MATHEMATICS

Paper 0580/11
Paper 11 (Core)

Key messages

To succeed with this paper, candidates need to have completed the full Core syllabus. Candidates are reminded of the need to read the questions carefully, focussing on instructions and key words. Candidates also need to check that their answers are in the correct form, make sense in context and are accurate.

General comments

This paper proved accessible to many candidates. There were a number of questions that were standard processes and these questions proved to be well understood. Most candidates showed some working with the more able candidates setting their work out clearly and neatly. There were other questions that were more demanding, for example finding the local time for a plane's arrival and the area of a sector of a circle.

When calculations of two or more steps are needed it is best if all steps are shown separately for ease of checking by the candidate and for method marks to be awarded if the answer is incorrect. This is particularly important with algebra questions such as **Question 14** along with **Questions 8**, **10**, **11** and **15**.

The questions that presented least difficulty were **Questions 1**, **6(a)**, **7(b)**, **8** and **9(a)**. Those that proved to be the most challenging were **Questions 11**, mean calculation from a bar chart, **13**, radius of a disc, **15**, an approximation and explanation, **20(b)**, set notation, and **21**, area of a sector of a circle. There were few questions left blank but those that were the most likely to be blank were **Questions 17**, **19**, **20(b)** and **21**. The last two have already been mentioned as questions candidates found challenging.

Comments on specific questions

Question 1

This was answered well by most candidates. Occasionally, candidates were incorrect with the fraction which caused problems with the percentage when they tried to follow through with their incorrect value. Sometimes the percentage was given as 2.5 or 250.

Question 2

This proved challenging to some as it relied on the understanding of the word perimeter, as frequently the number of squares (area) was given instead of the distance around the shape. Those that did understand the need to find the perimeter occasionally made arithmetic errors in the addition or missed out one or other of the 1 cm sides. Crossing off the sides when the lengths have been added is a good strategy to use.

Question 3

This was answered well by many candidates. A significant number drew lines of symmetry or stated angles rather than the order of rotational symmetry.

Question 4

This was a well answered question. There was only one correct answer so those that gave the correct and an incorrect answer gained no credit. Incorrect answers were most often *B* (the same orientation) or *C* (an enlargement). Occasionally the answer *F* was given as if the candidates were labelling the shaded shape.

Question 5

Some candidates were very confident with both parts but the concept of the stem was not known or understood by many.

(a) A very common answer was 2 either because candidates forgot they needed to include the 2 from the stem (making 22) or because 2 was the most common digit in the entire diagram.

(b) Again, the stem was often ignored and the candidates ordered the single digits from within the table and so gave 4 as their answer. Some understood the concept of stem-and-leaf diagrams but still listed every number out, often arriving at the correct answer but doing far more work than was necessary and introducing places where errors could be made. Some candidates gave the mean.

Question 6

Both parts were answered well.

(a) Some candidates did not know the conversion factor for changing kilometres to metres, leading to common incorrect answers of 270 (as if they were converting centimetres to metres) or 0.027 (dividing by 1000 instead of multiplying).

(b) This part was almost always correct.

Question 7

(a) A minority of candidates answered this problem solving question correctly and demonstrated a clear ability to deal with flight times combined with time zones and the 24-hour clock. Other candidates correctly found 11 15 (time in Los Angeles when the plane arrived) but did not find the local time in Shanghai or found 12 40 (time in Shanghai when the plane took off) but did not include the time of the flight. Some subtracted the 15 hours or went back in time by taking off the length of the flight from the leaving time. Other errors seen included adding 13 h 35 mins to 21 40 as 34 75 but being unable to convert this firstly to 35 15 and then to 11 15; being unclear to the differences between, for example, 21 40 and 09 40; incorrect use of am and pm and slips with arithmetic. Some had difficulties moving from one day to the next, as a common error was to miscount the time 00 00 either by adding two hours instead of one or accidentally skipping it. Many candidates forgot to write the day, although they got the date and time correct, or wrote the incorrect day with the correct date. Some also used the decimal number system whilst adding the times and forgot that there are 60 minutes in an hour. Lack of working or confused working cost many candidates' credit.

(b) Errors seen in this part were of two types; dividing the price in dollars by the exchange rate instead of multiplying or giving an answer rounded to the nearest dollar instead of including the cents.

Question 8

Many candidates answered this question correctly. Many gained the mark for a correct substitution although some wrote 38 instead of 3×8. After this stage, the most common error was to make one or more sign errors when rearranging.

Question 9

(a) Many candidates measured in centimetres accurately then multiplied by 4 to get the distance in kilometres. A few were not very accurate with their measuring, but if they then multiplied their less accurate measurement by 4, the method mark was gained.

(b) This part was not answered particularly well. Common errors came from not positioning the protractor in the correct place. Common incorrect answers were 025 (from 90 – 65) and 245 (from 180 + 65), the reverse bearing.

(c) There were many accurate responses seen. A few positioned *X* on a bearing of 140 from *Q*. Candidates needed to take care with the measurement of length of the line for *P* to *X* as inaccuracies like those in **part (a)** were seen here.

Question 10

Most candidates were able to calculate the interest, although many did not add this to the principal to find the total value. Candidates must read the question carefully as some questions ask for the interest only but not in this question. Some gave a rounded answer and another error was to treat this as a compound interest question.

Question 11

Only a few candidates were successful, gaining full credit. Most attempted to read the frequencies from the bar chart, although many made errors, with frequencies such as 14.5 being seen. Candidates must remember the context of a question; all the heights of the bars had to be whole numbers as this was the number of people who gave each score. Very few calculated $\sum fx$ and most just added the frequencies, often incorrectly even though the total frequency was given in the question, and then divided by 6. Quite a few candidates stated incorrectly that $4 \times 0 = 4$. A few showed the method but then gave their answer as 3 instead 3.08.

Question 12

(a) This question was found to be very accessible by most candidates.

(b) The most common errors were to give the next term, 14, or to write $n - 4$.

(c) Only very few of the candidates gained full credit in this part, with many showing the difference of 2 in their working but being unsure how to proceed. Many had learnt the expression, $a + (n - 1)d$ but did not know how to substitute in the difference or the first term. The negative also caused further problems with the algebra.

Question 13

This question was not answered well. Incorrect values of π were used frequently and values were rounded in the middle of the calculation (for those that found the diameter, wrote down a rounded value then halved for the radius). There was some confusion about which formula to use as many used the area formula, dividing by π then square rooting. Some divided by π but then did not divide this by 2 or sometimes, divided by 2 twice.

Question 14

(a) This part was answered well with many candidates gaining full credit or partial credit for a correct partial factorisation. Some factored out the $6x$ but then in their answer only gave the remaining factor, $(3x - 2)$. Some treated this as an equation and went on to try to solve it.

(b) Fewer candidates gained full credit in this part. A number of candidates wrote that $+ 5x - 3x$ was $-2x$ or $\pm 8x$ following on from a correct expansion suggesting they had misunderstood the rules about positive and negative signs but had handled the more complex process correctly.

Question 15

(a) There were few correct answers seen in this part. Most candidates did not round both given numbers to 1 significant figure with the cost per book often being given as \$22 rather than \$20. Many worked out the answer to a calculation involving exact or rounded values and then rounded or truncated their answer to 1 significant figure. A few wrote 1400 on the answer line but did not show their rounded values or their calculation. Showing the values and calculation was vital to be able to answer the next part.

(b) Most candidates incorrectly stated that the estimate would be greater than the actual cost. Those who said it would be less often described the process for rounding numbers rather than how this had affected the result in this case. A large number referred to only one value rather than both.

Question 16

45° was a very common incorrect answer and some candidates found the total of the interior angles of the octagon, 1080°, but then did not go on and divide this by 8. Other candidates started with an incorrect polygon formulae and others did not remember that an octagon had 8 sides.

Question 17

Some candidates were successful in showing the necessary logical working, first, 1 – 0.1 = 0.9 then subdividing that to get to find one part twice the size of the other, i.e. 0.6 and 0.3 in this order. Others tried various methods and some did not write their answers in the table, as instructed, so only gained partial credit if it was not clear which relative frequency was which.

Question 18

Many candidates showed clear working and gave all of the relevant steps required to evaluate the calculation. Most candidates, who were able to convert the mixed number to an improper fraction, went on to add the two fractions correctly. Some candidates who got as far as $\frac{67}{30}$ stopped without giving the answer as a mixed number as asked for in the question.

Question 19

There were few correct answers seen in this question. Most candidates did not interpret the scales correctly and counted squares when finding the gradient, leading to a common incorrect value of $m = 1.5$. Some read coordinates from the graph but were unable to use these to evaluate the gradient correctly from using 'rise/run'. There were a few triangles drawn on the graph often without lengths of sides. The most common mark was for writing $y = mx + 2$, with a variety of incorrect values seen for m.

Question 20

(a) Most candidates gained credit, usually for placing the values 10 and 6 in the correct places on the Venn diagram. The majority made an error when working with the value 23, with most writing this into the diagram directly, rather than realising they needed to subtract 10, before writing 13 and 10 on the Venn diagram. Some wrote 23, 10 and 6 on the diagram, leaving the remaining section blank. Occasionally, two values were written in one section.

(b) There were many errors seen in this part. A large number found $n(C \cap B)$ or $n(C)$. Many candidates made arithmetic errors, despite having access to a calculator. Those who had left a section blank in **part (a)** often only added their two values. It was possible to gain the mark even if the previous part was incorrect; the 50 families minus the 6 families without a car and without a bicycle is 44 families.

Question 21

Some candidates rounded their answer to 2 significant figures or used an inaccurate value of 3.14 or $\frac{22}{7}$ for π. A number of candidates recognised the need to find the area of the whole circle, but many made no further progress. Many others had no idea how to approach this, with attempts that involved multiplying and dividing the numbers in the question or use of trigonometry.

MATHEMATICS

Paper 0580/12
Paper 12 (Core)

Key messages

To succeed with this paper, candidates need to have completed the full Core syllabus. Candidates need to read what the question is asking and make sure that answers are possible for the question. Basic definitions, terms and processes need more emphasis since many questions ask for evidence of this knowledge.

General comments

Overall, candidates made a good attempt at most of the questions and many showed a thorough understanding of the syllabus. However, there was often seen a weakness in knowledge of standard definitions and calculations. While there were a few questions on the paper which demanded more thought, there were many straightforward bookwork ones.

Comments on specific questions

Question 1

(a) Most candidates wrote the numbers correctly but there were a variety of zeros seen. 4 000 400 and 40 400 were quite common answers. Some felt that it was two distinct numbers to be written, 400 000 and 400.

(b) This was mostly correctly answered but 60 300 and occasionally 60 280 were seen. Some candidates simply gave the answer 60.

Question 2

It was very rare to see an incorrect answer to the square root. Occasionally, the decimal point was omitted.

Question 3

This basic term was usually correct but quite a number of candidates wrote obtuse. Just the word ‘triangle’ was seen while some thought they had to measure the angle.

Question 4

(a) 0.9 was a common incorrect answer but $\frac{9}{100}$ was also seen. Otherwise, this was very well answered.

(b) Overall, a fraction format was seen, but in some cases it was un-simplified.

Question 5

The meaning of ‘reciprocal’ as a term in mathematics was clearly not known by many candidates. Those who did know it more often gave the answer as a fraction rather than a decimal, although either was accepted. Multiples, factors and $\frac{20}{1}$ were seen as well as blank responses.

Question 6

(a) There were quite a number of correct responses to the order of rotational symmetry, although 4 was a common answer and occasionally 3 was seen.

(b) The vertical line was usually seen, either alone or with at least an attempt at the sloping lines. Reasonable accuracy was expected but some lines did not go through the vertices or missed the mid-points of the opposite sides. Nearly all candidates drew ruled lines.

Question 7

Most candidates completed the construction well with construction arcs. There were a few that were not triangles or were triangles with very inaccurate sides. Some drew perfect arcs but did not draw the lines to make a triangle.

Question 8

While 9.5 and −9.5 were seen quite often, the vast majority of candidates answered this correctly.

Question 9

The vast majority of candidates answered this correctly but there were a few giving 300 or 3.

Question 10

Quite a number of candidates did not know the name for a polygon with 5 sides, as evidenced by hexagon and trapezium seen quite often.

Question 11

Many candidates found drawing the net quite challenging. The common error was to show all four larger rectangles as 5 by 2.5, instead of two being 5 by 3. Some did not understand what a net is and attempted a 3-dimensional drawing. However, there were quite a number of well-drawn correct nets with rulers almost always used.

Question 12

Some candidates appeared not to be familiar with stem-and-leaf diagrams. This was evidenced by answers for mode and sometimes the median just containing the leaf figure. Those who did understand the topic generally found the mode correctly but for some, the median was challenging due to confusion with mean evident at times. The third part was found the most challenging which showed a lack of understanding of how to find a percentage, rather than a difficulty with the diagram.

Question 13

Most candidates answered this correctly, although the common error of dividing instead of multiplying was evident quite often. A few candidates gave an answer to one decimal place instead of the full exact answer.

Question 14

(a) This question on the basic rules of operations on vectors was well answered with just a few slips. Fraction lines were seen occasionally and a few only had a single item in the vector brackets.

(b) The single number, 15 or −15 was more evident in this part although overall it was better answered than **part (a)**. Clearly multiplying a vector by a number presented less difficulty than adding two vectors when some negative values are involved.

Question 15

Changing a time in decimals into minutes was challenging for many candidates with the error of 0.15 hour taken as 15 minutes. There was little evidence of 2.15 × 60 being performed with clearly the vast majority of correct answers from 2 × 60 and 0.15 × 60 and then added.

Question 16

(a) Although the solution of a linear equation was done well, many candidates did make the error of not accepting that the answer, or the first step, could be negative. 18 – 4 was often seen instead of 4 – 18. Answers without working were seen a number of times and while that was not penalised in this question if correct, it was more often incorrect, usually an answer of 2.

(b) Some gave the answer 7^{12} but the common error was to divide 18 by 6 instead of 18 – 6. However, incorrect responses were rare.

Question 17

(a) It was exceptionally rare to see an error in adding 7 to 24.

(b) Many candidates did not understand what was meant by a term to term rule, or even if they did, they just wrote 7 or 'a difference of 7'. Some gave a response containing n, mostly $n + 7$ or the expression for the nth term.

(c) Most understood that an expression had to include a part with n and a constant, but $4n$ and just $7n$ were seen. Others gave $7n$ but with an incorrect constant, commonly +3, the first term. A correct un-simplified answer did gain full credit if not spoilt, but this was often seen as $3(n – 1) × 7$ instead of $3 + (n – 1) × 7$.

(d) The correct answer in **part (c)** usually resulted in success in this part while others gained credit by following through their incorrect **part (c)**. Some listed all the values or otherwise worked from the starting point of the sequence. While this was successful for some, errors were made frequently.

Question 18

The most common error was to assume that the whole angle at point A was split into two equal angles of 43°. Credit was still available for those who then realised that triangle ABC was isosceles. Another assumption made was that angles ACD and ABC were equal. However, quite a number of the more able candidates started correctly to work out that angle CAD was 64° which then led them to the correct answer. Candidates who worked on the diagram, filling in angles, generally were more successful than those just using the working space.

Question 19

This question was quite well answered with a good number of fully correct solutions or 11 for those who did not add on the first hour. A common error was to add 15.50 to 7.25 and then divide 95.25 by the answer. Many did not have a clear idea of how to tackle the question while others did repeated addition methods, some of which were successful.

Question 20

This two-stage fraction question was answered quite well although a small number of candidates used an incorrect order of operations by doing addition before division. Division was most often answered by invert and multiply (a few inverted the incorrect fraction)' although division with common denominators was often seen. Many did not write the division answer in its simplest terms so had a larger denominator than necessary for the addition. However, once this was completed it was rare to see a final answer not in its simplest form. The few who did not show working in either or both parts or gave the correct answer with incorrect working did not score any credit for those parts.

Question 21

This standard question on interior angle of a regular polygon was not well answered. Many candidates simply divided 360 by 10 to give the exterior angle and then stopped. However, the exterior angle method was the most successful since using an incorrect formula (often $n – 1$ rather than $n – 2$) was common. Once the total of the interior angles was found many did not divide by 10 to find one angle. While there was no diagram shown, candidates should realise that interior angles of polygons with more than 4 sides had to be obtuse, but there were various acute angles given for the answer.

Question 22

While there were many correct answers for the expected number, premature approximation on dividing 650 by 117 resulted in an inaccurate answer. A common error was to subtract 117 from 650.

Question 23

(a) (i) It was most common for partial credit to be gained from two numbers correctly placed (usually the given 43 and 61) but few realised they needed to work out the other two values. Often there was no value or the total, 125, in the section just in circle *E*.

(ii) This part was rarely correct, partly due to many cases of no entry in the just in *F* section since even the follow through mark required the addition of two numbers.

(b) There was correct shading for most candidates, although a few shaded all sections, the union or even the part outside the circles.

Question 24

This problem solving question was found challenging. Many wrote down $\frac{1}{5}$ for the 4 white flowers and then showed no further progress. Some did realise that there had to be a total of 20 flowers and this did often lead to 13 for *x*, although that did not always progress to the stage of a probability. Solutions from percentages or ratio were seen but with less success.

MATHEMATICS

Paper 0580/13
Paper 13 (Core)

Key messages

To succeed with this paper, candidates need to have completed the full Core syllabus.

Candidates should show working; just writing the answer means method marks cannot be awarded if the answer is incorrect.

Candidates should be encouraged to attempt all questions and check their work when they have completed the paper.

General comments

Candidates need to ensure they read the questions carefully. For example, **Question 19** asked for the radius of a circle and several candidates gave the diameter.

'Show that' questions require working to be shown to lead to the given answer, candidates do not gain any credit when they use the given answer in their calculations.

Comments on specific questions

Question 1

(a) Most candidates gave the correct answer. The most common incorrect answer was 0.5 with 20 and 0.005 also seen.

(b) This part was mainly answered correctly.

(c) This part was mainly answered correctly.

Question 2

(a) This part was mainly answered correctly.

(b) Many correct answers were seen in this part and very rarely did candidates add incorrect fraction lines. Some did confuse the directions and common incorrect answers were
$\begin{pmatrix}5\\4\end{pmatrix}, \begin{pmatrix}4\\3\end{pmatrix}, \begin{pmatrix}-2\\3\end{pmatrix}, \begin{pmatrix}-4\\-6\end{pmatrix}, \begin{pmatrix}0\\1\end{pmatrix}, \begin{pmatrix}-2\\2\end{pmatrix}, \begin{pmatrix}2\\3\end{pmatrix}$.

(c) This part was mainly answered correctly.

Question 3

This question was mainly answered correctly.

Question 4

This question was mainly answered correctly. Incorrect names seen were pyramid, prism and cylinder.

Question 5

A significant number of candidates were unable to place the arrow in the correct position. The most common incorrect answer was placing the arrow at the fourth mark. Some had placed their arrow between marks.

Question 6

(a) The majority of candidates were able to give the correct mode. A small number appeared to be familiar with the terms mode, median, mean and range, but were unable to identify which was which. 35 was a common incorrect answer from calculating the mean.

(b) Fewer correct answers were seen in this part than in **part (a)**. Some had calculated the mean. 73, the middle number in the given list, was a common incorrect answer.

Question 7

Many candidates gave the correct answer. Most understood how to substitute the numbers given but there were some who scored partial credit for the correct substitution followed by an incorrect attempt to solve the equation.

Question 8

(a) Almost all candidates attempted this question with the majority able to give the correct answer. The most common incorrect answer was –2. Also seen were 13 and 15 from miscounting.

(b) This part was generally well answered with the only common incorrect answer being −13 from subtracting 5 instead of adding.

Question 9

This question was mainly answered correctly.

Question 10

Many candidates were able to give the correct answer. Some tried to work out 26% of 208 and others divided 208 by 26 giving an answer of 8%. Other incorrect answers seen were 54.08 and 0.54.

Question 11

This question was mainly answered correctly. The common error was to give 15 alone or 13 and 15 as they are the pair giving the product 195.

Question 12

(a) Most candidates only circled one symbol, usually $\neq$.

(b) Most candidates inserted brackets in the correct place. A small number did not read the question carefully and inserted more than one pair of brackets.

Question 13

Many candidates gave the correct answer. Others gained partial credit for the subtraction 180 – 132.

Question 14

(a) This part was mainly answered correctly.

(b)(i) This part was mainly answered correctly.

(ii) The *n*th term proved more challenging for most candidates. It was common to see a numerical value as the answer. Other incorrect answers involved –4 but without *n* in the expression and several candidates did not attempt this question.

Question 15

This problem-solving question was found challenging by many candidates and only a few correct solutions were seen. There were several stages needed and common errors included dividing 62 by 5 and/or 68 by 6. Some gave the answer 6, the difference of the means in the question.

Question 16

Most candidates attempted this question and many gave the correct answer. Some multiplied by 0.9 rather than dividing.

Question 17

This problem-solving question was found challenging by many candidates. Some did gain partial credit for forming a correct equation (usually in stages) but few solved it correctly. 8 was a common incorrect answer. Some split the trapezium into a rectangle and a triangle then worked out the area of each but many were unable to work out the base of the triangle once they knew the area was 12.

Question 18

Many candidates gave the correct answer. Some gained partial credit for working out 15% of 420 but did not subtract this to find the selling price.

Question 19

A number of candidates confused area and circumference of circles. Dividing 26 by 2 and not using π was a common error. Some correctly calculated the diameter but did not then find the radius. Some divided 26 by π then rounded their answer, ending up with a final answer out of range after the division by 2.

Question 20

Many candidates gained full credit for correct rounding and a correct answer. Common errors were to use 6 rather than 7 for 6.6 and 31 for 30.7. Many gained partial credit for correctly rounding three numbers or having trailing zeros. Some had clearly worked out the actual sum on a calculator and then rounded.

Question 21

Several of the more able candidates were able to give the correct answer. Many did the first stage of dividing 360 by 7 but left the answer as the exterior angle.

Question 22

This was a very straightforward fraction addition which was answered correctly by most candidates. Very few did not start correctly but many didn't change the improper fraction to a mixed number. A small number did not show working.

Question 23

(a) Some candidates gained full credit, with others scoring partial credit, usually for $8g^{k}$. Some had omitted the g and just written 8^{28}.

(b) Those who understood 'factorise completely' were able to gain full credit. Some appeared to be simplifying with a variety of answers, often involving $5j$ but without brackets. A few scored partial credit for a correct but not complete factorisation.

(c) This part was very well answered with all positive signs making this more straightforward. A few did make slips but gained partial credit for 3 terms of the expansion correct.

Question 24

(a) Many correct answers were seen in this Pythagoras' theorem question. The most common error was not squaring the numbers before adding.

(b) Most candidates started this question correctly but then some did not transform the relationship correctly, $3.8 \times \cos 50$, rather than $3.8 \div \cos 50$ was common. Some used 5.9 in their calculation often to find the third side by Pythagoras' theorem first. However, some did what was required and gained full credit for finding a more accurate value which rounded to 5.9.

MATHEMATICS

Paper 0580/21
Paper 21 (Extended)

Key messages

To succeed in this paper candidates need to have completed full syllabus coverage, remember necessary formulae and definitions and show all working clearly. They should be encouraged to spend some time looking for the most efficient methods suitable in varying situations. This was particularly important in **Questions 1**, **8**, **10** and **21**.

General comments

The level and variety of the paper was such that candidates were able to fully demonstrate their knowledge and ability. Working was generally well set out. Candidates should ensure that their numbers are distinguishable, particularly between 1 and 7 and between 4 and 9 and should always cross through errors and replace rather than try and write over answers.

Candidates need to be reminded that prematurely rounded intermediate answers bring about a lack of accuracy when the final answer is reached. Checking that answers are sensible should also be encouraged. Algebraic manipulation involving brackets was an issue in **Questions 13**, **17** and **19**; an area for centres to address. Many candidates get into the habit of leading one line of working into the next, particularly in algebra questions. For example, in **Question 17**, within a first line of working of $y - yx = 3x - 2$, candidates then often carried out the next step incorrectly, for example by crossing out the x from both sides, rather than writing out the next line as the next step. Clear, methodical working showing all steps clearly and separately should be encouraged.

Candidates should always check that their calculator is in the correct degrees mode for angles. It should also be emphasised that the general instruction of rounding an answer to 3 significant figures only applies to inexact answers; where an answer is exact, it should not be rounded.

Comments on specific questions

Question 1

There were few candidates who did not score any marks on this first question. Many did get the correct answer but there were almost as many who were not able to deal with the fact that there were two conditions to be satisfied. Many stated either a prime number in the range, often 61, or found the only square number in the range and subtracted 2 to give the very common answer of 62.

Question 2

There was a large range of understanding in **part (a)**, for both the concept and dealing with time. The most successful candidates took each stage separately and converted the interim step to an actual time; for example those who started by adding 13 hours 35 minutes and got to 34 75, then changed this to 35 15 and then 11 15. Candidates who did not use this approach often became muddled and ended up with an incorrect time and/or an incorrect day with no opportunity to gain any interim working marks. Mistakes were often made when dealing with midnight; 01 15 was a common incorrect answer resulting from losing an hour by counting 24 00 when adding either the flight time or the time difference. Some candidates split the time up to midnight and after midnight, an efficient strategy which was often carried out successfully, but also caused confusion about when to add and when to subtract, leading to errors. Conceptual errors involved subtracting 15 hours rather than adding and occasionally subtracting the flight time. Some candidates omitted the day from the answer line and Saturday 23rd was also common. The correct day and date was, however, often the one mark gained by candidates who had made errors in the time calculations. **Part (b)** was much better attempted with very few candidates who did not score the mark. Candidates should remember that if an answer is exact, then they should give the full answer and not round it. Some candidates were rounding the answer to 3 significant figures but the full answer was often seen within the working to gain the mark. Candidates would occasionally divide by the exchange rate rather than multiply.

Question 3

The vast majority of candidates answered this correctly, demonstrating an efficient use of the calculator. With little working shown, it was difficult to see where candidates who did not gain the mark went wrong. From those who did show working, it appears that the errors were made in the denominator, either adding 0.2 or dealing with the cube root incorrectly.

Question 4

Stem-and-leaf diagrams appear to be familiar to the majority of candidates and a good understanding was demonstrated. In both parts, there was a minority who did not interpret the key, giving an answer in **part (a)** for example, of either $\frac{2}{2}$ or just 2. The vast majority were able to give the mode correctly in **part (a)**, although there was confusion between the median and the mode in a small number of cases. **Part (b)** was also well attempted. Some candidates did not know how to deal with the even number of data items and so gave an answer of 29 or 31 or both. Candidates should be careful with the use of the calculator here and put brackets around the two numbers being added before dividing by 2. Some candidates calculated the mean and those who did not interpret the key correctly calculated $\frac{9+1}{2}$ giving an answer of 5.

Question 5

Most candidates showed understanding that relative frequencies sum to 1 and indicated the sum of the ‘lost’ and ‘drawn’ was 0.9, usually resulting in full marks, although some did have the values in reverse order. Others had values that added to 0.9 which were not in the correct ratio, with 0.2 and 0.7 being the most common. A number showed the correct ratio of 2:1; the value of ‘lost’ as twice the ‘drawn’ value, but gave values that did not add to 0.9. $2x$ and x in the boxes with no other work was common. Another group of candidates calculated the value of 0.9 and used that as one of the answers and either doubled or halved 0.9 for the other value, hence 0.9 and 0.45 was regularly seen.

Question 6

The vast majority of candidates measured accurately and used the scale correctly to gain both marks in **part (a)**. One mark was also awarded, either for an inaccurate measurement (where perhaps the candidate was lacking a ruler) correctly converted or for an accurate measurement which was either not converted or converted incorrectly. The latter was often when candidates were changing kilometres into metres. Measuring a bearing continues to cause problems and **parts (b)** and **(c)** were not as well answered because of this. It must be emphasised to candidates that a bearing is measure clockwise from north and they must read the question carefully as to which point the bearing is measured from. Common incorrect responses in **part (b)** were 115°, 245° and 70°. Some candidates may have been lacking a protractor as there was a reasonably high rate of blank answer spaces. There were many correct points plotted in **part (c)** but it was plotting the bearing which once again proved difficult, with many candidates gaining one mark for plotting a point at 7 cm from *P* but on an incorrect bearing. It was common to see a bearing of 40° where the wrong scale on the protractor was being used and it was also common to see 140° measured in an anticlockwise direction.

Question 7

Most candidates understood what was expected of them for this question, both in terms of showing their working and giving their answer as a mixed number in simplest form. The most successful and most common strategy was to change $1\frac{5}{6}$ into an improper fraction, which meant that the whole number 1 was not forgotten at the end. Virtually all candidates understood that a common denominator was required and the value of 30 was almost always sensibly selected. Those who dealt with the whole number at the end sometimes left their answer as $1\frac{37}{30}$ but the more common way to lose the final mark was to leave the answer as the improper fraction, $\frac{67}{30}$.

Question 8

Candidates demonstrated a good understanding of simultaneous equations and those choosing the most efficient method of doubling the top equation and adding to eliminate y were by far the most successful. Many multiplied both equations in order to equate the coefficients of either x or y; perfectly valid methods but unnecessary, which often led to arithmetic and sign errors. Candidates should be very careful when dealing with negative values as it was very common to see inconsistent addition and subtraction of the terms. Many candidates rearranged one of the equations to make either x or y the subject and then substituted into the other equation. These candidates made far more algebraic and arithmetic errors following this. Candidates should be encouraged to check that their values fulfil both equations.

Question 9

Candidates demonstrated a good recall of the trigonometric ratios with the majority gaining both marks. Many candidates made extra work for themselves and often lost accuracy by using Pythagoras to find the third side and then using either sin or tan. Premature rounding of the cosine value also lost accuracy and so candidates should be encouraged to process the whole calculation in one go rather than re-type numbers into their calculator. A few candidates wrote down the correct method but then did not know how to use the inverse function to find the angle.

Question 10

The most successful strategy in this question was to find the exterior angle and then divide this in to 360 and centres should encourage this method when finding the number of sides. Many candidates could get no further than finding the exterior angle of 6 and many left the answer space blank. The majority of candidates who did not score any marks on this question used the interior angles formula incorrectly. The equation $180(n-2) = 174$ was seen many times, instead of $180(n-2) = 174n$. As a result, an inappropriate answer of 2.97 or 3 sides was extremely common. Some of those who did state the correct formula were unable to manipulate it to get to the correct answer.

Question 11

A full range of marks was awarded for this question with a good proportion giving the correct equation. A large number were awarded 2 marks for giving an answer in the form $y = mx + c$, with either the gradient or the intercept correct, more commonly the latter. Many gave an incorrect gradient of either –5 or $-\frac{1}{5}$. It was common to see the point (0, 6) substituted into the equation in order to find the intercept of 6. Weaker candidates rearranged the given equation to make x the subject, or simply reversed the signs and many did not attempt the question.

Question 12

Most candidates struggled to understand the concept of this question. Had they made up a starting value to provide more of a context, I am sure that many more would have got to the correct answer. One mark was frequently given for 100 – 35 or its equivalent. 100 + 40 was seen far less frequently and 0.65 × 0.4 was often calculated. Some candidates gained 2 marks for reaching 91 per cent, but then did not make the final step of subtracting this from 100. A large proportion of candidates were adding or subtracting the percentages and 5 was a common answer, either from 40 – 35 or (65 + 40) – 100.

Question 13

There were many completely correct answers to this inequality and a large number were awarded 2 marks for correctly dealing with the algebra but dealing with the inequality incorrectly. Those who kept the unknown positive on the right-hand side, usually went on to the correct answer but the majority of those who moved the unknown to the left-hand side ended up with $-14x \geqslant -14$ followed by $x \geqslant 1$. There were fewer candidates than in previous sessions who ignored the inequality sign and put $x = 1$ or just 1 on the answer line. Successful candidates usually made the first step of multiplying by 5 and then went on to isolate the terms in x. The most common algebraic mistake was to write, for example, $5 \times 4 - 3x \geqslant 6 - x$, followed by $20 - 3x \geqslant 6 - x$. There were some sign errors when isolating x terms and weaker candidates jumped straight to adding x before they had dealt with the fraction.

Question 14

Candidates should ensure that they read the information in proportion questions very carefully, as the majority of errors came from setting up the incorrect relationship at the beginning of the working. It was often seen as a direct relationship or without the square root or without the –2. Those that set up the correct relationship and worked step by step to find a multiplier first, often went on to gain full marks. The final step of evaluating x caused more problems than in previous sessions, with a large number of candidates scoring both method marks but not the answer mark. Difficulties occurred in the algebraic manipulation of isolating x, due to it being within the denominator and within a square root. Those multiplying by $\sqrt{x-2}$ first, in order to remove it from the denominator, fared much better than those who squared first, when 18 was commonly not squared. Weaker candidates had no strategy to deal with this question, showing various calculations involving the numbers given.

Question 15

Only very able candidates gained marks on this question. The vast majority took no account of the fact that the ratios were given for the heights and that the question asked for the ratio of areas and so did not score any marks. Those who did understand that the height ratios should be squared usually scored 1 mark for this by showing 25 or 64. Very few candidates appreciated the need to subtract the small unshaded area from the shaded area or to subtract the shaded area from the large unshaded area. Most did nothing with the 5 for the shaded area, and for the unshaded, added the 8 and 1; hence the answers 5:9 and $\frac{5}{14} : \frac{9}{14}$ for those using the length scale factors and 25:65 simplified to 5:13 for those using area scale factors were very common. Some did score 2 marks for 25 – 1 but very few could get to 64 – 25 + 1.

Question 16

It was common to see the next term in the sequence given as the answer in both parts of this question, even after an attempt, correct or incorrect, to find the nth term. A minority of candidates scored full marks in either part of the question but many part marks were scored in both. In **part (a)** there were many who started with a correct strategy of looking at differences. Some stopped at the first or second step but many did get to a constant third difference and scored a mark. Some connected this to a cubic expression but the majority attempted to find a linear or quadratic sequence using 6 as the starting point. Many used the same strategy of differences for **part (b)** which led nowhere. A good proportion of candidates scored the mark for the correct numerator of $n + 1$. Many were clearly familiar with geometric sequences and could also apply the general formula to find the nth term for the denominator. The term-to-term rule of multiplying by 4 was often spotted and some scored a mark for 4^n, although most translated this to $4n$ or sometimes n^4.

Question 17

A full range of marks was scored in this 4-step rearrangement. It was a minority who scored all 4 marks but the majority made the correct first step of multiplying by $1 - x$. Weaker candidates did not know what to do from here and often started to add or subtract terms from within the bracket. Many did successfully multiply out the brackets but then proceeded to either add yx to give $y =\ldots$ or they rearranged to give $x =\ldots$ but where x was also a term on the other side of the equation. Candidates who isolated the terms involving x generally realised that they needed to factorise and went on to divide correctly. Some candidates made errors with signs when isolating but could still gain 3 marks for a correct factorisation and division. As mentioned in the general comments, this question was an example where candidates combined two lines of working which often rendered a correct line of working as incorrect after 'cancelling' or attempting inverse operations. Clear line by line working should be encouraged.

Question 18

Candidates demonstrated a good understanding and recall of using the sine formula for the area of a triangle and the majority scored full marks. Some broke it down into two parts, using 800 × sin 30 to find the height of

400 and then using $\frac{1}{2}$ base × height to find the area, and with no rounding issues, this caused no problems. There were some rounding issues for those who split the triangle into two right angled triangles unnecessarily and worked with each triangle separately. A number of candidates incorrectly applied bounds to the measurements, perhaps because the question asked for the greatest number of houses. Some candidates did not score because they used cos rather than sin in the formula. The most common misconception was to treat the triangle as right-angled at *B*, with many correctly using the cosine rule to find length *BC* and then incorrectly calculating the area as $\frac{1}{2}$ 800 × *BC*. Others used the perimeter of the triangle after calculating *BC* and divided this by 400.

Question 19

Candidates clearly understood the method involved here and the most common score awarded was 2, for correctly setting up a single fraction or two fractions with a common denominator. It was a minority who then went on to simplify this correctly for the final mark. The very common error was to multiply out the brackets but only have a subtraction sign for the first term, hence adding the other terms. Candidates must be very careful when dealing with brackets, both with signs and ensuring that they are inserted where necessary. As in **Question 14**, brackets were often omitted and not recovered, for example $x+3(x+2)$ and $x+3\ (7)$. It was reasonably common to see candidates immediately crossing through the $(x+3)$ in the second term of the numerator and the denominator and this is a misconception for centres to address. A less common error was to change one or both of the signs in $x+2$ or $x+3$ to a negative, presumably because of the subtraction. Weaker candidates had no strategy to deal with the fractions and many simply added the numerator and the denominator as a first step.

Question 20

It was a minority of candidates who gained all 3 marks for giving both values of *x* as a final answer. It was extremely common to award 2 marks for the answer of 109. It would be beneficial for candidates to draw a quick sketch of the trigonometric function they are working with, in order to see the number of solutions and how to find them. Many of those who did recognise that there was more than one solution added 180 to 109. The majority of candidates who correctly rearranged the equation to $\cos x = -\frac{1}{3}$ went on to gain the mark for the angle 109, although some seemed to lose the negative sign, either carelessly or intentionally to give an answer of 70.5. Weaker candidates struggled to make $\cos x$ the subject of the equation and it was common to see $\cos 3x$ rather than $3\cos x$.

Question 21

Most candidates made an attempt at this question with a full range of marks awarded. A large proportion identified the correct triangle containing angle *ECO*. It would be advisable for candidates to draw and label the correct triangle as many angles marked on the diagram were ambiguous and could not score a method mark if they then continued incorrectly. Those who had identified the correct triangle usually went on to use the correct trigonometric function of tan $\frac{9}{OC}$. Some used the inefficient method of finding *EC* and then used sin or cos to find the angle, adding an extra unnecessary step which often led to inaccuracy due to rounding. Premature rounding was an issue throughout this question and centres should continue to remind candidates about this. $\sqrt{50}$ was often rounded to 7.1 and then halved to 3.55, sometimes without showing working and so marks could not be awarded as the value was incorrect and no working could be seen. Many candidates gained marks for finding the required length of either *AC* or *OC* but then could not progress to find the correct angle. A large number of candidates assumed a length of 2.5 for *OC* and so could only be awarded a maximum of one mark if they were attempting to find the correct angle. Those not scoring were generally using the wrong triangle, often *EBC* and attempting to find angle *ECB*.

Question 22

Candidates demonstrated a good knowledge of the basic laws of indices in **parts (a)** and **(b)** with a good proportion getting the correct answer to these parts. Of those with a correct strategy in **part (a)**, were some who did not score because they gave the answer –2 or did not fully simplify, leaving the answer unprocessed as $x^{-\frac{6}{3}}$. A common error made by those who did not know how to deal with the indices was to cancel the 3s from the denominator of each index and give an answer of $x^{\frac{1}{4}}$. Successful candidates in **part (b)** wrote out each side of the equation as a power of 2 or 4, although it seems that some successfully used a trial and improvement approach using a sensible starting point. Some lost the answer mark by converting to a decimal and not giving the answer to 3 significant figures which is required if inexact. Others left the fraction as $\frac{1}{1.5}$, also not an acceptable form. The answer of $\frac{1}{4}$ was reasonably common, presumably from the fact that 64 ÷ 16 = 4. There were many candidates producing concise, elegant solutions in **part (c)**. The most common method was the expected method of changing the base of $\frac{1}{9}$ into base 3 in order to equate the indices, although other equally valid methods were seen. Some candidates worked out that the value of x was 1 but negated this with clearly wrong working trying to make the answer fit and sometimes it did, only because the value of x was 1. Clear errors were for example, to simply remove the $3x$ from both indices, multiply out the 9, divide incorrectly by 3, write $\frac{1}{9}$ as 0.111…, combine the indices as given and so on. There was a high no response rate for this question along with those who simply rewrote the question.

MATHEMATICS

Paper 0580/22
Paper 22 (Extended)

Key messages

To succeed in this paper candidates need to have completed full syllabus coverage, remember necessary formulae, show all necessary working clearly and use a suitable level of accuracy.

General comments

There were many high scoring scripts with a significant number of candidates demonstrating an expertise with the content and showing good mathematical skill. Where candidates scored highly but did not get full marks, it was frequently **Questions 14b** and **16b** that were the cause, either wholly or in part. There was no evidence that candidates were short of time, as almost all attempted the last few questions, with omissions due to lack of familiarity with the topic or difficulty with the question, rather than lack of time. Only a very small number of candidates were unable to cope with the demand of this paper. Candidates showed particular success in the fundemental skills assessed in **Questions 1** to **6** and **Questions 16a** and **17**. As well as **Questions 14b** and **16b**, the other most challenging questions were **Questions 13b**, **14a** and **20b**. Candidates were very good at showing their working, although occasionally some stages in the working were omitted. This was particularly significant in **Questions 6** and **18**, in which candidates were instructed to show all their working. The standard of presentation was usually good and, in the main, responses were contained within the allocated answer space.

Comments on specific questions

Question 1

This offered a familiar start to ease candidates into the paper, with nearly all candidates scoring the mark. Most candidates were aware that ‘difference’ should be a positive answer, compared with for example a ‘change’ in temperature which might be negative. Amongst those few candidates with an incorrect answer by far the most common were 9.5 and –9.5.

Question 2

This question was well answered. Those candidates who lost marks tended to reverse their first two answers i.e. writing 43 for the mode and 41 for the median. Some candidates found the mode as 58, which suggests they thought the mode was the highest number. Other candidates found the median to be 45, 44.2 or 42.5, which suggests a lack of precision when using the stem-and-leaf diagram. Some candidates wrote the mode as 1 and the median as 3, perhaps implying that they knew how to find the mode and median but did not know how to interpret the key in the stem-and-leaf diagram appropriately. Those candidates who wrote an incorrect answer for the percentage of women that are older than 51 years tended not to show a calculation.

Question 3

For this question candidates were required to convert 2.15 hours into minutes. Many candidates were able to correctly obtain the answer of 129 minutes. Where working was seen there were two main methods – 2.15×60 and $2 \times 60 + 0.15 \times 60$ which was sometimes seen in stages. The most common error was to give the answer 135 minutes from incorrectly interpreting 0.15 hours as 15 minutes and adding this to the 120 minutes for the 2 hours.

Question 4

This question was generally well answered with many candidates earning full marks. Where part marks were awarded, it was often due to an arithmetic slip or for a correct angle marked on the diagram. Most answers were accompanied by clear correct working using either the angles in quadrilateral *ABCD* or in the two triangles *ABC* and *ACD* separately to arrive at the answer. One common incorrect answer involved an assumption that *AC* bisects angle *DAB,* leading to $ABC = \frac{(180-43)}{2}2 = 68.5°$. Some candidates showed clear wrong working *ACD* = (180 – (43 + 58)) leading to *ACD* = 79°, assuming that the two triangles were congruent. A small number thought that as both triangles were isosceles, *ADC* = *ACD* = *ACB* = *ABC* = 58°.

Question 5

In a very high proportion of cases candidates gave the answers of either 11 or 12. The most common method for the correct answer was $\frac{95.25-15.5}{7.25}$. Many candidates knew the correct method to achieve 11 but did not always add on the extra 1. Very occasionally, a candidate made a slip in their subtraction 95.25 – 15.5, leading to a decimal value for their 11 such as 95.25 – 15.5 = 76.75 then 76.75 ÷ 7.25 = 10.59, 10.59 + 1 = 11.59

Sometimes this decimal number was incorrectly copied and then rounded up e.g. 95.25 – 15.5 = 79.75, followed by 79.25 ÷ 7.25 = 10.93. It was not uncommon for candidates to misread the value of 95.25 or 15.50.

Question 6

This question was very well answered with most candidates obtaining the full 4 marks for showing full working leading to the correct answer. The majority of candidates chose to find the reciprocal of $\frac{7}{6}$ and then to multiply by this then cancel down the $\frac{1}{3}\times\frac{6}{7}=\frac{1}{1}\times\frac{2}{7}=\frac{2}{7}$ as the first step. Those using the common denominator method of $\frac{2}{6}\div\frac{7}{6}$ tended to be less successful as $\frac{2}{7}$ did not always follow from this working. If candidates reached $\frac{2}{7}$ this allowed the addition to be done without needing to cancel afterwards. Those who chose to multiply without cancelling first, to reach $\frac{6}{21}$, then tended to use 105 as the common denominator with 51 as the numerator and then cancel down from there. It was not uncommon for candidates to forget to cancel if they took this approach as they could not see common factors in the numerator and denominator of $\frac{51}{105}$. Some correctly showed the working required for the division but then did not show the working for the addition i.e. just wrote down $\frac{2}{7}+\frac{1}{5}=\frac{17}{35}$ without showing the two fractions with a common denominator. A very small number performed the operations in the wrong order, i.e. finding $\frac{1}{3}\div\left(\frac{7}{6}+\frac{1}{5}\right)$. A small number chose to express all three fractions with a common denominator at the start. Some of them went on successfully to score full marks.

Question 7

About two-thirds of the candidates answered this question well, with many candidates presenting full solutions leading to x = 18 and a correct answer of $\frac{37}{60}$. Nearly all candidates recognised the need to add the given expressions together to obtain the total number of flowers, 5 + x + 2x + 1, but this was then often incorrectly equated to 1 or 12 and very occasionally there were slips in simplifying the expression. Others tried to equate x + 2x +1 to $\frac{11}{12}$. Candidates who attempted to multiply probabilities together generally made no progress here. Some identified that the total number of flowers was 60, but did not go on to solve for x. A number of candidates gave 37 as their final answer, not realising that the question asked for a probability. A few candidates followed the correct working of 5 + x + (2x + 1) by 5 + 2x^2 + x, i.e. actually finding 5 + x(2x + 1).

Question 8

This question was one of the more challenging questions on the paper with a variety of incorrect answers produced. Incorrect answers seen include 1.25 (from $\sqrt[4]{39\times\frac{1}{16}}$), 2.499 (from $\sqrt[4]{39}$), 6.25 (from $\sqrt{39\frac{1}{16}}$), 1.56 (from $\sqrt{39\times\frac{1}{16}}$ and 25 (possibly from misreading the calculator screen). Candidates are advised that during their checking they should have raised their answer to the power 4 to see if it was correct.

Question 9

Many candidates reached the correct order here, having converted to decimals, usually giving their answers in the form given. Some did not write down equivalent decimals first and often made at least one error in the ordering. Usually the first and last numbers were correct, although some candidates misread the fraction as $\frac{24}{100}$. By far the most common error was to ignore or misunderstand the recurring dot in the second number, which usually led to it being placed second in the list. Where 0 marks was awarded, this was usually due to multiple wrong conversions rather than a misunderstanding of the inequality signs, the reverse order was rarely seen, possibly prevented by the inclusion of the word 'smallest' under the first answer line.

Question 10

This question was answered well by approximately two-thirds of the candidates. Those who found the exterior angle first i.e. using the method 360 ÷ (180 – 156) were the most successful. Part marks were rarely awarded as most of those who reached the wrong answer started with an incorrect method. Some common erroneous starting points were 180(n – 2) = 156 or 180(n – 1)/n = 180. A small number of candidates worked out 360 ÷ 156 to give 2.30, not appreciating that their answer should be an integer. Some did then round to 2, showing no appreciation that a polygon can not have 2 sides. Some candidates, appreciating this fact, rounded 2.30 up to 3.

Question 11

About two-thirds of the candidates completed the speed-time graph correctly gaining 3 marks. Where candidates did not give a fully correct speed-time graph they often had part of the method or graph completed, most commonly this was the horizontal line representing the time travelled at a constant speed. Where candidates just had the time travelled at a constant speed correct then it was common to see them joining (35,14) to (50,0) for the deceleration section of the graph, due to assuming the graph would end at the far right of the time axis. A smaller number of candidates had the correct line for constant speed followed by a deceleration section of the graph ending at an incorrect time other than 50 seconds, or had the deceleration section of the graph not ending at a speed of 0 m/s. It was less common to see an incorrect length of line for the constant speed section of the graph followed by a line with the correct gradient for the deceleration section of the journey. Not all candidates showed their working for the two required calculations: 210 ÷ 14 and 14 ÷ 1.4.

Question 12

The arithmetic sequence A was generally correct. Some candidates wrote 5n, n – 5 or –5n + 8 as the nth term and a few who used the formula to find the nth term for the sequence wrote 8 + (n – 1) –5 with no brackets around the –5, which scored 0. Sequence B proved to be more difficult, although a number of correct responses were seen. Many of those who got this wrong did not notice that the numerators and denominators could be treated separately but instead tried to attempt a method using the differences between the terms. Sequence C also caused some problems. Those who realised that it involved powers of 2 were usually successful, with only a few having an incorrect power. Most of those who gave incorrect algebraic answers used powers of n rather than powers of 2. A number of candidates gave the 6th term, i.e. the next term, of each sequence instead of the nth term.

Question 13

Both parts of this question were a challenge for many candidates, particularly **part (b)**. Weaker candidates thought that they could multiply the 243 and 27, so it was common to see 6561 followed by an incorrect answer of 3^8, 3^{8n} or 3^{16n} arising from this misconception in **part (a)**. There were quite a few examples of incomplete simplification, usually leaving their answer as $3^5 \times (3^3)^{2n}$ or $3^5 \times 3^{6n}$ or incorrect simplification such as $3^5 \times (3^3)^{2n} = 3^{11n}$ or 3^{5+5n} or writing $3^{(8+5)(2n)} = 3^{16n}$. Some did not give their answer as a power so an answer of 6n + 5 was very common. Converting 243 to 3^5 was not as well done as converting 27 to 3^3. Other misconceptions such as attempting to solve to find a value of *n*; cubing the whole expression i.e. $(243 \times 27^{2n})^3$; picking a value of *n* (often 2) and ignoring the *n* completely were also seen.

Part (b) was one of the most challenging questions on the paper, even for some of the stronger candidates and many candidates offered no response at all. $1944p^6$ was a common answer, scoring 1 mark, and a mark was also often awarded for correctly squaring *k* to reach $2^2 \times 3^4 \times p^6$. Those doing this frequently went on to spoil $6(2^2 \times 3^4 \times p^6)$ by multiplying each of the powers inside the bracket by 6, i.e. $6 \times 2^2 \times 6 \times 3^4 \times 6 \times p^6$. Some candidates invented a value of *k*, often 5. Many candidates did not get any further than $6(2 \times 3^2 \times p^3)^2$, not appreciating that they needed to express 6 as a product of primes too. A significant number of candidates thought they needed to solve something to find the value of *k* or thought they needed to rearrange $k = 2\times3^2\times p^3$ or $6k^2 = 2\times3^2\times p^3$ to make *p* the subject.

Question 14

Full marks were rarely achieved on this question, even among the stronger candidates who frequently found difficulty in expressing a geometric reason. In **part (a)** many candidates correctly identified the angle as 55° but without a correct geometrical reason. Phrases such as ‘alternate angle’, ‘opposite angle’ or ‘opposite segment’ etc. were commonly offered, and ‘corresponding angles’ was also sometimes seen. When an incorrect angle was given it was usually one of: 30°,45°, 60°, 65° or 90°. Occasionally candidates offered a correct reason but not a correct angle so could not be awarded the mark.

Part (b) was the most challenging question on the whole paper, with less than a fifth of candidates answering it correctly. There were many incomplete answers given. Some good explanations from candidates included the words ‘tangents’ and ‘equal’ but did not mention the ‘common point’. General properties of isosceles triangles were often quoted – it was quite common to see ‘because 2 sides are the same length’ (possibly the most popular wrong answer) or ‘the base angles are equal’. Some gave the angle between radius and tangent = 90° as the reason here. In both parts some attempted longer geometrical arguments but it was rare for all steps to be correctly reasoned.

Question 15

Part (a) of this question was well attempted by most candidates with a very large proportion finding the correct line, $y = 3x + 7$. Most correctly used the given points to find the gradient and went on to substitute one of the points into $y = mx + c$ to find the *y*-intercept. Quite a few candidates overcomplicated their work using the midpoint of *AB* to find the *y*-intercept. They tended to do this correctly but were less successful than those substituting *A* or *B*. A common error was to use the negative reciprocal gradient for the equation of the line, i.e. finding the equation of a perpendicular through *A* or *B* or the midpoint. Another common error came in the simplification to find *c* with many candidates going from $16 = 9 + c$ to $c = \frac{16}{9}$ or having arithmetic slips when subtracting 9 from 16, with 9 or 8 sometimes given instead of 7. Some candidates attempted to find the distance between *A* and *B*.

In **part (b)**, the majority of candidates recognised that the negative reciprocal gives you the perpendicular gradient and wrote down the correct answer of –2. Some left this as $\frac{-1}{0.5}$ and did not earn the mark here. 0.5 and –0.5 were common incorrect answers. A significant number of candidates gave an equation of the line, i.e. $y = -2x + c$, with *c* being various values, as their final answer rather than the gradient. On rare occasions an answer of $-2x$ was seen.

Question 16

The table in **part (a)** was often completed successfully. Most candidates identified 6 as the missing multiple of 3 but quite a few gave 4 as the next prime number. Occasional arithmetic errors were also seen in the table resulting in one or two incorrect entries.

Part (b) proved to be much more difficult than **part (a)** with few correct answers seen. The most common error was to give a denominator of 9, the candidate possibly missing that only even numbers were required. Denominators of 15 were also seen which presumably included the numbers in the column headings. A very common answer was 0 which the candidate often accompanied by a statement such as if it was 9 it could not be even. Negative answers or answers greater than 1 were also occasionally seen, showing a misunderstanding of probability.

Question 17

The majority of candidates were able to score here, although many seemed not to be taking the direct route of equating each bracket to zero and writing the solutions. It was common to see the brackets expanded followed by an application of the quadratic formula, or possibly using their calculator to find the roots of their expanded quadratic, this was much more frequently incorrect due to errors in the expanding or simplifying. Some expanded and then refactorized to solve it. Reversed signs, i.e. answers –0.6 and 3.5, was a common error, as well as both answers given as positive.

Question 18

On the whole this question was fairly well answered with about two-thirds of the candidates scoring full marks. Some did not note the instruction to show all of their working and some part marks were lost because of this. Usually by not showing the factorisation (or use of the formula) instead going straight to answers $x = 3$ and $x = 8$. It was noticeable that many candidates used the quadratic formula rather than factorisation to solve the quadratic equation. Candidates who chose to rearrange $y = 2x - 3$ and then substitute to eliminate the x's were rarely able to gain more than 1 mark for this approach as usually there were errors in the rearranging or more frequently errors made in attempting to evaluate $\left(\frac{y+3}{2}\right)^2$ or $-9\left(\frac{y+3}{2}\right)$. A small number had a correct starting point, but were then unable to solve the quadratic equation they reached, and tried to make x the subject. Some tried to solve $x^2 - 9x + 21 = 0$ instead of $x^2 - 9x + 21 = 2x - 3$.

Question 19

This question proved to be a challenge for many candidates, with the first diagram more often wrong than the second. Nearly every candidate attempted this question and there was a wide variety of answers, but only a small percentage of candidates obtained both marks. When asked to shade the region $A' \cup B'$ common errors were to shade $(A \cup B)'$ or to interpret 'not A or not B' as 'A or B but not both'. When asked to shade the region $(C \cup D) \cap E'$, common errors included shading $(C \cap D) \cap E'$, shading E', shading $(C \cup D)$ or including in their shading one (or more) of the regions which are in $(C \cup D) \cap E$.

Question 20

There were a good number of correct answers to **part (a)**, with many caniddates showing complete and correct working. Some started well by correctly finding $2^{(6-3)}$ followed by an incorrect step such as 8 × 8, $2^{(x-3)} \times 8$ or 2^8. A few candidates worked through as far as 2^5 but then did not evaluate this.

Part (b) was less well answered with less than half of the candidates scoring the mark. Most stronger candidates were able give their answer with no working, realising that applying the inverse function to a function got you back to the starting point. A significant number did not realise the implication of the inverse function and worked through the stages to arrive at the right answer often an un-simplified answer such as $\frac{2x+42}{2}$. In this process it was common for minor slips in the working to result in wrong answers such as

$x + 20$, $2x + 20$ and $\frac{2x+41}{2}$. Some correctly found g(x + 21) = 2x + 41 and then tried to find an 'inverse' of this leading to the answer $\frac{x-41}{2}$.

There were many more fully correct answers in **part (c)** and most candidates were able to score a method mark for the correct first step, correctly evaluating h(84) = $\frac{1}{16}$. Algebraic and arithmetic slips or sign errors when equating the powers were often seen, leading to a wide range of incorrect final answers. The use of logarithms was occasionally seen.

Question 21

This was a well attempted question, especially by the stronger candidates who were usually successful. Weaker candidates struggled with the expansion of $(x-3)^2$ which was often expanded incorrectly to x^2+9 or x^2-9. Very occasionally $(2x+5)$ was squared instead of as well as $(x-3)$.

Question 22

This question was attempted by the majority of candidates, with many scoring the at least 1 mark for reaching sin x = $-\frac{2}{7}$ or –16.6. Many went on to score 2 marks for correctly obtaining 343.4° or 196.6°. Where the first mark was not obtained it was most often due to the missing negative sign in the rearrangement leading to $\sin x = \frac{2}{7}$ and a value of 16.6°. The most common incorrect working and answer was to do 180 – 16.6 = 163.4°. A number of candidates gave three answers with one incorrect or outside of the region $0° \leqslant x \leqslant 360°$ i.e. often accompanying the correct answers with –16.6°or 163.4° which still scored 2 marks for one correct answer being seen.

Question 23

Despite this being the last question of the paper, many strong candidates demonstrated good algebraic skills and fully factorised the numerator and denominator to arrive at the correct answer. A number of incomplete attempts were made here on both the numerator and the denominator. A common error on the numerator was to see $3y(x+12)-5(x-12)$ which then often lead to partial cancelling with the denominator. Another common error was to see the numerator correctly factorised but $(x+12)(x-12)$ as the denominator, as many candidates incorrectly cancelled out a 2 in both terms rather than factorising it out. Of those making partial progress $2(x^2-144)$ was quite common, some went on to incorrectly write this as $2(x+12)^2$. Those who attempted to cancel individual terms on the numerator and denominator generally made no progress.

MATHEMATICS

Paper 0580/23
Paper 23 (Extended)

Key messages

It is important for candidates to show each single step in a method and they should avoid trying to do more than one step on each line. Final answers should be checked to see if they are in the form required, in the correct order, and to the accuracy requested.

General comments

In longer problems candidate should keep to as much accuracy as they can in the intermediate steps, and only write their final answer correct to a certain number of figures. In a single right-angled triangle, only one of the three trigonometric ratios, sine, cosine or tan, will normally need to be used to solve the triangle. The sine rule or cosine rule are more appropriate for triangles which do not have a right angle and candidates should look to improve their awareness at identifying which rule needs to be used for which scenario.

Comments on specific questions

Question 1

This question was answered very well. The two common errors seen were $\frac{26}{208} = 0.125$ or $\frac{208}{26} = 8$.

Question 2

Again, this was answered well with the common incorrect answer being 132.

Question 3

Here a few incorrect answers were seen, generally either both 13 and 15 given together or a single answer of 15.

Question 4

(a) It was not uncommon to see only one answer ringed, usually >.

(b) Very few answered this wrongly, but some candidates did not use brackets and instead changed the second subtraction sign into an addition sign to give the answer 7; $7 - 3 + 1 + 2 = 7$.

Question 5

The most common error was $153 \times 0.9 = 137.7$. Most responses were correct.

Question 6

This question was well answered with the most common correct method being $420 \times 0.85 = 357$. Those who calculated 15 per cent of 357 then occasionally forgot to subtract the 63 from 420. Other incorrect methods seen were $420 \div 1.15$ or $420 \div 0.85$.

Question 7

Most candidates who achieved full marks for this question did not show any working. The common incorrect answers seen were 8^{28} and $8g^{8}$.

Question 8

Candidates found this question difficult. The most common wrong method was to write $\frac{4+4.5+4.5}{3}=4.33$.

There was some premature rounding when converting $\frac{2}{4.5}$ to a decimal i.e. writing 0.44 and then $\frac{1+2}{0.25+0.44}$, giving the answer of 4.35. The other common incorrect method seen was $\frac{4+4.5}{2}=4.25$.

Question 9

Many candidates did not show any working at all and just wrote $\frac{3}{11}$ or $\frac{27}{99}$ in the answer space. The most common wrong answer was $\frac{27}{100}$.

Question 10

(a) Almost all responses were correct.

(b) Many answers were correct with little or no working shown. The common incorrect answer was $n-4$.

Question 11

(a) Most of the candidates gave the correct answer to this question and showed their working.

(b) Most correct answers were in the form $\sqrt{\frac{P}{M}-h^2}$. Sometimes this was seen in the working and then spoilt on the answer line by writing $\sqrt{\frac{P}{M}}-h$ as some candidates wrongly attempted to take the square root of the expression. A common error in the first move was to subtract M and write $P-M=g^2+h^2$. Many thought that $\sqrt{g^2+h^2}$ was $g+h$. Those who chose to expand the brackets first usually wrote $=Mg^2+Mh^2$ and then most of them gave the correct answer in a slightly different form. Square roots were mostly written correctly by including the whole fraction.

Question 12

Candidates who did not gain full marks to this question usually showed the working $\left(\frac{11}{12}+\frac{9}{12}\right)$ and then wrote their answer as an improper fraction (usually $\frac{5}{3}$). Some chose other denominators such as 48 and this did not impede them gaining full marks.

Question 13

Nearly all candidates got this correct with an answer of 1×10^{-2}. Some of the few errors seen were 1×10^{2} or 10^{-2} and in these cases candidates usually achieved the mark for 0.01 seen in their working.

Question 14

(a) In this question, most candidates gained full marks. Common wrong answers included just $\{d\}$ giving the intersection instead or by including all the letters in the diagram $\{a\,b\,c\,d\,e\,f\,g\}$.

(b) This part was not so well answered. A common error was to list all four of the elements of the set, or give the answer of 3, showing that they understood the n() notation but had not include the element within the intersection.

(c) This part was also not well answered and the solutions were very diverse. Some common errors were listing the elements or giving the letter d on its own.

Question 15

The most popular correct method was $x = \frac{153.70}{1.06} = 145$. Common incorrect methods included $153.70 \times 6\% = 9.222$ then $153.70 - 9.222 = 144.478$ or $153.70 \times 0.94 = 144.478$.

Question 16

The most common correct method was to form two equations and solve one, then substitute into the other i.e. $J + M = 26$ and $J = 5 + M$, then substitute the second into first to produce $5 + M + M = 26$, giving $M = 10.5$ and $J = 15.5$. Candidates then doubled their values to produce the correct ratio. Some candidates did not convert 10.5 and 15.5 to 21 and 31, or they presented the answer the wrong way around as 21:31. The most common error was producing 9:4 from 18:8, which came from $26 \div 2 = 13$ and then adding and subtracting 5 to reach 18 and 8.

Question 17

Most candidates got the correct answer, mainly using the interior angle formula $\frac{(n-2)180}{n} = 178.5$, with fewer of them using the exterior angle formula $\frac{360}{n} = 180 - 178.5$. The most common error was to use the incorrect equation $(n-2)180 = 178.5$.

Question 18

The most common method here was work out the gradient $\frac{10 - -2}{3 - 2} = 12$, then substitute a point to produce c = −26. The most common error was to invert the gradient formula and produce $\boldsymbol{m} = \frac{1}{12}$, or to draw the diagram and achieving the correct gradient but then the incorrect *y* intercept value.

Question 19

The most common correct method was to find the arc $\frac{80}{360} \times 2 \times \pi \times 12.6 = 17.6$, then add on the straight side opposite the 80° using the cosine rule $a = \sqrt{12.6^2 + 12.6^2 - 2 \times 12.6 \times 12.6 \times cos80°}$. Many candidates found the area, which they confused with the perimeter, using πr^2 instead of $2\pi r$ for the arc and then adding on the area of the triangle

Question 20

This question was not answered well, with most candidates not dealing adequately with the conversion of the square units. Many candidates thought that $3\text{km}^2 = 3 \times 1000 \times 100 = 300000\text{cm}^2$. Two very common incorrect answers were $\frac{300000}{18.75} = 16000$ and $\frac{18.75}{3} = 6.25$. Some candidates, who successfully dealt with the squared units, often failed to square root their answer of 1 600 000 000.

Question 21

This was well answered. Common incorrect answers were $243y^6$ or 27^6.

Question 22

This was a generally well answered question. The most common correct method came from equating the *y* expressions $x^2 - 3x - 13 = x - 1$. Most candidates were able to rearrange to get $x^2 - 4x - 12$ and then to use factorisation to achieve correct values for *x*. The quadratic formula method was less successful with candidates struggling to deal with $(-4)^2$ in the discriminant. A small number of candidates just produced correct values for *x*, probably from their calculator. Most errors were in simplifying their equation.

Question 23

(a) Most candidates gave 13.6 as their answer. Their working was clear and well set out.

(b) The most common error was to think that the required angle was CAB. The most common method was to use 'tan' but others candidates chose the sine rule or squeezed in a cosine rule calculation.

Question 24

Most candidates scored at least one mark, almost always for an answer of 60. Common errors included answers of 300 and –60. A small number of candidates gave an answer of 1.73 and/or –1.73.

Question 25

The most common method for this question was in three steps as follows: $\frac{3x(x-6)}{a(x-6)+2c(x-6)}$ then $\frac{3x(x-6)}{(a+2c)(x-6)}$ and finally $\frac{3x}{a+2c}$. The most common error was to cancel one of the $(x-6)$ factors from the denominator in the first step above producing:- $\frac{3x}{a(x-6)+2c}$ or $\frac{3x}{a+2c(x-6)}$ with a final answer of $\frac{3x}{(a+2c)(x-6)}$.

Question 26

A small number of candidates gave a correct answer with no working, likely using the ratio theorem. Most candidates realised that the point *X* was such that $\vec{RX} = \frac{2}{5}\vec{RT}$ or $\vec{TX} = \frac{3}{5}\vec{TR}$. Many recognised that the position vector was *OX* or gave a correct route or wrote $\vec{TR} = \mathbf{r} - \mathbf{t}$ or $\vec{RT} = \mathbf{t} - \mathbf{r}$. Some candidates would write these last two the wrong way round.

MATHEMATICS

Paper 0580/31
Paper 31 (Core)

Key messages

To be successful in this paper, candidates had to demonstrate their knowledge and application of various areas of mathematics. Candidates who did well consistently showed their working out, formulas used and calculations performed to reach their answer.

General comments

This paper gave all candidates an opportunity to demonstrate their knowledge and application of mathematics. Most candidates were able to complete the paper in the allotted time. Few candidates omitted part or whole questions. Candidates generally showed their workings and gained method marks. Centres should continue to encourage candidates to show formulas used, substitutions made and calculations performed.

Candidates find 'show that' questions challenging and often do not show all steps needed. Candidates should be reminded that to gain credit on these types of questions they must not use the fact they are trying to show.

Candidates should also be encouraged to process calculations fully and to read questions again once they have reached a solution so that they provide the answer in the format being asked for and answer the question set.

The standard of presentation was generally good; however, candidates should be reminded to write their digits clearly and not to overwrite their initial answer with a corrected answer but to re-write.

Comments on specific questions

Question 1

(a) (i) Nearly all candidates correctly identified 17 as the square root of 289. Occasionally a value was given that was not from the list. Answers were sometimes spoiled by candidates writing 17^2 and therefore not answering the question.

(ii) Some candidates gave factors of 81 that were not on the list, usually 9, but the vast majority were successful in identifying 27 as the factor of 81.

(iii) Again, the vast majority of candidates gave the correct answer of 30 as the common multiple of 3 and 5. Some candidates gave a common multiple of 3 and 5 which was not in the given list, usually 15. Some others gave 25 or 27 as multiples of 5 or 3, rather than a common multiple.

(b) Few candidates gained full credit in this question. A number of errors were seen including 1 as a prime number, three correct values but not consecutive or square and cube numbers in the wrong places. Whilst most candidates were able to gain partial credit by satisfying at least two of the criteria, few found three consecutive numbers which fitted the criteria. The use of indices for the cube and square numbers (such as an answer of 2, 3^3, 4^2) showed misunderstanding of what was required. Successful candidates wrote a list of prime, cube and square numbers to then pick the three suitable numbers from their lists.

(c) (i) The majority of candidates successfully placed one pair of brackets in the correct place in **parts (i)** and **(ii)**. Errors were uncommon but those that did occur included ÷ or ÷ 2 inside the bracket.

(ii) Occasionally two sets of brackets were seen around 51 – 12 and 3 + 6.

(d) (i) Many candidates did not understand the term 'reciprocal' leading to varied answers. Some answers showed that they had an idea, such as 8/1 or –8. Other common errors were to give the cube root or the square of 8.

(ii) Finding the value of 14^0 was usually answered correctly, with 0 or 14 seen occasionally.

(e) (i) Nearly all candidates correctly used their calculator or showed understanding of indices to reach the correct answer of 625.

(ii) Again, this part was well answered by candidates using their calculators, although not as successful as **part (e)(i)**. A common incorrect answer was $\left(3\times\sqrt{6859}=\right)248.457...$

(iii) Fewer candidates were able to calculate with a negative fractional index number. Common incorrect answers came from misreading the question as $16-\frac{1}{2}=15.5$, interpreting the power as halving with a common incorrect answer of 8, or not interpreting the negative index number correctly with the common incorrect answer of –4.

Question 2

(a) Most candidates demonstrated their understanding of place value and place holders well on this question. Unsuccessful candidates often missed out the zero in the hundreds column (49 650) or treated the given number as two separate numbers, i.e., 496 000 50 or even three separate numbers, i.e., 400 96000 50, along with other variations.

(b) (i) The vast majority of candidates achieved the mark for 'Musicals' but fewer scored the mark for the angle. Some wrote the incorrect angle on the answer line while indicating the correct angle on the diagram. Some candidates may not have had a protractor as they left the angle blank or appeared to be trying to calculate it. Only a few referred to a different sector of the chart.

(ii) This part was quite well attempted but 90% was a common error, confusing degrees with percentage. Some gave 27% presumably from the Operas angle. Many candidates chose to calculate that an exact quarter of the circle represented 25%, e.g. $\frac{90}{360}\times100$.

(iii) Many candidates were successful in calculating the number of opera performances as 24. Most correct answers found the fraction of the pie chart and then multiplied by 320. There was some confusion between percentages and degrees in pie charts from some candidates. Some chose to work out the percentage that represented opera, 7.5%, but either did not know what to do with that or did not make it clear that it was a percentage. Many incorrect approaches were seen such as expressing their fraction of opera performances out of 320 instead of 360 (giving 30.375) or found 27% of 320 or 320 ÷ 27 = 11.85.

(iv) Candidates found this part more challenging. Many used the usual ratio method of adding the values in the ratio (12) dividing 56 by the total (4.666...) and then multiplying by 5 (23.333). These candidates had not appreciated that the 56 was the number of classical music concerts and not the total number of concerts.

(c) Candidates showed good understanding of working with money with successful solutions showing every step of their working out. Many candidates used a correct method to reach 78 but did not halve it whilst others did not include the fact that Alex was buying for 3 children not just 1. Other candidates made errors with arithmetic when rearranging their equation.

(d) Calculating the percentage reduction was well attempted with most candidates gaining at least partial credit. The most common correct method was to calculate the reduction first (9.10) and then divide by the original cost (65) and finally multiply by 100. Common incorrect answers were 86 (55.90 as a percentage of 65) or the use of the incorrect fraction $\frac{9.1}{55.9}$.

Question 3

(a) Almost all candidates calculated 64 and 160 correctly but many had difficulty with a column or row with two missing values. In these types of questions candidates must be very careful as a single arithmetic mistake can result in other values being incorrect.

(b) (i) Candidates were less successful in using the table of results to calculate the probabilities in all three parts of **(b)**. Candidates often gave all three answers out of 360 rather than the correct denominators as identified by the wording in the question. In this part there were many incorrect answers, with $\frac{62}{121}$ the most frequent incorrect answer from using the total for the Wildlife Centre instead of the total Girls. Some converted a correct fraction to a decimal with less than 3 significant figures without showing that fraction first.

(ii) The correct answer was seen often as $\frac{9}{24}$ or its simplified form $\frac{3}{8}$. Many candidates gave the denominator as the grand total, so $\frac{9}{360}$ was often given as the answer. Another incorrect answer seen was $\frac{9}{163}$ using the subset of Girls.

(iii) Successful candidates added the number visiting the Adventure park and Botanic gardens before forming a fraction or added two separate fractions to reach $\frac{168}{360}$. Common incorrect methods included $\frac{144}{360}\times\frac{24}{360}\left(=\frac{2}{75}\right)$.

(c) Around half of the candidates correctly found the number of coaches (3) and the number of empty seats (12). This was either done by dividing 144 by 52 or by repeated addition. A common incorrect answer was 2,40 from $\frac{144}{52}$ being 2 remainder 40.

(d) (i) Candidates found writing an expression challenging and often wrote an equation instead. $550 + 1.12x = 551.12x$ and $x = 550 + 1.12x$ were seen often.

(ii) Only the most able candidates could equate their expression with the given expression and then solve correctly. Some candidates who were unable to get to the correct answer could often equate the expressions for the two companies and start to rearrange them. Some simply added the two expressions. There were many attempts to use simultaneous equations by equating both expressions to y, but these attempts generally did not prove successful. Some candidates were able to find the correct value of 125 km through trial and improvement.

(e) There was a great variety of answers. Around half of the candidates did give the correct answers but of those who did not, a few got the numbers the wrong way around or rounded to whole numbers giving, e.g. 52 and 53 or 54. Others gave the answers correct to the nearest 100 m or 200 m not the nearest kilometre as required by the question. 53.4 as the upper bound was seen only a few times.

(f) (i) This part was the most successfully answered part of this question. Most candidates correctly found the amount spent to be \$9. Common errors seen were converting $\frac{2}{7}$ to a percentage and then finding 28.6% or 28.5% or 29% of 31.50 and therefore not giving the correct level of accuracy needed.

(ii) Around half the candidates were able to give the correct fraction as $\frac{6}{7}$. Some started correctly by doing $\frac{4.50}{31.50}$ and getting as far as $\frac{1}{7}$ to give the fraction left, but then not subtracting it from 1 to give the fraction spent as stated in the question.

Question 4

(a) (i) The majority of candidates correctly identified angle *a* to be 48. Common incorrect answers were 132 (answer to **part (ii)**) and 72.

(ii) Fewer candidates were able to identify angle *b* to be 132. Common incorrect answers were 48 (answer to **part (i)**) and 84 (180 – 48 – 48).

(b) Many candidates correctly found *x* to be 74, the most common successful method being 360 – 72 – 119 – 63 = 106 and then 180 – 106 = 74. A significant number of candidates gave the final answer of 106 as they did not complete the full method. Other common incorrect answers were 108 (180 – 72), 63 (incorrectly using alternate angle with angle *BCD*) and 72 (incorrectly using corresponding angle with angle *BAD*).

(c) (i) Many of the candidates correctly named the line *BC* as a chord. The most common incorrect answers given were radius and tangent.

(ii) Explaining why angle *ABC* is 90° proved to be a challenging question. Candidates must use correct terms from the syllabus - '*Angle in a semicircle is 90°*'. Many candidates gave longer answers which included terms like diameter and chord.

(iii) Finding the value of *x* was equally as challenging and only the most able candidates found the correct answer. A number of incorrect assumptions were made by candidates about the triangles *ABO* and *BCO* which led to incorrect answers. First was that angle *CBO* and angle *ABO* were equal and therefore 45° each which often led to the incorrect answers of 91 or 89. The other assumption was that triangle *ABC* was isosceles and therefore angle *BCA* was 46° which often led to the incorrect answer of 88. Other incorrect answers seen were 90 (often with little or no working out – assuming angles *COB* and *AOB* were equal) and 44. Candidates should be encouraged to write known or calculated angles on the diagram.

(iv) More candidates were successful in finding angle *y* to be 44°. Successful methods used correct right-angled triangles *BCD* or *ACD*. Some candidates incorrectly assumed that triangle *BCD* was isosceles.

Question 5

(a) The majority of candidates were able to find the range. Many candidates showed they understood that range was the difference between two values but used 2 and 13 (first and last values in the table) or 25 and 20 (television not social media). A large proportion of candidates attempted to find the mean or median instead of the range.

(b) (i) Many less able candidates did not attempt this part despite answering all the other parts. Of those that did answer many were accurate when plotting the points. However some were in the incorrect place because of plotting them the wrong way around (up first then across). Others were just one square out because of misreading the scale, especially horizontally. Many candidates only plotted one of the points correctly.

(ii) More candidates recognised that this diagram showed negative correlation and some qualified it with weak or strong. Incorrect answers such as descending or inverse were seen. A small number of candidates recognised it was about correlation but incorrectly gave it as positive.

(iii) Many of the attempted lines of best fit were acceptable. Lines which were not accepted were generally too steep or no single line drawn. Many candidates joined the points.

(iv) Candidates' answers were often within the acceptable range even from an incorrect or no line. Several follow through marks were awarded for answers outside of the range using their line of best fit.

Question 6

(a) (i) To be successful, candidates had to explain that the train had stopped moving. This could have been given in a variety of ways including stationary, at rest or at Wengernalp.

(ii) Most candidates were able to read off the times that the train left Allmend (13 59) and arrived at Wengernalp (14 09). However not all were then able to give the correct answer of 10 minutes. Common incorrect answers were 11, 25 and 9.

(iii) Most candidates realised the need to use the speed distance time formula. The correct formula was quoted often and successful candidates used the correct distance of 6.4 m and time of 25 minutes which they either correctly converted to hours as $\frac{25}{60}$ or $\frac{5}{12}$ hours. Candidates who converted their time to hours but rounded to 0.417 or 0.416 often did not gain full credit as their final answer was not exactly 15.36. Many candidates divided 6.4 by 25 but did not then multiply by 60 to give their answer in km/h. Many candidates were unable to find the correct time from the graph with 24, 19, 14 and 29 seen often or the actual time of day 14 19 used.

(iv) A large number of candidates did not attempt the drawing of the journey for the second train. Those that did often gained partial credit for the final two parts of the journey (14 18 to 14 30). However many were unable to gain full credit as they either did not start at the correct position, with (14 01, 6.5) plotted instead of (14 01, 6.4), or the end of the first part of the journey finished at (14 18, 2) instead of (14 18, 1.9).

(v) Most candidates were able to identify the time that the two trains passed each other from their intersecting lines on the graph. Many candidates gained this mark as a follow through from an incorrect line in **part (iv)**.

(b) Candidates demonstrated good understanding of negative numbers with the vast majority correctly giving the temperature as 7. Common incorrect answers were 13 and −13.

(c) Some candidates found this substitution question challenging although the vast majority did get the correct answer of −4.

Question 7

(a) (i)(a) Many candidates were able to identify *C* and *G* as the two corners which join to corner *A*. Common errors were *G* and *H*, *F* or *N* or pairs with *B*, *M* or *N*.

(i)(b) Many candidates were able to identify the edge which joins with *KL*. Common errors were CD, *MJ* and *IN*.

(ii) The most successful solutions showed the area of all 3 different rectangles and then adding 6 values or doubling and adding 3 values to reach the correct answer of 76 cm². Some candidates however found it difficult to find the 3 separate dimensions from the net and various attempts at incorrect rectangle areas were seen. Some candidates used the formula for the volume in this part. Few candidates counted squares from the net (those that did generally got it correct).

(iii) Fewer candidates were able to find the volume than the surface area with a significant number of candidates not attempting this part. Successful solutions showed the formula and full working out to reach the correct answer of 40 cm^3. Common errors came from using one incorrect dimension from the net, e.g. $5 \times 4 \times 4 = 80$ cm^3 and $4 \times 4 \times 2 = 32$ cm^3.

(b) (i) Good solutions often came from quoting the correct formula for the volume of a cylinder and then substituting in 3.2 for *r* and then rearranging to find *L*. Common incorrect answers came from wrong formulas used for the volume of the cylinder or the area of the circle. Many less able candidates simply divided the volume by the radius.

(ii) Candidates were given the formula for the volume of a sphere and therefore were more successful in this part than the other two parts in **Question (b)**. Few candidates did not attempt it and most were able to gain at least partial credit for a correct substitution of 3 for *r*. Some candidates showed the correct substitution but then squared instead of cubed and gave a common incorrect answer of 37.7.

(iii) This challenging percentage and volume question was not attempted by some candidates. Only very able candidates gave the correct answer. Successful solutions were carried out in steps with full working shown. Candidates generally started by multiplying their answer to **part (ii)** by 4 and then subtracted this from 775. The full method required a percentage so this value had to be divided by the total volume of the cylinder and multiplied by 100. Common errors included not subtracting from 775 (finding the percentage not empty), dividing by an incorrect value and not multiplying by 4. Some candidates thought they needed to find the largest number of spheres that could fit in the tube and therefore did not multiply by 4 (often by 6).

Question 8

(a) (i) Whilst most candidates recognised this was a Pythagoras' theorem question about finding a short side and therefore involving a subtraction, some were unable to show clearly each step leading to the answer of 75. Often candidates did not explicitly show the subtraction. Few candidates who attempted a trigonometric solution got all the way to the end. Only a few started with 75 and therefore did not 'show that' it was 75. However, there were many fully correct answers showing the required squares, subtraction and square root.

(ii) This part was less well attempted with only a minority gaining credit. Many did not recognise this as a trigonometry question and many who did often used the incorrect sides with the trigonometry ratio or wrote them upside down. A common error was to use $\sin^{-1}\left(\frac{100}{125}\right)$. Premature rounding was an issue for some and others rounded their final correct answer to 36.8 without showing a more accurate answer. Possibly some did not know how to do the inverse of a trigonometric function on a calculator. Others did not use trigonometry, giving answers of 45, 90, etc.

(b) Some candidates found this question challenging and tried to use trigonometry, Pythagoras' theorem, or various combinations of adding and subtracting the given numbers. Candidates who found the correct area, 96, of the lower triangle often went on to gain full credit. 192 was a common incorrect area with the candidate forgetting to divide by 2 for their triangle. A significant number of candidates did not attempt the question.

Question 9

(a) (i) Many candidates were able to correctly rotate triangle *A*. However, a large proportion of candidates were able to gain partial credit for rotating triangle *A* 90° clockwise but about the incorrect centre; common incorrect centres were (3, 2) or (3, 5).

(ii) Many candidates were able to correctly reflect triangle *A* in the line $x = 5$. Common errors were to reflect in the line $x = 4$ or $x = 0$.

(iii) This enlargement question proved to be the most challenging of the three transformation questions. Only a minority of candidates were able to enlarge correctly in the correct position. Many candidates did however gain partial credit for a correct size and orientation but in the incorrect place, often using (7,7) as the point for the right angle rather than the centre of enlargement.

(b) Many candidates gave the correct description. Common incorrect vectors given were $\begin{pmatrix}7\\2\end{pmatrix}\begin{pmatrix}2\\-7\end{pmatrix}\begin{pmatrix}7\\-2\end{pmatrix}$. Translocation was the most common incorrect answer instead of translation.

Question 10

(a) Completing the table was the most successful part of this question. Nearly all candidates attempted the question and a majority were fully correct. Substituting a negative value of x (–2) into a quadratic expression challenged some candidates. The common incorrect answer was 2 or –2 for $x = –2$.

(b) There was good plotting of points with smooth curves drawn and very few straight lines joining points were seen and even fewer thick or feathered curves drawn. Common errors were joining (1, 6) and (2, 6) with a straight line and plotting point (–1, 0) at (0, 0) or (0, –1).

(c) In this question candidates were asked to solve an equation by using their graph, which most candidates did not realise that they simply had to read the x-coordinate of the points of intersection of their curve and the given straight line. –1 and 4 were the most common incorrect answers given from solving the quadratic = 0. Candidates who attempted to give the points of intersection often gained partial credit for the positive value between 2.7 and 2.9 although the negative value was less successful with many answers less than –2 given.

MATHEMATICS

Paper 0580/32
Paper 32 (Core)

Key messages

To succeed in this paper candidates need to have completed full syllabus coverage, remember necessary formulae, show all working clearly and use a suitable level of accuracy. Particular attention to mathematical terms and definitions would help a candidate to answer questions from the required perspective.

General comments

This paper gave all candidates an opportunity to demonstrate their knowledge and application of Mathematics. Most candidates completed the paper making an attempt at most questions. The standard of presentation and amount of working shown was generally good. Candidates should realise that in a multi-level problem solving question the working needs to be clearly and comprehensively set out particularly when done in stages. Centres should also continue to encourage candidates to show formulae used, substitutions made and calculations performed. Attention should be made to the degree of accuracy required. Candidates should be encouraged to avoid premature rounding in workings as this often leads to an inaccurate answer. Candidates should also be encouraged to read questions again to ensure the answers they give are in the required format and answer the question set. Candidates should also be reminded to write digits clearly and distinctly. Candidates should be prepared to use an algebraic approach when solving a problem solving question. Candidates should use correct time notation for answers involving time or a time interval.

Comments on specific questions

Question 1

(a) Most candidates answered this question correctly and were able to gain full credit. Common errors included giving the answer as the total cost of $15.10 and omitting to work out the change, only using either 2 cups of coffee or 4 glasses of cola.

(b) The majority of candidates answered this question correctly. However there were a number of errors which indicated that candidates did not recognise that the $37.80 dollars represented 7 + 2 = 9 parts, with candidates working out 37.8 ÷ 7 or 37.8 × 7 or 37.8 × 9. Other candidates successfully worked out one part as $4.20, but either did not multiply it by 7 or multiplied it by 2, to find the amount spent on drink, or multiplied it by 9 to get back to $37.80.

(c) This question was also answered correctly by the majority of candidates. The most common error seen was to find the increase in the price of the ticket, $5.76, but omitting to add this to the original price to find the new price of the ticket. Other errors included decreasing the ticket price by $5.76, using $48 ≡ 88% or simply adding 48 + 0.12.

(d) Whilst many candidates answered this question correctly it was evident that many could not accurately find the difference between either 09 18 and 10 03 or 09 18 and 11 05. The most common errors were to use 100 minutes in an hour, for example, 10 03 – 09 18 = 0085 or to make mistakes in subtraction such as 11 05 – 09 18 = 02 13.

(e) Candidates did not always appreciate the fact that the key to completing the pie chart was to start with 42° representing 28 tickets. Successful candidates either used this to work out that each ticket was represented by 1.5° or that there were a total of 240 tickets. Calculations such as 192 × 1.5 and $\frac{192}{240} \times 360$ leading to 288° usually resulted in the correct pie chart. Common errors included using $\frac{192}{(192+28)} \times 360 = 314$ or drawing 192 adult tickets as 192°, inaccurate drawing of angles and dividing the blank sector in half.

Question 2

(a) (i) This part on identifying a multiple of 24 was generally very well answered, although the common error of 8, a factor of 24, was seen.

(ii) This part on identifying a square number was generally well answered, although the common errors of 8 and 72, were seen.

(iii) This part on identifying a cube number was generally reasonably well answered, although the common error of 49 was seen.

(iv) This part on identifying a prime number was less well answered, with the common error of 51 often seen.

(b) This part on writing 420 as a product of its prime factors was generally answered well, particularly by those candidates who used a ladder diagram or a factor tree in their working. Common errors included simply listing the prime factors, incomplete diagrams and using non-prime numbers as part of the answer.

(c) This part on finding the LCM was again reasonably well answered. The two most commonly used methods of prime factors, or making lists, were equally successful. Common errors included 6 (HCF) and 2520 (from 30 × 84).

(d) Candidates found this question on finding an estimation for a given calculation challenging. The most common error was simply to evaluate using a calculator and then possibly rounding their answer. Many candidates didn't appreciate the necessity and requirement to round to 1 significant figure, with those who did try to round often only rounding to the nearest whole number or 1 decimal place.

Question 3

(a) This question was found challenging by many candidates and proved to be a good discriminator. Candidates should realise that in a multi-level problem solving question such as this the working needs to be clearly and comprehensively set out. Those candidates who used a ratio method using the two given distances were slightly more successful. Those who used the distance, time, speed equations were usually able to correctly find the running speed in metres per second but were then unable to apply a correct formula to find the total time taken. Other common errors included incorrect conversions of 400 m or 6 km, and incorrectly converting the correct time of 19.75 minutes into minutes and seconds, with 19 mins 75 secs, 20 mins 15 secs being the common incorrect answers.

(b) This part on finding a probability was generally answered very well although common errors of 0.6, $\frac{1}{0.94}$ and $\frac{47}{50}$ were seen.

(c) (i) Common errors in this part included giving the median, the largest number, the last number in the list and calculating the mean value.

(ii) Common errors in this part included stating the middle number of the unordered list, the answer of 26 from using 24 and 28 in the ordered list and calculating the mean value.

(iii) Common errors in this part included stating the largest or smallest value, 17 from 32 – 15 of the unordered list and calculating the mean value.

(d) This part proved to be quite challenging for a number of candidates, and proved to be a good discriminator, although many correct solutions were seen. These often resulted from setting up an equation with clear working, using the two totals of 330 and 402 while some used a trial and improvement method. Common errors included adding on 67, the value given for the new mean, to the original list and finding the mean of these 6 values, finding the mean of the given values and dividing the total of the given values by 6.

Question 4

(a) This question on geometric properties was answered reasonably well particularly with the follow through applied. Common errors included $x = 73$, $y = 122$ or their value of x, incorrect use of *ABC* as an isosceles triangle to find $y = z = 61$, $z = 107$ and the incorrect use of 360 as the sum of the angles in a triangle.

(b) This part was generally answered very well with the majority of candidates able to identify the angle of a semicircle as 90°, and then to perform the required calculation. Common errors included 32 or 74 from the incorrect use of triangle *PQR* as isosceles, 148 from 180 – 32, and again the incorrect use of 360 as the sum of the angles in a triangle.

(c) This question on finding the perimeter of the given sector was found challenging by many candidates and proved to be a good discriminator. Candidates should realise that in a multi-level problem solving question such as this the working needs to be clearly and comprehensively set out. Common errors included the use of area formulas rather than circumference formulas, incorrect or no use of $\frac{72}{360}$, and omitting the addition of the two radii.

Question 5

(a) This was a well answered question with the majority gaining full credit. One successful strategy often seen was to re-write the question, grouping the *a* values and *b* values together. Common errors included $12a - 5b$, $12a + b$, $-2a - b$, and $11ab$.

(b) This part on finding the value of an expression was generally well answered although common errors of 34 (from 40 – 6), $40x - 6y$, and a small number of arithmetic errors were seen.

(c) Candidates demonstrated good algebra skills dealing with this equation with the majority able to make the correct first step of transposing the like terms to reach $4x = 11$. Common errors included incorrect first steps of $8x = 5$, $8x - 5 = 0$, $4x = 5$ and incorrect second steps such as $x = \frac{4}{11}$, 11×4 and $11 - 4$.

(d) This part on changing the subject of the formula was generally answered well. Common errors included incorrect first steps of $6t = P - 11$, $t = 6P - 11$, and incorrect second steps such as $(P + 11) \times 6$, $\frac{P}{6} + 11$.

(e) The majority of candidates had the mathematical knowledge and skills to gain some credit in this question on simultaneous equations with many successfully gaining full credit. The most common and most successful method was to equate one set of coefficients and then use the elimination method, and the majority of candidates showed full and clear working for this. It was less common to see a rearrangement and substitution method which is where more algebraic mistakes occur. Common errors included a range of numerical errors, incorrect addition/subtraction when eliminating, lack of working, and the apparent use of a trial and improvement method which was largely ineffective. A small number of candidates were unable to attempt this part.

Question 6

(a) This part was generally answered well. Those candidates who wrote down the decimal equivalents in the working space tended to do better.

(b) (i) This part was answered reasonably well although the common errors of 0.004, 0.00497 and 4.973 were often seen.

(ii) This part was answered less well with the common errors of 0.005, 0.0049, 49, 50, 0.00410 and 49.73 often seen.

(c) Candidates found this questions on bounds challenging and few correct answers were seen. Common errors included $37.83 \leqslant h < 37.85$, $37 \leqslant h < 38$, $37.79 \leqslant h < 37.89$, and $3784 \leqslant h < 3785$.

(d) This part was answered reasonably well although the common errors of 201×10^6, 2.01×10^6 and 2×10^8 were often seen.

(e) (i) This part was generally very well answered although the common error of China was often seen.

(ii) This part was generally very well answered although the common errors included Eritrea and China.

(iii) This part was generally well answered with the correct answer equally given in standard or normal form.

(iv) This part proved to be quite challenging for a number of candidates, and proved to be a good discriminator. Many candidates were able to substitute the correct values into the given equation but were unable to then reach the correct answer. Common errors included subtracting or adding the two values, the inverse division, incorrect conversion into normal form, incorrect use of standard form on the calculator and omission of or incorrect rounding to give the answer correct to 2 significant figures.

Question 7

(a) This question was found challenging by many candidates, and proved to be a good discriminator, although few correct and complete answers were seen. Candidates should realise that in a multi-level problem solving question such as this the working needs to be clearly and comprehensively set out. The majority of candidates sensibly attempted to answer this question in stages. Common errors in finding the area of the quarter circle included incorrect formulas used, omission of dividing by 4, use of 7.5, and simply using 15×15. Common errors in finding the area of the trapezium again included incorrect formulas used, the inefficient method of splitting the shape into triangles and rectangles resulting in a variety of incorrect formulas used and/or numerical errors, and simply using 12×22. Less able candidates often didn't attempt this part, or simply multiplied the four given numbers together.

(b) This part was generally better answered with a good number of fully correct answers seen. Common errors included using the given value of 387.1 as the perimeter resulting in 177.75, incorrect use of $\frac{2}{w}$ or $\frac{1}{2}lw$ for the area of the rectangle, and incorrectly attempting to use Pythagoras' theorem.

(c) This part was generally well answered with a good number of fully correct answers seen. Common errors included $15 \times 18 \times 32 = 8640$, $\frac{1}{3} \times 15 \times 18 \times 32 = 2880$, finding the total surface area, or finding the area of just one face, often the triangular side or the rectangular base.

Question 8

(a) (i) Candidates demonstrated a very good understanding of similarity with the majority getting to the correct answer. Some candidates gained partial credit for setting up a correct equation but then made errors in rearranging the equation to find the unknown. Some candidates found the correct ratio using corresponding sides from the small to the large triangle, but then incorrectly multiplied rather than divided by this ratio. Candidates should be encouraged to check their answers are sensible, making sure that in this case, the side they have found is bigger than the corresponding side. Less able candidates made the common error of finding the difference between the corresponding sides and then adding this to the length *BC*, resulting in the answer 68.3.

(ii) There were many fully correct answers to this question, with the vast majority of candidates recognising that the use of trigonometry was necessary. Common errors included the incorrect use of sin and less often, the use of tan, the correct cosine ratio was sometimes given upside down, and loss of accuracy due to premature approximation. Candidates should be encouraged to leave the value of the ratio in their calculator or to process the whole calculation at once in order to maintain accuracy. A small number of candidates found the missing side using Pythagoras' theorem and then used a different ratio to find the angle. This was often completely correct working but inefficient and unnecessary, and often resulted in a lack of accuracy due to rounding.

(b) Able candidates attempted this question well, using Pythagoras' theorem correctly, gaining full credit, or 3 marks if they forgot to halve 78 to find the length of one tile. Some correctly halved both lengths and so were working with one tile from the beginning which was an equally sensible strategy. As in the previous part, some candidates decided to take an unnecessarily longer approach, finding an angle and then using trigonometry which usually led to inaccuracies. Candidates should take their time at the beginning of a question to consider the most sensible strategy. Some candidates who correctly chose to use Pythagoras' theorem, made errors when using the formula, either adding rather than subtracting or sometimes forgetting to square or square root. Another common error was to halve 84.5 but not 32.5, or less often, the other way round. Less able candidates, who did not recognise the need to use Pythagoras' theorem, gave various answers involving the addition and subtraction of the lengths given, sometimes halved, and many wrote the measurements on the diagram but could get no further.

(c) (i) Many candidates were able to gain full credit on this question. Most plotted point *B* at the correct distance and many also followed through from their point *B* correctly for point *C*. The bearing of 058 caused the most problems and it was very common to see the point plotted at a bearing of 032, indicating that candidates were perhaps measuring from a horizontal line rather than the north line. Many candidates plotted point *C* from *A* rather than continuing from point *B* and some continued on the same bearing from *A*, extending their line further. The most common error when plotting point *C* was to draw it to the west rather than the east, and less common, in a north or south direction.

(ii) Giving the required bearing proved challenging for the majority of candidates. It is difficult to tell whether candidates were measuring the bearing incorrectly or misunderstanding which angle they needed to measure. Candidates were often giving the bearing of *A* from *C*, the obtuse angle *ABC*, angle *BAC* or the bearing of *B* from *A* again. Calculations were also seen and 58 + 90 = 148, 180 – 58 = 122 and 180 + 58 = 238 were common. Less able candidates sometimes gave a distance as the answer.

Question 9

(a) The majority of candidates were able to identify the given transformation as an enlargement but not all were able to correctly state the three required components. The identification of the centre of enlargement proved the more challenging with a significant number omitting this part, and (0, 0), (1, 1) and (3, 3) being common errors. The scale factor also proved challenging with 3, 3.5, –2 and $\frac{1}{2}$ being the common errors. A significant number gave a double transformation, usually enlargement and translation, which results in no credit. Less able candidates often attempted to use non-mathematical descriptions.

(b) This part was generally answered well with the majority of candidates able to identify the given transformation as a rotation and more were able to correctly state the three required components. The identification of the centre of rotation proved the more challenging with a significant number omitting this part, and (1, 1), (1, 0) and (1, −1) being common errors. The angle of rotation was sometimes omitted with 90 (with no direction) being the common error. Again a smaller but significant number gave a double transformation, or used non-mathematical descriptions.

(c) This part was generally answered well with the majority of candidates able to draw the given translation. Common errors included drawing only one of the vector components correctly and putting one of the vertices at the point (5, –3).

Question 10

(a) The table was generally completed very well with the majority of candidates giving 3 correct values. The common error was in substituting $x = -2$ into the given quadratic, usually resulting in a y value of 4. Candidates should be encouraged to look at the general shapes of different groups of graphs as the majority followed through their error to plotting, not realising that this could not possibly be the correct point for this quadratic graph.

(b) Many curves were really well drawn with very little feathering or double lines seen. A few joined some or all of their points with straight lines. Some joined (2, –8) and (3, –8) with a horizontal line rather than continuing the curve. Occasionally a curve started at (–1, 4) even though (–2,12) had been plotted.

(c) This part was generally answered well although common errors of incomplete lines and $x = 2$ drawn, and a small number unable to attempt this part.

(d) This part on using the graph to solve the given equation was well answered with candidates reading the values off accurately from their curve. Common errors included misreading of the scale, omission of the negative sign, and incorrect values of 5.2 and –0.4 from using the intercept values from the x-axis. A significant number were unable to attempt this part. A small yet significant number of candidates tried to solve the equation algebraically, which was not the required method and is beyond the syllabus for core, and this was rarely successful.

MATHEMATICS

Paper 0580/33
Paper 33 (Core)

Key messages

To do well in this paper, candidates need to understand and use mathematics across the breadth of the syllabus, namely, number, algebra, shape and space and probability and statistics.

Candidates need to ensure that they read the questions carefully and ensure that they are answering the question as required.

Working should be shown when answering questions and calculations should always be completed to enough accuracy. This will often enable marks to be awarded even when the final answer is inaccurate or incorrect.

General comments

Overall there were some excellent responses with a good level of mathematical competency and skills evidenced by many candidates.

Working needs to be given to enough accuracy, so that final answers are accurate to at least 3 significant figures unless they are exact answers, in which case the complete answer should be given.

Candidates should practice measuring and drawing lines and angles accurately. The zeros on the protractor and ruler should be lined up carefully and lengths and angles should be measured to the nearest degree or millimetre where possible, as in **Questions 1(e)(i)**, **1(e)(ii)**, **4(a)(i)** and **6(a)(iii)**.

It is important to be able to work with time calculations. Candidates should understand the 24-hour clock as well as being able to use am and pm. They should be able to add on and subtract times and be able to find time periods. They need to be able to convert between seconds, minutes and hours and understand that, for example, 11 hours 15 minutes is 11.25 hours.

Comments on specific questions

Question 1

(a) (i) Whilst some candidates were able to correctly work out the time that the plane arrived in Los Angeles, many errors were seen. These errors included subtracting the 11 hours 15 minutes rather than adding it, and/or adding on 8 hours rather than subtracting it. Some made errors when crossing over midnight with not all candidates correctly using the fact that there are 24 hours in a day. Candidates need to write down times precisely, for example, 06 55, 18 hr 55 mins and 18 55 am were not accepted for 18 55.

(ii) Most candidates correctly used the formula, $\text{speed} = \frac{\text{distance}}{\text{time}}$. However, many candidates divided by 11.15 rather than converting 11 hours 15 minutes to 11.25 and others divided by 675 minutes. Some of those candidates working in minutes were able to gain full credit by later converting back into km/h. A few candidates used the incorrect formula with 8760 × 11.15 = 97674 km/h or similar seen, which candidates should realise would be an impossibly large speed for a plane.

(b) (i) Some candidates were able to answer this correctly. Those who omitted the $C =$ gained partial credit. Other errors included answers such as $C \times d$, $56 + 436 = 492$, $56d + 436C$ and $C + d + 56 + 436$.

(ii) Nearly all candidates worked out the correct probability. The few candidates who made arithmetic errors were often able to gain partial credit if they evidenced a correct method.

(c) (i) Most candidates rounded 4986 correctly to 5000. The most common errors seen included rounding down to the nearest 100 as 4900.

(ii) Many candidates correctly wrote 4986 in standard form. Answers needed to be exact and rounded answers such as 4.99×10^3 did not score. Incorrect answers included 4986×10^0, 49.86×10^2 and 4.986×10^{-3}.

(d) Many candidates worked out the amount of tax correctly as \$1.40. However, a large proportion did not score because they then worked out the total ticket price, \$17.50 + \$1.40 = \$18.90. Others calculated \$17.50 × 1.08 = \$18.90, which in a different question, would have been an efficient method. Other candidates thought that 8% tax meant \$0.08.

(e) (i) The majority of candidates were able to measure the length of *AB* accurately and correctly multiply their measurement by 5. Other candidates either measured the line inaccurately or did not multiply by the scale.

(ii) Many candidates marked the position of *C* accurately on the diagram. Other candidates frequently scored partial marks for either drawing line *AC* the correct length or marking *C* on the correct bearing from *A*. Common errors included not measuring the angle clockwise from the north or small inaccuracies in measuring the length or the angle. In addition, candidates should ensure that the position of the point *C* is unambiguous and marking it with a small dot or x are recommended ways of marking its position. A few candidates marked the position of *C* from point *B* instead of *A*.

Question 2

(a) (i) Almost all candidates drew the bar correctly. A small minority of candidates did not score because they either drew the bar touching the June bar or they drew a bar of only half the required width.

(ii) Almost all candidates answered this part correctly. A few candidates did not read the question carefully and gave the number of cars in either March as 15 or May as 6.

(b) Some candidates answered this question correctly but there were a wide range of errors seen. These included having the incorrect number of hours that the garage was open each day such as, 8 or 10 hours on a weekday and 5 or $5\frac{1}{2}$ hours on the Saturday. Sometimes candidates included only 2 days and worked out 9 + 4.5 = 13.5 or had the incorrect number of weekdays. Other errors included arithmetic slips after seeing the correct working.

(c) Most candidates correctly calculated the amount paid for the 36 hours as \$378. Whilst many candidates went on to complete the question correctly, a good proportion did not know how to deal with the Saturday pay, with $1.5 \times 378 = \$567$ and $1.5 \times 10.50 = \$15.75$ frequently seen.

(d) Many candidates answered this question efficiently by using the compound interest formula. Others were successful despite laboriously working out the amounts year by year. Some showed a list of numbers with errors in and without supportive working, did not score. Other errors included not rounding to the nearest dollar at the end, using an incorrect formula, decreasing by 2.4% per year or finding simple interest.

(e) Most candidates gained full credit on this question. The few errors that were seen included, dividing \$12 000 by 3, arithmetic errors in 8 + 4 + 3, or dividing \$12 000 by 8,4 and 3.

Question 3

(a) Whilst some candidates were able to correctly give the order of rotation of both shapes there were many incorrect answers seen. These included order 4 or order 8 for both shapes. Other common incorrect answers included 1, 2, 12 and a few candidates attempted to name the shapes or draw lines of symmetry on them.

(b) (i)(a) Many candidates recognised that the transformation was an enlargement but not all candidates used the correct language with incorrect words such as stretch, magnify and expand used. Whilst some candidates described the enlargement correctly, giving the scale factor and centre of enlargement, descriptions were often incomplete. Ambiguous descriptions such as '2 times the size' should be avoided, as this could refer to area. In addition, a number of candidates did not give a single transformation and those who described more than one transformation, such as an enlargement followed by a translation, did not score.

(i)(b) Many candidates recognised that the transformation was a rotation but only a minority of candidates were able to completely describe the rotation by correctly giving both the centre and angle of rotation. As in the previous part, a number of candidates did not give a single transformation and those who described more than one transformation, usually the rotation followed by a translation, did not score.

(b) (ii) Many candidates reflected triangle *C* correctly. The most common error was to reflect the triangle in the incorrect vertical line, usually the *y*-axis.

(iii) Most candidates who answered this part translated triangle *C* correctly. In this part, there were a noticeable number of no responses.

Question 4

(a) (i) Most candidates were able to accurately measure the angle. Other candidates did not measure the angle accurately enough. A few candidates gave answers such as 138° from misreading the protractor.

(ii) Most candidates named the angle correctly. The most common errors seen included obtuse, reflex and isosceles.

(b) This question was answered well with many candidates working out the value of *y* correctly. When candidates did not gain full credit, they were frequently rewarded for showing 53° in working or correctly placed on the diagram. The most common errors seen included arithmetic slips, having an incorrectly orientated isosceles triangle with angle *DBA* = 74° or merely calculating 180° – 74°. A number of candidates gave an incorrect answer with no working which, had working been shown, may have earned method marks.

(c) (i) A good proportion of candidates correctly named line *FG*. However, there were a very wide range of incorrect answers including hypotenuse, segment, tangent, bisector, obtuse and line of symmetry.

(ii) Very few candidates were able to correctly explain that angle *EFG* is 90° because it is an angle in a semicircle. The incorrect responses varied widely and included ideas such as symmetry, isosceles, rectangles, chords, tangents, perpendicular and angles in a triangle add to 180°.

(iii) Many candidates correctly calculated the area of the circle. Common errors seen included using 12 cm for the radius rather than 6 cm or using the incorrect formula for the area of a circle. A few candidates overlooked the given information, that the diagram was not to scale and *EG* = 12 cm and used a measured radius of the circle.

Question 5

(a) (i) Many clear and accurate nets were drawn. Candidates who made an error were often able to gain partial credit for correctly drawing two or three 4 cm by 2 cm rectangles in the correct place. Incorrect rectangles measuring 4 cm by 4 cm, 1 cm by 2 cm and 1 cm by 4 cm were often seen. Some candidates misread the question and drew a 3-dimensional representation of a cuboid, rather than a net and a number of candidates did not offer a response.

(ii) Whilst some candidates correctly calculated the surface area, it was clear that many candidates who had the correct net did not connect the area of the net with the surface area of the cuboid. Common incorrect answers included 8, the area of the given drawn side or 16, the volume of the cuboid or a partial surface area of 32.

(iii) Many candidates answered this correctly. The most common incorrect answer was 200, with candidates omitting to multiply by 3. In addition, a number of candidates misread the question as ‘there are 25 cuboids and 3 faulty cuboids’, (that is 28 cuboids altogether) rather than ‘3 of the 25 cuboids were faulty’. Other errors seen included $\frac{5000}{3}$, $\frac{5000}{25-3}$ and (5 000 ÷ 25) ÷ 3.

(b) A minority of candidates answered this question correctly. Many candidates did not recognise that they needed to divide by 6 to find the area of one side of the cube in order to be able to work out the length of each side of the cube. Common incorrect methods included starting with 294×6, $\sqrt{294}$, $\sqrt[3]{294}$. Other errors, after correctly reaching 49, included 49^3 and $(49 \div 2)^3$.

(c) Many candidates answered this correctly demonstrating a clear understanding of bounds. Some candidates gained partial credit for having one of the bounds correct, usually with 23.5 correct but the upper bound incorrect as 24.4, or for writing the correct numbers in the incorrect sides of the inequality. The most common answer that did not score was $23 \leqslant l < 25$.

Question 6

(a) (i) A good proportion of candidates were able to show that 100 people chose tennis by evidencing a clear calculation, usually, $\frac{60}{360} \times 600$. Calculations that used two stages, such as $\frac{360}{60} = 6$ and 600 ÷ 6 = 100 were also acceptable. Candidates who either used 100 in their calculation or who used 6 or 0.6 without showing where they came from, did not score.

(ii) Although some candidates did not attempt this question, those that answered it usually gained full credit. Whilst most candidates gave an exact answer of 45, a few candidates lost the accuracy mark after using premature approximation within a two-stage method such as 360 ÷ 27 = 13.3 followed by 600 ÷ 13.3 = 45.1.

(iii) Most candidates were able to work out the sector angle correctly and complete the pie chart accurately. Some candidates offered no response, usually those who had not attempted the previous part. Others divided the pie chart into two incorrect sectors with no evidence as to how they had arrived at the angles they had used.

(iv) This part was often completed correctly. Some candidates worked out the fraction of people playing tennis or cricket whilst others were equally successful using the fraction of the pie chart that represented these two sports. Candidates had read the question carefully and almost all proceeded to give their answer as a fraction in its simplest form, as required.

(b) Most candidates were able to correctly place the 8 outside the two circles and gain partial credit. Whilst a number of candidates went on to gain full credit in this question others did not. A common error made by many was to overlook the fact that some of the 36 playing hockey may also play netball and similarly that some of the 53 playing netball might also play hockey. These candidates placed 36 and 53 on the diagram with nothing in the intersection. Adding 36 + 53 + 8 gives 97 people, which is more than the 80 people in the group, which is the clue to 17 having to be placed in the intersection.

Question 7

(a) Many candidates wrote the number correctly in figures. Common incorrect answers seen included 63821, 6003821, 60 300 0821. A few candidates gave 3 separate numbers as 600, 3800 and 21.

(b) This question was answered correctly by the vast majority of candidates. The few errors seen were usually slips with arithmetic or finding the cost of the pens but not going on to calculate the change.

(c) (i) Almost every candidate square rooted 81 correctly.

(ii) Almost every candidate worked out the value of 6^3 correctly.

(iii) Almost every candidate knew that $3^0 = 1$. The most common incorrect answer was 0.

(d) Many candidates were able to express 130 correctly as a product of its prime factors. Common errors included slips in arithmetic when completing a factor tree, not finding all the prime factors, for example 130 = 5 × 26, including × 1 in the final answer, for example 1 × 2 × 5 × 13 or finding the factors and adding them as 2 + 5 + 13 = 20 or giving a list of all the factors of 130, namely 1, 2, 5, 10, 13, 26, 65, 130.

(e) Candidates answered this question very well with a significant proportion of candidates obtaining the correct time. A common approach was to work out the lowest common multiple of 12 and 14, which was usually found by writing out a list of the multiples to obtain 84 or sometimes by using factor trees. Candidates usually then correctly converted this to 1 hour 24 minutes and added it on to 09 30. An equally common approach was to write out lists of times starting from 09 30 and whilst this is an equally valid method, candidates made more errors adding on the 12 and 14 minutes or did not write out long enough lists to reach the same time. Other candidates, who found another common multiple after 84, such as 168, gained partial credit.

Question 8

(a) Only a minority of candidates gained full credit on this question. Many candidates did not take account of the axes having different scales and consequently a very common incorrect answer was $y = 0.5x + 10$, with these candidates gaining partial credit for the correct *y* intercept. Other candidates gave a correct calculation to find the gradient, such as $\frac{15-(-5)}{2-(-6)}$ but then made slips with the arithmetic and negative signs.

(b) (i) Many candidates completed the table correctly. The most common error came from errors with order of operations when working with the negative x value, $x = -2$, with candidates calculating $-2^2 + 4 \times (-2) = -12$ rather than $(-2)^2 + 4 \times (-2) = -4$. It was clear that some candidates were trying to complete the table using differences and symmetry but not all were successful.

(ii) Curves were generally drawn well. However, candidates should ensure that they plot all points accurately and then carefully draw the curve through all of their points. In addition, curves should be smooth, a single line and not ruled.

(iii) The most successful candidates drew the line $y = 10$ on their graph to enable them to solve the equation using their graph. The most common errors seen included misreading the *x*-axis scale or giving the coordinates where their graph crossed the *x*-axis rather than where their graph met the line $y = 10$. A number of candidates attempted to use the quadratic formula to find the solutions, but this is beyond the core syllabus and was not what the question was asking candidates to do.

Question 9

(a) Almost all candidates were able to simplify the expression correctly. The most common errors included omitting the *g* and giving the answer as 6, slips with addition or attempts at factorising such as $g(3+7-4)$.

(b) This question was answered very well. Most candidates started by subtracting 5 from both sides to reach $4x = 27 - 5$ and from here it was rare for candidates not to be successful. Some candidates who attempted to divide by 4 as their first step forgot to divide the 5 by 4, having $x + 5 = \frac{27}{4}$ rather than $x + \frac{5}{4} = \frac{27}{4}$.

(c) Most candidates answered this question correctly. The most common errors seen were 20 from adding 17 + 3 and 5.67 from $17 \div 3$ or giving an embedded or final answer of 6^{14}. A few candidates attempted to work out 6^{17} as a number and divide it by 216. These candidates were unable to write their answer in terms of a power of 6 so were not successful.

(d) Many candidates produced some excellent answers to this question with accurately and clearly presented algebra frequently seen. Most candidates were able to set up the two equations correctly and solve them using a methodical approach. The most common errors seen were slips with signs, slips with arithmetic or incorrectly choosing to add or subtract the equations. Some candidates found the costs through trial and improvement rather than solving by simultaneous equations.

MATHEMATICS

Paper 0580/41
Paper 41 (Extended)

Key messages

To achieve well in this paper, candidates need to be familiar with all aspects of the extended syllabus. They need to be able to recall and apply mathematical formulae in structured questions as well as interpret situations mathematically in unstructured questions. Some candidates may have achieved more highly by taking the Core papers.

Work should be clearly and concisely expressed with answers written to an appropriate degree of accuracy. It is important that candidates retain at least 4 figures in their intermediate working to ensure that final answers are correct to three significant figures or better. Accuracy marks may be lost if candidates round prematurely in their working or if answers are not given correct to at least three significant figures.

Candidates should show full working on the question paper to ensure that method marks are considered where answers are incorrect. Method marks may not be gained if working with only 2 significant figures. Candidates should write down any intermediate step that they may have done with a calculator. Rough paper should not be used.

In questions where a level of explanation is needed candidates should use the terminology as described in the syllabus rather than trying to describe, for example, a cyclic quadrilateral.

Candidates should avoid writing in pencil and then overwriting in pen as solutions can become illegible.

Candidates should take sufficient care to ensure that their digits from 0 to 9 can be distinguished.

Candidates should ensure that their calculator is set in degrees.

General comments

Many candidates demonstrated their understanding of a wide range of mathematical concepts and were able to apply them in structured questions. The unstructured question parts were more challenging for candidates, as was the question on finding the equation of a tangent using differentiation, an addition to the syllabus in 2020.

The majority of candidates indicated their methods with clarity but some candidates gave answers with no working and subsequently could not gain partial marks. A significant number of candidates showed minimal working. This sometimes resulted in ‘near miss’ values which, with no supporting evidence, do not receive credit. Some candidates are using the ratio symbol for division and unconventional ‘crossing arrow’ notation without ever forming an equation. This approach is often insufficient to gain partial marks.

Candidates seemed to have sufficient time to access all questions.

Most candidates followed the rubric instructions with respect to the values for π although a few used $\frac{22}{7}$ or 3.14, which may give final answers outside the range required.

Candidates should expect to give final answers as a numerical value rather than a complex fraction or expression involving π unless the question requests a particular format.

The topics that proved to be accessible included: using proportion to find costs in a practical context, increasing by a percentage, exponential increase, finding an estimate of the mean from a grouped frequency table, constructing and solving linear equations and using the quadratic equation formula. Also use of circle theorems, plotting points and drawing unfamiliar graphs.

More challenging topics included: Reverse percentage, calculating with upper and lower bounds, combined probability without replacement, factorising a quadratic with co-efficient of x^2 not equal to 1, difference of two squares, geometrical reasoning using correct vocabulary to support angle calculations, manipulation of an equation to cubic form, position vectors, completing the square and sketching curves and finding the equation of a tangent making use of differentiation. Candidates also sometimes struggled to identify the appropriate technique in unstructured questions.

Comments on specific questions

Question 1

(a) (i) This question was generally well answered with most candidates understanding the concept of surface area. Errors seen included calculating areas of only some of the rectangular faces or calculating volume. The sum of the edges of the cuboid was also occasionally seen.

(ii) This was also generally well answered with most candidates multiplying a correct volume by the density, however, many of these candidates did not correctly conclude by converting grams into kilograms. Some other candidates carried out a correct conversion but reduced it to two significant figures. A few candidates had a correct volume calculation but did not use the given density formula correctly. A small number of candidates used the surface area from **part (i)** instead of the volume.

(b) This was very well answered. The only challenge appeared to be dealing with the 200 and the $175 to find the cost of one brick, where 200 was occasionally divided by 175. A small number of candidates gave the cost for one house only.

(c) This proved to be a more challenging question with the context of hours worked, days worked and the starting date. There were many correct answers, and many candidates reached the value of the number of days to be 4.166.... A number of these candidates gave the answer of July 11th, thinking that the work started after July 6th as opposed to on July 6th. A smaller number of candidates rounded the number of days to 4 and gave the answer of July 9th.

(d) There was a mixed response to this question part with some candidates having difficulty recalling and applying the formula for the volume of a cylinder. Some candidates used the formula for volume of a cone while others did not associate capacity with volume and instead used area formulae. The conversion from cubic cm to litres was often either incorrect or overlooked. A few candidates treated the given diameter as the radius.

Question 2

(a) (i) Many candidates found this question part difficult. A common error was to work out $\frac{5}{16}$ or $\frac{7}{16}$ as a percentage, due to working out Chao's or Mei's time as a percentage of the total. Some candidates knew what to do but gave their answer as 71 correct to two significant figures, rather than giving at least three significant figures. A small number of candidates found both Chao's and Mel's time as a fraction or percentage of the total and then correctly divided these two answers, rather than using the efficient approach of $\frac{5}{7}\times 100$.

(ii) Most candidates knew that they needed to work with a time and divide by 4 then multiply by 7. Some candidates had success by initially changing Bob's time to seconds, avoiding the need to process minutes and seconds. Some candidates used a fully correct method having rounded a decimal version of 55 minutes and 40 seconds. The error 55.4 was often seen, as was premature rounding to 55.7 or truncating to 55.6. Working separately with the minutes and seconds was a useful method for some candidates, although errors were made when reconverting to minutes and seconds. Another approach was to find the total time and then find the correct fraction of this for Mei's time. Candidates who showed each stage of working were able to pick up some marks, even if they calculated Chao's time.

(b) (i) This question part was well answered. Most candidates used the multiplier of 1.28 to directly obtain the answer. The main errors were candidates just finding the increase, division by 28, or use of 72 per cent.

(ii) This percentage calculation proved to be difficult for many candidates. Many thought that 47.50 was 60 per cent of Mei's money rather than 40 per cent. This resulted in many candidates stating $\frac{47.5}{0.6}$ rather than $\frac{47.5}{0.4}$. Other candidates did not see the question as requiring a reverse percentage calculation and found either 40 per cent or 60 per cent of 47.50 as an incorrect first stage and frequently 160 per cent of 47.50.

(c) This proved to be a challenging question part and many candidates achieved only partial success. The best solutions realized that they had to find the limits of the ranges of the two values and then combined these values using the minimum for 11.2 divided by the maximum for 70. Choosing this combination and with the need for consistent units was demanding for most candidates. The main errors with finding the upper and lower bounds were 11.2 given as 11.1 to 11.3 and 70 given as 65 to 75. A significant number of candidates did not recognise that it was a bounds question at all and calculated 1120000 ÷ 70. Amongst the minority of candidates who had the correct method were those who gave the answer 15379.3 or rounded their answer to 3 significant figures, not realising what was required in the context of the question.

(d) Almost all candidates understood how to efficiently use exponential increase. The main error was to write out their answer in full rather than giving an answer in millions. A small number of candidates used the correct but inefficient method of separate calculations for each year but usually worked with sufficient accuracy. A small minority of candidates used simple interest, others decreased by 2.4 per cent or spoilt their method by continuing to subtract 1.6 million from the amount raised by the charity in 2020.

Question 3

(a) The construction of a box-and-whisker plot on an in-line grid directly below the cumulative frequency diagram was required. This layout was used well by many candidates to produce an accurate plot, drawn using a ruler. Most candidates who knew that the quartiles were needed, drew them in the correct place. A significant minority of candidates were unfamiliar with a box-and-whisker plot.

(b) (i) There was a mixed response to this question part. The common error was to use 30 on the cumulative frequency to give an incorrect answer of 58.5 kg. Most candidates who understood to find 30 per cent of 80 first, went on to gain full marks.

(ii) This part was well answered with many candidates obtaining the correct answer. Others read 64 correctly for boys with a mass of 75 kg or less but did not then subtract from 80. Some candidates misunderstood the scale and 18 was a common incorrect answer, often after 62 was seen in the working.

(c) (i) A good proportion of candidates correctly calculated the missing values in the table.

(ii) This question part on finding the mean from grouped data was very well done. Those candidates who had incorrect values in **part (c)(i)** usually still earned method marks due to clear working shown. The most common error seen was from the minority who used an interval width of 10 instead of the mid-interval values.

(iii) This was a challenging question for many candidates, and it was rare to see the fully correct answer. Many candidates were able to score partial marks for $\frac{10}{24}$ or $\frac{14}{24}$ seen and others for the correct product $\frac{10}{24}\times\frac{14}{23}$, just omitting to multiply by 2. A common mistake was to multiply fractions with denominators of 80 and 79, not acknowledging that the two boys were chosen only from those with a mass greater than 70 kg. The other common error seen was the product $\frac{10}{24}\times\frac{14}{24}$. Almost all candidates showed the products of fractions that they used so that it was possible to award partial marks when appropriate.

Question 4

(a) (i) This question part was answered very well. Those candidates who expanded the bracket as their first step and then collected the terms together were the most successful in solving this equation. The minority of candidates who chose to divide by 6 first found this more problematic and made errors with both the fraction calculations and the signs when collecting the *x*'s together. Most errors seen were arithmetic when expanding the bracket, or sign errors in the collection of terms. Some candidates gave their answer as 3.3, which as a 2 significant figure value, does not gain full marks.

(ii) The candidates who were able to begin with $3\times 2x = 2(x-5)$ were often able to continue and solve the equation to obtain the correct answer of –2.5. Sometimes the bracket was omitted and $2x-5$ was common to see rather than $2x-10$. After the correct line $6x = 2x-10$ a common error that followed was to state $4x = 10$. Candidates who retained the fraction $\frac{2}{3}$, and attempted to solve $2x = \frac{2}{3}(x-5)$ found this more difficult. It was common to see the bracket omitted and fractions replaced by decimals, which caused further problems in the collection of terms.

(b)(i) Although the complete factorisation was seen by the most able candidates, many candidates saw only the common factor of 2 and obtained $2(x^2 - 144y^2)$, giving this as their final answer, or following it with $2(x-12y)^2$. For those who recognised the method of difference of squares, incorrect responses included $(x - 12y)(x + 12y)$ and $2(x - 12)(x + 12)$.

(ii) Many candidates found this factorisation of a quadratic a challenge. It was evident that a significant number of candidates used their calculator function, or the quadratic formula, to solve $5x^2 + 17x - 40 = 0$ and then attempted to work backwards from their solution. $(x+5)(x-\frac{8}{5})$ was a common wrong answer.

(c) For this question candidates needed to simplify and rearrange the given cubic equation to $4x^2 - 17x + 9 = 0$, and then solve using the quadratic formula. The use of the quadratic formula to solve a quadratic equation is well understood by most candidates and many set out their working with accuracy and clarity. It is acceptable to write $(-17)^2$ or 17^2 or 289 as part of the discriminant but a common error seen was to write -17^2. The error –17 at the start of the formula was also seen. Some candidates had a short division line writing $17 \pm \frac{\sqrt{17^2 - 4\times 4\times 9}}{2x4}$ which does not earn full marks even when followed by correct answers. A few candidates showed no working within the formula but arrived at correct solutions, which does not earn full marks as the question requires candidates to show all their working. Writing only $\sqrt{145}$ for the discriminant is not sufficient working. Most candidates gave their answers correct to 2 decimal places as required but answers to 1 dp or 3 dp were also seen. Some candidates made a sign error in re-arranging the equation at the start to give $4x^2 - 17x - 9 = 0$. Weaker candidates did not recognise that the cubic equation simplified to a quadratic.

Question 5

(a) (i) The majority of candidates were able to correctly calculate angle CBD as 62°. Giving a correct geometrical reason proved to be more problematic. Candidates are expected to use the correct vocabulary. Words such as middle, origin or angle O are not acceptable alternatives to 'centre'. Edge, top, bottom, at the point, are not acceptable alternatives to 'circumference'. Showing a sequence of calculations leading to 62° is also not a geometrical reason.

(ii) Many candidates showed good competency in using the isosceles triangle OCD and the sum of opposite angles in a cyclic quadrilateral to calculate angle BAD as 117°. Of those that did not reach 117, many were still able to demonstrate some knowledge by stating angle OCD = 28. The most common incorrect angle size for BAD was 63°, where candidates thought that opposite angles in a cyclic quadrilateral were equal. Giving sufficient geometrical reasons using correct vocabulary was once again problematic. Many candidates omitted to state that triangle OCD was isosceles. Candidates who attempted to state that opposite angles in a cyclic quadrilateral are supplementary often omitted ‘opposite’ or ‘cyclic’. Others referred to opposite sides instead of angles or described a quadrilateral in, or inscribed in, a circle, which is not an acceptable alternative for ‘cyclic’. As in **part (a)(i)** many felt that showing a calculation was the same as giving a geometric reason.

(b) This proved to be one of the more challenging question parts. Common misconceptions were that triangle SPR was isosceles and that SQ and PR intersected at 90°. This led to candidates working with incorrect right-angled triangles. Some candidates recognised angle SQP = 42° but did not progress by using angle SPQ = 90° as an angle in a semi-circle. Other candidates stated in error that angle RPQ was equal to 42 due to alternate angles. Candidates that worked with the right-angled triangle SPQ were usually able to reach a correct diameter and then the correct circumference, although prematurely rounding the diameter to 7.9, which led to an inaccurate value for the circumference, was seen from some candidates. Other candidates created the isosceles triangle POQ and used the sine rule successfully to find the radius. The error $C = \pi r$ sometimes followed.

Question 6

(a) (i) The majority of candidates correctly evaluated the three points. The most common errors were to give negative values for the points at $x = -3$ and $x = -2$ due, for example, to entering $(-3)^2$ as -3^2 on the calculator.

(ii) The plotting of points was usually accurate. Candidates typically plotted points at the correct vertical lines for the x values. The most common errors were the plots at $x = 0.2$ and $x = -0.2$ which were often incorrect by a complete small square. The curve was usually correct following their plots although some curves did not pass sufficiently close to the plotted points. Errors seen included using clear straight-line segments or crossing the y axis and joining the two separate branches.

(b) This was often left blank by candidates who did not see the need to draw the straight-line $y = \frac{24}{5} - 2x$. When drawn, the line was usually sufficiently accurate to lead to full marks. Some candidates drew a correct line but then mis-read the scale. It was common to see candidates not draw a line and use an algebraic method to try and solve the equation.

(c) The combination of the need to deal with denominators and rearrange proved difficult for many candidates. The most successful solutions had more than one stage to remove the denominators and then rearranged their equation to equate it to zero. This usually resulted in full marks unless a sign error was made in the rearrangement. Some candidates tried to work with decimal values for a, b and c as they could not make the link between the given equation and a cubic.

Question 7

(a) (i)(a) There were many diagrams drawn showing that candidates understood the idea of the scale factor of enlargement being 2 but they were less able to draw this enlargement using the centre (0,1). A variety of different centres appeared to be used.

(i)(b) This part proved quite challenging for many candidates, who were unable to begin by drawing the line $y = x - 1$ correctly. Common errors seen were to reflect in the line $x = 1$ or $y = x$. Some candidates who did draw the correct line were sometimes unable to accurately reflect across this diagonal line.

(ii) Most candidates recognised that the transformation was a rotation and many could give the angle as 90°, but there were many wrong centres of rotation given or no centre given at all.

(b) This part proved to be challenging for many candidates. For those who understood the steps they needed to take, there were errors in signs when finding vector AB or vector BA. This followed through their working to give incorrect results for other vectors. Even when correct vectors were found for AB or BA, using them to find BM or AM and subsequently a result for OM was found problematical when collecting the terms together. Most candidates would benefit from setting their work out in a clearer way, showing which vectors they are attempting to find. A number of candidates left this part blank and some who attempted it did not seem to appreciate that they needed to find vector OM.

Question 8

(a) (i) Forming the equation from a linear function equated to a given value was well answered. A common error seen was to substitute the value –5 into the function. Almost all candidates who set up the correct equation gained full marks.

(ii) The inverse of the linear function was also well answered. Any errors were usually sign errors, rather than a misunderstanding of inverse of a function. Almost all candidates started with *y* equal to the function and then a correct first step of either re-arranging or interchanging *x* and *y*. A flowchart approach is not advised as candidates struggled with the inverse of subtracting *from* 3, usually stating adding or subtracting 3. One misconception was to think that $f^{-1}(x) = \frac{1}{f(x)}$.

(b) (i) This completing the square question was very challenging. Many candidates struggled to cope with the negative sign of the x^2 term and many others simply found the topic demanding. There were few fully correct answers.

(ii) The sketching of the graph of the completed square equation was equally challenging. Some candidates aimed to sketch the correct parabola but need to take care to keep it smooth and symmetrical. Intercepts with the axes were not required but when found, the shape of the curve was often distorted to try to fit them. The candidates with a completed square expression often did not connect this to the turning point on the sketch. Some candidates chose not to use their answer to **part (i)** and used calculus to find the turning point. This was a lot of work for the marks but these candidates were more comfortable with calculus than they were with completing the square. There were few fully correct answers.

(iii) The stronger candidates found this calculus question about the equation of a tangent more accessible than completing the square. The topic is quite new to the syllabus but some candidates were very well prepared. Other candidates were less familiar with it and did not connect the question to calculus. There were a few slips with the signs when differentiating but the candidates who recognised that calculus was needed were usually able to connect the value of the derivative at $x = 4$ to the gradient of the tangent, although the error of equating the derivative to 0 and using this value of *x* was also seen. Candidates should use the correct notation for the derivative and avoid equating all expressions to *y*. Most candidates recognised the need to substitute $x = 4$ into the equation of the curve to find the *y* – coordinate and for several candidates this was the only mark achieved. A significant minority of candidates omitted this question.

Question 9

(a) The majority of candidates were able to set up and solve a correct linear equation in *x*. Occasionally numerical errors were seen when solving the equation but the most common error was to set up and solve $x + x + 3 = 20$. A minority of candidates confused area and perimeter and used $x(x + 3) = 20$.

(b) This question part required the application of the sine rule to an unfamiliar situation. Many candidates indicated on their diagram the correct side length of 5 cm for the rhombus but a minority were unable to recall this property of the rhombus and did not then progress. Many candidates were well prepared to use the sine rule, however they did not appear to consider using it to find the angle at M. Candidates focused on attempting to find the side opposite angle *y* first and a common error seen was to treat the given triangle as right-angled at *y* and use Pythagoras' Theorem with the sides of 5 and 2.5. This incorrect value for the side opposite angle *y* was then used in the sine rule to find angle *y* indicating some confusion. A less common error seen was to use the sine rule with angle *y* opposite side length 5. Candidates who correctly applied the sine rule to find the angle at M almost always continued to subtract this from 180°. Some candidates used the cosine rule to set up a quadratic equation in *x* for the missing side of the triangle, solved this correctly and chose the appropriate value for the side length to use in the sine rule, but then overlooked the information that *y* was obtuse and so gave the calculator value of 63.16 for *y*. Accuracy was also often lost in this inefficient method. This unstructured question part also proved to be a challenge. Most candidates understood to find r first and a significant number of these were able to set up the correct equation $2r + \frac{40}{360} \times 2\pi r = 20$. However, only a minority of these were able to manipulate this equation correctly to make r the subject. Other candidates used an approximated decimal for $\frac{40}{360} \times 2\pi$ but inevitably lost accuracy by using $r = 7.4$ in following steps. The most common error in finding r however was to omit the $2r$ term and use arc length = 20 instead of perimeter = 20. Once candidates had found a value for r there were many good examples of correct recall and use of the cosine rule to find z or sine rule with angles 40° and 70° to find z.

MATHEMATICS

Paper 0580/42
Paper 42 (Extended)

Key messages

To achieve well in this paper, candidates need to be familiar with all aspects of the extended syllabus.

The recall and application of formulae and mathematical facts to apply in familiar and unfamiliar contexts is required, as well as the ability to interpret situations mathematically and problem solve with unstructured questions.

Work should be clearly and concisely expressed with answers written to an appropriate accuracy.

Candidates should learn to hold accurate values in their calculators when possible and not to approximate values during the working of a question.

General comments

In general candidates followed the instructions on the rubric and showed all necessary working alongside solutions. There were a wide range of marks on the paper and most candidates were able to access most of the content of the paper.

There were a number of very high scoring candidates demonstrating an expertise with the content and showing excellent skills in application to problem solving questions, scoring in excess of 110 marks on the paper. At the other extreme, only a small number of candidates were inappropriately entered at extended tier and did not have the mathematical skills to cope with the demand of this paper.

Candidates appeared to have sufficient time to complete the paper and omissions were due to lack of familiarity with the topic or difficulty with the question rather than lack of time.

There were a small number of candidates that did not keep appropriate accuracy within calculations and approximated before the final answer and lost accuracy in the final answer as a result. A number of candidates did not follow the instructions given in the question for example in **Question 7(a)(i)** many gave a decimal answer rather then an answer in terms of π , and on **Question 8(a)(iii)** some used the quadratic formula rather than factorisation to solve the quadratic equation.

The topics that proved to be most accessible were calculations involving ratio and percentages including compound interest, standard statistical graphs and calculations, transformations, drawing algebraic graphs, solving linear equations, work with column vectors and finding lengths in similar triangles.

The most challenging topics were using graphs to solve equations related to a drawn function, reasoning with algebra, completing the square, problem solving with proportion, calculations with bounds, geometric reasoning with vectors and areas and volumes of similar shapes and objects.

Comments on specific questions

Question 1

(a) (i) This part was answered correctly by the majority of the candidates. As this was a question where the answer was given, it was essential that candidates showed every step of working. A few omitted the division step e.g. going from $18x = 450$ to $x = 25$.

(ii) Most candidates answered this part correctly, with a small number calculating the number of pear trees instead of plum.

(iii) This part was generally well answered. A few candidates used 175 in their calculation rather than 75, and some gave as their answer the total number of pear trees after the increase instead of only the number of extra trees.

(iv) Many candidates answered this part well, obtaining the correct number of apples. When rounding the answer to the nearest thousand there were a few errors with 5900 and 6 0000 both seen. Some candidates multiplied by 165 instead of dividing.

(b) (i) Although a large number of candidates were able to write the number correctly in figures, there were a number of incorrect values such as 375 000, 3007 500 and 3750 000.

(ii) A large proportion of candidates correctly wrote their answer to **part (b)(i)** in standard form. Some chose to round their answer and not give it exactly, which did not earn any credit.

(c) Many candidates used a reverse percentage method to answer this correctly, but the common error was to find 84 per cent of 37.7, or 116 per cent of 37.7.

(d) This part was answered well most of the candidates. A very small number used the simple interest formula, and a few did not use a formula, but calculated the increase year by year, leading to an incorrect final answer because of rounding errors.

Question 2

(a) (i) Most candidates gave the correct answer from the diagram. A few gave 100 or 120.

(ii) Although this was done well by the majority, some candidates gave such answers as 20 or 40.

(iii) Again, this was done well by many, with errors of 40, 60 or 90 given by some candidates.

(iv) This part was well answered by almost all

(b) (i) The large majority of candidates appeared familiar with finding an estimate of the mean and answered it well. Common misconceptions included using the interval width in their calculation and not the mid-value of each interval, adding the mid-values and dividing the sum by 6. There were some calculation errors after a correct method had been written in working.

(ii) Candidates are advised to use of a ruler when drawing the bars on histograms. Some candidates used freehand and were inaccurate with their bars.

Many drew an accurate histogram. For some the first bar was generally drawn correctly, although a few misread the scale and drew their line at 0.95 instead of 0.9. The other bars were less successfully drawn with a common error to use division by 20 throughout to obtain the frequency densities.

(iii) This was the most challenging part for many candidates. Most candidates knew there were 16 houses with a floor area greater than 130 m^2 and 14 houses with a floor area $\leqslant$ 60 m^2, so correctly used the fractions $\frac{16}{80}$, $\frac{14}{80}$, $\frac{16}{79}$ or $\frac{14}{79}$ somewhere in their calculations, which earned some credit.

There were a number of errors including addition of fractions, $\frac{16}{80} \times \frac{16}{80}$ and for those multiplying the correct pair only considering $\frac{16}{80} \times \frac{14}{79}$ and not the reverse option.

Question 3

(a) (i) The majority of candidates gained credit for showing use of the correct tangent ratio, whilst use of the sine rule was almost as common as the use of the tangent. A few used cosine to find *EA* then applied Pythagoras' but this tended to lose accuracy.

The majority however did not gain full marks as they did not show *AD* to at least 2 decimal places and simply wrote 94.5 which was given in the question.

(ii) Most candidates showed a good understanding of the sine rule and gained full marks. Some made errors when rearranging the sine rule into an explicit form, such as prematurely approximating the decimal value. A few attempted to use the cosine rule while others viewed this as a right-angled triangle, reaching a similar but incorrect answer.

(iii) This part was more demanding and fewer fully correct answers were seen. Most realised the need to use the cosine rule but often made errors when rearranging it. A common error was reaching cos *ACD* = 0.214 rather than –0.214. Others incorrectly calculated the cosine rule as $a^2 = (b^2 + c^2 - 2bc)\cos A$. Some were confused as to which was the largest angle in the triangle but they were able to gain some credit for calculation of one of the other angles. A few calculated all three angles then correctly identified angle *ACD*.

(b) This part proved difficult for a number of candidates. The area of triangle *LMN* was often correctly calculated and those who identified the shortest distance in the other triangle and formed an equation usually gained full marks. After finding the area of *LMN* some candidates could go no further while others thought they were similar triangles. A few calculated the area of *LMN* as $\frac{1}{2}\times 21.5\times 27.6$.

Question 4

(a) (i) Most drew the correct translation. There was an occasional miscounting of squares in one direction. A small number of candidates confused the *x* and *y* directions and drew the translation by the vector $\begin{pmatrix} 5 \\ -4 \end{pmatrix}$.

(ii) This was generally done well, but with some candidates reflected in a vertical line other than *x* = 1, or used the line *y* = 1.

(iii) There were many correct enlargements as well as those using the correct scale factor but an incorrect centre.

(b) (i) Almost all candidates recognised a rotation and many correctly gave the correct angle and direction. The centre was less well done, with a number reversing the coordinates as $(0, -3)$. Those candidates who gave more than a single transformation could not gain any marks.

Question 5

(a) The table was completed correctly by almost all candidates. The value of *y* at $x = -1$ caused occasional difficulty for some, with 1 or 5 being the common errors.

(b) Most candidates plotted their points accurately, and the graphs drawn were generally of a good quality. Candidates should try to use a reasonably sharp pencil, as some of the graphs were too thick or had incorrect curvature. Candidates should also remember that this function is a curve, and no section of their graph should be ruled. The quality of drawing between candidates does vary but all should attempt to draw the curve with regard to the correct curvature between the points.

(c) There were a number of fully correct answers to this part. Some obtained the equation of the required line correctly, although a number used $y = x - 2$. Many candidates who drew no line at all but gained marks for solving the cubic equation algebraically or using their calculators. A very small number tried to draw the cubic given in this part, ignoring the instruction to draw a straight line.

Question 6

(a) (i) Almost all candidates answered this part correctly. The few that did not, usually earned a method mark for correctly removing the brackets but then went on to make a sign error.

(ii) A smaller number answered this correctly. Almost all made a correct first step by giving $6x > 6 - 14$. When dividing both sides by 6, some reversed the inequality sign and many others omitted the inequality sign when writing the answer.

(b) This part was answered quite well with many candidates obtaining full marks. The first step to isolate the term in y was generally correct with just a small number of sign errors seen. There were some candidates who attempted to take the cube root of both sides as the first step. The second step of dividing both sides by 3 or –3 was done well, even when the first step was incorrect. The third step to take the cube root was also done quite well. Some omitted the cube root sign when writing down the answer on the answer line and a small number did not extend the cube root sufficiently to indicate that it was the cube root of the complete expression.

(c) This part was demanding and required an algebraic approach. Quite a large proportion of candidates thought that it is sufficient to substitute chosen integers into the given expression and show that, in each case, the result is a multiple of 4. Some of those who used a correct approach, using algebra, made errors when expanding $(2n - 5)^2$, such as giving $2n^2$ or –25. Some who obtained $4n^2 - 20n + 12$ showed clearly that the expression had a factor of 4 to complete the explanation.

(d) (i) Many candidates found this part challenging. A proportion of those who started with $5 + 12x - 2x^2$ earned 2 marks for obtaining $23 - 2(x - 3)^2$, but some then gave p as +3. Others made a sign error, often leading to $(x + 3)^2$ as part of their expression. The method of expansion of $q - 2(x + p)^2$ and then comparing coefficients was seen, but in most cases candidates made an error, usually when removing the brackets, in attempting to get to $-2x^2 - 4px - 2p^2$. Some used a trial and improvement method, which occasionally led to the correct answers.

(ii) Many of the candidates who answered the previous part correctly, wrote down the coordinates of the maximum point of the curve and Examiners allowed follow through credit from an incorrect answer in the previous part. There were a small number of candidates that restarted and used derivatives to obtain the correct answer.

(e) Candidates found this part very challenging. Only a small number gave the increased value of the speed, s, as $1.3s$ followed by the increase in the square of the speed is equal to $(1.3s)^2$ leading to the answer of 69 per cent.

Question 7

(a) (i) Most candidates used the correct method to find the volume of the hemisphere although some gave the volume of a sphere. Many gave a decimal answer rather than as a multiple of π as required in the question.

(ii) This was answered quite well by a reasonable proportion of candidates. Those that kept all of the volumes in terms of π were able to give an exact answer of 2.4 cm, others worked out decimal values and lost accuracy in the final answer. As a method, some wrote a complete equation in which the sum of the volumes of the hemisphere, the cylinder and the cone is equal to $\frac{88\pi}{3}$ whereas others went straight to the subtraction of the volume of the hemisphere and cylinder from $\frac{88\pi}{3}$ to give the volume of the cone. Candidates who did not set up a correct initial equation usually did not include the volume of the cylinder but often earned a method mark for giving the volume of the cone in terms of h.

(iii) This part was answered well by many candidates. A number did not use the volume of the container, using a calculation such as 35 000 ÷ 620 for the time. Those that gave the correct time in hours did not always convert this correctly into hours and minutes. For example, 1.63 hours given as an answer of 2 hours 3 minutes or 1 hour 63 minutes. A number rounded the time in hours to 2 significant figures leading to an incorrect answer of 1 hour 36 minutes.

(b) The final part of this question was challenging for most. Many candidates gave a correct expression for the area of the sector but did not attempt to find the area of the triangle *OAB*. Others attempted to find the area of the triangle using a method that involved finding the length of *AB*, rather than using area = $\frac{1}{2}ab\sin C$. Those that were able to set up a correct equation in r for the area of the shaded segment usually went on to the correct answer, with only a few not being able to rearrange the equation to make r the subject.

Question 8

(a) (i) Almost all candidates answered this correctly. A small number gave $12x$ or $x = \frac{12}{x}$, which was not acceptable.

(ii) This provided a challenge for many who either did not give a response or were not able to set up a correct equation. There were also some who started with the given equation and solved it. Those that did give a correct form of the equation often went on to simplify it correctly and score full marks. There were a few who made a sign error and a small number who made omissions in the method such missing '= 0' from the final answer.

(ii) This was answered very well with most candidates factorising the quadratic correctly and then giving the correct answers. A very small number of candidates made sign errors in the factors. There were a number of candidates who used the quadratic formula to solve the equation and did not use the method asked for in the question, so they only scored 1 mark for correct answers in this case.

(iv) There were many correct answers. A few showed calculations of journey times using 8 and –4 before choosing correctly. Some candidates gained partial credit as they gave the journey time for Kaito rather than Yuki.

(b) This part was challenging for many candidates with a minority scoring full marks. Most candidates used the correct formula for calculating the speed and earned at least one mark by giving a correct bound, usually 435. A large number gave incorrect bounds of 5.5 or 6.5 for the time, so an answer of 66.9, coming from 435 ÷ 6.5, was often given. Many did not appreciate that, to find the lower bound for the speed, it is necessary to use the higher bound for the time in the division. A few candidates calculated the speed using 440 ÷ 6 and then attempted to give a bound for their answer.

Question 9

(a) (i) The majority of candidates answered this correctly. The most frequent incorrect answer was (–7, 5) with (7, –5) and (3,–5) seen occasionally.

(ii) This part was almost always answered correctly.

(iii) A number of candidates appeared to be unfamiliar with what was required and were unable to make any progress towards finding the length of $\overrightarrow{FG}$. The most common mistake from candidates using the correct method was to find -2^2 instead of $(-2)^2$. A number of candidates give the answer as 3.6 and an answer of $\sqrt{13}$ or a decimal answer correct to at least 3 significant figures was required to earn both marks.

(b) (i)(a) Almost all candidates answered this part correctly.

(i)(b) Similarly this part was almost always correct and the small number of candidates with an incorrect answer to the previous part were credited with the mark with a correct follow through.

(ii)(a) This proved very challenging for most candidates and many did not offer a response. In order to show that *O*, *P* and *Q* lie on a straight line it is necessary to express one of the relevant vectors as a multiple of another with the same base vector. For example $\overrightarrow{OP} = \frac{1}{3}(2\mathbf{a} + \mathbf{c})$ and $\overrightarrow{OQ} = \frac{1}{2}(2\mathbf{a} + \mathbf{c})$ followed by a correct comment about the relationship. Many candidates found $\overrightarrow{PQ}$ and, although it is possible to use this vector in the explanation, very few of these candidates made further progress. Some candidates scored one mark by giving a correct multiplicative statement such as $\overrightarrow{OP} = \frac{2}{3}\overrightarrow{OQ}$ without having given the justification for this.

(b)(ii)(b) This part was, to some extent, depended on the candidate having some appreciation of the vectors used in the previous parts. As with the previous part many did not give a response but a number did give the correct answer. Some of the more common incorrect answers were 1:2, 1:3 and $1:\frac{2}{3}$.

Question 10

(a) The majority of candidates recognised that this question requires the use of calculus and many of these produced excellent solutions scoring full marks. Some made an error in the differentiation, giving for example $2x^2 - 12$ for example. A small number of candidates were unable to make further progress but the majority did clearly set the derivative equal to 0 and went on to solve the resulting equation, giving $x = \pm 2$, and then also finding the corresponding y values.

(b) A significant number of candidates did not attempt this part, including some who gave the correct answer to **part (a)**. The most successful and common method was using the second derivative to explain the nature of the turning points. Most candidates usually gave the correct second derivative. However, some did not substitute the x coordinates of the turning points into $6x$ in order to find the values of the derivative at these points and earned just one mark. Others, that did give these values, did not always explicitly state whether these values were less than 0 or greater than 0 and so did not score full marks. There are other methods available to determine the nature of the turning points. It was very rare indeed to see any attempts at either finding the values of y on both sides of each of the turning points or calculating the gradients on either side of the turning points. It is also possible to answer this part by drawing a reasonable sketch graph of the cubic equation with a maximum point shown in the second quadrant and a minimum point in the fourth quadrant. There were a very small number of successful attempts using this method.

Question 11

(a) (i) Many candidates gave correct answers with clear working seen. Sometimes the ratio of sides was used directly, whereas some others found, and simplified, the scale factor first. The common error was using an incorrect length ratio of 1:1.5 instead of 1.5: 1 between the two triangles.

(ii) Attempts varied with many fully correct answers, although some candidates found this part difficult. Those candidates using a simplified scale factor in the first part multiplied 63.6 by the square of their scale factor. However, some incorrectly multiplied by $\left(\frac{2}{3}\right)^2$. A few used a longer method and calculated angle Z and hence angle R enabling them to find the correct area. The most common error was to multiply 63.6 by the linear scale factor giving an answer of 95.4. Others thought the triangles were right angled and attempted calculations to find the base and height of the triangles.

(b) Most candidates found this challenging. Those that converted the ratio of volume to length and then area ratios were often successful. Many candidates formed an equation but the volume ratio of 64.8 ÷ 37.5 was often used as a length or area ratio without any conversion. A number found the equivalent of the length ratio 6:5 but then did not consider the area ratio but earned partial credit for the length ratio.
The most common incorrect response was to ignore capacity and surface area and set up the calculation $\frac{37.5}{64.8} = \frac{x}{0.792}$.

MATHEMATICS

Paper 0580/43
Paper 43 (Extended)

Key messages

To do well in this paper candidates need to be familiar with all aspects of the syllabus. The recall and application of formulae in varying situations is required as well as the ability to interpret situations mathematically and problem solve with unstructured questions. Work should be clearly and concisely expressed with intermediate values written to at least four significant figures with only the final answer rounded to the appropriate level of accuracy. Candidates should show full working with their answers to ensure method marks are considered when final answers are incorrect.

General comments

There were some very good scripts in which candidates demonstrated an expertise with the content and proficient mathematical skills. There were some poorer scripts in which a lack of expertise was clearly evident, and also a lack of familiarity with some topics, resulting in high numbers of no responses. There was no evidence that candidates were short of time, as most candidates attempted nearly all of the later questions. Candidates should be encouraged to read questions again once they have reached a solution. This would help to avoid unnecessary loss of marks, such as in **Question 5(a)**, where several gave the total balance in both parts rather than the interest paid. Candidates should not make assumptions about geometrical diagrams. For example, in **Question 2(a)**, assuming the angle at the centre was a right angle, and, in **Question 2(b)(i)**, assuming *CE* was a diameter were common errors. In **Question 3(b)** candidates needed to give exact values for the bounds and not rounded values. The topics that proved to be more accessible were simple transformations, simple and compound interest, mass and volume of a prism, straightforward algebraic manipulation, simultaneous equations, simple data handling, mean of grouped data, simple probability, use of the sine rule and much of the early work on functions. The more challenging topics were alternate segment theorem, reverse exponential decrease, the cosine rule, area of a quadrilateral, shortest distance, setting up equations and their solution, turning points, curve sketching, harder probability and harder function questions.

Comments on specific questions

Question 1

(a) Almost all candidates attempted a description of the transformation with varying degrees of success. The stronger candidates displayed a good understanding of rotation and almost always gave a correct description. Weaker candidates tended to omit at least one aspect of the rotation, the centre, the direction of rotation or the angle of rotation. A significant number of responses included a second transformation, usually a translation of $\begin{pmatrix}1\\1\end{pmatrix}$ or $\begin{pmatrix}1\\-1\end{pmatrix}$.

(b) (i) A large minority of the responses gave a correct description of the transformation. Other responses included a variety of errors. Describing the transformation as a move, movement or translocation was fairly common, all of which were not acceptable. There were many errors involving the vector with some giving coordinates instead of a vector, some vectors included the correct figures but some were reversed or the signs were frequently incorrect. A significant number of responses ignored the use of a vector and gave a worded description instead.

(ii) Calculating the distance moved by each point of the triangle proved challenging for a majority of candidates. Most that attempted Pythagoras were usually successful with errors usually resulting from forgetting to take the square root or multiplying the result by 3 for the three points. By far the most common error was giving an answer of 5, simply adding the horizontal and vertical displacements together.

Question 2

(a) A significant number of candidates made little progress in this part. Many were able to identify angle *AOB* as 104° but many did not recognise that this was an example of the angle at the centre and that angle *APB* was the corresponding angle at the circumference. Common errors included assumptions that angle *ABP* was a right angle and that angle *AOB* was a right angle. Several candidates gave their answer as 38°.

(b) (i) Only the stronger candidates recognised that the alternate segment theorem was required, resulting in a minority of fully correct solutions. Not all those that used the theorem matched up the correct pair of angles and angle *CFE* = 50 was a common error. Assuming that *CE* was a diameter and that angle *FCE* was 40° were very common errors.

(ii) A majority of responses displayed a good understanding of the opposite angles of a cyclic quadrilateral and many obtained the correct answer or an answer that followed on correctly from their answer to the previous part. Assuming that the opposite angles were equal was the most common error. A significant number of candidates made no attempt at this part.

Question 3

(a) (i) Most candidates had no difficulty in calculating the mass of the prism. Errors usually involved giving the answer in grams, using an incorrect conversion from grams to kilograms or dividing the volume by the density.

(ii) Success in this part depended on knowing the relationship between the volume and the area of the cross-section, and also knowing the correct method for finding the area of the cross-section. Fully correct solutions were in the majority with most incorrect answers resulting from errors in finding the area. Multiplying 10×5 was the most common error.

(iii) Calculating the total surface area proved more challenging. If the correct length of *BD* was obtained then candidates usually went on to find the correct area. Most opted to use Pythagoras' Theorem to find *BD* but not all used the correct length of 3 cm while others incorrectly assumed it was 5 cm. When *BD* was correct errors usually involved the omission of one or more faces.

(iv) Only a minority of candidates showed an understanding of the relationship between a linear scale factor and a volume scale factor. Those that used the factor of $\left(\frac{10}{5}\right)^3$ almost always reached the correct answer. Most incorrect answers resulted from the use of a scale factor of 2.

(b) Most candidates had some understanding of upper and lower bounds. Having found the two correct bounds in their working a significant number of candidates spoiled their good work by rounding their final answers. In some cases, only the rounded values were given. The most common error involved calculating the volume as 240 and giving the bounds for this value.

Question 4

(a) Most candidates produced some good algebra and solved the simultaneous equations correctly, with the elimination method being used more often than a substitution method. Incorrect answers often resulted from slips with the signs, slips with arithmetic or inconsistent addition/subtraction of their two equations. Following errors in finding the value of their first variable, some were successful in finding a value for the second variable and have a pair that satisfied one of the equations.

(b) Good algebraic skills were in evidence again in many of the responses and a majority obtained the correct solution. Common errors included multiplying the numerators by their own denominators, or reaching $11x = 12$ and giving the final answer as $\frac{11}{12}$.

(c) (i) Fewer fully correct solutions were seen in this part. Those responses that started by separating the statement into two inequalities were generally more successful than those that opted to work with the statement in its entirety. Starting from $-8 < 3x - 2 \le 7$ it was common to an incorrect first step, for example $3x + 6 \le 15$ or $3x - 2 > -15$. Other errors usually involved slips with the signs or slips with the arithmetic.

(ii) Almost all of those with a correct solution to the inequality gave a correct list of integers. Common errors usually involved the omission of 0 or just giving one possible integer. Some of those with an incorrect answer to the previous part were able to solve their inequality correctly. A higher proportion of candidates made no attempt at a response.

(d) A correct factorisation was seen in many of the responses. Common errors included partial factorisation, usually by taking 4 or a as the common factor, or attempts to treat it as the difference of two squares leading to answers such as $(4 - 2a)(4 + 2a)$.

(e) (i) Most candidates dealt with the division correctly, inverting $\frac{3}{4b}$ and multiplying. For these candidates, the most common error was forgetting to cancel either before or after the multiplication. Some attempted to write both fractions with a common denominator, usually $8ab$, before multiplication but this often resulted in incomplete cancellation. Other errors involved inverting both fractions.

(ii) Stronger candidates had no difficulty in writing the two terms with a common denominator and simplifying. Having reached the correct fraction of $\frac{x-2}{x-1}$, some spoiled their answer by incorrectly cancelling the x terms. Other errors included incorrect multiplication of $2(x - 1)$ as $2x - 1$, working with the numerator only and slips with the signs.

Question 5

(a) (i) A majority of responses calculated the correct simple interest on the investment. Incorrect responses usually involved calculating the total value of the investment rather than the simple interest, calculating the interest for just one year, or calculating the compound interest on the investment.

(ii) Although many candidates had a good understanding of compound interest fully correct answers were in the minority. A significant number stopped after calculating the value of the investment. Some candidates seemed unfamiliar with the formula for compound interest and calculations such as $(500 \times 0.03)^7$ and $500(0.03)^7$ were often seen.

(b) Appreciating the similarity between depreciation and compound interest usually meant that candidates found the correct value of the car. Most started with $6269.4 = A(1 - 0.1)^3$ and this almost always resulted in the correct answer. Many of the incorrect answers involved 6269.4 being multiplied or divided by numbers such as 1.1^3, 0.9^3, 0.7^3 and several others of a similar nature. Many of these calculations gave answers less than 6269.4 and candidates seemed unaware that these could not be correct answers.

Question 6

(a) Many candidates produced some good work on the sine rule and calculated the correct length for AD. In a few responses answers were given to only two significant figures rather than the 3 figures required. In other responses, angle ADC was treated as 90° even though clearly labelled as 100°. Responses such as 12sin50° were relatively common.

(b) Candidates were less successful in this part. In most responses the cosine rule was used but some candidates made algebraic errors in going from the implicit form of the cosine rule to the explicit form. When this was done correctly some candidates gave their answer to two decimal places, not appreciating that three decimal places were needed in order to show the rounding required by the question. Other errors involved the numerical slips when simplifying the cosine rule or attempts to use the sine rule. A significant minority of candidates made no attempt at a response.

(c) Most responses used $\frac{1}{2}ab\sin C$ as expected with some opting to calculate the perpendicular heights from *B* to *AC* and from *D* to *AC*. Fully correct answers were in the minority as success was often dependent on previous working. In addition, premature rounding in previous parts as well as this part also affected the accuracy of the final answer. A significant minority of candidates made no attempt at a response.

(d) Candidates were a little more successful in this part. Those that realised they needed to calculate the perpendicular height from *B* to *AC* were usually successful. Using an incorrect trigonometric ratio and slips with the numeracy were the common errors. Some thought that the line from *B* to the midpoint of *AC* was the shortest distance. In a small number of cases, calculating angle *ACB* using the cosine rule followed by simple trigonometry was seen.

Question 7

(a) This proved challenging and fully correct solutions were in a minority. When a valid equation was set up it was almost always solved correctly. Writing a correct expression for the total cost, in cents, of three cakes and two loaves was common but, more often than not, this was equated to the total cost in dollars. Forming an expression for the total cost of three cakes and one loaf and equating this to the given total was another common error.

(b) A greater number of correct solutions were seen in this part. Candidates that set up a valid equation or pair of equations usually succeeded in finding the cost of a bottle of water. Stating the equation $22w = 42(w + 1)$ was a common error. Some realised that the difference of $20 in the total cost meant that 20 bottles of each drink were bought and simply divided 22 by 20.

(c) (i) This proved challenging for all but the strongest candidates. Those that formed correct expressions for the walking time and running time usually found the correct starting equation and rearranged it to show the required quadratic equation. Many did not read the question carefully enough and attempted to solve the quadratic equation. Another common error was treating the time as distance times speed leading to $9x + 5(2x + 1) = 2.5$.

(ii) Of those who were able to derive the equation in the previous part, most solved the equation correctly either by factorisation or by using the formula. Some of those that solved it in the previous part used their answer to obtain the running speed. Some did not refer back to the information at the start of the previous part and gave the walking speed as their answer instead of the running speed. Many found the question too demanding and correct answers were in the minority. A significant proportion of candidates made no attempt at a response.

Question 8

(a) (i) Many correct responses were seen. Several candidates used $600 \div 60$ and gave the answer as 100 while some used a completed grid method but did not show the required calculation.

(ii) Candidates were far more successful in this part and a large majority calculated the correct number of people.

(iii) Many correct pie charts were seen. Some candidates calculated the correct sector angle but were unable to draw it accurately or drew it freehand.

(b) A good proportion of the responses had correct box-and-whisker plots. Some candidates had all the correct figures but a lack of accuracy when drawing some of the lines, sometimes without a ruler, led to an incorrect plot. Plotting 4.1 and 8.1 without doing the necessary calculations was a common error.

(c) (i) Only the better candidates gave a correct value for the range of the scores. Giving the range as 17, the range of the frequencies, was by far the most common error.

(ii) Far fewer incorrect responses were seen in this part. Common errors included 25, the frequency of the mode, and answers such as 0 or no mode.

(iii) Stronger candidates had no difficulty in finding the median. Common errors included finding the median of the frequencies, ordering the scores based on frequency and finding the median from this order and in a few cases the mean was calculated.

(d) The correct value for the mean was seen in a majority of responses. Some candidates used a correct method but made an error with the midpoints or an arithmetic slip in the working. Incorrect methods usually involved using the interval widths instead of the midpoints or, to a lesser degree, finding the mean of the frequencies or the mean of the midpoints.

Question 9

(a) This proved challenging for many candidates. Those that understood what was required usually obtained the coordinates of the three points. Many did not know how to start and some attempted to expand the brackets but got nowhere, some attempted a variety of substitutions and in some cases the y-coordinates were values other than 0. A significant proportion of candidates made no attempt at a response.

(b) A majority of candidates were able to show the required expansion. Weaker candidates were prone to errors, usually an incorrect power or a slip with the signs or occasionally brackets omitted in the working. A very significant number of candidates made no attempt at a response.

(c) This proved to be a very demanding question with only the strongest candidates showing a complete solution. When differentiation was attempted, it was often correct, but the omission of +2 was a common error. The derivative was often set to zero or implied by the working that was shown when solving the resulting quadratic. The omission of the working for solving the quadratic and slips in substituting into the formula were common errors. The final answers were often given to more than one decimal place. The previous part led some candidates to assume that the turning points were at $x = 0.5$ and at $x = 1.5$.

(d) Fully correct sketches were in the minority. Some attempted to label the axes, calculate points and draw the curve. This was almost always unsuccessful as the chosen scales made it difficult to draw a good sketch. The connection to the earlier parts of the question seemed to be missed by many. A wide variety of sketches were seen from negative cubics or cubics with no turning points, to straight lines, parabolas and hyperbolas. A very high proportion of candidates made no attempt at a response.

Question 10

(a) (i) This was almost always correct.

(ii) Many responses reached the correct probability. Some candidates seemed to ignore the fact that the spinner had two 1s and $\frac{1}{4} \times \frac{1}{4} = \frac{1}{16}$ was a common incorrect answer. The answer $\frac{1}{2}$ was another common wrong answer.

(iii) This proved challenging and correct values for n were not common. Successful candidates often used trial and improvement to find a value of n that satisfied $\left(\frac{3}{4}\right)^{n-1} \times \frac{1}{4} = \frac{729}{16384}$. Others worked with either the denominator or the numerator only and attempted to solve $4^n = 16384$ or $3^x = 729$. With the latter, some forgot to add on one after finding $x = 6$. Many of the incorrect attempts involved multiplying or dividing the given probability by $\frac{1}{4}$, or simply converting the given probability to a decimal. A high proportion of candidates made no attempt at a response.

(b) (i) Many correct responses were seen. Weaker candidates often gave the mean of the two given probabilities as their answer.

(ii) This proved to be more demanding and only a small majority found the two possible combinations and added them to find the correct probability. Several found only one of the two combinations and gave that as their answer. Others found both but multiplied them rather than added them. Only a few considered the option of 1 – (passing both tests + passing neither test). Those that drew a probability tree were usually successful.

Question 11

(a) (i) Almost all candidates found the correct value.

(ii) Although candidates were less successful in this part, many did find the correct value. The most common incorrect answer was 320 from the misapprehension that fh(3) = f(3).h(3) leading to the answer of 5×64.

(b) This proved more challenging and fully correct solutions were in the minority. Success depended on a correct interpretation of gf(x) and its correct manipulation. Writing gf(x) as $(2x-1)^2 + 2(2x-1)$ was frequently seen as were $(2x-1)^2 + 2x$ and $(2x-1)\left(x^2 + 2x\right)$. Errors in expanding $(2x-1)^2$ were common with most involving the omission of the x term or squaring the x term as $2x^2$. When expanded correctly most candidates went on to solve the equation correctly. A small number opted to factorise the original expression as $(2x-1)(2x-1+2)$ and usually went on to solve the equation correctly.

(c) Candidates were evenly split between those that recognised p(x) as the inverse of f(x) and those that did not. Those that did usually started correctly but some made errors in manipulating the algebra, usually involving an incorrect sign. Some left their final answer in terms of y and a few answers of $\frac{1}{2x-1}$ were seen. Several candidates made no attempt at the question.

(d) This proved to be the most demanding question on the paper and very few fully correct solutions were seen. It was common to see the product $4^x \cdot 2^x$ but very few were able to proceed correctly. The product was often written as one of 8^{2x}, 8^{x^2}, and to a lesser extent as 6^{2x}. After setting up a correct equation some were unsure what to do with the square root of 2. Those that rewrote it as a power of 2 usually went on to find the value of x. Some opted to change it to a decimal but this did not lead to a correct value of x. Although not required by the syllabus, some attempted to use logarithms, but without much success.