt; 2.617</td>
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<td>1976</td>
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<td>&lt; t&lt;sub&gt;0.05&lt;/sub&gt; = 2.093</td>
<td>19</td>
<td>-4.573 &gt; t&lt;sub&gt;0.01&lt;/sub&gt; &lt; 2.66</td>
<td>19</td>
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<table>
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<td></td>
<td>'t' Value</td>
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<tr>
<td>1977</td>
<td>4.40118</td>
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<tr>
<td>1978</td>
<td>-2.15044</td>
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For example, in 1976, $t = -4.57276$ and so $|t| = 4.57276 > t_{0.01} < 2.66$ for d.f. = 65. In this year, M is negative, hence d is negative and so the value of $Y$ is greater than the value of $X$. That is to say, the 'method' marks are higher than the 'basic' marks. These 'method' marks are significantly higher at the 1% level.

For these seven occasions, two of them are significant at the 1% level (1970 and 1976), one is significant at the 2% level (1972), and one is significant at the 5% level (1965). On the other three of those seven occasions when the 'method' marks were higher than the 'basic' marks, they were not significantly so (1969, 1971, 1974).

Of the fifteen years for which we have records of the women's marks in 'basic' and 'method', there were also eight years in which the 'basic' marks exceeded the method. In these eight occasions, there was a significantly lower 'method' mark in 1963, 1964, 1967 and 1975 at the 1% level. It was significantly lower at the 5% level in 1966. On the remaining three occasions (1962, 1968 and 1973), the method marks, though lower than the basic, were not significantly so. For the years 1977 and 1978, when the marks for the men and women were taken together, there was in one year (1977) a significantly lower method mark at the 1% level, and in the other year (1978) a significantly higher method mark, but only at the 5% level.

So, for the men, a significantly lower 'method' mark than 'basic' in thirteen of the fifteen years. The majority of these being at the 1% level. For the women students, there was a significantly lower 'method' mark than the 'basic' on only five of the fifteen years. For almost half of the fifteen years the 'method' marks are at a 'higher' level than the 'basic' marks, and significantly so on five occasions.
Comparing these results with the mean basic scores and with the 't' tests made on the basic scores, one sees that, in 1965 for example, when the 'basic' score for the women was significantly below that of the 1958 level, the corresponding 'method' marks were significantly higher. Again in 1969, when the 'basic' marks were significantly higher than the 1958 level, the 'method' marks were again higher, but this time not significantly so. In 1970, when again the 'basic' marks for the women are significantly higher than the 1958 level, the 'method' marks are significantly higher than those.

It seems, from this evidence, that although for the most part the 'basic' marks of the women were below those of the men, they had made a much greater effort to comprehend the processes and thus were more likely to be able to offer a reasonable explanation to children, though the way in which this was done was likely to be rather inflexible. The Mathematical help and advice which they could offer the children was likely to be rather limited.
CHAPTER 7

Interpretation and Discussion of the 
Results including Recommendations

Remarks about Craft Apprentices.

A great deal of attention has been given during the last few years, in the national press, to the alleged declining standards in basic subjects. Whether or not they have declined is difficult to say, but that standards are at a low level in Mathematics seems very evident by the kind of failure rates amongst the school leavers, the students in training to be teachers and the teachers themselves, which are indicated by this investigation. The work of Rees (1971) should be borne in mind also. Here on 'common core' items nearly all the groups tested gave their weakest performance. She considered it not insignificant when 28% of the students at University I level, taking a test designed for Craft students, got the ten weakest items wrong. The author's test shows that for the first seven items, ('common core'), the mean failure rate for the students in training to be teachers was 22%; and for the teachers in local schools was 23%. If one admits into this 'common core' set the question which asked that the area of a circle be calculated, then the mean failure rate reaches 31% for each group.

The examination which was given to the would-be apprentices by the local engineering company which was under investigation showed failure rate spreads of 59-82% for the candidates who had obtained, or were taking, G.C.E. 'C' level Mathematics; 78-93% for the C.S.E. level group and 33-89% for the group who were taking courses at local colleges of Further Education. This examination was a rather curious one and, whereas it did distinguish between these groups of candidates, it was
not matched in any way against the kind of test used by Rees or against any school based examinations. The totals of the percentages of failures on the five Mathematical questions were,

- F.E. College Course Candidates: 345
- G.C.E. level candidates: 368 (i.e. Maximum 500)
- C.S.E. level candidates: 419 (See fig. 7.1)

The local candidates taking 'technical' courses at F.E. colleges did better than the candidates from the local schools, though the fact that there were few of them compared with the numbers in the other groups cannot rule out the likelihood that this occurred by chance.

These F.E. college students actually did better than the G.C.E. level candidates on three of the five Mathematical questions. Strangely, perhaps, they fared least well of all the groups on question seven, which was concerned with a relationship between screw sizes and which had a certain practical application. They also did only as well as the C.S.E. level candidates and less well than the G.C.E. level candidates on question five, in which a knowledge of Physics was essential to the solution. The failure levels for all three groups of candidates was very high indeed, though it must be said that this was not the kind of paper on which a teacher would be prepared to judge a candidate's Mathematical ability or potential.

Criticisms have been levelled against some of the Mathematical papers set by industry, pointing out their unrealistic nature, having regard to the demands of the industry involved and the courses being followed by the candidates.

"Selection tests should be reviewed in the light of (a) the current needs of the job, (b) present school syllabuses." (97)
Failure Percentages on each question

"G.C.E. Level Group" "O.S.E. Level Group" "Tech. Course Level Group"

Fig. 7.1
The particular test set by this local company, (see appendix 3.1), is clearly one which schools would find it difficult to plan for. It seems, to the author, to be testing some things which more properly are the concern of post-selection courses rather than pre-selection. According to the training officer of this particular company, the Mathematical ability of the candidates is crucial in deciding their suitability for training. This may be so, but the selection tests which are employed may not be good predictors of future job performance. Dickson (1977) working at Chelsea College of Science and Technology, University of London, showed in her research that some of the standard tests were in fact poor predictors of future performance. The reliability of such tests has also been questioned by the working party of the Royal Society (1976).

The particular test we are examining had no elements even of a standardised test. Most of the questions were ad hoc and ill considered both in relationship to the industry they were serving and the language in which the questions were couched for interpretation by the candidates.

This examination is certainly not a true test of Mathematical skills. There are skills, very relevant to this industry, which this paper did not even tackle. There was, for example, only one question given in Imperial Units, and this was such that a lack of ability to handle the related skills would hardly have affected anyone's solution.

There is no doubt that in the engineering industry, for many years to come, the ability to handle certain Imperial Units will be necessary. Many of us in schools and colleges hoped that the promised programme of metrication would have been seen through at an early date. Apparently this was grossly over optimistic.
The Cleveland Working Party (1977) states that,

"Imperial units are still in regular use in industry and commerce and will remain so for some years to come. Costly capital equipment cannot, and will not, be scrapped overnight and there are many spares - replacements needed for existing plant and machinery." (98)

This seems, to the author, to be a realistic view. In his interviews with training officers in this county, statements concerning capital expenditure on 'Imperial' plant and machinery having a further forty years of working life were continually made. Many machines are based on Imperial Units, and very often components made on metric machines have to be processed on Imperial machines, thus necessitating a procedure of conversion from one set of units to the other. This was certainly true of this company, whose craft apprentices have to deal with such conversions and be thoroughly conversant with some aspects of Imperial units and the related Mathematical skills. Strange, then, that this aspect should have been omitted from the paper.

In the engineering industry there is great need for the use of units of linear measurement and, in order to handle these in Imperial units, the main requirement is a thoroughgoing ability to handle fractions and their conversions to decimals. In this particular examination there was no knowing to what extent the school leavers could, or could not, handle them, simply because the questions were complex and depended upon other concepts.

The matter of liaison between such companies and schools is crucial, even if it is only a matter of a consensus, after research, on the type of testing to be used at apprentice selection. In the locality of this particular company, only one school has a regular Schools/Industry Liaison Committee. Some of the others had rather tenuous links, and the fault seems to be with the schools rather than industry.
The Training Officer of this company was enthusiastic for such links and indeed was Chairman of the previously mentioned Liaison Committee. He expressed his regret that he was not able to liaise with many of the other local schools inspite of the many approaches which he personally has made to them. In these cases, the communication between the company and these schools was very poor. Consequently it manifested itself in the lack of preparedness of their pupils to tackle such a paper, and the choice and presentation of the questions themselves. The language chosen to communicate what was wanted in the questions was not well considered. The choice of linguistic form could well have been more straightforward. In addition to this the questions, if they are to be fair and to select on potential as well as on attainment, should not have hurdles to overcome which could exclude otherwise worthy Mathematical candidates. These candidates came from a wide spectrum of the school population and it may be all too easy to confuse some of them. The tackling of the questions themselves, from an Arithmetic point of view, left a lot to be desired. Some thoroughly unsatisfactory methods were employed. For example, in the attempts to find 10% of 18, sometimes a fraction, whose denominator was a multiple of ten, was reduced by a series of 'cancellations' which could be open to errors, to dividing nine by five.

\[
\frac{1}{5} \times \frac{9}{100} = \frac{9}{500}
\]

Are teachers insufficiently aware themselves of the need for, and do they do sufficient to insist on, the retention of multiples of ten with which to operate in the denary or decimal system?
In general, the attempts to find percentages was appallingly handled. In the company examination, 66 out of the 101 candidates failed on the percentage question where it was related to limits. (Question 2). Bajpai (1977) quoted the 75% who were incorrect in finding what percentage of 150 was 21, on the 1975 tests given by Plessey & Co. Ltd. This same question was included in the report of the C.B.I. (Wales) 1977 report on numeracy and literacy in Wales. In this report, it was quoted that 86% of the school leavers to whom the test was given failed this question. It is interesting that this higher failure rate is in accord with the findings of the A.P.U. Report in their Secondary Survey (1980). In this the Welsh region is way behind the other regions in the skills, concepts and applications of number. (See fig. 4.3, page 73 of the report) The author's own findings about this question, when related to students training to be teachers, and to a sample of local teachers, was that 43% of the students and 35% of the teachers also failed this question. Inspite of the fact that Rees (1973) classifies this kind of question as 'difficult' (p50), and lecturers and teachers must be fully cognisant of the fact when devising teaching strategies, is this not totally unsatisfactory? When 35% of a sample of teachers, most of whom were teaching in primary schools, could not find 21 as a percentage of 150, surely not much could be expected of the children. The idea of finding 10% has clearly not been communicated to the C.S.E. level candidates who were taking the company paper, 80% of whom failed to succeed on Question 2. Some of these candidates, as we have seen, thought to achieve the required 10% by adding or subtracting 10. Some even multiplied or divided by 2 as their method of getting the 10%.

Common to all the groups of students and teachers who attempted the percentage question selected from the C.B.I. (Wales) report, was the
error demonstrated by those who had picked up half an idea but did not truly understand what it was they were doing. This concerned the inability to remember, (it was clearly a memory game), the arrangement of the numbers in the calculation of a percentage. Thus we had variations on $\frac{150}{100} \times 21$ in order to try to find what 21 is as a percentage of 150. Similarly the author found in the company examination, school leavers who wrote $\frac{10}{15} \times 100$ in order to try to find $10\%$ of 15. As such these are good illustrations of the futility of learning by rote.

There is seen to be a large area of misconception including, and surrounding, the ideas of fractions, percentages, decimals and their interrelationships. We see an example of this in the attempts by some students to write $\frac{3}{5}$ as a decimal. They actually have to attempt to calculate it, and in doing so write $\frac{3}{5} \times 100$. Two of them even wrote the answer with the percentage sign! It seems clear that the concept of equivalence needs attention. Discipline is also needed so that if this method is to be used, the 100 denominator is retained and not squandered, so obtaining $\frac{3}{5} \times \frac{100}{100} = \frac{60}{100} = 0.6$.

It may be that using this same approach for the purpose of obtaining a decimal fraction when needed or a percentage when that is needed has a certain economy. In these cases investigated, there is an inability to handle it. Such a method clearly has more advantage if the numerator of the fraction is a factor of 100, but the method is not invalid if this is not so. The problem which arises from this method, when the denominator is not a fraction of 100, is that of the greater likelihood or error due to the extra care needed with the script. There being less help in the layout for the division which is necessary.

Thus for example, $\frac{2}{9} \times \frac{100}{100} = \frac{200}{9 \times 100} = 22.2 = 0.222$

may be effectually made more accurate in performance by the retention
in it of \( \frac{2}{9} = 0.222 \) even though it breaks up the continuity of the Mathematical statement.

This survey shows that there is a conceptual problem in this and other similar operations. This concerns the relationship between remainders and the decimal fraction. For example, \( \frac{5}{3} \) may be rendered as 1.2. Attendant upon the initial division is a remainder of 2 units which are then written as 2 tenths. There are variations on this, as for example when \( \frac{9}{5} \) is correctly shown to be \( 1\frac{4}{5} \) and then this in turn is written as 1.45.

These are considered by many teachers in this county to be 'core' items as may be seen by the contents of the 'Mathematics Guidelines 5-13' which have been drawn up or are being prepared at the moment. These items will be required to be taught by teachers, many of whom are ill equipped to do it.

This seems to be an area of which many of the future teachers and present teachers are likely to have difficulties. The figures for the question (No. 4) concerning the addition of fractions taken from the C.B.I. (Wales) report show that 70\% of the school leavers were unable to do this correctly. In addition, 27\% of the students could not do it correctly and 26\% of the sample of teachers also could not get the correct answer. The highest failure rate was that of the Diploma of Higher Education students without 'O' level Mathematics, whose figure was 41\%. This is disturbing since this is the new type of entrant into teaching.

Teachers who themselves are capable of writing \( \frac{7}{4} + \frac{7}{4} = \frac{14}{7} = 2 \) are not very likely to be able to help their pupils. 
83% of the errors made by the teachers were errors involving the non-comprehension of the concept. We also find that the work of the school leavers and the teachers in training showed a high percentage of errors were due to not understanding the concepts involved. In fact, 26 out of the 40 errors made by the students training to be teachers were of this kind. This kind of work is one which is basically not understood by a substantial one quarter of the teachers and the students who will become teachers.

There are simple computations and, after the start of the Nuffield Mathematics Project 5-13, its director, Dr. Geoffrey Matthews, felt obliged to point out that the core of the subject was computation. The project materials make this clear. Somehow we find that teachers and students have sought a refuge from this computation, and the fact that something else was also being done in the project overtook the initial and well founded idea of a basis in computation. Whereas at one time teachers had to concentrate on computation, they could now seek a refuge from it in what they may have erroneously have thought to be easier areas where their inadequacies could not so easily be detected. There would seem, to the author, to be some justification in the comments of Lindsay (1974) when he said that,

"The horror stories of the engineers could seemingly be capped by those from the primary schools; of teachers who 'taught' children how to subtract while being unable to do it themselves; of the grasping at straws, resulting in an unhealthy obsession with 'sets'; of the wishful thinking over calculators ousting calculation; of the realisation of personal inadequacy leading to much the same kind of breakdown in self-confidence and to hysteria."

(99)

The ability to do this calculation very much depends upon the ability to understand the basic ideas. The project's basic intention...
in its methodology was to develop ideas. These ideas must have a foundation in substance. They exist not one without the other but in an interdependence. The misunderstanding of the fundamental concepts affects a wide ranging area of the work to be done in Mathematics. So misunderstood are many of these concepts, as shown by this survey, that teachers with these misconceptions will pass them on to many pupils during the years in which they are teaching. Misunderstandings occur in the vital areas of equivalence and place value. One way of avoiding embarrassment due to the lack of understanding is to hide from any real scrutiny. Don't teach a substantial group of children; always work from books letting the pupils move from page to page without any substantial teaching programme.

This company examination included, in question 4, the need to solve an equation when the unknown quantity was a denominator. The inability of many of the school leavers to handle this kind of equation is shown in Chapter 3 of this study. The statement that, \( \sin 65^\circ = \frac{3}{AB} \) then necessitates the finding of AB, and for many of the candidates this proved to be the insurmountable barrier to the eventual solution. This was seen to be so even for many of the G.C.E. 'O' level candidates. Of those who were able to write that \( AB = \frac{3}{\sin 65^\circ} \) and that \( AB = \frac{3}{0.9063} \) some were then unable to deal with the resulting Arithmetic, even though they had Log. tables available. Perhaps they might as well have had electronic calculators available, though merely to use them unthinkingly would have been unsatisfactory. Such a calculation should at least be accompanied by a realisation that it approximates to \( \frac{3}{0.8} = \frac{10}{8} = \) the order of the result is around 4.

If the concepts of place value, of equivalence of fractions, and the
skill of simple division is present in the pupil, then this might most respectably be done using a calculator. Worthy (1977) has shown both the need for the use of the trigonometry of the right angled triangle and the transposition of formulae in the engineering industry. The difficulties inherent in the handling of such Mathematics by apprentices has previously been commented upon by Allan (1975). The non-understanding of basic concepts in Arithmetic and of basic Mathematics is a most serious matter when it occurs in teachers and in future teachers. In the case of the students at the college in 1979, there was a total of 267 errors which were of the non comprehension of the concept type out of a total of 585 errors. Thus just under 50% of the errors made by these future teachers were concept errors.

Discussion: Some General Remarks.

From the author's experience of teaching these future teachers, he feels that the degree to which they understand the underlying ideas in elementary Mathematics is very limited. To many of them the notion of building ideas upon physical experience is foreign. In addition to this aspects of Mathematics are treated as separately as they might treat subjects such as Geography, History and Physics. Integration and interrelationship is not what they naturally understand. As a consequence much of what they do in their teaching is canalised, and, even with this straight route, many of the ideas tackled are isolated. Whether we are providing experiences which are necessary for the erection of logical structures or whether we are structuring experience in a logical way, the underlying interrelationship in many of the parts of what is to be taught in Mathematics are of a logical nature. Thyer and Maggs (1981) believe that teaching programmes must include those in which interrelationships are present and which may be used for reinforcement.

The notion of providing experiences in, and teaching, length, mass and weight, capacity just as isolated parts of the basic Mathematics
programme seems to them not to be in the best interests of promoting understanding of fundamental principles. The necessary need for the idea of transitivity in these measuring situations may well, if handled in that way by the teacher's structuring, be used to reinforce children's ideas of number, where this principle is a necessary foundation. Clearly this means that the teaching programme must not be such that it leads to the misconception of isolation. 'Practical' Mathematics is very often neglected in the early years in school, and notions about measurement are often left until children have had a few years of number work.

For the sample of teachers on the same test, the concept errors amounted to just over 50%.

The students now in training to be teachers were pupils in schools in the late 'sixties' and throughout most of the 'seventies'. The teachers who in 1979 were taking an in-service course were themselves in teacher training colleges in the 1960's and 1970's. Students who entered colleges at the commencement of the expansion in teacher training are now in their late thirties, if they came directly from school. They now have some fifteen years or so of teaching behind them. What was the Mathematical situation like when they were students?

In 1979, 39% of the Diploma of Higher Education students did not have 'O' level Mathematics. The figure is much higher, at 65%, for the students on the teacher's certificate course in that year. This means that for the 1979 intake as a whole, 50% were without 'O' level Mathematics. A look at the figures for the years 1958-1978 shows that the percentage of students without 'O' level Mathematics is as high as it ever was. This matter will be remedied from 1980 when the
intake into teacher training will, in normal circumstances, have to have 'O' level Mathematics as well as 'O' level English Language.

The basic Mathematics examination set by the college for the new intake in 1962 enabled the author to compare the mean levels achieved from 1958 until 1978. The test which was given consisted of the kind of Mathematics which one would expect to be done by the top band of a Comprehensive School in the second year. It is not really asking a lot that future teachers should be secure in this limited area of Mathematics. On this examination, 31 out of 43 of the men did not achieve 75% on the paper and 10 of the men failed to reach the 50% mark. Even so we see that the mean score for the men is significantly higher than the 1958 mean. Thus we have, in the opinion of the Mathematics staff at the college, a most unsatisfactory standard in 1958. For a quarter of the next twenty years, the standard of Mathematics, as judged by these basic Mathematics tests, fell below that of the 1958 standard. There were eight years only in which the standard, as judged by a 75% mean, would have satisfied the internal examiners. Even then, in these relatively successful years, when viewed as a whole, there were many students who were eventually passed out as primary school teachers, who were very poor mathematically and would have been more of a liability than a help to pupils learning Mathematics.

It was not a practical possibility in those years, from the point of view of the Department of Education and Science, to allow a high percentage of failures on the Teacher's Certificate Course. Teachers were needed in those years to cope with the large number of children in the schools. The cost of training a teacher is high and, if more than a low level of Mathematical attainment had been required,
many would have failed. Consequently, the requirement that students should have 'O' level Mathematics on entry to colleges was never applied, and only a small failure rate on the Certificate final examination was tolerated. The alarming feature of these figures lay in the numbers of the women students who had only a very fleeting acquaintance with Arithmetic, let alone Mathematics, in their secondary school lives. Many had given up all Mathematics or Arithmetic Courses by the time they were in the second year of the secondary school.

All this is a created situation which affects our schools and especially the pupils now, and we have to live with it.

A further alarming feature is seen, in the significantly lower level, in the 'method' papers of the men. That is to say, although the men students may have been able to do some of the basic operations in Arithmetic, they are seen to be at significantly lower level when it comes to making an adequate explanation of what they are doing. This may have considerable interest to those who have seen the video tapes made by the Open University for use with teachers' courses and due to be shown on television later in 1981. The author was present at a preview in which teachers were staggered at the misconceptions of the children in some very basic Arithmetic processes.

During these years, the women seem to have been more conscientious in getting to grips with adequate explanations, for whereas they follow the men's marks in 'basic' fairly closely, though usually being lower in their mean score, they have a higher level of 'method' marks, though not always significantly so.

Throughout the years from 1960 to 1974, the mean percentage of the men without 'O' level Mathematics in the Gwent College was 26.3
with a range from 19% to 34%. The mean percentage for the women was 45% with a range from 33% to 62%. Even with the contraction of teacher training and with the advent of the Diploma of Higher Education with an entry requirement of two 'A' levels, the percentage of students without 'O' level Mathematics before 1980 has shown no significant change. It would be instructive to see whether in the basic Mathematics test having 'O' level Mathematics has made any difference.

Figures 4.5 and 4.7 show that for Questions 1 and 2, which were given to students at the college, the students without 'O' level Mathematics did better than those with 'O' level Mathematics. For Question 3, (Fig. 4.9), a substantial multiplication in the denary system, over twice the percentage of the students without 'O' level Mathematics failed this question. Nearly 30% of those without 'O' level Mathematics could not multiply three numbers together as compared with the 13% who failed but had 'O' level Mathematics. An even greater percentage of those without 'O' level Mathematics could not add two mixed fractions. The difference now being that nearly three times the percentage of the students without 'O' level Mathematics failed at this question as compared with the percentage of those with 'O' level Mathematics. The story is continued when it comes to the division of fractions where almost twice the percentage of those without 'O' level Mathematics failed as compared with those with 'O' level Mathematics. Even so, nearly one quarter of those students with 'O' level Mathematics failed to divide a pair of fractions correctly. One of the questions asked the students to write $\frac{3}{5}$ as a decimal. Eleven per cent of those with 'O' level Mathematics failed to do this correctly and the figure was almost two and a half times greater at 27% for those students without 'O' level Mathematics who could not do this question. If one examines
the guidelines of some other areas of this country, one sees that it is expected that at top primary school level or first year secondary level it is expected that children will be taught to express one number as a percentage of another. In the case of a question like this it was found that over half of the students in training who do not have 'O' level Mathematics could not do this. Even for those with 'O' level Mathematics nearly one third could not do it correctly.

The highest failure rate occurred on the question requiring the calculation of the area of a circle. Not a piece of work for the primary school but a very common requirement for most of the students to have had to have done in their school days. 88% of all the students could not do this question correctly and the results for those with 'O' level Mathematics were only marginally better than those with. 84% of those with 'O' level Mathematics were unsuccessful compared with the staggeringly high figure of 93% of those without 'O' level Mathematics.

The two remaining questions on the paper were written in terms of 'Calculations in a technical context' (Rees 1973). In both of these questions the students with 'O' level Mathematics did better than those without 'O' level Mathematics.

So we see that, taken in all, those who had 'O' level Mathematics were better able to tackle this 'basic' paper than those without 'O' level Mathematics, even though on some questions they themselves showed considerable inability. Some areas of what is usually considered to be fairly easy Arithmetic causes a great deal of difficulty even for people with 'O' level Mathematics. The fact that a student does have 'O' level Mathematics does not necessarily mean that his ability over even that work in the primary schools guidelines in
Mathematics can be taken for granted. In addition, there must be some considerable disquiet over the inability of the vast numbers without 'O' level Mathematics to cope adequately with this area of work. In the future, when 'O' level Mathematics in most cases will be a requirement, we can expect that the overall Mathematical ability, when it comes to primary schools requirements, will be greater than at present. The disquieting fact is that we are still talking about a failure rate of from 5% to 84% on these questions even for those with 'O' level Mathematics.

The future teachers entering by the Diploma of Higher Education had a lower failure rate on seven of the questions than the Certificate students, both groups having 'O' level Mathematics. In this case, a higher level of education pursued has also made a difference. The three questions on which the Diploma of Higher Education students fared worse than the Certificate students with 'O' level Mathematics, were Questions 4, 5 and 8. All of these were questions involving some aspect of work on fractions. One must be aware that even though these Diploma students in general fared better on these questions, nevertheless they still exhibited a failure rate of from 5% to 79%.

All of this suggests to the author that unless additional measures are taken to improve the basic arithmetical performance of our teachers and our future teachers, the chances of getting out of the present cycle of events is slim. To begin to climb onto a more advantageous Mathematical ability spiral we must first start with the teachers in our primary schools. Here an effort must be made to provide in-service training which will demand more in terms of a teacher's own Mathematical attainment, as well as considerations of strategies of learning for his pupils. The present system of voluntary attendance
and no incentives will have to be reconsidered. Incentives may be provided by courses leading to the Mathematics Diploma of the Mathematical Association. This has been on offer for the last two years at the college but has had no takers. Enormously more successful in take up have been Diplomas linked to the B.Ed. degree, and the college hopes to be able to offer a Diploma in Mathematics for the Primary School teachers which is so linked from September, 1982.

This, of course, is in the long term. There is still a need to consider what may be done for industry in the short term. Certainly more and closer liaison between schools and industry should lead to a consideration of the provisions that schools make in the light of the requirements of industry. Schools might make special efforts to improve children's Mathematical skills in those areas indicated as being useful to industry and commerce. Such areas as may be concentrated upon have been identified by Fitzgerald (1976), Worthy (1977) and Dickson (1977) as well as a number of special survey groups set up by education authorities and industry working in partnership.

The work of Worthy (1977) suggests that the particular group for whom concern should be shown is the C.S.E. 2-4 grade band.

"..........the particular area of dissatisfaction centred around the craft apprentice in the C.S.E. 2-4 grade band. That demand for Mathematical skills at this level was accompanied by a considerable shortfall from the schools was particularly worrying for instructors." (100)

At the same time, Worthy quoted training instructors who spoke quite favourably of the Technician Grade apprentices who had left school with C.S.E. grades 1 or 2. The present investigation seems to
indicate that the canker has eaten deeper than this, certainly in this area of the country, and that the basic arithmetical ability of the 'O' level graders should also come in for some scrutiny. That schools are not always sufficiently aware of the requirements of industry and commerce is shown by Dickson (1977). She met many Mathematics teachers during the course of her investigation and was able to say that,

"Some of the Mathematics' teachers who were met during the course of this study displayed ignorance of the practical applications of their subject in an industrial context." (101)

In this county a greater willingness on the part of the schools to grasp the hand of co-operation offered by industry is necessary. There is much to be discussed and few things are more important than the relationship of the work done by the Mathematics department and the needs of industry when it comes to craft and technician apprentices.

Examinations do have a considerable influence on curricula and that Mathematics deemed to be suitable to be tested at 'O' level and even that for C.S.E. may not lead to the kind of proficiency of calculation which is seemingly so wanted by industry. Fitzgerald (1978) offers the idea of a "corridor of power", where potentially useful Mathematics could be arranged in a hierarchy as a result of studying the topics in order of conceptual difficulty. This could lead to the existence of tests of competence which would stand side by side with C.S.E. and G.C.E.

Prior to this identification of conceptual difficulty and resulting hierarchical arrangement of useful Mathematics, schools themselves might institute a certificate of Mathematical or Arithmetical competence. Such is the influence of a bold and imaginative head of
department backed by the headteacher, that a motivation could be induced by which pupils would wish to exhibit their competence by taking the local Certificate. Such a local certificate was introduced and successfully carried out at Holbrook High School in North Yorkshire by Wright (1979). Wright showed that many pupils who passed C.S.E. in fact were failed on the school test, and that some pupils who were only able to get a low level C.S.E. grade were nevertheless able to pass the local examination. Even some remedial pupils in Mathematics were able to gain passes in the local examination and thus experienced a boost to their morale and Mathematical motivation.

The only school which had a Schools/Industry Liaison Committee in this area had also instituted a "school certificate". In this case it was not confined to Mathematics but attempted a profile of the pupil over a much wider area.

National ventures in profiling might serve as a catalyst to schools in taking action in this field. The "16+ School Leavers Attainment Profile Test of Numerical Skills", initiated by the Schools and Industry Committee of the Mathematical Association, would appear to be one such useful move. These "Slapons" would inevitably mean a compilation of numerical skills which many researchers and commentators have shown to be needed by industry and commerce. They might also initiate a more critical view of requirements on the part of a particular company or industry.

Carroll (1978) comments upon the felt need for numeracy tests "as a predictor of general ability" (102); a feeling which Dickson (1977) shows to be misplaced in the sense that performance on Arithmetic tests were no useful predictions of an apprentice's later performance in his training. In the case of our local company, the training officer
believed that a Mathematics paper was useful as a predictor, and yet we find that the company sets a paper whose many faults may exclude school leavers otherwise worthy of a training place. Such a profile test as has been cited earlier, would necessarily mean that the company, if it could be persuaded that such a test was in its best interests, would seriously have to consider what it did require in, and want to know about, school leavers.

This being said, one would not want Mathematics in schools to degenerate, under such pressures as industry and commerce, (and government!), could bring, into a concentration upon Arithmetic skills to the exclusion of other aspects of Mathematics. During the past twenty years, we have seen a movement away from the preparation of children only to be able to regurgitate drilled solutions at the appropriate examination stimulus. Education has rightly, in the opinion of the author, turned its back upon fact learning alone, in favour of the weighing of evidence. Children have been encouraged to think and, in Arithmetic operations, they have been encouraged to understand what it is they are doing. The 'thinking' child has been the aim, not the passive 'receiving' child. The educational world will not turn its back on this, whatever pressures may be put upon it. Many criticisms of the aims of education are uninformed and cannot be taken too seriously. The education service must, however, take seriously the claim of inadequacy when it comes to numerical skills in order to do a job. Mathematics is, for many people, a tool, and the products of our schools should be able to handle that tool in the jobs for which they are suited. Perhaps it is time in education to separate these two aspects in our schools, so that one does not survive at the expense of the other.
Calculation should, in the author's opinion, have an existence of its own in schools but, if it does so, then we as teachers must guard against methods which militate against understanding. Useful practical calculating skills depend for their intelligent use upon understanding, a point made by Armitage (1975),

"Ambitious Craftsmen, employers, teachers and society are all agreed that skill - without understanding - (which can be attained more quickly at less cost), is in the long run utterly unacceptable as a preparation for future innovation or preferment." (103)

This is as true of electronic calculators as it is of calculation on paper. It is interesting to observe the feeling of anathema that accompanies the mention of the use of a calculator in the workshop. For some reason, log tables are respectable but not the electronic calculator. The training officers of the industries in this county which the author interviewed were very much set for log tables and against the calculator.

The view of many educationists is summed up by Griffiths and Howson (1974) when they state about the role of Mathematics in the curriculum,

"... it is essential to remember that our primary concern should be the overall education of the pupil - that the teacher's job is to educate and not merely to instruct." (104)

The author's analysis of the kind of errors made would seem to him to justify Armitage's statement, even taking it to a further point. These school leavers, future teachers and present teachers were unable to succeed on these fairly elementary questions simply because of their lack of comprehension of the concepts involved. When nearly half of all the errors made were due, in the author's opinion, to a lack of understanding
of the concepts involved, it would seem to be ample justification for not abandoning teaching with understanding. The evidence of this enquiry is against this being adequately done by many of the teachers investigated.

The author is concerned that the energy and drive generated by the Mathematics projects of the 1960's has, to some extent, been dissipated. The 1978 H.M.I. reports on primary education in England and in Wales were concerned at aspects of the teaching of Mathematics. Certainly they felt that teachers could do more to match work given to pupils to their abilities to cope with it. Many were under-achieved in this area of the curriculum. In addition, they were concerned that pupils were losing sight of the relevance of the Mathematics they were being taught. Much more could be done in the primary schools where the pupils are more receptive to the work programmes provided.

The great problem which needs to be tackled, as Dickson (1977) has shown, is the lack of motivation of pupils in their early teens. Pupils in those areas of the secondary schools from which Craft and Technician apprentices are drawn, often come from classes where there is a great deal of disruption and unrest which is not conducive to a learning atmosphere. The problem here may well lie in the appreciation of relevance and needs, but also involved is the greater problem of the organisation for learning of classroom and school. The author questions the situation of the C.S.E. pupils having to move from each 35 minute lesson to another 35 minute lesson carrying their work around with them in bags. Work is only seen in isolated bits and pieces with no opportunity to build up an investigation and display the fruits of the research.
Conclusions.

The Company in setting this examination did not clearly identify what it was they needed to have in an apprentice. Both the literacy part and the numeracy part were so intermingled with each other and with aspects of physical science that the identification of the necessary skills which may have been needed were inhibited. It was difficult, in some of the questions, for the C.S.E. level candidates to understand what was required because of the use of inappropriate language. It was possible on this paper for pupils whose calculation skills were good to fail the paper and for some to pass whose calculating skills were poor.

Questions which were preferred by the C.B.I. (Wales) for apprentice selection and on which the failure rate, causing great concern to the C.B.I., was from 13% to 99% also brought about a failure rate of from 4% to 88% for the students and from 7% to 93% for the teachers.

The possession of an 'O' level pass in Mathematics brought down the failure rate of the two 'A' level students to the rates shown in Fig. 4.26. The Certificate students even with an 'O' level pass in Mathematics fared worse then the Dip.H.E. students on most of the questions. The lowest failure rate was that of the two 'A' level Dip.H.E. students with a pass in 'O' level Mathematics, but even so the failure rate of from 5% to 79% should be looked upon as most unsatisfactory.

The students who were in the college in the '60's and '70's had spreads of marks from 100 down to 1, with the mean of their scores being below a satisfactory level for a great many of those years.

The errors made indicated overwhelmingly that the ideas were not understood and that a reasonable score was very largely dependent on that factor.
Recommendations

a. The case of the local company examination in the short term

1. The company should identify clearly what it requires to know about a school leaver in relation to its own needs.

2. There should be separate papers or a sectionalised paper in order to more precisely seek the information deemed to be needed.

3. The language part of the paper should be orientated towards the kind of skills most appropriate to the industry.

4. More realistic ways, in view of the current educational pattern, should be sought to test the language adequacy.

5. Questions in Mathematics should be so framed that no school leaver, as far as possible, should be put at a disadvantage by the technical orientation.

6. The content of the questions and the written form should not be disproportionately in favour of the G.C.E. level candidate.

7. Local schools should be entirely aware of the needs of the school leavers when faced with examination papers given by local industries. This company could well circulate a specimen paper to all local schools as a starter in this liaison.
8. Every teacher of Mathematics should be aware of the kind of Mathematical work likely to be included in the apprentice selection tests.

9. Teachers of Mathematics should be aware of the uses of the Mathematics they teach in local industries. In this matter they should take the initiative and seek the relevant information.

b. In the long term

1. Local Primary/Secondary link Mathematics guidelines should not be compiled with only the eventual G.C.E. C.S.E. examination system in mind.

2. Consultations should be made with representatives of local industry concerning some aspects of Mathematical provision made by schools.

3. Each secondary school or groups of such schools should establish a Schools/Industry Liaison Committee.

4. The encouragement of numeracy should be considered separately from other Mathematics. (No separation should be made at least before the upper Junior School.)

5. Secondary schools should establish a certificate in basic numeracy.

or

6. A nationwide institution of numeracy profiles should be made.
7. Industry should be made aware of the aims of education in the second half of the twentieth century, by contacts with the educational services through schools/Industry Liaison Committees.

8. Each company should examine critically its expectations of the Mathematical needs of school leavers called for selection.

9. Links should be instituted between industry, representatives of L.E.A. advisory services and local colleges of education.

10. Within each L.E.A. should be instituted an in-service provision for Mathematics education for primary school teachers to cover not only methods of teaching Mathematics in primary schools but also the teachers' own needs and inadequacies in basic Mathematics.

11. Within the colleges of education there must still be a reasonable allocation of time given to 'basic' Mathematics in order to help students in their inadequacies, even though they will have 'O' level Mathematics.

12. Diagnostic tests to discover areas of weakness in the comprehension of concepts should be devised and used in colleges of education and in in-service work with teachers.

13. No student should be passed fit to be a primary school teacher unless he/she is able to demonstrate a high degree of ability in 'basic' Mathematics.

14. A 'leadership' scheme should be introduced where, if possible, a primary school or groups of primary schools should have a teacher
well qualified and motivated in Mathematics to lead the work of the other teachers.

15. Imperial units, which are found to be necessary to industry and commerce, should be re-introduced into schools' Mathematics programmes.

16. Mathematics teaching in primary schools should include more instances of children using Mathematics in the real world. As for example one may find in Environmental Studies (see Maggs (1978)).

17. Research should be carried out to identify the sources of errors in the common core of basic Mathematics.

18. Suitable common methods of calculation skills which are agreed upon by teachers in secondary schools and their feeder primary schools. (This does not exclude the need to give freedom to think flexibly about methods to the more able children.)

19. The use of electronic calculators to be encouraged, but not permitted to be used unthinkingly and without approximations being made.

20. No student should be passed fit to be a primary school teacher unless he/she is able to demonstrate a high degree of ability to explain Arithmetic processes.
21. There should be links established between secondary schools and F.E. Colleges to ensure a continuity between the Mathematics curricula as far as it affects the students at Craft and Technician level.

22. More work oriented courses in secondary schools in order to try to overcome the lack of motivation.

23. A detailed investigation should be carried out by the county advisory service concerning a core curriculum in Mathematics.

24. Regular practice and testing to be part of the programme of work in basic numeracy skills.

25. A greater emphasis than at present should be placed on fractions and percentages.

26. That note be taken of the following areas of difficulty:
   (a) Rounding off a number.
   (b) Finding a given percentage of a number.
   (c) Find what percentage one number is of another.
   (d) Multiplying and dividing by multiples of 10.
   (e) Place value.
   (f) Conversion of fractions to decimals.
   (g) The relationship between remainders and decimal fractions.
   (h) Addition of fractions where numerators tend to be added and denominators added.
   (i) The concept of the division of fractions.
(j) The use of a common denominator regardless of the kind of operation with fractions.

(k) Finding common factors and correctly 'cancelling'.

(l) Equivalence of fractions.

(m) Multiplication by a two or more digit number, carried out using the associative law and not the distributive law.

(n) Carrying figure errors due to carelessness.

(o) Misquoting

(p) Use of diameter instead of radius in \( A = \pi r^2 \).

(q) Incorrect concept of \( r^2 \) as \( 2r \).

(r) Equating of \((a + b)^2\) with \( a^2 + b^2 \) in Arithmetic calculation.

(s) Equating of \( \left( \frac{a}{b} \right)^2 \) with \( \frac{a^2}{b} \) in Arithmetic calculation.

(t) Comparison of fractions.

(u) Approximations of answers.

(v) Errors in division when zeros are not entered into the answer line.

(w) Divisions of the type \( \frac{1}{0.3192} \).

(x) Changing form of the equation in order to find the unknown, as for example in \( \cos 60' = \frac{3.5}{x} \).

27. That understanding still be given priority over rote learning.

28. That a 'long course' of in-service training in Mathematics in the primary school be established.


15. D.E.S. (WALES) (1979) "Literacy and Numeracy and Examination Achievements in Wales". Report on a conference held at Mold. P. 34 Para. 10.2


23. HAMPSHIRE EDUCATION COMMITTEE (April 1974) op. cit. P. 8

<table>
<thead>
<tr>
<th>No.</th>
<th>Author(s)</th>
<th>Date</th>
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<th>Publisher/Source</th>
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<tr>
<td></td>
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<td>Wales Science Bulletin No. 17</td>
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<td>H.M.S.O. &quot;Primary Education in Rural Wales&quot;</td>
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<td>27.</td>
<td>WELSH OFFICE</td>
<td>(1978)</td>
<td>Education Survey No. 6</td>
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<td></td>
<td>H.M.S.O. &quot;Primary Education in Rural Wales&quot;</td>
<td></td>
</tr>
<tr>
<td>32.</td>
<td>SCHOOLS' COUNCIL</td>
<td>(Dec. 1979)</td>
<td>&quot;Draft Evidence to the Cocker report Committee of Enquiry into the Teaching of Mathematics&quot;</td>
<td></td>
</tr>
<tr>
<td>34.</td>
<td>D.E.S.</td>
<td>(May 1975)</td>
<td>&quot;Survey of Mathematics in Schools 11-18&quot;</td>
<td>Results of a survey conducted by H.M. Inspectors. P 3 Table 2</td>
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<tr>
<td>36.</td>
<td>MATHS ASSOCIATION</td>
<td>(July 1977)</td>
<td>&quot;School and Working Life&quot;</td>
<td></td>
</tr>
</tbody>
</table>
   B. 127 Para 3

   in the post-James Era."
   An Interim Report prepared by a
   working party at a DES/ATCDE
   Conference at Hereford.

40. BOND, R.M. (1978) op. cit.
   Unpublished M.Sc. Dissertation

41. NUFFIELD NATIONAL COMMITTEE Summary of Submission to the
   Cockcroft Committee
   "Bulletin No. 2" P. 10 para 5.3

42. FRY, A. (March 1979) Interview with the Training
   Officer at Whitehead's Iron
   and Steel Works, Newport.

43. CARROLL, J.C. (July 1974) Symposium Proceedings No. 6
   "Arithmetic in the Basic
   Training Workshop" p. 89

44. D.E.S. (April 1972) "Trends in Education" pp. 35-40

45. THYER, D.F. and HAGGS, J.E. (1971) "Teaching Mathematics to
   Young Children"
   First Edition

46. AUSUBEL, D.P. (1978) "Educational Psychology"
   a cognitive view. P. 494

47. DICKSON, L. (1977) "A case study based on the Mathematical
   achievements and experiences
   of ten London Transport Craft
   Apprentices".
   International Journal of Maths
   Education in Science and Technology.
   Vol. 10 No. 2 pp. 251-278.

48. DICKSON, L. (1977) op. cit.

49. MATTHEWS, D. (1977) "The Relevance of School leaving
   Experience to performance in Industry"

50. D.E.S. (1978) "Primary Education in England"
   A survey by H.M. Inspectors of Schools.

51. HAGGS, J.E. (1978) "Mathematics and Environmental Studies"
   A progression of Mathematical skills
   linked to four Environmental Studies.
   Schools Council
   Curriculum Development Project.
   Under publishing review.

   Mathematics 5-13 years".
   Acton Local Office
53. WRIGHT, D. (1979) "Basic Numeracy"
   Links Vol. 5 No. 1 pp 24-27

54. JELSH OFFICE (1978) "Literacy and Numeracy and
   Examination Achievements in Wales".
   Report of a conference held at Llandudno.

55. FITZGERALD, A. (1978) "Corridor of Power"
   Mathematics in School Vol. 7 Part 1

56. GRAHAM, M.J. (1978) "School Mathematics Related to the
   Needs of Entrants to the Engineering Industry at Craft Level - an
   Analysis of the Present Situation and Proposals for Change"

   School Mathematics in Relation to Craft and Technician Apprenticeships in the Engineering Industry".
   International Journal of Mathematical Education in Science and Technology Vol. 8 p. 488

58. BAJPAI, A.C. (1977) op. cit. P. 488

   in Wales".
   Working Party report. P. 7

60. ARMITAGE, J.V. (1974) "Symposium Proceedings No. 6"
   Mathematical Needs of School Leavers Entering Employment. P. 1

61. CRANK, J. (1975) "Symposium Proceedings No. 12"
   "Reflections on the Interface"
   P. 12

62. THWAITES, B. (1974) "Symposium Proceedings No. 6"
   "Manipulation Skills in School Mathematics".
   P. 75

63. CARROLL, J.C. (1978) "Mathematics - Needs of Industry"
   Training Vol. 3 P. 10

64. C.B.I. (WALES) (1977) op. cit.
   PP. 16-18

   P. 5

   Standards of Numeracy and Literacy in Wales.
67. D.E.S. (1978) "Primary Education in England" A survey by H.M. Inspectors p. 55 Ch. 5 Para. 5.58

68. WELSH OFFICE (1978) "Primary Education in Rural Wales" Welsh Office Education Survey No. 6 p. 32 Para. 3

69. WELSH OFFICE (1978) op. cit. p. 32 Para. 3

70. GWENT EDUCATION COMMITTEE (1979) "Mathematics 4-13" Newport Schools' Working Party Report. Block 7 Items 7.4, 7.6


72. SOMERSET EDUCATION COMMITTEE (1978) "Primary and Secondary Liaison Mathematics" Guide Lines for School Mathematics in the Age Range 5 - 11/12 years. N 42 N 39A

73. WARD, M. SCHOOLS' COUNCIL (1979) "Mathematics and the Ten Year Old" Working Paper No. 61 P. 51

74. NUZZIELD NATIONAL COMMITTEE (1979) op. cit.

75. GWENT EDUCATION COMMITTEE (1979) "Mathematics 4 - 13" Newport Schools' Working Party Report, P. 14 Para. 1

76. WARD, M. SCHOOLS' COUNCIL (1979) "Mathematics and the Ten Year Old" Working Paper No. 61 P. 27

77. WARD, M. (1979) op. cit. P. 29

78. C.B.I. (WALES) (1977) op. cit. P. 17

79. C.B.I. (WALES) (1977) op. cit. P. 8 para 1

<table>
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<tr>
<th>No.</th>
<th>Author/Institution</th>
<th>Year</th>
<th>Reference</th>
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<tbody>
<tr>
<td>81.</td>
<td>HAMPSHIRE EDUCATION COMMITTEE</td>
<td>(1974)</td>
<td>op. cit. P. 3 Para 4</td>
</tr>
<tr>
<td>82.</td>
<td>HAMPSHIRE EDUCATION COMMITTEE</td>
<td>(1974)</td>
<td>op. cit. P. 3 Para 4</td>
</tr>
<tr>
<td>88.</td>
<td>MATHEMATICAL ASSOCIATION</td>
<td>(1970)</td>
<td>op. cit. P. 19 Para 3</td>
</tr>
<tr>
<td>89.</td>
<td>MATHEMATICAL ASSOCIATION</td>
<td>(1970)</td>
<td>op. cit. P. 19 Para 10</td>
</tr>
<tr>
<td>90.</td>
<td>UNIVERSITY OF WALES BOARD OF STUDIES</td>
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<td>&quot;Entry Qualifications in Mathematics&quot;</td>
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<tr>
<td>91.</td>
<td>UNIVERSITY OF WALES BOARD OF STUDIES</td>
<td>(1965-69)</td>
<td>&quot;Entry Qualifications in Mathematics&quot;</td>
</tr>
<tr>
<td>92.</td>
<td>THYER, D.F. MAGGS, J.E.</td>
<td>(1965-69)</td>
<td>'Caerleon College of Education Mathematics Department Records'</td>
</tr>
<tr>
<td>93.</td>
<td>THYER, D.F. MAGGS, J.E.</td>
<td>(1965-69)</td>
<td>'Caerleon College of Education Mathematics Department Records'</td>
</tr>
<tr>
<td>95.</td>
<td>CAERLEON COLLEGE OF EDUCATION</td>
<td>(1962)</td>
<td>Basic Maths Exam 1962 op. cit. p. 139</td>
</tr>
</tbody>
</table>


100. WORTHY, J. (1977) "Mathematics and the Needs of Industry" Coventry L.E.A. Monograph


103. ARMITAGE, J.V. (1975) 'Symposium Proceedings No. 11' Introduction P. 3

2. Papers consulted but not referred to in the text.


BRIDGE, J.R. (1972) 'ROSLA and After' Mathematics in School Vol. 1 pp. 8-9


COVENTRY EDUCATION COMMITTEE (1977) 'Mathematics - A Common Core of Agreed Minimum Goals'. "Educational Needs of the 14 - 19 Year Olds'.


DAVIES, K. (1978) "Links with Industry - the Curricular Implications for Mathematics". Wales Science Bulletin No. 19

DEPARTMENT OF INDUSTRY (1979) "Case Studies of Industry/Education Links".

DEPARTMENT OF INDUSTRY (1979) "A Short Guide to Industry/Education Links".


ENGINEERING TRAINING BOARD (1977) "The Relevance of School Learning Experience to Performance in Industry" Report

TUNIS, H.B. (1978) "Career Education - out with the New Math?" School Science and Mathematics

LONDON BOROUGH OF HAVERING EDUCATION DEPT. (1978) "Mathematics - School to Employment".


REES, R.M. (1975) Brunel Further Education Monograph No. 5 Maths in Further Education: Difficulties Experienced by Craft and Technician Students.
<table>
<thead>
<tr>
<th>Author(s)</th>
<th>Year</th>
<th>Title</th>
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<tr>
<td>BURGESS, D.N.</td>
<td>1975</td>
<td>&quot;Applications of School Mathematics in Industry&quot;</td>
<td>Longman</td>
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<td>CHOAT, E.</td>
<td>1978</td>
<td>&quot;Children's Acquisition of Mathematics&quot;</td>
<td>N.F.E.R.</td>
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<td>CLARK, R.D.</td>
<td>1979</td>
<td>&quot;Strategies for Education in the 1980's&quot;</td>
<td>A.S.E.</td>
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<td></td>
<td></td>
<td>The 1979 MacMillan Education Lecture.</td>
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<tr>
<td></td>
<td></td>
<td>Reprinted in 'Education in Science' No. 82.</td>
<td></td>
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<tr>
<td>BELL, A.W.</td>
<td>1972</td>
<td>'End Points'</td>
<td>Shell Centre for Mathematical Education University of Nottingham.</td>
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<td></td>
<td></td>
<td>Wales Science Bulletin No. 17</td>
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<tr>
<td>KLINE, M.</td>
<td>1976</td>
<td>&quot;Why Johnny Can't Add&quot;</td>
<td>Random New York</td>
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<td></td>
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<td>&quot;The Failure of the New Math&quot;</td>
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<tr>
<td>LEICESTER &amp; COUNTY CHAMBER OF COLLEGES &amp; LEICESTERSHIRE EDUCATION DEPARTMENT</td>
<td>1975</td>
<td>&quot;Mathematical Requirements of Employers and Lower Ability School Leavers&quot;</td>
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<td></td>
<td></td>
<td>The Schoolmaster</td>
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<td></td>
<td></td>
<td>June 1977</td>
<td></td>
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<tr>
<td>MATHEWES, D.</td>
<td>1977</td>
<td>&quot;The relevance of School Leaving Experience to performance in Industry&quot;</td>
<td>E.I.T.</td>
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<tr>
<td>MATTHEMATICS DEPT. THORNCLIFFE SCHOOL BARRIE IN PURNESS SCHOOL COUNCIL</td>
<td>1966</td>
<td>&quot;Mathematics in the Primary School&quot;</td>
<td>H.M.S.O.</td>
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<td></td>
<td></td>
<td>Curriculum Bulletin No. 1</td>
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<td>THYER, D.P.</td>
<td>1965 - 69</td>
<td>&quot;Caerleon College of Education Mathematics Department Records&quot;</td>
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<td>NAGGS, J.E.</td>
<td></td>
<td></td>
<td></td>
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</tbody>
</table>
UNIVERSITY OF WALES (1965-69) 'Entry Qualifications in Mathematics'
BOARD OF STUDIES
MATHEMATICS

FENSHAM, P.J.

ALLAN, G. (1975) 'An Investigation into the Mathematical Background and Training of Mechanician and Artificer Apprentices in the Royal Navy'. Symposium Proceedings No. 11


GUILFORD, J.P.
FRUCHTER, B. (1973) "Fundamental Statistics in Psychology and Education."

Welsh Office McGraw-Hill
Tokyo 5th. Ed.
APPENDIX 3

3.1 Examination paper for apprentice selection. A company in Gwent.

3.2 The author's Report to the Training Officer of that company.

3.3 The author's suggested interim papers.

Note: Appendices are numbered in relationship to the chapters.
APPRENTICE ENTRANCE EXAMINATION

JULY, 1979

ATTEMPT ALL QUESTIONS:

Time Allowed: 2 hours

Log. Tables Provided.

\[ \pi = 3.142 \]

Hints towards answering the paper:

1. Read all questions carefully before answering.
2. Extra marks will be awarded for layout, neatness and clarity of expression.
3. Allocate time per question and attempt ALL.
4. Questions may be answered in any order.

Question 1
Put beside each word in List 'A' a word from List 'B' which has the opposite (or almost the opposite) meaning:

<table>
<thead>
<tr>
<th>LIST 'A'</th>
<th>LIST 'B'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Distant</td>
<td>Intangible</td>
</tr>
<tr>
<td>Togetherness</td>
<td>Intangible</td>
</tr>
<tr>
<td>Immune (adj.)</td>
<td>Susceptible</td>
</tr>
<tr>
<td>Affluent (adj.)</td>
<td>Common</td>
</tr>
<tr>
<td>Adjacent (adj.)</td>
<td>Foreign</td>
</tr>
<tr>
<td>Dubious (adj.)</td>
<td>Meticulous</td>
</tr>
<tr>
<td>Indigenous (adj.)</td>
<td>Poor</td>
</tr>
<tr>
<td>Healthy</td>
<td>Bereavement</td>
</tr>
<tr>
<td>Single</td>
<td>Certain</td>
</tr>
<tr>
<td>Praise</td>
<td>Certain</td>
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<tr>
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<td>Bereavement</td>
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<tr>
<td>Poor</td>
<td>Bereavement</td>
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<td>Bereavement</td>
</tr>
<tr>
<td>Single</td>
<td>Bereavement</td>
</tr>
<tr>
<td>Praise</td>
<td>Bereavement</td>
</tr>
<tr>
<td>Certain</td>
<td>Bereavement</td>
</tr>
</tbody>
</table>
Apprentice Entrance Examination (cont'd.)

Question 2

The following are a selection of preferred values of resistors, each having a tolerance of ± 10% of their marked values. What are the possible limits of each of the resistance values?

(i) 15 K\Omega  (ii) 18 K\Omega  (iii) 22 K\Omega
(iv) 5.6 M\Omega  (v) 270 \Omega

Question 3

Does the lens of a camera produce:

(i) (a) An erect image?  OR  (b) An inverted image?
Answer (a) or (b).

(ii) Do unlike magnetic poles:
(a) Attract each other?  OR  (b) Repel each other?
Answer (a) or (b).

State Units.

(iv) What is an electrically charged atom called?
Which are the three basic particles that form an atom?

Question 4

Three holes, with centres A, B and C are drilled in a terminal board as shown in the Figure below.
Calculate the lengths AB and BC using the mathematical tables provided:

![Diagram of holes and distances](image-url)
Apprentice Entrance Examination (cont'd.)

Question 5
State Ohm's Law.
Express it in symbols.

\[ \frac{V}{P} = I \]

In the Figure above, find the equivalent resistance of PQ and QR. Draw a circuit with the equivalent PQ and QR in series. Find the resultant resistance between the terminals P and R.

Question 6
A vehicle starts from rest and accelerates at \( \frac{4 \text{ m/s}^2}{2} \) for 20 seconds. Then it maintains its constant velocity for 15 seconds. It then decelerates to a stop in 15 seconds.

Find - (i) The deceleration.
(ii) The total distance moved.

Question 7
A hollow metal cylinder is represented in the Figure above. The dimensions are:
Inner radius \( R_2 = 1.5 \text{m} \), Outer radius \( R_1 = 2 \text{m} \) and the Height \( H = 5 \text{m} \).
Derive a formula for the volume of a cylinder.
Also, derive formula for the volume of metal in the hollow cylinder shown.
What is the cost of metal in the above cylinder if the metal costs £50 per cubic metre?
Report for Mr. Jim Winfield
Some observations on the Company entrance examinations for apprentices 1979

Let me say at once that I was very disturbed, to say the least, by some of the ineptitude shown by these representatives of the educational system. If we gather as a group those who had no idea at all about question 2, those who could not find 10% and those who made arithmetic errors, this amounts to 46% of the candidates. This figure does not include those who had no idea about the meaning of limits, but it does include those who could not change a fraction to a decimal. The fact that they needed to do this question in this way was in itself reprehensible, e.g. \(10\% \text{ of } 18 = \frac{10 \times 18}{100} = \frac{9}{5}\) worked as a fraction.

Many of the candidates worked in this way, and one can only suppose that the form triggers a response in the way of fractional treatment. If sufficient work were done on \(\times 10, \div 10, \frac{1}{10}, \text{ and } 10\%\) then one would hope that 10% of 18 as \(\frac{1}{10}\) of 18 would be treated in a place value way.

Anyway, the consequences of this malpractice is that \(\frac{9}{5}\) must then be converted to a decimal and we get \(\frac{9}{5} = 1.4\\). This constitutes a major error, repeated many times in various forms. Amongst the errors we get those of the person who is able to convert but cannot see the need to round off, \(\frac{8}{3} = 2.6\). At least those who have done this have understood the idea of 10% but the overall figure includes those who have no idea at all of the meaning. There are:

- those who subtract 10
- those who multiply by 10 (perhaps the seeds for this lies in rote learning) and
- those who do it can't remember whether it is \(\frac{10}{100}\) or \(\frac{100}{10}\) or the other variations \(\frac{10 \times 100}{15} \text{ for } 10\% \text{ of } 15\) or \(\frac{15 \times 100}{10}\),
- those who add 10
- those who divide by 2
- those who multiply by 2
those who take 10% as 1.

In addition, division by 10 in this question often appears as it does here: $\frac{5.6}{10} = \frac{2.8}{5} = 5.3$. Again we are back at the lack of adequate attention to place value and the multiplication and division by powers of 10. Clearly this is the responsibility of colleges and schools to do what can be done about this deplorable state of affairs.

From the Company's point of view, they must now endeavour to select from those who come forward as candidates, those who are adequate both in personality and in basic skills for future training. In an examination, we are not likely to be able to discern qualities of reliability, resourcefulness and determination, qualities which may be as important as basic skills. We should, by the examination system, be able to discern those with adequate basic skills.

I am worried by an examination which allows a successful candidate, (this candidate is taking 'O' level Mathematics), one who, in question 4 could not work out $\frac{3}{0.8192}$

in question 5 could not add $\frac{1+1}{4} + \frac{1}{8}$ or $\frac{1+1}{8} + \frac{1}{10}$

in question 6 was extremely confused

in question 7 was not successful in the long division required.

That is to say, a student could be successful on this paper and yet only be able to do ONE of the Mathematics questions. For the rest, he picked up marks on some required information of a scientific/technical nature, and on the word comprehension question. This worry is compounded by the case of one of the unsuccessful candidates. This lad is pursuing a foundation course in engineering at a local technical college. Like the successful candidate, he could do question 2. For the rest of the questions, he calculated in an excellent fashion, including long division.
What he could not tackle was the ideas presented in the individual questions, and neither could he pick up the incidental marks to be gained from the word question or the scientific/technical question which the '0' level candidate was able to do. The question is, should he have been able to understand the question asked? Let us look at some of the evidence.

Question 6: Of the successful candidates, 35% had no real idea at all helpful to the solution to this question, and over half of these successful candidates were either taking or had taken '0' level.

It could be argued that any person taking '0' level Mathematics should be able to tackle this kind of question but, since those who were taking '0' level found it beyond them, how much more so was it for other candidates who were taking C.S.E. or City and Guilds. In fact, of the candidates who were taking or had taken '0' level Mathematics, 43% had no real idea about this question, and the figure for the C.S.E. candidates was 76%. Now, were this question germane to the training of apprentices for this industry, we could acquaint the schools with this situation and ask them to give the problem their attention. It does not seem to me to be so crucial a question. Are we, therefore, talking about a realistic question to set to a widely varying ability group?

Then, suppose a candidate is able to exhibit his basic skills in Mathematics, and is also able to apply himself to the solution of problems but is in some cases unable to do so because of his lack of knowledge of the technicalities of the question, must he know all the technical ideas also at this stage? We surely owe the candidates a framed question such that if he is unfamiliar with the territory he can pick his way over it with some given signposts. Of course, eventually, when he is in training, he must know about these technicalities, but at
this stage? One may expect that the 'O' level candidates will be unfamiliar with the technical elements, but one also finds in the papers the case of the student taking an engineering course at the local F.E. college who also is unable to make a constructive attempt at an apprentices selection examination. Look at question 5 for example, surely a technical question. No candidate who does not know how to sum resistances in parallel and in series could do this question. Perhaps many of these hopefuls are not doing, or have not done any physics in school. This aspect will be a part of the training programme in this industry and will soon be learned but, at this stage, it may very well represent a question not in the best interests of the company. Of the candidates who are taking, or have taken 'O' level Mathematics, 43% had no real idea at all about this question. For the C.S.E. level candidates it was 57%. Again, if we look at the answers to question 2, we see that two of the successful candidates had no idea about the meaning of limits. Looking overall at this question, we see that many of the candidates had no idea of the technicalities of this question. We cannot tell exactly how many because of the deplorable number of the candidates who could not surmount the first hurdle of the calculation of 10%. In fact, the figure is a staggering 66% who failed in some way at this question.

Some thought, it seems to me, should be given to the desirability or not of questions 1 and 3. In such a mixed paper it is not easy to sort out the candidates with precisely those requirements most useful in an apprentice. His Arithmetic ability really should be reviewed separately from his language ability and his technical knowledge. Shouldn't the emphasis, in this industry, be upon the ability of the candidate to (a) read and interpret a set of instructions and be able to act upon these instructions, and (b) to perform some sequential set
of operations and then to be able to make a report of exactly what was
carried out? I wouldn't have thought that question 1 would have done
this. In fact, this question is one which is more appropriate on an
'0' level paper than at C.S.E. level. Indeed, if it were to be found
on an '0' level paper, it would be in a far more structured form than
it is at present. Perhaps it might be structured thus -
'Underline one of the three words in the brackets which are opposite,
or nearly so, in meaning to the first word in the line:
Immune (common; boring; susceptible).'
The content words have also to be considered. They are unlikely to be
those which a C.S.E. candidate would handle with any degree of certainty
at all. Aren't we talking about drawing many of our apprentices from
the C.S.E. level?

Of the other questions, number 4 seems rather odd from another
point of view. If the holes have been bored in the terminal board,
then, to a practical person, the way to find what is wanted is to measure
the lengths. Perhaps a more realistic question could be devised.
There was also no chance for a candidate to demonstrate his ability at
basic mathematical operations and, in particular, no conversions from
one system of units to another, something which the apprentices will be
required to do throughout their training, and later.

Lastly, are the schools sufficiently aware of the needs of the
hopeful apprentices, and of the type of examination paper set, to try to
determine the candidates deemed suitable by the company? The Training
Officer of this company has been most acutely aware of these needs and
is to be congratulated on the pioneering work he has done in the field
of local industry/schools liaison.

May I then offer some suggestions concerned with the selection
process as it affects Mathematics and related to the present paper?

1. At present we cannot easily tell what it is we are examining, and so the paper should be either sectionalised or separated off entirely into papers related to what the company wants to know about the candidate.

2. The language part of the paper should be more orientated towards the kind of skills most appropriate to the industry.

3. The questions should be so framed that no-one, as far as possible, is put at a disadvantage by the technical orientation.

4. The content of the questions should not be disproportionately in favour of the 'O' level standard candidate as neither should the written form.

5. Local schools should be entirely aware of the needs of the hopeful apprentices, and this awareness should not stop at the careers teachers. Every Mathematics teacher should be aware of the application of his subject to local industrial needs.

6. This awareness should be shared by teacher education establishments and by local authorities. Local Mathematics guidelines should not be compiled with only the eventual leaving external examination system in mind.
Mathematics Test 1

1. \[ 651 - 274 \]
2. \[ 532 \times 67 \]
3. \[ 4,617 \div 27 \]
4. \[ \frac{1}{3} + \frac{1}{2} + \frac{5}{6} \]
5. \[ 6\frac{1}{2} - 4\frac{7}{16} \]
6. \[ 1\frac{5}{6} + 2\frac{7}{16} \]
7. \[ (3\frac{3}{16} - 2\frac{1}{2}) \times \frac{1}{2} \]
8. Change \( \frac{3}{16} \) to a decimal.
9. Change 0.125 to a fraction.
10. Multiply 38.26 \( \times \) 3.142.
11. Divide 3.32 \( \times \) 0.6.
12. Find 5% of 20. Find 5% of 18. Find 5% of 5.6.
13. \[ \frac{1}{R} = \frac{1}{8} + \frac{1}{4} \]
14. Find \( R \)
15. Find \( AB \)
16. Find \( AC \)
17. 1 inch = 2.5 cm. What is 2 ft. 8\( \frac{1}{2} \) in. in centimetres?
18. (a) formula for volume. (b) formula for volume.
19. \[ P = \frac{RT}{V} \]
20. Write 2.66 correct to one decimal place.
1. A comprehension question.

A written account of some process which is carried out in the industry, but not too technical, is given.
The student must then answer questions based upon the text.
These questions should include some where conclusions are called for.

2. An operation is set to the candidates which they perform themselves. They must then write an account of the progression of the process, sufficient for someone reading it to be able to follow and repeat the process.

e.g. The assembling of a bicycle pump, (they may have to be shown how to do this). No doubt a more satisfactory example and one more closely related to this particular industry comes to mind.

For both these questions a language specialist could be consulted.
1. A resistance of 15 \( \Omega \) is wanted. A 10% tolerance is acceptable, so any resistance between the limits 13.5 \( \Omega \) and 16.5 \( \Omega \) will do. What are the possible limits for the following resistances for the same 10% tolerance?

(a) 18 \( \Omega \)  (b) 22 \( \Omega \)  (c) 3.8 \( \Omega \)  (d) 54.0 \( \Omega \)

2. Find this angle.

3. To find the total of some resistances in parallel we use

\[
\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2}
\]

If they are in series we add them directly \( R = R_1 + R_2 \)

Find the equivalent resistances to PQ and QR.

[Diagram]

Draw a circuit with these resistances of PQ and QR in series.

Find the resultant resistance between terminals P and R.
4. A cylindrical mild steel bar has to have a flat top machined to it. The diameter of the end of the bar is $2\frac{1}{4}$ in. and the width of the flat top is $\frac{7}{8}$ in.

What will the depth of the cut have to be?

5. A hollow metal cylinder. $\pi = 3.142$

- Radius of the bar is 2 metres.
- Radius of the hollow is 1.5 metres.
- Height of the bar is 5 metres.

Write down a formula which shows the volume of metal in the hollow cylinder. Use this to calculate the volume of metal in this case. What is the cost of the metal to make this cylinder if such metal costs £50 per cubic metre?
Questions forming the test given to students in training at the L.E.A. College in Gwent.

1. \[
\begin{array}{c}
4532 \\
125 \\
7609 \\
5431 \\
892
\end{array}
\]

2. Subtract 4,877 from 21,342.

3. Work out \(625 \times 57 \times 16\).

4. Add \(1 \frac{3}{4}\) and \(2 \frac{1}{4}\).

5. What is \(\frac{5}{6} \div \frac{2}{3}\)?

6. Write \(\frac{3}{5}\) as a decimal.

7. What percentage of 150 is 21?

8. If in a store there were round steel bars of diameters 1 inch, \(1\frac{1}{16}\) inches, \(1\frac{1}{8}\) inches, \(1\frac{1}{4}\) inches, \(1\frac{5}{16}\) inches, \(1\frac{3}{8}\) inches, and you require one with a diameter as near as possible to 1.221 inches, which one would you choose?

9. Find the area of a circle 2\(\frac{1}{2}\) inches diameter to two decimal places.

10. A No. 0 wood screw has a diameter of 0.050 inches, a No. 1 a diameter of 0.064 inches, and a No. 2 a diameter of 0.078 inches, and the diameter of the larger sizes goes on increasing by the same amount. Find the diameter of a No. 8.
Appendix 5.1

\[
\begin{align*}
\frac{1}{16} & = 0.0625, \\
\frac{1}{8} & = 0.125, \\
\frac{3}{16} & = 0.1875, \\
\frac{5}{16} & = 0.3125.
\end{align*}
\]

\[
\frac{1}{3} = 0.3333, \\
\frac{1}{2} = 0.5, \\
\frac{2}{3} = 0.6666.
\]

\[
1\frac{1}{2} = 1.5, \\
1\frac{3}{4} = 1.75.
\]

\[
\begin{align*}
14\frac{1}{2} & = 14.5, \\
14\frac{3}{4} & = 14.75.
\end{align*}
\]

\[
1.22'' = \frac{1.22}{120} = 0.010166666. \\
0.0625 = \frac{1}{16} = 0.0625. \\
\frac{3}{16} = 0.1875. \\
\frac{5}{16} = 0.3125.
\]

\[
\begin{align*}
14\frac{1}{2} & = 1.25, \\
1\frac{3}{4} & = 1.75.
\end{align*}
\]

\[
1\frac{1}{2} = 1.25. \\
1\frac{3}{4} = 1.75.
\]

\[
3\frac{1}{2} = 3.5.
\]

\[
\begin{align*}
14\frac{1}{2} & = 14.5, \\
1\frac{3}{4} & = 1.75.
\end{align*}
\]
6.1 Caerleon College of Education
Entry qualifications in Mathematics 1962-1969

6.2 Caerleon College of Education
Basic Mathematics Exam. and results 1962

6.3 Basic programmes
't' tests on significance between means
Each 'basic' Mathematics test compared with that of 1958

6.4 Basic programmes
't' tests on significance of a single mean
Each 'basic' Mathematics test compared with the 'method' test
### Caerleon College of Education Entry Qualifications in Mathematics 1962-1969

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<tbody>
<tr>
<td></td>
<td>M</td>
<td>W</td>
<td>M</td>
<td>W</td>
<td>M</td>
<td>W</td>
<td>M</td>
<td>W</td>
</tr>
<tr>
<td>Passed A level and O level</td>
<td>2.1</td>
<td>3.1</td>
<td>3.3</td>
<td>0.8</td>
<td>4.5</td>
<td>2.2</td>
<td>10.4</td>
<td>1.5</td>
</tr>
<tr>
<td>Failed A level, passed O level</td>
<td>2.1</td>
<td>1.5</td>
<td>6.7</td>
<td>4.1</td>
<td>6</td>
<td>2.2</td>
<td>3.1</td>
<td>0.8</td>
</tr>
<tr>
<td>Passed O level and passed</td>
<td>61.6</td>
<td>33.9</td>
<td>61.7</td>
<td>45.5</td>
<td>64.2</td>
<td>61.2</td>
<td>64.8</td>
<td>64</td>
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<tr>
<td>Failed O level (only)</td>
<td>10.7</td>
<td>6.1</td>
<td>6.7</td>
<td>5.8</td>
<td>8.9</td>
<td>4.5</td>
<td>8.3</td>
<td>4.5</td>
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<tr>
<td>Failed O level but passed Special Arithmetic</td>
<td>10.7</td>
<td>6.1</td>
<td>1.7</td>
<td>8.3</td>
<td>6</td>
<td>7.4</td>
<td>6.3</td>
<td>6.8</td>
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<tr>
<td>Passed Special Arithmetic only</td>
<td>6.4</td>
<td>17</td>
<td>10</td>
<td>16.6</td>
<td>4.5</td>
<td>10.4</td>
<td>5.2</td>
<td>15.8</td>
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<tr>
<td>Failed Special Arithmetic only</td>
<td>2.1</td>
<td>9.2</td>
<td>-</td>
<td>7.5</td>
<td>-</td>
<td>2.2</td>
<td>1.0</td>
<td>4.5</td>
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<tr>
<td>Dropped Mathematics or Special Arithmetic before 16+</td>
<td>4.3</td>
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<td>10</td>
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<td>6</td>
<td>9.7</td>
<td>3.1</td>
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<td>28.4</td>
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<td>32.3</td>
<td>10</td>
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<td>6</td>
<td>11.9</td>
<td>4.1</td>
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## Basic Mathematics 1962

### Results

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<th>Correct</th>
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<tr>
<td>17b</td>
<td>19%</td>
<td>21%</td>
<td>60%</td>
</tr>
</tbody>
</table>
1. Find the square root of 7056 using factors.

2. Is 499 a prime number? Give a reason for your answer.

3. Arrange the following fractions in order:
   \[
   \frac{4}{7}, \quad \frac{7}{13}, \quad 0.55, \quad \frac{27}{50}, \quad \frac{19}{33}
   \]

4. The average of ten numbers is 23.17 and the average of nine of them is 24.3. What is the other number?

5. Divide £16-4-4d by 1\(\frac{1}{2}\).

6. 0.2 \times 3.2 \times 0.5.

7. 25.2 \times 0.14.

8. 28.42 \div 0.014.

9. Simplify \(3\frac{1}{2} - \frac{1}{2} \times 5\frac{1}{2} - 1\frac{1}{2}\).

10. \(8\frac{1}{2} \div 2\frac{1}{2}\).

11. A box, with a lid, is 6" long, 4" wide and 3" tall. Find (a) its volume and (b) its surface area.

12. Fill in the missing numbers:
   (a) \(8398 + \boxdot\boxdot\boxdot\boxdot = \frac{\star\star\star}{\star\star\star\star\star}\)
   (b) \(7235 - \boxdot\boxdot\boxdot\boxdot = \frac{3\boxdot\star}{\star\star\star\star\star}\)
13. The sides of a triangle are in the ratio 2:2.5:3.5.
   If the perimeter is 12", find the sides?

14. 12% of a sum of money is £30. What is the sum?

15. A boy scores 36 marks out of 45 for an examination.
    What percentage is this?

16. Add 25% of £1, 12½% of 2/-, 50% of 2/6d, 66⅔% of 1/-
    and 20% of 2/6d.

17. If \( a^2 + b^2 - c^2 = p \), find

   (a) \( p \) when \( a = 5 \), \( b = 4 \) and \( c = 3 \).
   (b) \( a \) when \( b = 2 \), \( c = 5 \) and \( p = 15 \).
*BASIC PROGRAM SIG OF DIFF BETWEEN MEANS

5 LET A=B=N=0
10 LET C=D=M=1
15 READ X
20 IF X=0 THEN 50
30 LET A=A+X
35 LET B=B+X*X
40 LET N=N+1
45 GOTO 15
50 LET R=A/N
55 LET S=SQR(B/N-R*R)
60 DATA 65,45,55,100,70,60,40,50,70,60
65 DATA 50,55,60,70,80,60,45,40
70 DATA 40,65,55,60,50,80,40,50,45,55
75 DATA 40,55,60,40,60,30,75,70,50,60,55
80 DATA 60,90,50,70,70,50,50,60,55
85 DATA 50,55,60,55,55,50,50,60,55
90 DATA 45,40,50,40,50,60,55
95 DATA 80,90,60,50,55,70,55,60,40,50
100 DATA 70,25,60,30,30,61,20,30,40,30,70
105 DATA 90,80,50,50,50,80,85,60,50
110 READ Y
115 IF Y=0 THEN 145
125 LET C=C+Y
130 LET D=D+Y*Y
135 LET M=M+1
140 GOTO 110
145 LET F=C/M
150 LET G=SQR(D/M-F)*F
155 PRINT "MEAN":R;" SD":S
160 PRINT "MEAN":F;" SD":G
165 LET T=(R-F)/SQR(S*S/N+G*G/M)
170 PRINT "T":T
175 STOP
180 DATA 76,81,63,63,59,40,73,81,41,53
185 DATA 45,50,56,63,53,53,64,63,14,67
190 DATA 59,56,66,15,53,60,53,60,43,60
195 DATA 47,44,40,27,33,27,36,13,44,33
200 DATA 40,20,33,27,27,33,33,47,53,13
205 DATA 28,24,37,33,31,47,64,51,20,57
210 DATA 41,52,36,31,0,57,31,37,60,33
215 DATA 51,27,51,37,47,37,64,47,57,57
220 DATA 44,60,57,37,60,40,44,33,63,57
225 DATA 40,37,57,47,53,86,40,44,64,53
230 DATA 80,51,73,47,0,0
235 END

Appendix. 6.3

Basic Marks compared.

1958-60

MEN

1960-63

MEN

MEAN= 59.1327 SD= 16.6693
MEAN= 46.2404 SD= 15.8687
T= 5.62472

...
### Men 1962-65

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<tbody>
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<td>DATA</td>
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<tr>
<td>DATA</td>
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### Women 1962-65

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<tbody>
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**Mean** = 59.1327  **SD** = 16.6603

**Mean** = 51.7  **SD** = 22.9262

**T =** 2.03462
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<th>SD</th>
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<td>16.6603</td>
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<td>Women</td>
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<td>15.9898</td>
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<tr>
<td>1963-66</td>
<td>Men</td>
<td>59.1327</td>
<td>16.6603</td>
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<tr>
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<td>Women</td>
<td>55.7431</td>
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<td>MEAN = 59.1327</td>
<td>SD = 16.6603</td>
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<td></td>
</tr>
<tr>
<td>---------------</td>
<td>-------------</td>
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<tr>
<td>T = 3.1515</td>
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**MEN**

```
42 170 DATA 38,31,26,49,46,37,45,56,49,26
175 DATA 26,59,51,27,58,78,63,55,41,46
44 480 DATA 38,37,67,64,22,57,26,50,42,49
185 DATA 61,45,30,56,57,64,97,83,46,75
48 190 DATA 46,46,45,51,67,46,40,29,49,45
195 DATA 91,55,55,40,57,51,43,61,61,73
48 200 DATA 73,81,53,50,56,79,53,50,70,72
205 DATA 83,49,79,61,55,56,72,54,32,38
50 210 DATA 70,70,61,18,0
215 END
```

**1965-68**

**WOMEN**

```
50 DATA 78,56,15,50,61,27,49,41,70,54,38
175 DATA 22,26,38,33,45,31,19,29,56,18
44 180 DATA 15,55,21,56,47,19,72,70,42,47
185 DATA 50,64,51,43,55,23,51,38,41,58
48 190 DATA 54,56,26,64,74,47,40,58,55,33
195 DATA 57,41,61,32,46,57,41,47,63,53
48 200 DATA 61,33,59,56,50,29,61,75,61,56
205 DATA 86,61,69,77,75,55,50,32,50,51
50 210 DATA 76,67,57,50,52,61,54,31,61,40
215 DATA 41,56,21,30,14,50,23,70,74,22
52 220 DATA 58,65,67,69,50,46,19,45,29
225 DATA 61,67,59,65,42,50,32,31,41,47
54 230 DATA 32,49,45,45,55,42,46,54,47,0
235 END
```

**1965-68**
<table>
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<th>Women 1968-71</th>
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<td>90, 74, 71, 85, 94, 84, 91, 66, 64, 94</td>
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<td>83, 75, 82, 52, 67, 79, 48, 63, 58, 72</td>
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<td>91, 58, 68, 44, 63, 81, 69, 75, 64, 91</td>
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<td>73, 76, 61, 75, 85, 95, 69, 71, 88, 75</td>
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<td>81, 73, 74, 67, 90, 71, 60, 96, 78, 80</td>
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<td>87, 67, 95, 72, 55, 60, 64, 64, 77, 78</td>
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**MEN**

- Mean: 59.1327
- SD: 16.6603

**WOMEN**

- Mean: 65.7647
- SD: 15.9403
### Men 1969-72

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<td>83, 90, 82, 89, 85, 77, 73, 75, 80, 79</td>
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<tr>
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**MEAN** = 59.1327  **SD** = 16.6603
**MEAN** = 82.7773  **SD** = 15.0494

### Women 1969-72

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<td>85, 77, 85, 77, 75, 71, 91, 85, 81</td>
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<td>95, 91, 74, 87, 35, 82, 74, 83, 75, 36</td>
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<td>90, 81, 87, 89, 80, 77, 83, 74, 78, 72</td>
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**MEAN** = 59.1327  **SD** = 16.0603
**MEAN** = 79.2270  **SD** = 11.8329

**E=10.2270**
**MEN**

1970-73

**MEAN** = 59.1327  SD = 16.6603

**MEAN** = 73.2588  SD = 13.5301

**T** = 6.59501

**WOMEN**

1970-73

**MEAN** = 59.1327  SD = 16.6603

**MEAN** = 21.3916  SD = 12.5726

**T** = 6.1778
170 DATA 75, 67, 26, 90, 89, 82, 38, 73, 83
175 DATA 85, 74, 78, 98, 71, 79, 75, 73, 82, 74
180 DATA 80, 75, 81, 58, 88, 81, 95, 86, 83, 72
185 DATA 66, 75, 79, 80, 84, 74, 81, 60, 80
190 DATA 86, 90, 22, 87, 31, 77, 73, 89, 29, 83
195 DATA 69, 85, 84, 87, 69, 84, 85, 81, 90, 80
200 DATA 72, 36, 82, 51, 92, 73, 64, 51, 87, 35
205 DATA 79, 72, 91, 83, 90, 44, 92, 62, 76, 79
210 DATA 85, 81, 75, 33, 70, 72, 83, 56, 0
215 END

MEN

1971-74

MEAN = 59.1327    SD = 16.6603

MEAN = 78.7273    SD = 10.2022

Y = 9.77891

WOMEN

1971-74

MEAN = 59.1327    SD = 16.6603

MEAN = 75.1329    SD = 14.0515

Y = 7.79524
MEN

1972-75

DATA: 70, 77, 78, 81, 84, 83, 92, 89, 85, 97, 80

DATA: 70, 88, 87, 79, 78, 79, 86, 95, 75, 84

DATA: 85, 97, 94, 79, 90, 83, 53, 71, 69, 48

DATA: 83, 94, 73, 95, 92, 79, 74, 92, 78

DATA: 76, 88, 56, 87, 52, 64, 94, 86, 27, 78

DATA: 69, 68, 74, 93, 86, 49, 56, 80, 87, 77

DATA: 85, 50, 71, 86, 84, 67, 82, 63, 77, 83

DATA: 73, 75, 72, 69, 81, 71, 72, 56, 0

210 END

WOMEN

1972-75

DATA: 59.3, 1327 - SD = 16.6003

DATA: 76.7, 436 - SD = 14.2554

T = 7.55228

MEN

1972-75

DATA: 59.3, 1327 - SD = 16.6003

DATA: 76.7, 436 - SD = 14.2554

T = 7.55228

WOMEN

1972-75

DATA: 59.3, 1327 - SD = 16.6003

DATA: 76.7, 436 - SD = 14.2554

T = 7.55228
### Men 1973-76

<table>
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<tr>
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<th>185</th>
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<th>215</th>
</tr>
</thead>
<tbody>
<tr>
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<td>82.60.74.60.74.70.76.49.55</td>
<td>80.88.81.93.81.62.74.47.45.35</td>
<td>76.62.45.62.93.57.33.81.60.76</td>
<td>50.76.91.47.15.74.72.55.42.76</td>
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<td>70.88.62.57.57.86.52.62.42.67</td>
<td>62.72.72.55.26.30.70.55.31.91</td>
<td>91.30.50.60.83.66.93.82.0</td>
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**Means and Standard Deviations:**
- Mean: 59.1327
- SD: 16.6603

### Women 1973-76

<table>
<thead>
<tr>
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<th>205</th>
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<th>215</th>
</tr>
</thead>
<tbody>
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<td>81.76.15.78.91.33.74.62.62.76</td>
<td>72.31.40.33.52.70.74.81.86.57</td>
<td>64.81.74.31.50.10.55.81.72.86</td>
<td>69.60.81.33.70.60.91.60.78.45</td>
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<td>40.23.15.76.67.62.47.71.64</td>
<td>45.45.74.76.83.31.71.67.71.64</td>
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**Means and Standard Deviations:**
- Mean: 59.1327
- SD: 16.6603

**F Test:** 1.6925
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| MEAN = 53.6667 | SD = 16.4725 |
| T = 2.5062 |</p>
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175 DATA 80, 72, 79, 83, 84, 83, 65, 70, 90, 86
180 DATA 0
185 END

1976-79

MEAN = 59.1327  SD = 16.6603

T = 10.2073

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170 DATA 71, 83, 77, 83, 71, 87, 96, 75, 85, 81
175 DATA 73, 79, 61, 71, 83, 85, 81, 61, 71, 60
180 DATA 64, 72, 79, 92, 70, 87, 63, 81, 92, 72
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190 DATA 78, 82, 90, 69, 43, 76, 80, 71, 81, 86
195 DATA 75, 69, 84, 81, 73, 63, 96, 92, 78, 39
200 DATA 85, 85, 67, 89, 89, 82, 0
205 END

1976-79

WOMEN

MEAN = 59.1327  SD = 16.6603

T = -8.02285
MEN AND WOMEN
1977-80

MEAN = 59.1327 SD = 16.6603
T = 8.68572

MEN AND WOMEN
1978-81

MEAN = 59.1327 SD = 16.6603
T = 8.68572
APPENDIX 6.4

Basic compared with 'Method' M £ N 1962-65
## Women 1962-65

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| DATA | 48, 53, 31, 52, 33, 57, 80, 63, 50, 39 |

| DATA | 65, 50, 76, 49, 65, 59, 53, 50, 44.44 |

| DATA | 33, 63, 65, 52, 48, 26, 50, 52, 39, 66 |

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| DATA | 75, 35, 43, 30, 82, 65, 51, 53, 65, 42 |

| DATA | 43, 70, 53, 71, 50, 58, 75, 32, 17, 48 |

| DATA | 65, 37, 22, 32, 50, 66, 72, 30, 75, 62 |

| DATA | 45, 55, 35, 52, 45, 57, 65, 58, 72, 47 |

### Summary Statistics

- N = 61
- M = 2.14754
- S = 22.144
- T = 757445

## Men 1963-66

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| DATA | 83, 48, 76, 39, 73, 43, 75, 35, 55, 47 |

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| DATA | 71, 48, 84, 45, 95, 47, 58, 48, 50, 25 |

| DATA | 91, 43, 85, 53, 45, 45, 76, 34, 21, 41 |

| DATA | 54, 40, 90, 57, 77, 51, 92, 58, 71, 59 |

| DATA | 58, 49, 72, 49, 78, 33, 43, 38, 82, 40 |

| DATA | 94, 72, 88, 47, 52, 42, 67, 46, 52, 72 |

| DATA | 87, 65, 72, 42, 73, 42, 70, 34, 82, 73 |

| DATA | 61, 58, 65, 50, 73, 13, 69, 38, 83, 58 |

### Summary Statistics

- N = 55
- M = 27.5455
- S = 17.6242
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*Note: Data values are placeholders for illustrative purposes.*
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**Summary:**

- For **women**, the data range from 1966-69 with specific values in the table.
- For **men**, the data range from 1967-70 with specific values in the table.

**Additional Data:**

- For **women**, the range is from 1966 to 1969 with a total of 132 data points.
- For **men**, the range is from 1967 to 1970 with a total of 152 data points.

**Note:** The values in the table represent specific measurements or categories, but the exact nature of these measurements is not specified in the provided data.
24 DATA 71,65,75,77,79,80,87,84,94,72
28 DATA 62,57,78,93,99,69,48,26,78,54
32 DATA 66,77,61,64,68,39,86,52,81,75
36 DATA 66,77,75,80,78,71,73,86,84,92
40 DATA 77,79,90,82,85,84,65,52,70,63
44 DATA 66,52,46,71,91,87,73,57,93,89
48 DATA 66,72,39,49,88,40,77,61,81,74
52 DATA 87,87,89,95,92,33,76,87,80,75
56 DATA 84,61,54,59,91,60,86,90,81,76
60 DATA 77,78,63,45,74,67,76,80,77,87
64 DATA 67,44,70,40,86,92,60,85,92,82
68 DATA 75,70,62,77,56,60,85,93,76,35
72 DATA 99,90,73,59,64,28,86,62,90,47
76 DATA 77,79,55,79,73,84,75,72,69
80 DATA 58,79,89,92,70,84,77,66,84,89
84 DATA 77,85,76,79,63,70,80,82,34,62
88 DATA 96,74,70,86,85,90,86,68,80,20
92 DATA 86,60,66,74,78,81,70,58,93,77
96 DATA 95,82,63,62,88,65,53,26,81,78
100 DATA 74,91,67,53,82,50,80,84,86,39
104 DATA 91,93,68,85,66,61,92,86,95,83
108 DATA 81,68,97,86,77,65,66,50,77,65
112 DATA 70,69,73,80,72,77,76,76,0,0
116 END

N = 114  M = 5,21053  S = 14,6386  T = 3,80044

24 DATA 65,83,86,52,79,60,86,49,83,54
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32 DATA 83,61,32,79,73,44,80,74,82,42
36 DATA 84,74,82,67,70,71,58,29,95,63
40 DATA 80,77,70,62,86,81,86,25,93,66
44 DATA 67,61,97,86,65,29,93,74,69,41
48 DATA 76,55,30,75,74,56,82,63,61,38
52 DATA 70,83,85,75,58,51,52,49,48,31
56 DATA 79,57,63,49,96,94,81,67,70,81
60 DATA 74,57,74,61,98,85,90,69,80,60
64 DATA 80,68,85,40,85,69,83,44,87,80
68 DATA 88,41,89,53,87,94,91,83,73
72 DATA 71,45,87,50,76,71,95,30,67,22
76 DATA 80,41,83,74,91,53,82,44,89,91
80 DATA 82,53,82,58,63,67,73,49,79,28
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**Women**

1969-72

**Men**

1970-73

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77

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Women
1970-73

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MEN
1971-74

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</tbody>
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**[Data Table]**

- **N=20**
- **M=2.29**
- **S=14.3246**
- **T=7.02461**

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**[Data Table]**

- **N=60**
- **M=6.77273**
- **S=12.0325**
- **T=4.57276**
MEN AND WOMEN
1977-80

N= 39  M= 11.782  S= 16.8039  T= 4.40118

STOP

N= 42  M= 3.21429  S= 9.68685  T= 2.15044