MATHEMATICS

Paper 0580/11
Paper 11 (Core)

Key messages

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

General comments

This paper proved accessible to many candidates. There were a considerable number of questions that were standard processes and these questions proved to be well understood. Most candidates showed some working with many candidates setting their work out clearly and neatly.

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 23**.

The questions that presented least difficulty were **Questions 2**, **7**, **9**, **12** and **16(a)**. Those that proved to be the most challenging were **Questions 17(a)** find the term to term rule, **18(b)** understand the notation asking for number of elements in a set, **19** back bearing, **20(b)** find the errors made in a standard form answer and **22** show the length of a triangle's side using trigonometry.

Comments on specific questions

Question 1

This question was answered well by many candidates. Occasionally, candidates reversed digits, particularly the 0 and the 3 or missed out the 0 completely. Sometimes extra zeros were included in answers.

Question 2

Many candidates gave the correct name for this angle. Occasionally right angle, acute or reflex were seen along with other words that were not names of angles such as isosceles or perpendicular.

Question 3

(a) Many candidates measured the line accurately but gave the answer in the incorrect units, centimetres, when it was asked for in millimetres. Also seen were 70.7, 770 and 7700. Other answers were very inaccurate, for example, 50 mm; others such as 87 might have come from not starting measuring from zero but rather 10 mm. Other answers of around 3 were perhaps the measurement in inches.

(b) Many correct answers were seen but sometimes the line drawn was far from perpendicular. Also seen were a small number of parallel lines – complete with double arrows to indicate that the lines were really supposed to be parallel. Candidates must use a pencil and a straight edge to draw accurate lines.

Question 4

This construction question was answered well. Many accurate responses with good clear arcs were seen. Some triangles had accurate side lengths but did not have arcs or the triangle was reversed. It is vital to use a pencil, a ruler and compasses. Candidates must leave in their construction arcs to gain full credit.

Question 5

This question did not ask for the lowest common multiple so any common multiple gained credit. The common correct answer was 72, the LCM, but, for example, 144 or 432 (18×24) were acceptable answers. There were a number of candidates who gave a common factor of the two numbers so 2, 3 or 6, the HCF, were seen frequently and sometimes, more than one factor was given.

Question 6

This question proved challenging for some candidates. As the units of the two lengths are different, one must be converted, and the fraction simplified. It was simpler to convert 2 m into 200 centimetres than 32 cm into 0.32 m. Some candidates got as far as $\frac{8}{50}$ without doing the final cancelling. A considerable number did not do the conversion to the same units or inverted the required fraction. A few gave a decimal as their answer.

Question 7

(a) The majority of candidates gave the correct answer of Oslo but Helsinki was seen as the most frequent incorrect answer, maybe as its temperature is also negative and there was confusion which was the coldest. Berlin was also seen; it has the smallest number of the positive values.

(b) This question was answered correctly by the majority of candidates. The most common incorrect answer came from 7 – 2 rather than 7 – (–2).

Question 8

Many candidates answered this question correctly. There were a variety of methods with incorrect assumptions, for example, 180° – 71° = 109°, 180° – 71° – 71° = 38°, (180° – 71°) / 2 = 54.5°. Those who used the diagram to identify angles or showed workings were more likely to produce a correct answer or gain partial credit.

Question 9

Candidates did well with this question with most gaining full credit. A small number gained partial credit for showing the method to reach one part, $20. A few misunderstood the concept of splitting a number into two parts by, instead, dividing the $200 by 7 for one answer and then by 3 for the other. For this question it did not matter in which order the answers were given.

Question 10

(a) Many candidates had difficulty completing the stem-and-leaf diagram and used the incorrect format for the leaves. Candidates used the whole of a piece of data for example 2.1 or part of each, 0.1 or .1 as leaves.

(b) The sixth birth weight was required for the median so using the stem-and-leaf diagram, the answer was the sixth birth weight from either end. If candidates did not understand the stem-and-leaf diagram, they could still find the answer by going back to the list of data at the start and find the median from that. This will entail more work and often errors were made by missing out values. Some gave the answer 2.2 kg, which is in the middle of the unordered list or the mean, 2.84 (to 3 significant figures). A few looked at the leaves, (without reference to the stem) put those in order and found the middle value, 3. A further note is that when using the stem-and-leaf diagram to find the median, such as here, candidates should not cross out the data too heavily otherwise it is difficult to assess the work for **part (a)**.

Question 11

(a) When candidates are asked to show a result, they must not start with the result and work backwards. This was seen often in this question.

(b) The most common error was to draw a sector of the pie chart of 110° often with no working shown. Another common error was to write $\frac{110\times240}{360}$ = 73.3 instead of $\frac{110\times360}{240}$ = 165.

Question 12

This question was answered well. There were some incorrect methods such as 520 – 15 or 520 ÷ 0.15. Some found 15% and then either went no further or added it to 520.

Question 13

This fractions question is one of the more straightforward types, being addition with no whole numbers. Only one fraction needs to be changed from $\frac{1}{3}$ to $\frac{2}{6}$ as the other fraction is already in sixths. This could be answered using the common denominator 12 or 18 but that would mean more work and more places for errors to occur. After the addition, the resulting fraction of $\frac{7}{6}$ (or $\frac{14}{12}$, etc.) must be turned into a mixed number in its simplest form. Often this last step was omitted by candidates.

Question 14

(a) Candidates needed to take 0.04 away from 1 but some took 0.04 from 100 or gave the answer 0.6 or 0.06. Some converted 0.04 to a fraction then gave the correct fractional probability. In this question it did not state the form of answer, so the correct fraction or percentage gained full credit.

(b) The calculation 0.04 × 850 = 34 was done correctly by many candidates but some gave the answer as 0.34 or 340. Some candidates tried to use their answer to **part (a)** as well as or instead of 0.04. A small number focused on the fact Mario tested 850 cars in a one week so divided 850 by 7.

Question 15

Many candidates misunderstood the scenario, dividing 330 by 14 and multiplying by 11 to get 259 which must be incorrect as the answer should be greater than 330. Some candidates added this on to 330 to get 589. A small number converted $\frac{11}{14}$ to a decimal or percentage but then worked with a rounded value, losing accuracy.

Question 16

(a) Most candidates completed the table correctly. Some rounded or truncated their answers to one decimal place. Occasionally the signs of one or both answers were incorrect.

(b) This was a complex graph to draw as many points were not on the crossing points of the grid. Many candidates were very successful and produced smooth curves going through the correct points. Candidates were able to gain credit for their correct plots if their curves were not fully correct. Plotting the points at x = +/- 4 was found most challenging. Many candidates recognised that the graph did not cross the axes. There were also graphs drawn using a ruler which is not appropriate for a curve.

Question 17

(a) Many candidates found the term to term rule challenging and frequently candidates gave 243, the next term, or listed the common differences as their answer. Some gave the nth term for this sequence. Answers of 3 × n, showed that candidates realised that multiplication by 3 was required but this is not how the term to term rule should be expressed. The answer, multiples of 3, again showed some understanding but this is not acceptable as an answer. Also, multiples of 6 or 9 were seen.

(b) The most common errors were to give the next term, 29, or to write $n + 4$ or $9n + 4$. Only a small number of candidates gained full credit, with many showing the difference of 4 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 and the first term. Some candidates gave the formula incorrectly as $a(n - 1)d$.

Question 18

(a) Most candidates identified *a*, *b* and *c*, but a large number omitted *d*.

(b) Many candidates were not confident about the meaning of the notation – the number of elements in the union of sets *P* and *Q*. Most listed all the elements in the diagram or just gave *d*.

Question 19

The majority of candidates found this question challenging, partly as no diagram was given. This question was also the one that was most often left blank. This needed knowledge of angles in parallel lines to help candidates recognise alternate angles. Some candidates drew a sketch of the situation and that helped greatly with understanding of the calculation that needed to be done. For the calculation, many gave 360 – 137 = 223 instead of 180 + 137. For those that said, 180 – 137 = 43, one more step of 360 – 43 would also have got to the correct bearing. Some tried to draw a diagram with accurate angles and then measure the angle; mostly these were inaccurate – it is far better to use a sketch to understand what calculation should be done.

Question 20

(a) Most seemed to understand what was required but not all were able to write the number in the correct form. Some wrote 273 rather than 2.73. There were also errors in the exponent, with some omitting the negative sign, others writing plus or minus five. Others wrote $2.73 \div 10^3$.

(b) Some of these answers showed great understanding of Sam's errors and were clearly expressed. Candidates were expected to show the error Sam made in respect of the rounding of the figures and the error with how the standard form is expressed. Candidates had to do the calculation to see where Sam had gone wrong. For this question, it was only necessary to point out an error, candidates did not have to go further and make the corrections for Sam but many did and as long there were no contradictions or errors in what they wrote, they gained credit.

Question 21

This question on similar figures was answered well. Those who started with the correct ratios usually arrived at the correct answer. Some either got to a scale factor such as 8.5 and then forgot to multiply by 4 or rearranged incorrectly. Other incorrect responses often arose from adding or subtracting the known lengths. A few candidates tried to use trigonometry.

Question 22

There were some good answers seen in this question. With this type of question candidates need to start from the information given and progress to show the required value. Those who arrived at $\frac{17.5}{tan48}$ often gave the answer 15.8, but in order to show that this is correct to 3 significant figures, candidates must show a more accurate value that rounds to 15.8. A significant number were unable to use trigonometry. Some attempted to use trigonometry but formed the ratio incorrectly or wrote their calculation as $x = 48 \tan 17.5$. Others used another trigonometric ratio to find the hypotenuse and then Pythagoras' theorem to find *x*. If candidates rounded in the middle of the calculation, the final value was often inaccurate.

Question 23

There were many neat, clear correct solutions for this question. This question spilt into two parts. First, candidates had to write down two equations from the given information using a different variable for each plant's cost. It did not matter if these equations were in cents or dollars but must not be rounded, i.e. using 9.35 or 935 but not 9. Second, these equation must be solved to find the cost of the two kinds of plant. If working was in cents, these answers had to be converted to dollars. Candidates used the full range of acceptable methods to find one variable (cost) then substitute that into one of their equations to find the other cost. There were rounding errors here as well as arithmetic slips. As this context is of cost, candidates should have realised that answers must not be to more than 2 decimal places (for the cents) – if this happened, candidates should have checked their working thoroughly.

MATHEMATICS

Paper 0580/12
Paper 12 (Core)

Key messages

Candidates need to cover the whole syllabus with sufficient depth to understand direct straightforward questions.

When using a calculator for a more than one step problem, do not round in the middle of the process.

General comments

This was a straightforward paper with a large majority of marks gained for simple application of the syllabus. While there were some very good, clear scripts many did not seem to have a clear understanding of certain topics. Presentation and working where necessary were generally quite good. A few did not have the basic geometrical instruments and occasionally it seemed that a candidate did not have a calculator. Lack of clarity was seen from some in questions where the stages needed to be developed.

Comments on specific questions

Question 1

(a) Most responses had just 8s and zeros but some confused 80 with 18. The incorrect number of zeros was common with one or three zeros between the two 8s often seen.

(b) Quite a few variations were acceptable for the mark. Both the value represented by the 4 or the column where it was placed were seen regularly. Those who did not understand the question often gave 640 000 or 64 or 4.

Question 2

The vast majority of responses were correct, but some omitted the decimal point. A few omitted the question suggesting no calculator or one without a square root key.

Question 3

Nearly all candidates seemed familiar with entering data into a table of frequencies. However, it was common to see the frequencies in the tally column with probabilities or cumulative frequencies in the frequency column. The frequencies were nearly always correct but occasional slips were made in them.

Question 4

There were many fully correct, well drawn, nets. Some drew a three-dimensional figure or a series of unconnected rectangles. A common error was to add three more 5 by 2 rectangles below the given one or two 5 by 4 rectangles next to each other. Partial marks were gained regularly for partially correct nets.

Question 5

Although the length of this shape was significantly longer than the width, many candidates drew diagonal lines. Only a few drew just one line, the vertical being most common.

Question 6

In both cases, the vast majority of candidates placed the brackets correctly with only a few putting in two pairs. Some omitted the question showing lack of at least making some trials.

Question 7

Candidates were told the triangle was isosceles and appropriate equal marks were shown on the sides. With all that information quite a number ignored the other angle of 34° and simply subtracted 34 from 180. While the diagram was not to scale, just adding the 34's to give 68 as an answer neither fitted the diagram or the universally known property of angles of a triangle add to 180.

Question 8

(a) Many correct answers were seen but some spoilt otherwise correct answers by thinking further combination of the terms was needed. It was common for candidates to ignore minus signs and give both coefficients as 8. Some made progress but incorrectly collected the 'a's or 'b's, usually the latter.

(b) Most candidates gained partial credit for working out 5*t*. Grouping 3 and 6 together was a major error leading to 18^2 instead of 3×36.

Question 9

(a) With very few showing lines between components and simple addition of 2 positive and 2 negative numbers, the vast majority gave the correct answer.

(b) This was also well answered although some did not multiply both components correctly by 6.

Question 10

The question was answered well provided candidates knew a common denominator had to be seen and used. Those using the LCM were more successful in gaining full credit as it produced a fraction in its lowest terms. Some using a higher common denominator did not reduce their fraction or made errors in doing so. Missing out necessary steps in the working did not happen very often.

Question 11

Those who knew the probabilities added to 1 generally got the correct answer. An answer of 0.25 was common, just simply one quarter for a fair dice. Others added the three given probabilities and divided by 4 leading to 0.19. Many did not enter an answer in the table and showed various erroneous calculations.

Question 12

(a) Most candidates gave the correct next two terms but 0, −13 from subtracting 11 and 13 was common. Others gave the differences of −9 and −11 as their answers. Some candidates thought the sequence was increasing and were reluctant to consider a negative for the second term.

(b) There were quite a number of fully correct responses and many gained partial credit for either the 7 or the −4. Many realised that the difference of 7 was involved in the formula but some gave $4n - 7$. Starting from an unsimplified form was common which could gain full credit. However, errors were often made in trying to simplify. The usual error of $n + 7$ was seen but not very often.

Question 13

(a) Apart from the small number who found the mean, an attempt to order the items was seen in most responses. Decimals caused confusion for some with 4.5 in the incorrect place. There was also reluctance to have a decimal value for the median so 3, 4 or simply 3 or 4 were seen. A significant number did not order the items and worked on the middle two from the original list, 3 and 18.

(b) Candidates found this question challenging. Most responses referred to the decimal in the list of numbers or that the mean gave a decimal value. The idea of one value being much larger than the rest was not often seen.

Question 14

(a) This was correctly calculated by the vast majority of candidates but some put a decimal point in the answer, presumably since there was one in the question. There were a few other incorrect responses but 2880 from 1.2^2 instead of 1.2^3 was seen occasionally.

(b) Without any specific instruction on working for the fraction or form of the answer there was quite a mixture of calculator used or standard fraction method for multiplying fractions. It was well answered with fraction and decimal as the final answers. Fractions not in simplest forms were also fully accepted in this question.

(c) Again this part was well answered with many fully correct responses seen. Errors in the order of operations was evident for some but a major error was working out numerator and denominator separately and rounding them before the division.

Question 15

This question required several stages, the first being to find the cost of the ribbon. Most of the candidates dealing with that stage correctly made good progress and usually gained full credit. Errors were, for example, adding the lengths of ribbon and fabric together and then dividing that into the total cost.

Question 16

(a) The expansion was well done by most candidates but it was common to see a further step after the correct answer. A common error was $2x$ for x^2 but most gained at least partial credit.

(b) Most candidates either factorised correctly or a correct partial factorising was seen. An attempt to combine the terms into one expression was seen.

(c) Although most candidates realised that the terms in x needed to be on the left and the numbers on the right, many did not get the signs correct, most often $6x$ instead of $4x$ was seen.

Question 17

(a) (i) Some candidates found this Venn diagrams question challenging. Many no responses and clear lack of understanding was evident. Of those who made some progress, the two given values, 15 and 35, were usually correctly placed. Only a few made further progress with the other sections so the award of full credit was rare.

(ii) Some correct responses were seen and a few gained credit from the follow through. Some gave numbers of people rather than probabilities.

(b) The symbol for union was not well known. Most shaded the intersection or the area outside the circles.

Question 18

Having to find a length from a given volume rather than just finding the volume of the prism made this a challenging question. Many of those who made some progress neglected the half in the formula for area of a triangle. Lack of understanding was clear in attempts involving surface area or trying to apply Pythagoras' theorem to the situation.

Question 19

Most candidates realised that a proportion calculation was needed and in most cases the correct answer was found. Rounding results at a first stage in a 2-stage calculation meant quite a few didn't gain full credit.

Question 20

(a) The common error of 4 from 8 ÷ 2 was seen quite often but many understood the rules of indices and found the correct answer. As quite clear from the answer space the value of *x* was required and not 5^6.

(b) Adding the indices, instead of multiplying them was often seen. However, there were many correct answers although, once again, the form of the answer was important and just 15 was not a correct answer.

Question 21

Many correct answers were seen but a significant number of candidates did not realise that a trigonometry calculation was needed. Some found the other angle and used sine. Longer unnecessary methods sometimes produced errors in the calculations or rounding.

MATHEMATICS

Paper 0580/13
Paper 13 (Core)

Key messages

It is vital to cover the whole syllabus in the preparation of candidates for the examination.
Premature rounding in calculations should be avoided.
Candidates should be familiar with multi-step questions and understand how to break them down.

General comments

Candidates should ensure they show clear working as in many cases answers without working or confused working were evident.
Poor handling of directed numbers was seen for many. Candidates need to understand the difference between a net and a 3D representation of a solid. Candidates need to understand set notation.

Comments on specific questions

Question 1

Many correct answers were seen. Of those who did not write the correct answers for the first two parts many gained the final mark for correctly adding their values.

Question 2

This was almost always answered correctly.

Question 3

(a) The correct answer was usually given; the most common error was 164.

(b) The correct answer was usually given; the most common error was again 164.

Question 4

(a) Few candidates gave the answer rhombus. The most common answer was parallelogram, with quadrilateral and trapezium also seen. Several candidates did not attempt this question.

(b) The most common answer was 4. Several candidates wrote the number of degrees rather than the order of symmetry.

Question 5

(a) Many candidates wrote out a list of the numbers from the stem-and-leaf diagram rather than working from it for all parts. A significant number gave 27–64 as the answer rather than calculating the range.

(b) Many candidates were able to give the correct answer 55. Others knew how to calculate the mean, median and mode, but did not understand which was which. Some just wrote the value of the leaf rather than the two digit value it represented.

(c) Although the correct answer of 45 was seen often, the same comments as **part (b)** apply here.

Question 6

This was well answered with the majority of candidates gaining full credit. The common incorrect answers were 6 hours 37 minutes and 6 hours 23 minutes.

Question 7

(a) Most candidates gave a correct answer and were able to gain full credit. Some did not attempt this question. Candidates should ensure they have the necessary equipment, in this case a protractor was needed.

(b) Candidates who recognised $\frac{120}{360}$ usually went on to correctly simply and gain full credit. The most common incorrect answer was $\frac{1}{4}$.

(c) Few candidates were able to give the correct answer. It was rare to see logical working even when the answer was correct. Some gave figures for each sector added but it was not clear where the figures were from.

Question 8

This question was well answered but some lost accuracy by splitting up the calculation and giving the answer 6.1 without a more accurate value shown.

Question 9

Very few correct answers were seen as the majority of candidates confused the question with compound interest.

Question 10

Some good clear geometrical reasons were given which gained full credit. Those who did not gain credit usually did not include the word angle.

Question 11

(a) (i) Most candidates knew how to expand the brackets and gained at least partial credit, usually for $4d + 4$. Many were able to simplify correctly but of those who were not able to simplify, the most common incorrect answer was $2d + 13$.

(ii) This part proved more challenging than the previous part. The common errors were –12 from -3×-4 and a final answer of $x^2 - 12$. Several did not include the x when simplifying the middle terms.

(b) Candidates who understood factorising usually gave the correct answer. It was clear many did not understand what they needed to do and a significant number just repeated the question on the answer line.

Question 12

Those who realised the need for a common denominator usually gained full credit. A common error was to subtract the numerators and denominators leading to an answer of $\frac{3}{4}$. Several gave the answer without showing any working. A small number converted their fractional answer to a decimal.

Question 13

This was well answered; the majority of candidates understood the notation and gave the correct values. The most common errors were to omit 0 or 2.

Question 14

Several candidates were able to give a clear explanation. A variety of incorrect statements involving the origin, not referring to the *y*-axis or 'there's no gradient' were seen. A significant number of candidates did not attempt this question.

Question 15

Several candidates gave the correct answer. The main error was to multiply 14.2 and 7.5 giving an answer of 106.5. Others did not know how to answer this question and several incorrect calculations were seen using some or all of the dimensions given.

Question 16

Although several candidates were able to answer this question correctly, many found this question challenging. Common incorrect answers were; dividing by π but not halving the answer, just halving 130 and treating 130 as the area of the circle rather than the circumference.

Question 17

The majority of candidates were able to give the correct answer. The most common error was to write the power as 3 rather than –3. Those who did not understand standard form often wrote $\frac{7}{1000}$.

Question 18

(a) Many candidates gained full credit. However, a small number who understood how to answer the question gave an answer which lacked accuracy. Candidates who did not answer this question correctly usually added 14^2 and 10^2 rather than subtracting or gave 4 as the answer from 14 – 10. Some also tried to use trigonometry but did not use the full method.

(b) Candidates who had an answer for **part (a)** usually gave the correct answer or gained the follow through for this part. Some worked out the area rather than the perimeter.

Question 19

(a) $A \cup B$ was more common than the correct answer of $A \cap B$. Some also tried to give a description in words, e.g. 'in both'.

(b) (i) The majority of answers were correct. The main error was not including *s* and *d* from the intersection.

(ii) Although a small number of candidates gave the correct answer, it was evident many were not familiar with set notation as few candidates gave a numerical answer. The most common answer was *m,e* (the elements in neither *A* or *B*).

Question 20

Many candidates gave the correct answers. Some subtracted the equations and others had not realised that there was a common coefficient in the question and tried multiplying both equations which often led to errors.

Question 21

Candidates who fully understood trigonometry were able to give the correct answer. The most common error was using the cosine ratio with the angle 56. Several candidates did not make any attempt to answer this question.

Question 22

(a) This part was well answered. The most common incorrect answers were 2^3 and 4.

(b) This part was not well answered. Very few gave the correct answer or showed an attempt at finding the lowest common multiple. Candidates who used the listing method often gained partial credit.

Question 23

There were a significant number of candidates who knew how to rearrange this formula but didn't write their answer correctly. It was common to see $q - r \times 7$ as the answer and these candidates usually gained partial credit for $q - r = \frac{m}{7}$. Some chose to multiply by 7 first but did not multiply r by 7.

Question 24

It was rare to see the correct answer to this question and most candidates did not realise the solution needed to be calculated in stages. Several candidates gained partial credit for calculating $x = 16$. Many then tried to use the formula for the sum of the interior angles rather than just considering exterior angles. It was common to see $7x + 44$ equated to $x + 8$ or the two expressions multiplied together.

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. When solving more challenging questions, they should be encouraged to spend some time looking for the most efficient, suitable method.

General comments

The level and variety of the paper was such that candidates were able to 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 they should always cross through errors and replace rather than try and write over previous answers.

Candidates are often losing marks by not reading the question carefully; this was particularly apparent in **Questions 3, 6, 8, 9** and **15**.

Candidates need to be aware that prematurely rounded intermediate answers often bring about a lack of accuracy when the final answer is reached.

Checking answers should be encouraged in order to highlight method or numerical errors. This would have highlighted errors in questions such as **Question 4** where the two values must equal 200, checking that the solutions to simultaneous equations work in both equations in **Question 11,** or that the factorisations in **Question 20** multiply out correctly.

Comments on specific questions

Question 1

The majority of candidates were awarded this mark, with 72 and then 432 being the most common answers. A significant minority of candidates confused multiples and factors, giving answers of 2, 3, 6 or a combination of these.

Question 2

This was well attempted, with the majority of candidates finding the correct time. A good strategy often seen was to add on 20 minutes to get to midnight and then add 6 hours and 50 minutes to that. A common incorrect answer was 6 h 10 min, when 00 40 is overlooked. 8 h 10 min was another frequent mistake, as was 7 h 30 min. Candidates should be encouraged to add on to the earlier time rather than subtract, which often led to using 100 minutes in an hour, hence 23 40 – 06 50 = 16 90. Reversing the times was sometimes seen, with an answer of 16 h 50 min from 06 50 to 23 40.

Question 3

The majority of candidates gained both marks on this question, understanding the need to convert the units. Some candidates gained the method mark for a correct starting point of $\frac{0.32}{2}$ or $\frac{32}{200}$ which they then left as a decimal 0.16 or processed incorrectly. Many candidates did not deal with the different units, resulting in $\frac{2}{32}$ and $\frac{1}{16}$ and some thought that 1000 cm = 1 m. A significant number of candidates wrote the fraction the wrong way round and so $\frac{2}{32}$ and $\frac{200}{32}$ were common. Another common error was to correctly change 1 m to 100 cm but then forget that the length is 2 m, resulting in $\frac{32}{100}$ and $\frac{8}{25}$.

Question 4

A good understanding of ratio was demonstrated, with the vast majority of candidates giving the correct values. The only common error, made by weaker candidates, was to divide 200 by 7 and by 3.

Question 5

The vast majority of candidates gave the correct angle, usually marking 55 to make a straight line with 71 and *x* and then subtracting from 180, although some did double all the angles and used angles around a point. The most common misconception was to assume that the diagram is symmetrical and so 38, from 180 – 2 × 71 was common, along with other incorrect answers with 55 and 71 being incorrectly placed on the left transversal. Some subtracted 71 from 180 to give 109, occasionally halving this to 54.5. Others gave 55, perhaps confusing alternate angles or vertically opposite angles.

Question 6

The vast majority of candidates gained both marks in this question, with others gaining one mark for evaluating 15 per cent correctly to give 78. The most common method was to find 15 per cent and subtract it from 520. The most common misconception was to treat $520 as the reduced price and find $\frac{520}{0.85}$.

Question 7

The notation in **part (a)** was very well understood with the vast majority of candidates giving the correct list. The most common error was to omit *d*. The notation in **part (b)** was less familiar. It was common to see the list of elements rather than the number of elements. The other confusion was with the union notation, which many treated as intersection, giving an answer of 1, or more commonly, *d*.

Question 8

The majority of candidates recognised that each term is three times the term before it and gave a correct answer to **part (a)**. Weaker candidates looked at differences but could get no further. Some more able candidates did not gain the mark because they had not read the question carefully and gave 3^n or 3^5 as the answer. Candidates are becoming increasingly more able to produce an *n*th term for a linear sequence with the majority giving a correct expression in **part (b)**. Those not gaining both marks were often awarded one mark for an expression containing 4*n* or for a correct starting point using the general formula which was then incorrectly simplified. Candidates who did not score often gave the next term of 29, as had been requested in the previous part of the question, or after finding the common difference of 4, gave $n + 4$ or simply 4 as the answer.

Question 9

Candidates showed clear, full working and the majority were awarded 2 marks. The majority used the most efficient method of converting $\frac{1}{3}$ to $\frac{2}{6}$ but many chose to convert both to either twelfths, or more commonly eighteenths, which was usually done correctly. There were many who either did not read the question carefully or who did not understand the meaning of a mixed number, giving the answer $\frac{7}{6}$ and so did not get the answer mark. There were very few who did not show any working and it was only the weakest candidates who did not understand the need for a common denominator.

Question 10

The vast majority of candidates understood how to deal with the coefficients and the indices and were awarded two marks. Some dealt with the coefficients and indices in the same way, resulting in answers of $2x^2$ and $9x^9$. A few removed the *x* completely and gave 2^9 as their answer. A small minority attempted to factorise and had brackets in their answer.

Question 11

This was well attempted by all but the weakest candidates. It would have been beneficial for candidates to look for the most efficient way of dealing with the equations, as subtracting the first equation from the second gets straight to the first answer of $x = 4$. Many multiplied the first equation by 2 to eliminate *x*, usually resulting in the correct answers but with more working. Many candidates struggle with eliminating two negative coefficients and the most common error was to incorrectly eliminate the *y* terms by adding, resulting in $3x = 18$ and $x = 6$. Candidates should be encouraged to check that their answers satisfy both equations.

Question 12

Part (a) was extremely well attempted; the vast majority of candidates understanding that the scale factor is $\frac{2}{3}$ with *PQ* being the corresponding side to *AB*. The most common error was to divide by the scale factor, resulting in an answer of 13.5. A small number of candidates involved the area of 18 in their calculation.
Part (b) was not well attempted by weaker candidates, who did not understand that the length scale factor is different to the area scale factor and the answer 12 was extremely common. More able candidates used the given scale factor of $\left(\frac{2}{3}\right)^2$ or the lengths $\left(\frac{6}{9}\right)^2$. Some candidates were confused by what values should be squared or square rooted and so did not show a correct method. Candidates who did not understand area scale factors often managed to work around the problem by finding the height of triangle *ABC* and applying the length scale factor to find the height of triangle *PQR* followed by a correct area calculation. This often resulted in a loss of accuracy due to rounding the height of $2\frac{2}{3}$.

Question 13

The majority of candidates understood how to find acceleration in **part (a)**. Those giving an incorrect answer were often finding the triangular area underneath the graph, calculating 5×14, using Pythagoras to find the length of the diagonal line or using the total time of 15 rather than 5. The majority of candidates understood the need to find the area under the graph in **part (b)** with many correct answers given. Some used the area of a trapezium; most calculated the rectangle and triangle separately. Sometimes arithmetic errors were seen or candidates forgot to halve for the area of the triangle. The most common method error was to multiply 15 by 14 and sometimes candidates multiplied 5 by 2.8 for the first section of the graph.

Question 14

Most candidates recognised rotation for one mark. Many were also awarded the mark for 90 clockwise, although a significant number gave 90 but forgot the direction, or gave it as anticlockwise, or gave 180. Finding the centre was the most problematic and it was often omitted. (4,3) was a common incorrect centre. Candidates should be aware that if the question requires a single transformation then a second transformation given invalidates the answer. This was the case for those candidates who said that a translation had also been carried out, implying a rotation with a centre on the shape followed by a movement, rather than looking for a centre off the shape which would result in the correct image.

Question 15

This question was well attempted by more able candidates. Many candidates worked with the area of the sector rather than its perimeter and so could not be awarded any marks. Of those candidates that were using the circumference, more used 26 as the arc length rather than subtracting the two radii and were awarded one mark if all other working was correct. Some candidates gave a correct first line of working, adding 16 on to the expression for arc length and equating to 26 but then dealt with solving the equation incorrectly.

Question 16

There were many candidates with correct values for all 4 angles and a full range of marks was seen. Each value can be found independently so one incorrect value did not rule out others being found correctly. It was clear that many weaker candidates did not know the rules for circle theorems, or were not able to pick them out in a more complex diagram like this. Successful candidates wrote any angles which they could easily fill in on the diagram as a first step. It seems that many were treating the top two lines in the horizontal direction as parallel, with $x = 20$ and $u = 36$ often given, perhaps as alternate angles. $w = 108$ was often the only correct answer where a candidate spotted that it was an opposite angle in a cyclic quadrilateral. Others thought it was a right angle and some gave it as 62, probably treating the angle of 124 where the two diagonals intersect as the centre of the circle.

Question 17

Candidates once again demonstrated a good knowledge of indices and many fully correct answers were seen. There were very few who were not awarded any marks, as at least one of either the index or the coefficient was usually correct. The common answers scoring one mark were $5x^5$ and $625x^{625}$. Some candidates wrote $\sqrt[5]{3125}$ but were unable to evaluate it.

Question 18

The vast majority of candidates understood that the sine rule was the appropriate method in this question and gained all four marks for an accurate answer. Some premature rounding caused some to lose the final answer mark. Showing full working was important in this question, as often the correct ratios were set up, but without the explicit working to find the length, only an accurate answer could imply the correct final step of working. The first step to answering this question is to realise that 30 should be used to pair up with the given side and many candidates scored a mark for this even if they could progress no further. Some candidates understood that the sine rule was required but paired 7 with sin 35 and could not be awarded any marks. Other candidates who did not score were using ratios without sine or were using trigonometry for right-angled triangles.

Question 19

Successful candidates had a methodical approach and were careful with signs and powers. Careful checking of work should be encouraged in this type of question where a careless slip can cause many further errors. Two marks were awarded to those who made an error resulting in just one term in the final answer being incorrect or to those who made an error collecting terms following a correct expansion. It was more common to award one mark for a correct first stage of multiplying out two of the sets of brackets where one error in a term was allowed. This error was often a sign error, commonly -4 at the end of the expansion of $(x-2)^2$. Less able candidates were often able to access this mark, even if they could progress no further. Many candidates struggled with $(x-2)^2$, often using x^2-4, x^2+4 or confusing it with the difference of two squares and writing $(x+2)(x-2)$. Those who tried to multiply out all 3 sets of brackets in one line invariably made errors and did not score any marks. Candidates should be aware that when asked to expand, they should not factorise their final answer.

Question 20

Less able candidates struggled with the factorisation in **part (a)**, perhaps because it was in an unfamiliar format. More able candidates had few problems with it, a common starting point being $1+x-y(1+x)$ and others arranged to $x-xy+1-y$. Some struggled with the signs and did not have a bracket common in both terms. A large number of candidates simply took out a common factor of 1. Others felt that there must be a difference of two squares involved somewhere, leading to answers such as $(x+y)(x-y)$, without multiplying out to check. Less able candidates fared better in **part (b)**. Carelessness often caused a loss of marks here with incorrect powers of x either inside or outside the bracket which would have become apparent if multiplied back out to check. Fewer candidates understood that the bracket could be further factorised as the difference of two squares and some factorised to $(x-9y)(x+9y)$ or $(x-3y)^2$.

Question 21

Only the most capable of candidates were awarded both marks for this question. It was clear that the majority had little understanding of the difference between a linear, quadratic and cubic graph or the meaning of a gradient changing sign. There was a significant proportion of candidates who did not make any attempt at drawing the graph.

Question 22

There were a good number of well-drawn cosine curves gaining both marks in **part (a)**. Many other candidates gained partial credit for a curve that started at (0, 1) and was in the shape of a cosine curve, but had the wrong amplitude or period. There were a considerable number of attempts with properties of a sine curve, along with some tangent graphs. A small minority drew a curve that was correct, except that it did not start until (90, 0). More able candidates had no problem finding the correct two values in **part (b)**. One mark was also awarded to a significant number of candidates either for finding one angle, usually 120, or for understanding that both angles must sum to 360. Many candidates thought that the two angles should sum to 180 or added 180 to 120 and so they should be encouraged to use the graph of the function when looking to solve within a range. Some candidates omitted the negative from $\frac{1}{2}$, resulting in an angle of 60, which was often paired with 300 to gain one mark. Weaker candidates worked out cos $\frac{1}{2}$ and there was a significant proportion who did not attempt either part of the question.

Question 23

There were few completely correct answers to this question but the majority of candidates were able to score at least one mark. Many gained a mark either for correctly expressing *y* in terms of *x* or *x* in terms of *w*. Many candidates then understood the need to replace *x* to give a relationship for *y* in terms of *w* and gained two marks for a formula such as $y = \frac{1}{\sqrt{(c)w^2}}$ or equivalent. Only a small minority who could progressed from here to find the constant of proportionality. Those who understood that the two constants could be combined to $y = \frac{k}{w}$ fared better than those dealing with squares and roots after substituting the values of 12. Many candidates did not know how to replace *x* and wrote for example $y = \frac{k}{\sqrt{x} = kw^2}$ or did not understand the need to replace *x* at all.

Question 24

There was a good proportion of correct answers, but error bounds continue to be misunderstood by many candidates. The most common misconception was to find the difference between the two numbers and then apply the bound by adding 0.5 to the answer. Many did understand that the bound should be applied before any calculation and were awarded one mark for giving a value with a bound correctly applied. The most common error from this point was to use the upper bound of both values, hence 39.5 – 36.5 rather than finding the maximum difference.

Question 25

Part (a) was well understood with the majority of candidates giving a correct answer to both parts of the question. Those who did not give a correct answer in **part (i)** were generally multiplying the two probabilities rather than adding. The follow through in **part (ii)** allowed those who made an error in **part (i)** to gain the mark here. There were many correct answers to **part (b)** from more able candidates, with many adopting a successful strategy of drawing a tree diagram showing outcomes. Another successful and efficient strategy was to find the probability of getting 2 balls of the same colour and subtracting from 1. Most were finding outcomes of different colours and many errors were made, either with the probabilities, dealing with the fractions or not being methodical in listing the different outcomes. Many did not understand that red, blue for example could also be the other way round as blue, red, and so omitted half of the possible outcomes. Weaker candidates demonstrated many misconceptions, for example adding probabilities, multiplying 3 probabilities together or looking at probabilities with replacement. Only a very small number of candidates were awarded any marks in **part (c)**. There was a high proportion who did not attempt the question. Able candidates tended to be looking for an algebraic way to solve the problem, trying to find an equation involving *n*. Very few considered trials which is often a good starting point for some problems, even if some form of algebraic method then follows.

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 adept mathematical skills. Premature, excessive or careless rounding did cause several candidates to lose marks, and this was particularly evident in **Questions 10(c)**, **21** and **22**. Candidates showed particular success in the basic skills assessed in the earlier shape and space and algebra questions on the paper. Where candidates scored highly, but did not get full marks, it was frequently **Questions 8(b)** and **19** that were the cause. There was little evidence that candidates were short of time, as almost all attempted the last few questions. A few candidates were unable to cope with the demand of this paper.

Comments on specific questions

Question 1

All candidates attempted this question and nearly all answered it correctly. The most common misconception was $\frac{180-34}{2}=73$ from assuming that the unknown angles were the same.

Question 2

This question was answered well by most candidates. Common errors were to take y out as a common factor but then not simplifying the figures in the bracket giving $y(27 - 77)$ as a common wrong answer. A few candidates treated it as a type of quadratic expansion, expanding $(y \times 27) - (y \times 77)$, leading to answers such as $y^2 + 77y - 27y + 2079$ which was then simplified in a variety of ways. Other common incorrect answers included $-2079y$ and $2079y$.

Question 3

This question proved challenging for about half of the candidates. Some were confused about the word *sum* and simply listed the values of 3^2 and -3^2, consequently a common incorrect answer was 9, –9. Another common error was to calculate $(-3)^2$ and give an answer of 18. A few tried to use laws of indices to unsuccessfully combine the numbers.

Question 4

This question was well answered by most candidates. Some candidates earned only one mark by having one correct term from two in their final answer, usually the $3x$. The most common errors were to write $3x + 2x^2$ or $3x + x^2$ as the final answer. Some candidates wrote the correct answer in their working but then attempted to simplify this expression, which often resulted in a final answer such as $4x^4$ or $3x^4$.

Question 5

This question was well done and many candidates achieved full marks. One of the causes of errors was candidates confusing the ribbon with the fabric. Occasionally candidates confused the amounts for fabric with the amount of money. There were a minority of candidates who made slips when calculating, most commonly getting 20.4 instead of 2.04 for the total cost. Some candidates identified the need to multiply the 2.4 by 0.85 but could not identify that they needed to subtract from 33.48. A common error was to divide rather than multiply in the calculations.

Question 6

(a) This question was very well answered with the majority of candidates correctly continuing the sequence. The most successful strategy was to find the differences and continue the sequence. One mistake was to correctly calculate 2, and then give an answer of 0 rather than continuing into negative numbers. Another wrong answer was to add on 9 and 11 rather than subtracting, leading to the most common incorrect answers of 20 and 31. Some other incorrect answers came from calculation errors resulted in answers of 2, –8, or 2, –10.

(b) Sequence **A** was very well answered with a large number of candidates giving the correct answer. The most successful strategy involved calculating the common difference of 7 and then working back to the zero term of –4, or identifying the sequence $7n$ and comparing it with the given sequence to see what adjustments needed to be made. Many preferred to use the formula $a + (n - 1)d$, with $d = 7$ and $a = 3$. Those using the formula tended to make more errors, either in remembering the formula incorrectly or in simplifying incorrectly. Incorrect answers came from incorrect use of the first term, giving the answer 7n + 3, or confusing 7 and –4 to give $-4n + 7$. Incorrect application of $a + (n - 1)d$ was seen with $3(n - 1)7$ being the most common resultant error. Weaker candidates sometimes simply gave the answer as $n + 7$ or add 7 or gave the next term in the sequence.

Sequence **B** was not so well answered. Most candidates who did not obtain the correct answer did obtain 1 mark for finding the second difference of 6. If a quadratic answer was not given, some found the nth term of the differences $6n + 3$ and some used the second difference to give $6n - 4$. Those who were most successful found the $3n^2$ and then used this to calculate 3, 12 and 27 and then identified that you needed to subtract 1 to give the correct answer of $3n^2 - 1$. As with sequence **A**, weaker candidates either continued the sequence or offered $n + 6$ as the answer.

Question 7

Candidates nearly always scored 2 marks in this question with most managing to showing correct working to reach the answer. Most common was the use of 54 as a common denominator rather than the more efficient 18 and occasionally 36 was used. Whilst the demand was to work without a calculator, those reaching a wrong answer may have benefited by checking their answer with a calculator as this may have prompted them to check for the error in their working. Occasionally some weaker candidates simply subtracted the numerators and denominators, resulting in an answer of $\frac{4}{3}$. Very few gave the answer without showing working and most followed the instruction to give the answer as a fraction in its simplest form. Very occasionally the answer was left as $\frac{21}{54}$.

Question 8

(a) Many candidates were able to correctly find the median of the eight given values. This usually involved writing the numbers in order, although some candidates found the answer by tallying from each end. A few mistakes occurred either with miscounting, or counting 4.5 as two values 4 and 5, which often led to the wrong answer of 4. Another common error was to find the middle of the data as given, without first ordering the values, giving the common wrong answer of 10.5. Quite a few candidates mistakenly found the mean of the given data instead of the required median. In some cases the calculation (8 + 1) ÷ 2 was used to decide which number to find but with 4.5 then given as the answer. Some thought the answer had to be an integer and rounded 3.5 to 4.

(b) This proved to be one of the most challenging questions on the paper. A wide variety of reasons were seen explaining why the mean may not be appropriate. Whilst some candidates answered well, giving a clear explanation using appropriate language, the vast majority of candidates could not offer a valid explanation. The following examples were non-scoring responses: 'The data is not grouped', 'There are no frequencies given', 'There is a repeated value' , 'There are decimals involved', 'The range is too big', 'Because it's hours', ' There is not enough data'. A number of candidates offered no explanation at all.

Question 9

(a) Many candidates answered this question correctly. The most common incorrect answer was A and B.

(b) There was a small number of non-responses for this question. The majority indicated the correct answer. The most common incorrect answer was SAS followed by RHS.

Question 10

(a) This part was very well answered with few candidates giving an incorrect answer. A small number rounded to 3 significant figures but usually showed the required answer first and so were still able to score the mark. Candidates are advised that exact answers should not be rounded as per the instruction on the front of the question paper.

(b) Many answered this correctly. Some gave the answer $\frac{3}{34}$ with no working, likely from the misconception $2\times\frac{1}{8}\times\frac{6}{17}$, instead of $2\frac{1}{8}\times\frac{6}{17}$. A calculator was permitted in this question but some attempted it without and they were usually the ones with errors, often arithmetic.

(c) Again many candidates answered this correctly, giving an exact answer of 0.25 or $\frac{1}{4}$. There were some who obtained an inexact answer from using rounded version of cos 30 or $\sqrt{3}$ rather than typing the entire calculation into the calculator in one step. Where other wrong answers were given, it was usually not possible to see where they came from as working was not shown. Only a very small minority of candidates had their calculator set in radians instead of degrees.

Question 11

(a) Success was achieved by candidates who clearly understood that setting $x = 0$ gives the point where the graph intersects the y-axis, and that the value of b can be achieved by solving the resulting equation. Those who opted to expand the brackets in part **(a)** generally made no progress. For those scoring 1 mark, many wrote $–30 = (–3)(b)(2)$ but then went on to use addition or subtraction to solve the equation rather than division. This resulted in a common incorrect answer of –29. Another common misconception was evaluating
$(3)(–b)(–2)= –30$.

(b) It was clear that many students were unaware that the x-axis intercept is the point where $y = 0$ and that this could be found directly from the given factorised form. On rare occasions a lack of careful reading of the question meant that students gave one of the other x-axis intercepts. Some gave the y-intercept. Others opted for a random point on the curve such as (1, –36). A significant number offered no response to this question, more so than any other question.

Question 12

This question was not well attempted with many candidates not scoring at all. Most who got it correct did so by showing the factors and cancelling from numerator and denominator. Some seemed to ignore the 199^{57} and instead expanded the numbers to give 1575 ÷ 315 = 5 before putting the 199^{57} back in. Of those who did not score full marks, many gained a method mark for correctly giving the factors of 315, either by using a factor tree or by repeated division. Some divided each of 3^2, 5^2, 7 and 199^{57} by 315.

Question 13

(a) The majority of candidates showed some awareness of the concept of a cumulative frequency diagram in that they had plotted some points and drawn an increasing curve. Where this was not seen it was common to see a bar chart or a frequency diagram, omitting the need for this to be cumulative. Plotting the points accurately proved challenging and it was relatively common to see errors in the plotting of one or more of the points, which seemed to be based upon misinterpreting the scale on the axes. Usually the (22, 7) or (42, 50) were the ones wrongly plotted, often using 2 small squares to represent 2 units rather than 5 small squares. Another common error was to omit the point (20,0) when plotting. Once points had been plotted the attempts to join with either line segments or, more commonly, a curve were generally acceptable. A minority of candidates missed one or more of the points with their curve, often through inaccurate sketching.

(b) Where a cumulative frequency curve had been plotted it was common to see a correct answer to **part (b)** of the question. Sometimes candidates did not get the correct value here due to misreading the horizontal scale.

For candidates who did not plot a cumulative frequency curve it was still possible to answer this part of the question through interpolation and there were those that did this successfully. Some just found 90 per cent of 50 and gave the answer 45, not appreciating that this would be a mass higher than the heaviest child.

Question 14

This was one of the most challenging questions on the paper with many candidates not scoring any marks and a significant number not offering any response. A significant minority of candidates did arrive at a wholly correct answer in an efficient manner. Others took a slightly longer route to the correct answer, for example finding $\frac{1}{2}$ of 136 then subtracting this from 136 or finding $\frac{3}{4}$ of 144 and subtracting from 144. Some started well, finding $\frac{1}{2}$ of 136 and $\frac{3}{4}$ of 144 but then added these without further adjustment of the latter so $\frac{1}{2}(136)+\frac{3}{4}(144)=176$ was a common wrong answer. Another common wrong response was 34 which was sometimes accompanied by working of the form (180 – 160) + (174 – 160) = 20 + 14 = 34. A small number of candidates appeared to have the right idea but mixed up the girl's and boy's numbers and thus added $\frac{1}{2}(144)+\frac{1}{4}(136)$. Very occasionally candidates added 1 before dividing so $\frac{1}{2}(137)+\frac{1}{4}(145)$ was seen. There was some evidence of counting squares and on at least one occasion a candidate's working seemed to show counting squares on the vertical scale.

Question 15

This was a challenging question for approximately half of the candidates. The other half were able to offer a correct answer, although not always well expressed. The demand for 'a geometrical reason' meant they had to explain, not just give a calculation as some did. The minimum key elements required were **opposite angles**, and **sum** of **180**, or equivalent wording. Of those recalling the importance of 180 some did not gain the mark as they either omitted the sum (e.g. stating that the opposite angles *equal* 180, which is not true), or referred to opposite *sides* rather than angles. The most common wrong answer was to state that the angle sum was 360 (which is true for any quadrilateral), either not seeing or not understanding the word 'cyclic'. A smaller number reasoned for it being irregular – i.e. that no sides or angles were the same. Candidates are advised to learn the language used in the syllabus for the geometrical reasons and that instead of angles words like 'corners' should not be used and instead of 'opposite' words such as 'alternate' and 'across from each other' are not advisable alternatives.

Question 16

(a) This part was not well done with both shaded areas seen fairly infrequently. Candidates found the left-hand diagram with two sets easier and there were many more correct diagrams seen here than in the right-hand one. The most common error for $G \cap H'$ was to shade $(G \cap H)'$ or to shade $G \cap H'$ along with $(G \cup H)'$. Another common error was to shade the region for $G' \cap H$. When shading the region for $(J \cup K') \cap L$, two of the most common errors were to shade the region $J \cap L$ or to shade the region $(J \cap L) \cap K'$. Another common error was to shade $L \cap K'$ thus leaving the middle section of the Venn Diagram blank.

(b) This part was answered better than **part (a)** with many candidates scoring at least 1 mark. The most common error was to misinterpret n(C) = 42 and to write 42 in the bottom section of the circle for set C, where they should have written 32. Some candidates did not use the 17 at all, and left the section for $n(A \cup B \cup C)'$ blank.

Question 17

(a) The majority of candidates scored 1 mark on this question. The most common incorrect answer was –9.

(b) The majority of candidates correctly gave the answer of $2x - 5$. Some gave the answer of $y = 2x - 5$ or $2y - 5$. Common incorrect answers included: $2x + 5$, $2(x - 5)$. Many candidates scored a mark for either of these two correct first steps $2y = x + 5$ or for $x = \frac{y+5}{2}$. Of those scoring no marks it was common to see a numerical answer or simply $(g(x))^{-1}$ i.e. the answer $\frac{2}{x+5}$.

(c) A large number of candidates scored 3 marks on this question. Most candidates attempted the question although more left this blank than parts **(a)** and **(b)**. Those who scored a mark usually did so for $\frac{x^2+5}{2}$.

Many also scored two marks for $\frac{x^2+5}{2} = 63$. Some candidates left their answer as ± 11 missing the part in the question which said that $x > 0$. Some lost accuracy by not spotting that $hh^{-1}(63) = 63$ and instead did this by finding $h^{-1}(63)$ then continued using calculation and premature rounding caused them to sometimes result in an answer very close to 63.

Question 18

This question was reasonably well done with many candidates able to show a correct method for eliminating the recurring decimal by multiplying by 10, 100, 1000 or even 10 000, and then subtracting appropriate values. Some candidates made errors when subtracting two appropriate values involving a recurring decimal. Others reached $\frac{415}{990}$ using an appropriate method but did not write this fraction in its simplest form. Another approach that sometimes worked was to break the decimal down to 0.4 and 0.019 recurring but often this was less successful as there needed to be an explanation of why 0.019 recurring = $\frac{19}{990}$ which was not always shown. There were a number of candidates who thought the 4 was also part of the recurring pattern leading to the incorrect answer $\frac{419}{999}$, some who ignored the recurring aspect and gave an answer of $\frac{419}{1000}$, and others who had the idea of multiplying by a multiple of 10 but were unable to create a subtraction which eliminated the recurring part of the decimal. Quite a few candidates received one mark only as they wrote a correct answer with incorrect or insufficient working.

Question 19

This question was the most challenging question on the entire paper with fully correct responses rarely seen. Those who did get full marks generally worked succinctly with a table of outcomes and simply wrote down the correct answer. There were many probability calculations seen, but, as these were often not conditional probabilities, it was not clear what method was being taken. Many identified either the 7 cases of even sums, or the 3 cases of even sums containing only one 5. Even after identifying these options, most still believed the denominator on the probability to be 12. A common incomplete answer saw the calculation of the probability of selecting (3, 5), (5, 7) and (7,9), i.e. $3\times\frac{1}{3}\times\frac{1}{4}$. A significant minority of students gave answers greater than 1. Another common error was to include the outcome with two 5s, so $\frac{4}{7}$ was a common incorrect answer. Another common incorrect answer was $\frac{2}{7}$ arising from two 5s in the list of the 7 given numbers 2, 3, 5, 5, 6, 7 and 9.

Question 20

(a) This part was well answered with the most successful candidates dealing with the 81 and x^{16} separately. The most common wrong answers were $81x^{12}$, $81x^{16^{\frac{3}{4}}}$, $9x^{12}$, $27x^{8}$ or 3^3x^{12}. Sometimes $27x^{12}$ was seen in the working, with further processing then being carried out which resulted in 1 mark being awarded.

(b) This part was not so well answered with the question either being left blank, or the answer not being fully simplified. Such unfinished answers included $\frac{1}{y^{-1}}$ or just $\frac{y}{1}$. The most common incorrect answers seen were y^4, $\frac{1}{y}$ or just 1. Those who obtained the correct answer generally dealt with the negative power first to leave $y^{2\times\frac{1}{2}}$, and then either leaving as y^1 (which was marked correct) or just y.

Question 21

This question differentiated well between candidates. In terms of finding the volume of the frustum it appeared that many were familiar with the approach of finding the volume of the larger cone and then subtracting the volume of the smaller, removed, cone. The most common approach to this was to attempt to find the radius of the smaller cone, which had varying degrees of success, work out the two volumes and subtract. Only a minority of candidates used a scale factor between the large and small cone to find the volume of the small cone. Most candidates were able to successfully calculate the volume of the large cone although a small minority did not halve 9.2 correctly. Finding the radius of the smaller cone was not well done, and even those who did this successfully often did so via complicated roots such as finding the slant height of the large and small cones using Pythagoras' theorem or via approaches involving trigonometry - finding the angle between the slant height and the radius. When attempting to use the ratio of sides in similar triangles many incorrectly worked with 5.5, the height of the frustum, rather than 7, the height of the smaller cone. Having obtained a radius for the smaller cone either through correct or erroneous working candidates generally attempted to find the volume for the smaller cone, although some continued to work with 5.5 instead of 7 and subtracted this from the larger cone. Many used the same radius for the small cone as for the larger cone. Where candidates worked fully correctly there were sometimes issues with loss of accuracy due to working with approximations for π or rounding in intermediate calculation steps.

Question 22

Just over half of the candidates gave the correct answer. On the whole, candidates achieved either full marks or no marks with part marks awarded comparatively rarely. There were several who offered no response. There were a good number of completely correct solutions with the greatest efficiency and accuracy from those who used the method $\sqrt[3]{\frac{875}{56}} \times 18$. Those who made it more complicated and used methods such as $\sqrt[3]{\frac{875 \times 5832}{56}}$ were more likely to make arithmetic slips and errors. Some started well and reached the interim scale factor value of 2.5 or 0.4 but then did not make further progress. It was common to see squares or square roots featuring in the working of wrong answers. Some candidates thought that using the formula for volume as the product of length, width and height would take them to a solution and so expressions like $L \times W \times 18$ were seen. These attempts were usually unsuccessful. An incorrect answer of 281.25 occurred almost as frequently as the correct answer, usually stemming from $\frac{18}{56} = \frac{x}{875}$ or a similar starting point. There were a few candidates who had the right apporach but, as in some other questions, rounded interim values in their working which ultimately lost them accuracy.

Question 23

Many candidates were able to construct complete solutions to gain all 7 marks, some neglected to score the mark for showing how to solve their quadratic equation. Whilst many factorised, those using the quadratic formula to solve $6x^2 - 19x + 3 = 0$ were sometimes less successful and the most frequent errors were due to remembering the formula incorrect or not dealing correctly with the negative coefficients e.g. writing -19^2 rather than $(-19)^2$. There were a number who made algebraic slips reaching the quadratic equation, but then successfully showed how to solve their quadratic. To maximise the chance of scoring method marks candidates should be encouraged to show steps in algebraic rearranging to products (i.e. initially leaving brackets in place) as often the algebraic errors were in expanding brackets, e.g. $2(x + 1)$ to $2x + 1$ was seen a number of times. Often weaker candidates achieved 1 or 2 marks for an initial attempt at either a correct numerator or denominator, for expanding the common denominator, or for later simplifying incorrect working to the standard quadratic form. Some of the weaker candidates did not understand the concept of clearing fractions at all so did not start well and occasionally purely numerical attempts at trial and improvement were seen which rarely resulted in a correct answer. Some were unable to factorise $6x^2 - 19x + 3$ and $(x - \frac{1}{6})(x - 3)$ was sometimes seen, arising from using the formula or calculator to solve $6x^2 - 19x + 3 = 0$ and working backwards from the solution to the incorrect factorised form.

MATHEMATICS

Paper 0580/23
Paper 23 (Extended)

Key messages

Candidates need to read the questions carefully as several questions were frequently misinterpreted, particularly the question on direct proportionality. In other questions candidates found the correct answer but did not give it in the form requested.

General comments

Many candidates wrote partial results to only two significant figures and therefore their final answer was inaccurate. They need to work to a greater degree of accuracy in their calculations. In trigonometry candidates need to be aware that solutions to sin $x = k$ always have two solutions between 0 and 180 except, of course, when $k = 1$. This is always relevant when x is an angle in a triangle. Unusually, many candidates found the algebra in this paper challenging, especially questions involving algebraic fractions. Candidates should be able to identify square and cube numbers. They also need to know the difference between the lowest common multiple (LCM) and the highest common factor (HCF).

Comments on specific questions

Question 1

Most responses were correct. The common error was to subtract the hour as 24 + 2 – 20 and the common incorrect answer was 6 hours 23 minutes.

Question 2

(a) This was well answered; the most common errors were 11 and 164.

(b) This was again well answered; the most common errors were 6 and 120.

Question 3

This question was correctly answered by most candidates. The most common errors included giving the answer as a surd written directly from their calculator or giving the answer rounded to 6.1 with no more accurate answer seen in their working.

Question 4

Some candidates did not give four numbers in their answer, usually stopping at 2. There were many correct answers. The incorrect ones with four numbers usually did not fulfil one of the three requirements, a mode of 101 was the most common and the total of 390 was often fulfilled more than the other two.

Question 5

A small number gained the method mark for $\frac{15}{21}$ and $\frac{14}{21}$ but then added these two. It was rare to see a correct answer without supporting method. A few just subtracted the numerator and denominator to give $\frac{3}{4}$.

Question 6

(a) Many candidates clearly worked the answer out on their calculator and the most common answer by far was the fraction $\frac{7}{20}$. A small number of candidates failed to subtract from 1, giving an answer of $\frac{13}{20}$. An answer of $\frac{1}{3}$ was another incorrect answer found by adding the two numerators and denominators.

(b) A common answer was $\frac{48}{120}$. A few divided by 2 and multiplied by 5 to give 300.

Question 7

The most common error was calculating the highest common factor rather than the lowest common multiple. Common errors included the answer of 2160 or another multiple of 180. The most successful method was to write two factor trees and only a very few completed a list of multiples. A common method leading to an incorrect result was combining their factor tables into a single table, which they were unable to interpret.

Question 8

Few candidates gave the correct answer. The most common error was the calculation $\left(\frac{-3-5}{2}, \frac{5-2}{2}\right)$. Some candidates confused the midpoint formula with that for the length of a line.

Question 9

Most candidates gave the correct answer by using the method of elimination. The more difficult method of substitution was rarely successful, with the algebra often containing errors.

Question 10

In this question **part (b)** was marked as correct if it correctly followed on from **part (a)**.

(a) Most candidates gave the correct answer by using Pythagoras' theorem. A small number of candidates were not awarded the accuracy mark as they did not show a more accurate answer from their calculator and gave an answer that had been rounded incorrectly. A small number of candidates successfully used trigonometry to find one of the angles and then proceeded to find the value of *h*. This method was less successful than using the more straight-forward Pythagoras' theorem, with rounding errors frequently seen in their working.

(b) This answer was usually correct or a correct follow through from their answer in **part (a)**.

Question 11

The candidates who wrote $7x + 44 + x + 8 = 180$ nearly always solved this equation correctly, getting $x = 16$. Some of those who achieved $x = 16$, then wrote 16 as their answer because they did not know how to proceed from here. Some used the formula $\frac{180(n-2)}{n} = 7x + 44$ which rarely led to the correct answer. They usually used trials to find *n*, whilst others omitted to write the '*n*' in the denominator. The most efficient way to obtain *n* was to use $\frac{360}{x+8}$.

Question 12

Rounding errors and simple interest calculations were rare. Year by year calculations often led to an inaccurate answer. Many candidates gave the total investment as their answer and not the interest.

Question 13

A few candidates made the mistake of writing 2.4242….. instead of 2.4444…. Most used two from $100x, 10x$ and x and they showed the minimum number of 4's and then subtraction to get the correct answer.

Question 14

Candidates had some difficulty with the scale factor and with the units, so some showed the correct figures in their answer but an incorrect magnitude. The common error was to multiply by 200 000.

Question 15

(a) Most answers were correct with the most common error being $\frac{1}{2}$.

(b) Most candidates wrote 45 000 metres. Some then just used 'base × height' for the area of the triangle. However, the vast majority then divided their figure by 30 correctly but then did not add the 15. Most did not use the diagram to write down some working.

Question 16

A common error was to find the gradient of the line incorrectly and the most commonly seen gradients were $-4, 4, \frac{1}{4}, -2.5$. Some of those who did find the gradient correctly then made an error in rearranging $-5 = -\frac{1}{4} \times -2 + c$. A few had the correct gradient but did not use the point (–2, –5) to find the value of *c*.

Question 17

Many candidates started this question incorrectly by using inverse proportionality or by using a linear proportionality. Some read 'square' as 'square root'. Of those who started correctly, a few gave their k as 12.5, due to an error in solving the equation $25k = 2$.

Question 18

Those who knew how to find the linear scale factor from the volume scale factor usually gave the correct answer. The most common error was to calculate $12 \times \frac{768}{324}$, giving an answer of 28.4.

Question 19

Candidates who were able to manipulate functions usually answered this question correctly in its entirety.

(a) The method would usually start correctly with $\frac{10}{5x - 3 - 2}$, but many failed to simplify this correctly, or they would leave it in an unsimplified form.

(b) There were very few correct answers seen. Most candidates could not manipulate the equations correctly. The most common error was from $y = \frac{10}{x - 2}$, many would then add 2 to get $y + 2 = \frac{10}{x}$ which led to answer of $\frac{10}{x + 2}$.

(c) Most candidates did not realise that these two functions are inverses of each other and effectively 'cancel out'. There was often much manipulation which was usually incorrect.

Question 20

(a) There were many excellent graphs. Some candidates did not show the curve crossing the horizontal.

(b) The key method was to obtain $\sin x = -\frac{1}{8}$ from the given equation which many candidates were unable to do. Some answers given were outside the limits requested. Many obtained one value correctly but then could not find the second value. Many incorrect answers could have been checked by candidate's calculators.

Question 21

Many candidates were able to use the sine rule $\frac{17.6}{\sin B} = \frac{12.8}{\sin 25}$ and rearrange it correctly to find the angle at *ABC*, giving their answer as 35.5. They were told that the angle at *ABC* was obtuse but they did not know to use 180 – 35.5. Some calculated 90 + 35.5 or they crossed out the working and they started again. Many did not use the diagram, otherwise they would have realised that the bearing was found by calculating their angle *ABC* – (180 – 112).

Question 22

(a) Those who attempted to multiply all three brackets together often made errors by omitting some terms. The most successful method was to multiply two brackets out to give a three-term quadratic expression and then multiply by the third bracket.

(b) The most efficient method was to use the reciprocal of the second fraction $\left[\frac{4}{2x-3}\right] \times \frac{2x^2+11x-21}{2x^2+14x}$ to make the expression a multiplication rather than a division. Many candidates only achieved this expression and then they attempted to multiply out the numerator and denominator. The key was to factorise the numerator and denominator and then cancel out like terms correctly. Some candidates gave an answer of $\frac{4}{2x}$ without realising that further simplification was possible.

MATHEMATICS

Paper 0580/31
Paper 31 (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-step 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.

Comments on specific questions

Question 1

(a) The vast majority of candidates gained full credit in this question. Most errors were candidates not multiplying 4.95 by 2 for the needles and/or the 0.65 by 6 for the buttons. However they usually went on to add their figures correctly gaining credit for the total. A small minority wrote \$9.90 as \$9.09 and \$3.90 as \$3.09.

(b) This question was also well answered with the majority of candidates gaining full credit. Some only subtracted the cost of one ball of wool instead of eight and some included the amount she spent at the first shop too (**part (a)**), resulting in \$7.64 which still gained partial credit for \$24.96 if seen. A few candidates wrote 25.4 for 25.04.

(c) Only the most able candidates gained full credit in this question with very few method marks awarded. It is important that all elements of the solution are shown, including simple addition and division. Many candidates however were unable to gain any credit on this question as they used the 150 right from the start and found 150/10 = 15 then $5 \times 15 = 75$, $3 \times 15 = 45$ and $2 \times 15 = 30$.

(d) (i) This part was generally answered well. The most common errors came from using $(6 + 4) / 150 \times 100$, giving an answer of 6.7%, or $(6 + 4) \times 150 / 100$ giving 15%. Often candidates found the correct number of squares, 24, but then multiplied by 150/100 with 36% a common incorrect answer.

(ii) Few candidates managed to calculate the perimeter of the blanket; however many were able to gain some credit in this question. Few candidates drew a sketch; centres should encourage candidates to draw a diagram as those that did were generally successful in this question. Most gained at least partial credit for showing the length of one side, 4×15 or 6×15. Often these were then added together when they should have been multiplied by 2. Candidates who successfully gained both method marks by reaching 300, usually went on to gain full credit. Many candidates converted their partial answer to metres correctly but went no further. Candidates should re-read the question as a common incorrect method was to calculate 15×15 with 2.25 often seen.

Question 2

(a) (i) Most candidates correctly identified rotation with at least one correct property. Very few candidates used more than one transformation. Many candidates knew the three properties required were transformation, angle and centre. Frequent references to clockwise/anticlockwise showed that the candidate did not appreciate it made no difference to this transformation but either was acceptable.

(ii) Fewer candidates were able to identify the given transformation as an enlargement with even fewer 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) and (1, –1) being common errors. The scale factor also proved challenging with 2 and –2 being the common errors. Many attempted to describe the scale factor in words, half the size, halved, which gained credit. A significant number gave a double transformation, usually enlargement and translation.

(b) (i) Most candidates produced clear, ruled diagrams. Around half of the candidates reflected correctly in $y = 0$ (the x-axis) however around a third reflected in the y-axis. A few candidates reflected in $y = k$ with k not equal to 0, but many less able candidates did not attempt the question or drew a translation rather than a reflection.

(ii) Many candidates did a translation but drew it in the incorrect position. The most common error was to translate 7 left but then move 1 down instead of 1 up. Many who got it wrong often went in the wrong direction, e.g. down 7 then right 1.

Question 3

(a) (i) This part was very well answered by nearly all candidates – the most frequent incorrect answer was 8 30. Some candidates worked backwards as if reading 07 45 for arrival at work. Only a very few used an incorrect time format.

(ii) Candidates found this question challenging. The most able candidates gave a completely correct solution showing all elements needed – distance $\times$ time (in hours), where the conversion from time in minutes to hours has been shown clearly. Many drew the correct speed/distance/time triangle but did not know how to use it. 2/3 or 0.666.. was used for the time in hours, without showing clearly where those numbers came from (40/60). Most candidates used 38 in their workings, e.g. 38/57 = 2/3 or $38 \times 60/40$. It is important that candidates show all elements of a solution using the values given in the question, not the value being asked to show. Some showed 40/60 = 0.666 for example and then $57 \times 0.666 = 37.962 = 38$ when in fact the answer 38 is exact.

(b) Most candidates showed they understood that the expression $56w + 21p$ showed the total cost. However not all wrote this as the final answer and a large majority of candidates did not gain full credit because they changed this correct expression to an incorrect expression (for example $77wp$).

(c) Calculating the surface area of the cuboid proved the most challenging part of this question. Many candidates found the volume instead. A lot of successful solutions were seen – often accompanied by a clear 3-D diagram of the cuboid. Candidates who recognised that they needed to add the area of all 6 faces generally gained full credit. However, a significant number found 2 faces 20 by 20 and 4 faces 20 by 12 (or combinations similar with a square face). Common errors were multiplying each length by 2 and then adding, and thinking there were 5 sides only.

(d) (i) Successful solutions used the tally column to count the correct frequencies. The most common error was to get one or two of the entries incorrect.

(ii) Drawing the bar chart was well answered by the majority with clear neat diagrams, sensible scales and correct heights. Some missed off the scale and a small minority used a non-linear scale. A few candidates plotted points, forming a line graph, rather than drawing a bar chart.

(iii) This question was well answered by many candidates. Some candidates chose the mode of the frequency values rather than the modal group, for example, 0–5 and 21–25 were sometimes given as they both have a frequency of 2. Some candidates had 2 modes but did not give both as their answer or combined modal groups, e.g. 11–20 rather than giving two separate modal groups.

Question 4

(a) (i) This part was generally very well answered with most candidates identifying one of the 3 correct multiples of 3. The common errors were to give a multiple of 3 outside of the range or to give the answer as the 24th, 25th or 26th multiple, rather than the actual multiple.

(ii) This part was also very well answered with most candidates identifying one of the 2 correct factors. The most common error was to give a factor which wasn't between 5 and 10, e.g. 3.

(iii) This part was answered less well with the common errors of 4, 4^3, 81 or 8^2. Candidates should be reminded that they must give their answer as a value, not a power of a value.

(iv) This part was answered reasonably well although the common errors of 7/1, 14, 49, –7 were seen often.

(b) This part was generally very well answered with most candidates gaining full credit.

(c) (i) This part was answered less well with the common error of 174 from multiplying the square root of 3375 by 3.

(ii) Nearly all candidates gave the correct value. The common incorrect answer given was 0 or 12.

(d) Candidates found this a much more challenging question. Correct solutions were found by working backwards in the correct order, subtracting the delivery cost from the total cost and then dividing by the cost per day. The most common error was to do this backwards approach in the wrong order. Candidates often added the delivery cost and cost per day and divided by that value, assuming the delivery cost was charged each day.

(e) A number of correct methods were seen, although the most common and successful was by listing times after 08 00. Candidates who used product of prime factors often found 225 and then divided by 60 to reach 3.75 hours. However, this was sometimes incorrectly converted to 4 hrs and 15 mins to give the common incorrect answer of 12 15. Those who listed times from 08 00 regularly went wrong with one or both lists but were often able to list three correct times to gain partial credit. A common incorrect approach was to add 25 and 45 = 70 = 1 hr 10 mins to give an answer of 09 10.

Question 5

(a) (i) All but the least able candidates could correctly find the range from the frequency table.

(ii) Candidates were generally successful in finding the mean from the frequency table. The most common error was to add the frequency column and divide by the number of rows, giving the most common incorrect answer of 7.5. Candidates who did multiply the frequency by the number of items sold often only gained partial credit as they divided by 8 rather than the total of the frequencies.

(iii) This probability question was found challenging. Although candidates showed that they needed a fraction out of 60, most added the frequencies from 4, 5, 6 and 7 items sold, or gave the frequency from 4 items only, rather than from 5, 6 and 7 only. A very common error was to count the groups rather than the frequencies, with 3/8 often given as an incorrect answer.

(b) (i) Candidates found this question on bounds less challenging with around half of the candidates gaining full credit. Common errors included $95 \leqslant l < 97$, $95.95 \leqslant l < 96.05$ and $95.9 \leqslant l < 96.1$.

(ii) This multi-stage problem-solving question was the most challenging of the whole paper. Very few fully correct answers were seen. The best solutions showed correct formulae and substitution for the circumference of a circle, conversion from cm to km or vice versa, division of distance by circumference and finally understanding that to count complete revolutions candidates needed to truncate their answers. Common errors included finding the area of the circle instead of circumference, dividing without finding the circumference first, and errors in converting between km and cm or vice versa. Some candidates found the circumference or divided the distance by the circumference, but without correct conversions. Many candidates didn't truncate their decimal answers.

Question 6

(a) This part was very well answered although the common errors of cuboid and sphere were seen.

(b) This part was generally well answered with many fully correct answers seen. Most candidates were able to gain partial credit for subtracting 104 from 180. However not all were then able to find the correct answer, often leaving their answer as 76 or halving to give the common incorrect answer of 38.

(c) This question was found challenging by many candidates, and proved to be a good discriminator, although correct and complete answers were seen using both methods. The common error was to not complete the full method. Candidates often found the exterior angle (360 / 15) or total of the interior angles (13×180) but did not then divide by 15 to find the interior angle.

(d) (i) Over half of the candidates correctly identified line *BC* as a chord. Poor spelling was condoned but many incorrect answers were given, e.g. rope, tangent, radius, diameter, sector, segment.

(ii) A similar number of candidates were able to draw a tangent to the circle at point *B*. Lines had to be ruled with no daylight between point *B* and their tangent. A large proportion of less able candidates did not attempt this question.

(iii) Calculating the diameter of the circle from the given area was challenging for many candidates. Fully correct solutions were seen, with the best containing all steps to this multi-step problem (divide by π, square root and multiply by 2, not losing accuracy by prematurely rounding). Errors were made at each stage with the most common being dividing by 2π or 2. Many candidates rounded prematurely, so having divided by π and square rooted, rounding to 1 decimal place before multiplying by 2 to reach 17.6.

(iv) This part was generally answered well with the majority of candidates able to identify the angle in a semicircle as 90°, and then to perform the required calculation. Common incorrect answers included 38 and 104 from the incorrect use of triangle *ABC* as isosceles, 142 from 180 – 38, and the incorrect use of 360 as the sum of the angles in a triangle.

Question 7

(a) This was a well answered question with most gaining full or partial credit. One successful strategy often seen was to re-write the question, grouping the g values and h values together. Common errors included incorrect signs $2g - 3h$ or adding all terms $12g + 9h$.

(b) This part on finding the value of an expression was generally well answered although the common error of 62 (from 20 + 42) was seen often.

(c) This part on factorising the expression was generally well answered with over half of candidates gaining full credit. Correct partially factorised expressions were seen and gained partial credit. However many attempts were made to factorise to two brackets. Other common incorrect answers included $63x^3$, $7x^2(2x + 7)$ or $7x(2x^2 + 7x)$.

(d) Candidates demonstrated good algebra skills dealing with this equation with the majority able to make the correct first step of expanding the bracket or dividing by 8 to reach $24t - 72 = 108$ or $3t - 9 = 13.5$. The second step was often completed successfully although the common error was to subtract 72 (or 9) instead of adding. Common errors included incorrect expansion of brackets by multiplying one term only or addition instead of multiplication when expanding the bracket or subtracting 8 rather than dividing by 8.

(e) (i) Finding the value of *w* was well answered by the majority of candidates. Common incorrect answers were 29 (24 + 5), −19 (5 – 24) and 4.8 (24/5).

(ii) Finding the value of *x* was well answered by the majority of candidates. Common incorrect answers were 16 ($\sqrt{256}$), 4 ($\sqrt{256} \div 4$) and 64 (256/4).

(f) The majority of candidates had the mathematical knowledge and skills to gain some credit in this question on forming and solving equations, with many successfully gaining full credit. The most common and successful method involved forming a correct first equation from the worded information. Candidates who gave a correct first equation often went on to gain full credit. The most common error was to form an incorrect first equation, often only involving Juan instead of all 3 ages i.e. $3x + 4 = 46$. A small number of candidates were unable to attempt this part.

Question 8

(a) (i) This part was generally answered well by the majority of candidates. A few candidates treated the vector as a fraction and included a fraction line or multiplied the –3 by 4, or the 5 by 4, but not both. Some added 4 to both components instead of multiplying.

(ii) This part was answered less well. The most common error was to work out 10 – –4 incorrectly.

(b) (i) This was well answered with a very small number of incorrect answers of (1, 3).

(ii) Nearly all candidates plotted *Q* in the correct place. Some candidates got the *x* and *y* coordinates confused and plotted at (2, –4) instead of (–4, 2).

(iii) Candidates found plotting *R* challenging, with many taking the vector *PR* as the coordinates of *R* rather than the movement from *P* to *R*. Another common error was to start from *P* and move two squares and then one square but in the wrong directions; or doing the same thing but from the origin, not from *P*.

(iv) Most candidates identified the correct line and drew a solid, ruled horizontal line $y = 3$. A common error was to draw a diagonal line that went through 3 on the *y*-axis; $x = 3$ was also seen.

(c) (i) Candidates found this question on writing the equation of a straight line challenging and few correct answers were seen. Many candidates found the gradient to be 2 but could not put it into the form $y = mx + c$. Many then omitted the *x* in their final answer. Few right-angled triangles drawn on the grid to work out the gradient were seen. Many chose to use the *y* diff/*x* diff formula, with varying degrees of success. A lot of candidates knew the *y*-intercept to be –3 but were unable to put it into an equation of the form $y = mx + c$.

(ii) Many candidates did not see the connection between **8(c)(i)** and this part. This part was not attempted by many candidates. Some candidates gave an answer not in the $y = mx + c$ form. A common error was to negate the gradient of the previous part, indicating that they did not fully understand that parallel lines have equal gradients. Some were able to gain the follow through from their incorrect gradient in **8(c)(i)**.

Question 9

(a) (i) The vast majority of candidates showed their working and gave the correct answer. Most chose to work out 36×437.5 separately and then add their answer to 2250.

(ii) Many candidates gained full credit with full workings out shown. All three methods were seen. Common errors were finding the actual loss, 4320 and dividing that by 100; (13680/18000) x 100 but then not subtracting their answer from 100. Most knew to use 18000 as the denominator but some used 13680.

(b) Most candidates could substitute into the compound interest formula but many were unable to reach the correct solution, often multiplying by 6 instead of raising to a power of 6. There was a large proportion of candidates who used simple interest. Some tried to use an incremental year-by-year method but almost all ended up being inaccurate.

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-step 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 in problem solving questions. Candidates should use correct time notation for answers involving time or a time interval.

Comments on specific questions

Question 1

(a) (i) The large majority of candidates gave the correct answer. Various incorrect answers were given. In this part and in **(a)(ii)** candidates confused the meaning of factor and multiple; here the factor 2 was the most common incorrect answer.

(ii) The majority of candidates gave the correct answer. Various incorrect answers were given with the multiple 92 being the most common.

(iii) This part was generally answered well with most candidates able to identify the square number. The most common incorrect answer was 2.

(iv) This part was answered well with most candidates able to identify the cube number.

(v) This part was answered well by the majority of candidates who gave either or both of the prime numbers. A small number spoilt their answer by including an incorrect number with 2 or 29.

(b) (i) This part was not generally answered well. Common errors included 3.857, 0.003 and 0.386.

(ii) This part was not generally answered well. Common errors included 0.004, 386, 385, 0.00385.

(c) This part on compound interest was generally answered well with many candidates able to gain full credit. Common errors included using simple interest, using an incorrect formula, or finding just the interest added.

(d) (i) This part on writing 48 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.

(ii) 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 6048 (from 48×126).

(e) Candidates found this questions on bounds challenging and few correct answers were seen. Common errors included $28.49 \leqslant m < 28.51$, $28 \leqslant m < 29$, $23.5 \leqslant m < 33.5$, and $28.4 \leqslant m < 28.6$.

Question 2

(a) (i) The majority of candidates measured the angle correctly. A small number of candidates misread the protractor scale, giving 104 or 84 as their answer rather than 76.

(ii) The majority recognised the angle was acute while others described it as obtuse or less commonly a triangle or isosceles.

(b) (i) The majority of candidates measured and calculated the required distance correctly.

(ii) The majority of candidates measured the angle correctly. Common errors included 34, 146, 214 and 326.

(c) This question on geometric properties of parallel lines was answered reasonably well. Common errors included x = 43, 47, 227, 313, y = 133, 43, 137, 313.

(d) Few candidates gained full credit in this part. Although many were able to find the missing angle in the triangle as 30, few were able to give the correct reason for the triangle being scalene based on three different angles. Many referred to the sides being different, or just quoted angles in a triangle add to 180, whilst others gave no reason at all.

(e) This question on angles in polygons was generally not answered well. Common errors included 24 (the exterior angle), 2340 (the total of the interior angles) or use of an incorrect formula. The most successful method was to find the exterior angle of 360/15 = 24 first, and then to find the interior angle of 180 – 24 = 156.

(f) This question on geometric properties of parallelograms was answered reasonably well. Common errors included, 3 angles of 64, 3 angles of 39 from (180 – 64)/3, 3 angles of 99 from (360 – 64)/3, 64 with 2 incorrect angles, and 116 with 2 incorrect angles.

Question 3

(a) (i) The majority of candidates were able to draw the missing bar on the chart correctly.

(ii) This part was not generally answered well and few candidates were able to identify the mode as the colour green. Common errors included giving the height of the bar, 7, or giving the answer of 6 (because there were two bars with this height).

(iii) The majority of candidates were able to give the correct answer.

(b) This question was found challenging by many candidates, and proved to be a good discriminator, although a good number of correct answers were seen. Common errors included 33.5/5, 7.7/5, and 24/5.

(c) (i) The majority of candidates were able to give the correct answer.

(ii) The majority of candidates were able to correctly complete the pie chart. Common errors included angles of 105, inaccurate diagrams, with a small number unable to attempt this part.

Question 4

(a) This question was found challenging by many candidates, and proved to be a good discriminator, although a good number of correct and complete answers were seen. Candidates should realise that in a multi-step problem-solving question such as this the working needs to be clearly and comprehensively set out. Common errors included calculating the total tax payable but not finding the total cost of the holiday, calculating the tax for a child and an adult but not applying these to all of the family members. The most common error was made in calculating the tax payable by adding 0.08 or 8 to the cost, multiplying by 8 or dividing by 8 or by 0.08. It was evident, in many cases of incorrect answers, that candidates didn't consider if their answer was reasonable, with answers such as \$185 000 being common.

(b) (i) Some good responses were seen but in general fully correct solutions were in the minority. Some candidates had difficulty distinguishing between a time period and a time, for example, writing 22 15 as 22 hours 15 min which caused confusion in the method and incorrect notation. Others attempted work with a 12-hour clock and assigned am to times that were pm. Many problems stemmed from the change of day, resulting in a loss or gain of an hour. Equally problematic was dealing with the minutes and converting the addition into a proper time, for example leaving 21 75 rather than converting to 22 15. Some dealt with the time difference incorrectly, subtracting 17 hours instead of adding. Many did realise that it was Thursday but Friday was a common error along with answers that gave the day as a number, such as day 1 or day 2.

(ii) Few fully correct answers were seen. Most candidates understood the need to divide the distance by a time but many did not use a correct time. Common errors included using 11.6, 11.4, 1140, 700(min), or using a time of day from the previous part of the question, often their arrival time.

(c) Most candidates had a good understanding of how to approach the question, to read off the graph and scale up the reading. The most successful candidates chose higher values from the graph, often using 2 lots of \$40 plus \$20. Accuracy of reading from the graph was a problem, with many opting to read off for values such as \$1 and \$5 rather than values going through exact grid squares.

(d) This part on ratio was well understood with many correct answers seen. Rounding an exact money answer to 3 significant figures was often seen. Other errors included dividing 154 by 21 or 4 or treating the 21 and 4 as percentages.

Question 5

(a) There were many correct expressions seen but a large number of candidates found this challenging. After writing a correct expression some candidates spoilt their answer by incorrect simplification such as $14ab$ or $48ab$. Other common errors included 6a8b, $a + b$, $6 + 8 = 14$ or $6 \times 8 = 48$, or included \$ signs and/or the kg units in their answer.

(b) This question was found challenging by many candidates, and proved to be a good discriminator, although only a small number of correct and complete answers were seen. Few candidates appreciated that an algebraic approach could be used. The most successful candidates were able to write expressions for the three ages, set up an equation, and solve their equation to find the three answers. A numeric approach was often attempted but the correct $(167 – 23) / 4$ was rarely seen with the common error being $(167 – 22) / 3$. A number used trial and improvement, which often led to some, but not all of the conditions being fulfilled. A significant number were unable to attempt this part.

(c) 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) (i) 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), (5, 1) and (1, 1) being common errors. The scale factor also proved challenging with 2, 2.5, –3 and 1/3 being the common errors. A small yet significant number gave a double transformation, usually enlargement and translation. Less able candidates often attempted to use non-mathematical descriptions.

(ii) 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 (–2, 1), (–1, 0) and (–1, −1) being common errors. The angle of rotation was sometimes omitted with 90 clockwise and 180 being the common errors. Again a smaller but significant number gave a double transformation, or used non-mathematical descriptions.

(iii) This part proved more challenging and although a good number were able to identify the given transformation as a reflection, translation and rotation were common errors. The identification of the line of reflection proved more challenging with the common errors including, –2, y – 2, –2 on the y–axis, mirror line –2 and x-axis.

(b) This part was generally answered well with candidates able to draw the given translation. Common errors included only one of the vector components drawn correctly, reversing the directions, incorrect orientation, or an enlargement.

Question 7

(a) This question was generally not answered well by candidates. Many were able to obtain the perimeter of A as 28 but finding the missing side of B and thus the perimeter was not well done. Candidates rarely used the given information that the area of both rectangles was the same, instead assuming that either B was an enlargement of A and using 2 : 4 = 12 : x to give the other side of B as 24 cm or assuming that all the sides of B were 4 cm leading to the most common answers for the perimeter of B as 56 cm or 16 cm.

(b) This question was found challenging by many candidates, and proved to be a good discriminator, although a small number of correct and complete answers were seen. The use of the reverse equation to find the radius given the area proved challenging. Common errors included use of incorrect formulas, using 150 as the radius to find an area, using $r = 150\pi$, and not taking the square root as the final step. A significant number didn't gain the accuracy mark through premature approximation.

(c) This question was found challenging by many candidates, and proved to be a good discriminator, although a small number of correct and complete answers were seen. Only a very few candidates recognised that Pythagoras' theorem or trigonometry was required to answer this question. The most common error was to use $0.5 \times 12 \times 16$ to give the area of the triangle. Other common errors included incorrect use of Pythagoras' theorem, 12×16, $12 \times 16 \times 16$, $0.5 \times 12 \times 90$.

Question 8

(a) (i) The table was generally completed very well with the majority of candidates giving 3 correct values. The common error was being unable to deal with the substitution of negative values into the equation, ending up with the three values at $x = –4$, $x = –2$ and $x = –1$ being incorrect and frequently outside the range of the y-axis. 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.

(ii) 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 (0, –4), (–1, –5) and (–2, –4) with two straight lines rather than continuing the curve.

(iii) This question was found challenging by many candidates and few correct equations for the line of symmetry of the graph were seen. A variety of numerical answers were offered as well as various coordinates and inequalities.

(iv) 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, and omission of the negative sign. 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.

(b) This question was found very demanding by many candidates and few correct equations for the line were seen. Few candidates appreciated the significance that the line being parallel to line *L*, or that it passed through (0, –2), gave the values of the required gradient and intercept directly. A variety of numerical answers were offered as well as coordinates.

Question 9

(a) This part was generally well answered by the majority of candidates, although the common error of 0.333 was seen.

(b) This part was generally well answered by the majority of candidates, although the common errors of 3, 0 and 9 were seen.

(c) This part was generally not well answered although the correct fractions 7/50, 13/100, 3/20 and 1/8 were seen. Common errors included 3.5/25, 7/25, 1/25, 12/25 and decimals from 0.12 to 0.16.

(d) This part was generally well answered by the majority of candidates, although the common error of 4 seen.

(e) (i) Standard form was generally well understood with most candidates answering this part correctly. The common errors included, the decimal point incorrectly placed, giving an incorrect power of 10, or having the wrong sign on the power.

(ii) As in the previous part, standard form was generally well understood with the same common errors.

(f) As in **part (e)**, standard form was generally well understood and the common errors were similar. Additional common errors included incorrect calculations, rounding or truncation, and not giving the final answer in standard form.

MATHEMATICS

Paper 0580/33
Paper 33 (Core)

Key messages

Candidates need to have a clear understanding and knowledge across the whole syllabus.
Candidates need to ensure that they read the questions carefully and follow any instructions given. They should copy numbers carefully and ensure they notice the detail on diagrams.
Candidates should always be showing their methods and working when producing solutions so that the examiner can award method marks even when the final answer is incorrect.

General comments

Overall, there were some very good responses with a good level of mathematical competency, skills and knowledge shown by many candidates.

Candidates need to ensure that they learn the spellings and language of key mathematical words and phrases so that their responses are not ambiguous. When a question asks for geometrical reasons then mathematical phrases are required, for example 'alternate angles' rather than calculations and descriptions about adding angles together.

It is important to be able to work with time and, in particular, be able to convert between seconds, minutes and hours and understand that, for example, 1 hour 24 minutes is 1.4 hours.

In questions that require candidates to describe a transformation they should give the name of the transformation, for example 'enlargement', and not a description of where or how the shape has moved on the grid.

Centres should also continue to encourage candidates to write an answer that is non-exact correct to 3 significant figures.

Comments on specific questions

Question 1

(a) Some candidates were able to correctly list the 6 factors of 68. Common errors included omitting one or more of the factors, usually 1 or 68, or making an error with one of the factors, such as writing 32 for 34. Other errors generally came from candidates not reading the question carefully, for example, writing 68 as a product of its prime factors.

(b) (i) Candidates answered this well with most candidates correctly inserting a pair of brackets. All candidates could have used their calculator to check their answer and this may have helped the minority of candidates with incorrect answers to spot their error. Candidates inserting more than one pair of brackets did not gain credit. A few candidates did not attempt this question.

(ii) The success or otherwise of this part closely correlated with **part (b)(i)**, with the same recommendation that candidates use their calculator to check their solution.

(c) (i) Those candidates who understood the word reciprocal answered this part with ease. It was clear however, that many candidates did not know the word reciprocal, as evidenced by answers such as the decimal equivalent, 0.2857…or an equivalent fraction such as $\frac{4}{14}$ or its negative value, $-\frac{2}{7}$ frequently seen.

(ii) Almost every candidate knew the value was 1. The most common incorrect answers were 10 and 0.

(d) (i) Most candidates answered this question correctly. The most common error seen was candidates who multiplied to give 3^6. Other incorrect answers included 6^6.

(ii) Most candidates answered this correctly, giving the exact answer 6. The most common error was an inexact answer that arose from premature approximation of the evaluation of each of the surds separately prior to multiplying. For example, $1.73 \times 3.46 = 5.9858$.

(iii) Most candidates answered this correctly with answers 0.008, $\frac{1}{125}$ and 8×10^{-3} all accepted. Candidates choosing to write their answer in standard form needed to ensure that the standard form was precise with incorrect notation such as $8^{\times10^{-03}}$ or calculator notation such as 8E-03 not accepted. Other common errors included -125 and $\frac{-1}{125}$.

(e) Many candidates answered this question correctly. The most successful were those who wrote all the given numbers as decimals to enough accuracy. Many scored a partial mark having misplaced one number. The most common errors were for candidates to evaluate $\frac{22}{7}$ as 3.14 or 3.142 when a more accurate value was needed, or to give π less accurate than 3.141… Without these more accurate values it is not possible to compare and order these values correctly.

(f) Many candidates did not read this question carefully and it was common for the calculation to be worked out exactly, with no rounding, as 52.717… and then rounding to 1 significant figure at the end. Those candidates who wrote each number to one significant figure usually gained full credit. The most common rounding error was to round 136 to 140 and thus evaluate $\frac{140+50}{60\div 20}$, which gained partial credit.

(g) This part was answered correctly by almost all candidates. The few errors seen usually included miscopying the non-zero digits in the given number, having one too few or one too many zeros, dividing 4.73 by 10^6 or attempting to write the number in words.

(h) Most candidates answered this correctly. The most common incorrect answers were 33 or 39.

Question 2

(a) (i) Most candidates gave an estimate within the required range.

(ii) It was rare for candidates to give a clear explanation that explicitly related the tallest bars to the highest temperatures. Most candidates merely repeated the question stating in their own words the equivalent of ‘more people visit the beach when the temperature is warmer’.

(b) (i) The majority of candidates were able to measure the length of *ML* accurately and correctly multiply their measurement by 50. Other candidates either measured the line inaccurately or did not multiply by the scale.

(ii) Many candidates were able to measure the bearing of *M* from *L* accurately. The most common errors included answers such as 140° which were not accurate enough, 037° from measuring the wrong angle or misreading the protractor, and 223°, the bearing of *L* from *M*.

(iii) Many candidates marked the position of *B* accurately on the diagram. Other candidates frequently scored partial marks for either drawing line *MB* the correct length or marking *B* on the correct bearing from *M*. Common errors included measuring the angle anticlockwise from the north, measuring the angle as 68° anticlockwise from the east or small inaccuracies in measuring the length or the angle. In addition, candidates should ensure that the position of the point *B* 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 *B* from point *L* instead of *M*.

Question 3

(a) (i) Many candidates wrote the number correctly in words. Common incorrect answers included writing 'seven hundred thousand and thirty-five thousand', rather than 'seven hundred and thirty-five thousand', writing millions rather than thousands, writing, for example 20 instead of twenty, writing seventy instead of seven, writing hundredths instead of hundreds.

(ii) The majority of candidates calculated the division the wrong way round with 2 (or 2.01) being a very common incorrect answer. Those that calculated the correct division sometimes gave the answer inaccurately as 0.5.

(iii) A good proportion of candidates completed the division correctly. Some candidates completed the division the wrong way round and others used the land area of 1 477 300.

(b) Few candidates answered this bounds question correctly. Common incorrect answers gaining partial credit included $1568.5 \leqslant L < 1569.4$ or reversed answers $1569.5 \leqslant L < 1568.5$. Other common incorrect answers included $1568 \leqslant L < 1570$, $1569 \leqslant L < 1570$ and $1569 \leqslant L < 2$ km.

(c) (i) Almost all candidates answered this question correctly.

(ii) The majority of candidates answered this question correctly. The most common errors were 18 or -18, the difference between the minimum temperatures of the two mountains.

(iii) Many candidates answered this question correctly. Examples of the most common errors included $-20-27=-47$, $-38+27=-11$, $27-9=18$ and +27.

Question 4

(a) (i) Most candidates recognised that the fastest time was between 10 20 and 10 40. The most common errors seen were to give the time range 10 40 to 11 02 when Tia was in fact stationary or to give the range 11 02 to 12 00 where the speed was not quite the fastest. A few candidates attempted to give their answers in terms of distances or places.

(ii) A fair number of candidates completed the travel graph correctly with clear, accurately drawn, ruled lines. Many who did not gain full credit were frequently able to gain partial credit for a horizontal line from (*their*11 50, 12) to (12, 12). A common error was to have a horizontal line at 8 km taken incorrectly from the 8 km/h given in the question.

(iii) A good proportion of candidates gained full credit for reading off the correct intersection of Tia's and Andy's journeys. The most common errors arose from misreading the scales and not using 1 small square representing 2 mins and 0.4 km respectfully, in the *x* and *y* directions.

(b) A fair number of candidates gained full credit in this question. Other candidates gained partial credit for methods which led to 0.147 (or 0.1469...) or 114.6 to 114.7 but who omitted to either multiply by 100, or subtract 100, as a final step. Common incomplete methods included only finding the difference 521, or finding $\frac{4067}{3546}$. The most common incorrect method was to use 4067 as the denominator.

(c) (i) This question was answered well. Common errors included answers such as 27 : 33 or 3 : 3.66 which were not in the simplest form.

(ii) A minority of candidates answered this question completely. Some candidates gained partial credit for reaching 2016, the total number of cyclists. A few candidates calculated $\frac{432}{3}$. However, most other candidates produced incorrect solutions because they tried to use both of the ratios when only the latter was needed to solve this question.

Question 5

(a) (i) Candidates frequently showed a clear expression for the length of *AD* which included the five relevant lengths. Some candidates combined the lengths in stages, which, although not desirable, was acceptable.

(ii) The more able candidates started with the equation $(5x+8)\times 15 = 360$ and solved this algebraically to reach the correct answer. A common error was to set up the initial equation without brackets as $5x+8\times 15 = 360.$ Other errors were seen with algebra when dividing only some of the terms by 5 or taking 8 or 120 to the other side with the wrong sign. Some candidates chose to restart by adding the partial lengths together again rather than using $5x+8$ and often errors were seen in collecting the terms. Others incorrectly set $5x+8=360$. Some candidates only got as far as stating *AD* = 24.

(iii) Although there were a number of no responses for this question, many candidates were able to gain the mark for correctly multiplying *their* answer for **(a)(ii)** by 15. Common errors included working out only one of the shaded areas or having the same answer for this part as **(a)(ii)** from working out $\frac{x}{2}+\frac{x}{2}$.

(b) (i) Only a small minority of candidates recognised that the dimensions of the small cuboid needed to be taken into account and that only 4 cuboids would fit into the length of 65. The majority of responses gave the answer 26 from merely dividing the large volume by the small volume.

(ii) This part was answered well with many candidates working out the correct volume and giving the correct units. The most common method was to work out the large volume minus 24 of the small volumes, but some of those who had an answer of 26 in the previous part recognised they could just work out 2 of the small volumes. Common errors included the incorrect units, or working out surface area or using the fraction of the box as 0.333 rather than 5 cm in the calculation $18\times 30\times 5$.

(c) A minority of candidates answered this question correctly. Many candidates recognised that they needed to divide by 6 to find the area of one side of the cube but a good proportion either gave the answer 81 or then divided the 81 by 2 or 4. Common incorrect starting points included $\sqrt[6]{486}$, $\sqrt[3]{486}$, $\sqrt{486}$, $\frac{486}{k}$ where $k = 2,3,4,8$ or 12.

Question 6

(a) (i) Most candidates gave the correct value of 48 for *p.* Few candidates scored the mark for the geometrical reason, which required candidates to state ‘alternate angles’. Many candidates either showed calculations, which were not required, or stated ‘because the lines are parallel’ which was not enough.

(ii) This part was answered less well with a common incorrect answer of 132 frequently seen. Few candidates scored the reasoning mark. Candidates using the reason ‘angles in a quadrilateral add to 360’ also needed to state ‘angles on a straight line add to 180’ to provide complete reasoning. However, as in **(a)(i)** most candidates showed calculations or descriptions about adding and subtracting angles.

(b) (i) Most candidates named the triangle correctly as isosceles. The most common incorrect answers included scalene, equilateral, right angle and obtuse.

(ii) Most candidates answered this correctly.

(iii) A good number of candidates answered this correctly. Some candidates gained full credit by a follow through for *their y* satisfying *their x* + *their y* + 28 = 90. Others gained credit for indicating that angle *OGH* = 90. The most common incorrect answer was 62 and other errors included assuming triangle *OGH* was either isosceles or equilateral.

Question 7

(a) (i) Most candidates plotted the two points accurately on the scatter diagram.

(ii) Many candidates were able to describe the type of correlation as positive. Common incorrect answers usually included descriptions attempting to relate the distance to the price.

(iii) The majority of candidates drew a ring around the correct point on the scatter diagram.

(iv) The majority of candidates drew a good length ruled line of best fit that was representative of the data. The most common errors seen were lines whose gradients were either too steep or too flat. Other candidates merely joined the dots directly from one to the next in a zig zag pattern or made no attempt at answering the question.

(v) Most candidates with a line of best fit were able to estimate the ticket price, with only a minority reading the scale inaccurately.

(b) Candidates were not sure whether to multiply or divide 522 by 1.16 with almost as many candidates giving the incorrect answer of 605.52 compared to the correct answer, 450.

(c) (i) Most candidates correctly used the formula $\text{speed} = \frac{\text{distance}}{\text{time}}$. However, many candidates divided by 1.24 rather than converting 1 hours 24 minutes to 1.4 and others divided by 84 minutes. Some of those candidates working in minutes were able to gain full credit by later converting back into km/h but others prematurely approximated $\frac{939}{84} = 11.178\ldots$

(ii) Only a minority of candidates answered this correctly. Common incorrect or incomplete methods included 3.89×3.15, 939×3.15, $\frac{3.89 \times 939}{3.15}$ and calculations using their **(c)(i)** such as $3.89 \times 3.15 \times$ their **(c)(i)**.

Question 8

(a) (i) Many candidates reflected triangle *A* correctly. The most common errors included reflecting the triangle in the wrong horizontal line, usually the *x* axis, or in the line $x = -1$.

(ii) 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. A number of candidates did not give a single transformation.

(iii) Many candidates recognised that the transformation was an enlargement but not all candidates used the correct language with incorrect words such as magnify and expand used. Whilst some candidates described the enlargement correctly, giving the scale factor and centre of enlargement, descriptions were often incomplete. A common error was to give the centre as $(0, -7)$. As in the previous part, a number of candidates did not give a single transformation.

(iv) It was rare to see a correct answer for this part, with most candidates giving the incorrect answer of 3. A few candidates found the area of shape *C* as 13.5 and either gave 13.5 as their answer or $13.5 - 1.5 = 12$ as their answer.

(b) (i) Many candidates answered this correctly. The most common errors included sign errors or writing the vector upside down. In addition, a minority of candidates included fraction lines.

(ii) A high proportion of candidates plotted point *C* correctly. The most common error was points that were one unit out in one or more direction. In addition, there were a noticeable number of candidates who did not offer a response.

(c) (i) The majority of candidates answered this question correctly. A minority of candidates treated the vectors as fractions with answers such as $3\times\begin{pmatrix}5\\-12\end{pmatrix}=(-\frac{5}{4})$ and $3\times\begin{pmatrix}5\\-12\end{pmatrix}=\begin{pmatrix}15\\-12\end{pmatrix}$ seen or included fraction lines within an otherwise correct answer.

(ii) This part was completed well, but not as well as the previous part. The errors made were predominantly errors with signs such as $-12-7=-5$ or working out **p − t** rather than **t – p**. Again, a minority of candidates treated the vectors as fractions, working out $\frac{4}{7}-\frac{5}{-12}\ =\frac{83}{84}$ or included a fraction line within their answer.

Question 9

(a) Some candidates gained full credit in this question. Others gained partial credit for getting as far as working out that there were 10 green counters. However, a significant number of candidates misread the question as '$\frac{2}{7}$ of the counters are green after the 6 and 8 are taken from the 35' and these candidates worked out $\frac{5}{7}\times(35-6-8)=15$.

(b) (i) Only a minority of candidates completed the tree diagram correctly. Most scored partial credit for filling in the probability of the first counter being brown as $\frac{8}{15}$. The errors seen included not replacing the counter in the box and having denominators of 14, having denominators of 15 but decreasing the numerators and writing the numbers of counters rather than the probabilities.

(ii) It was rare to see this part answered correctly. Most candidates gave their probability of the second counter being brown without any reference to the first counter. A minority selected the correct two probabilities but often added rather than multiplied them together.

Question 10

(a) Almost every candidate drew Pattern 4 correctly.

(b) Almost every candidate completed the table correctly.

(c) (i) A good number of candidates gave the term to term rule correctly as 'add 2'. Other commonly seen acceptable answers included '+2', '2 more', 'plus 2'. Commonly seen answers which were not accepted included $n = n + 2$, $n + 2$ and 2. A significant number of candidates gave the *n*th term, $2n + 1$.

(ii) The majority of candidates gave a correct expression for the number of dots in Pattern *n*. Common incorrect answers gaining partial credit included $2n$ and $2n-1$. The most common incorrect answer gaining no credit was $n+2$.

(d) There were a good number of fully correct answers given to this part with clear understanding shown. Many candidates set up the equation $4n+1=129$ and found $n=32$ from it. Some candidates rearranged the equation incorrectly to $4n = 130$, but with working shown they were frequently able to pick up method marks. Others arrived at the correct answer by writing out all the numbers up to Pattern 32, and although this is not an efficient method some arrived at the correct answer. A common error was the answer 517 from merely substituting 129 into $4n+1$.

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. The recall and application of formulae and mathematical facts and the ability to apply them in both familiar and unfamiliar contexts is required, as well as the ability to interpret situations mathematically and problem solve with unstructured questions. Candidate's work should be clearly and concisely expressed with answers written to an appropriate degree of accuracy. Candidates should show full working for their answers to ensure that method marks are considered where answers are incorrect. Candidates must learn to hold accurate values in their calculators when possible and not to approximate during the working of a question. If they need to approximate, then they should use at least four significant figures. In 'show that' questions candidates need to ensure that no steps are missing and if a numerical value is given that they evaluate an answer to a greater degree of accuracy than the given value. It is extremely important that candidates take sufficient care with the writing of their digits and mathematical symbols. Candidates using π as $\frac{22}{7}$ or 3.14 are likely to achieve answers out of range. When solving quadratic equations candidates should use the method requested in the question paper and should show their working. The calculator function for solving quadratic equations should not be used in these circumstances.

General comments

Candidates scored across the full mark range and as a cohort showed good recall of all aspects of the syllabus. Individual candidates of all abilities appeared to have some gaps in their recall of some topic areas and even the most able candidates found the application of mathematical skills to less structured and less familiar contexts a challenge. Some 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. **Questions 1(d), 3(c)(i)** and **7(f)** showed that many candidates need to be more rigorous with their use and interpretation of brackets when squaring or subtracting an algebraic expression or fraction. Candidates should read the questions carefully, especially those which have many marks. This was particularly relevant in **Question 9(b)** where some candidates did not use the information, or the instructions given in the question. Solutions were usually well-structured with clear methods shown in the space provided on the question paper. Most candidates showed working within the question paper booklet and did not use additional supplementary sheets.

The topics that were most accessible included simple and compound interest, exponential decrease, interpretation of a cumulative frequency curve, estimation of the mean from a grouped frequency table, working with simple function notation, recall and application of the cosine rule, $\frac{1}{2}ab\sin C$ and Pythagoras' theorem and solution of quadratic equations using the formula.

More challenging topics included creating and manipulating algebraic expressions for *total* surface area of a cone and a cylinder, solving an equation involving the subtraction of an algebraic fraction, expressing separate fractions as a single fraction, use of frequency density and a multiplier to find the bar heights on a histogram, extracting data from a table to calculate non-replacement probability, vector journeys, 3D trigonometry and angles of elevation and interpreting mathematical information in three connected variables to form a quadratic equation in one variable. Differentiation of ax^n to nax^{n-1} was done well but progression to finding stationary points of the curve was more challenging.

Comments on specific questions

Question 1

(a) (i) The majority of candidates were able to correctly recall and use the formula for the volume of a cylinder. On occasion accuracy was lost by candidates using $\pi = 3.14$. Some candidates found the curved surface area instead of volume or made errors in the recall of the volume formula such as $2\pi r^2 h$ or $\frac{1}{3}\pi r^2 h$ for example.

(ii) Many candidates accurately calculated the volume of the hemisphere. A common error made by candidates of all abilities was to use the given formula to find the volume of a sphere and omit the division by 2 for a hemisphere.

(b) (i) Most candidates showed the required calculation 7.85 ÷ 1000 or equivalent, for example 7.85×10^{-3}.

(ii) Candidates were given credit for adding their volumes of the cylinder and hemisphere from **part (a)** and multiplying by 0.00785 to find the mass in kg and many candidates completed their calculation accurately for full marks. Candidates who showed no working, or minimal working followed by a truncated answer, often 15.9, or an answer rounded to only 2 significant figures were unable to score since inaccurate answers do not imply correct method. Some candidates did not complete the method, using 7.85 instead of the required 0.00785 to get the answer in kg. Another method error seen was to divide by 0.00785 instead of multiplying and some candidates did not understand that the volumes were required and instead began with a variety of area calculations.

(c) (i) Many candidates completed a fully correct method to find the percentage of iron left over after making 50 spheres. A significant number of these candidates completed the calculation accurately, however several lost accuracy by prematurely rounding values at different steps in the process. Other candidates found the percentage of iron used instead of the percentage of iron left over. Another error seen was to use the volume of just one sphere instead of the 50.

(ii) The response to this question part was very mixed. To find the length of the edge of the cube candidates were required to cube root the volume of iron left over. Errors seen included taking the square root of this value or dividing the value by 3, 4, 6, 8 or 12. Some candidates omitted this question part completely. Other candidates worked with the percentage value found in **part (c)(i)** instead of a volume. Other candidates used a correct method but gave an answer to 1 or 2 significant figures which is not sufficient accuracy to score.

(d) This question part was a challenge for many candidates. Few candidates began with correct expressions for both the *total* surface area of the cone and the *total* surface area of the cylinder. It was common for candidates to use only the *curved* surface areas or to include just one circle for the cylinder. Another common error was to use the formula for the volume of the cylinder. Of those candidates who did begin with the correct expressions and equated them, errors were usually made when substituting kx for R or when simplifying terms. For example, $3R \times 9R$ was often simplified to $27R$ and $\pi(3R)^2$ was often simplified to $3\pi R^2$ or was written as $\pi \times 3R^2$ throughout.

Question 2

(a) (i) This part was usually correctly answered. There were some answers that showed a lack of understanding of 'to the nearest 10'. Some gave the answer to the nearest unit, tenth or thousand.

(ii) There were many correct answers. Some of those that were not correct gave the answer as 1 instead of the required 1.0. A few had answers with the figures 983 but with the decimal point in different positions.

(iii) Given that candidates are familiar with using significant figures to write final answers to three significant figures this proved to be a straight-forward question part for many candidates. Writing a number correct to 2 significant figures seemed to imply to some candidates that only two digits should be written, which alters the value of the number. Instead of 2100 there were answers such as 20, 20.9, 21. There were also candidates who wrote 2090, 0.2090 or 20.90.

(b) There were many correct answers. When answers were wrong, they were mostly in the range between 90 and 100. A few candidates offered single digit primes. An incorrect answer such as 91 was often seen with the correct value of 97.

(c) This was generally well answered. A small minority of candidates gave $\frac{2}{6}$ as their answer.

(d) This part was generally well answered. There were some candidates who left out the final digit leaving their answer as 7.0×10^{-3}. There were a few answers of 701×10^{-5} and some with 10^3.

(e) This question was challenging for candidates. There were a few correct answers and a few that gained a method mark for getting the figures 165, but most candidates added 1.5 + 1.5 = 3. The powers of ten were not well dealt with, for example 10^{2x-1} or 10^{x^2-x}. A minority of candidates appeared to think that standard form had to result in a numerical power of 10 in their final answer.

(f) There were many correct answers seen along with clear working. There was also working seen that used $0.\dot{3}\dot{7}$ instead of $0.3\dot{7}$. The best solutions had clear statements for x, 10x or 100x leading to choosing a pair of values which led to a subtraction. Candidates are clearly used to working out a fractional answer from a calculator and some did not show sufficient method. A small number of candidates lost the method mark by using prior knowledge of the decimal equivalent of a particular fraction rather than a robust method.

Question 3

(a) Many candidates interpreted the number line correctly and produced the correct inequality for x, $-2 < x \leqslant 4$. The common error was to mix up the inclusivity at the boundaries and write $-2 \leqslant x < 4$. Other candidates omitted x from their answer writing for example $-2 \leqslant 4$. Another common error was to reverse the direction of the inequality symbols to give for example $-2 > x \geqslant 4$ or even $-2 < x \geqslant 4$.

(b) (i) Candidates who worked simultaneously with both sides of the inequality in the format given usually reached a correct solution, although on the left-hand side the subtraction of 3 from –3 was occasionally thought to be 0. Candidates who worked with the inequality in the given format but dealt with only one side at a time were almost always unsuccessful. For example, a common first step was $-3 \leqslant 2x < 6$ or $-6 \leqslant 2x < 9$. Candidates who worked with equalities and reached $x = -3$ and $x = 3$ were then unable to correctly re-insert inequality symbols. Candidates who treated the given inequality as the two separate inequalities $-3 \leqslant 2x + 3$ and $2x + 3 < 9$ to solve it usually successfully reached the correct solutions $x \geqslant -3$ and $x < 3$, although some went on to make errors when attempting to express this as the inequality $-3 \leqslant x < 3$, often reversing one or both inequality symbols. Starting from the given inequality $-3 \leqslant 2x + 3 < 9$ some candidates collected the –3 and 9 together, usually adding 3 to 9, with a result of $2x + 3 < 12$ and hence $x < 4.5$.

(ii) Candidates with a correct inequality in **part (b)(i)** often correctly listed the required integer values. The common error seen was to misinterpret the nature of the inclusivity of the inequality for example by omitting the 3 or including the –3. In addition, 0 was sometimes omitted from the otherwise correct list of integers.

(c) (i) This question part proved to be a challenge for many candidates. The most common approach was to expand the brackets first and then attempt to multiply by 5 to remove the fraction. Usually, a solution began correctly with $9 - 3x - \frac{2x+4}{5} = 1$ but was then followed by the sign error $5(9-3x) - 2x + 4 = 5$ or $\frac{5(9-3x) - 2x + 4}{5} = 1$. After a correct first line additional errors were also sometimes seen such as $9 - 3x - 2x + 4 = 5$ or $5(9-3x) - 2x + 4 = 1$.

(ii) Many correct solutions were achieved by candidates whose first line of working was $5(x+5) = 3(x+3)$. Occasionally numerical errors were seen when expanding the brackets, most commonly $5x+10=3x+9$, or $5x+15=3x+9$. After the correct line $5x+25=3x+9$ there was sometimes a sign error leading to the incorrect solution $x=8$. Candidates who began with $\frac{5(x+5)}{(x+3)(x+5)}=\frac{3(x+3)}{(x+3)(x+5)}$ were sometimes then unable to progress to remove the denominator. Candidates who began by collecting the fractions to one side and wrote $\frac{5}{x+3}-\frac{3}{x+5}=0$ usually made sign errors in subsequent steps or made the error $0\times(x+3)(x+5)=(x+3)(x+5)$ when trying to remove the denominator. Other candidates took a similar approach but omitted = 0 and so worked with an expression instead of an equation, which could not be given any credit.

Question 4

(a) (i) Many candidates were successful in this question part. The most common error was to calculate the interest only and give a final answer of 50. Another common error was to calculate compound interest instead of simple interest.

(ii) This question part was also well done. A small minority calculated simple interest and another small minority added or subtracted 500. Candidates that gained 0 marks when attempting to do compound interest usually went wrong in the way they wrote down the formula, for example $500(100+\frac{1.8}{100})^5$ or $500(\frac{1+1.8}{100})^5$.

(iii) This question part was challenging for many. Candidates who recognised the need to use trial and improvement to compare the two investments did not always use a systematic approach or did not continue far enough to reach 12 and 13 years. Answers were sometimes seen without working and whilst answers of 8 and 13 still gained credit other near misses such as 9, 12 or 14 did not. Candidates presumably did the trials on their calculator but without communicating any of the working on paper. Candidates should always write down their supporting methods as fully as possible. To gain method marks candidates needed to show that a comparison was being made between Zak and Yasmin's investment value each year. Some candidates did not show Zak's values or showed Yasmin's investment value but Zak's interest only. A common incorrect answer was 1 year as some candidates increased Yasmin's investment but omitted to increase the value of Zak's investment from \$550. There were also a number of candidates who attempted to solve the problem algebraically leading to an inequality e.g. $500(1+\frac{1.8}{100})^n>\frac{500\times2\times n}{100}+500$, which could not then be solved.

(b) Many candidates applied the correct method to decrease the value of the car exponentially but sometimes overlooked the instruction to give the answer correct to the nearest dollar. Where errors were made it tended to be by applying a 10 per cent increase instead of decrease, or by using a simple decrease of \$250 each year.

(c) This was a challenging question and a significant number of candidates were unable to set up the required equation to start. Of those that did begin correctly, many found it difficult to solve, often bringing the power of 22 inside the bracket. Other candidates used a power of $\frac{22}{365}$, clearly worrying about *r* being the percentage rate each day rather than each year as in previous parts of the question. Some candidates tried trial and improvement but were unable to reach sufficient accuracy.

Question 5

(a) (i) The majority of candidates were able to read the value of the median from the graph at the cumulative frequency of 50. Occasionally an error was made in reading the scale on the time axis. Weaker candidates gave the answer 10, presumably as the middle of 5 and 15, the values covered by the graph on the time axis.

(ii) Many candidates correctly read the upper quartile and the lower quartile from the graph and subtracted to find the correct value for the interquartile range. The scale on the time axis was occasionally misinterpreted so that an upper quartile of 10.2 was used instead of 10.4. Other candidates clearly showed in their working that they intended to use a cumulative frequency of 25 and a cumulative frequency of 75 but then used the scale on the cumulative frequency axis incorrectly and read the values at a cumulative frequency of 30 and a cumulative frequency of 70 instead. A common error from weaker candidates was to write the upper quartile as 75 and the lower quartile as 25, subtracting to get 50 and then reading the value at a cumulative frequency of 50 thus giving the median instead of the interquartile range. Others gave the answer as 50. A further error seen repeatedly was to do the subtraction 15 – 5 = 10 for the range instead of the interquartile range.

(iii) Many candidates were able to successfully read the graph to find the number of candidates taking more than 11 minutes to eat a pizza as 100 – 82 = 18. The answer 82 was also a common error seen. Some candidates misread the cumulative frequency scale and gave the answer 81 or 19.

(b) (i) Most candidates showed a clear, accurate method for this familiar task of finding the mean from a grouped frequency table. Occasional small numerical errors in the values of the mid-points were seen but method marks were still available if clear method was shown. A small number of candidates worked with group widths instead of mid – values and a further small number of candidates found the sum of the frequencies and divided by 5.

(ii) This question part proved to be a challenge for many candidates. Candidates seemed unfamiliar with how to progress from frequency densities to the height of the bars. It is advisable that the frequency density values are shown before further manipulation. A common misconception was to note that the height of the given bar was 4 more than the frequency density and so 4 was added to each of the other frequency densities instead of using the multiplier 1.5. Another common error was to multiply the frequencies by 0.3, deduced incorrectly from the frequency 40 and the given bar height 12. A significant number of candidates omitted this question part completely.

(iii) There was a mixed response to this question on 'non –replacement' probability which required candidates to extract information from the frequency table and calculate $\frac{15}{150}\times\frac{14}{149}$. Common incorrect methods seen were $\frac{15}{150}\times\frac{15}{150}, \frac{15}{150}+\frac{14}{149}, \frac{1}{15}\times\frac{1}{14}, \frac{1}{15}\times\frac{1}{15}$ or an answer of $\frac{15}{150}$. Some able candidates mistakenly multiplied the correct calculation by 2.

Question 6

(a) (i) This question part was very well answered. Occasionally candidates found 3***p*** instead of 3***q***.

(ii) This subtraction of column vectors was also very well answered.

(iii) There was a mixed response to this question to find $|p|$, although many correct answers were seen. Some candidates completed a correct method but gave their answer to only 2 significant figures or truncated to 3.60 and so did not earn the accuracy mark. Other candidates did not appear to understand that the length of the vector was required and made no attempt to use Pythagoras' theorem.

(b) This was another question part that elicited a mixed response. Many correct answers of $(6,1)$ were seen but the errors $(-2,13)$ and $(-6,-1)$ were also common. Candidates either misread $\overrightarrow{AB}=\begin{pmatrix}-4\\6\end{pmatrix}$ as $\overrightarrow{BA}=\begin{pmatrix}-4\\6\end{pmatrix}$ to get $(-2,13)$ or did not appreciate the importance of direction for vectors. The errors leading to an answer of $(-6,-1)$ seemed to stem from the misconception that $\overrightarrow{OA}+\overrightarrow{OB}=\overrightarrow{AB}$ instead of $\overrightarrow{AO}+\overrightarrow{OB}=\overrightarrow{AB}$.

(c) This question on vector routes proved challenging for many. Candidates should be encouraged to begin by writing the required vector as a vector route using lines given on the diagram. For example, $\overrightarrow{MK}=\overrightarrow{MH}+\overrightarrow{HK}$ secured a method mark. It was then necessary to express the vectors in terms of ***h*** and ***g***. Many candidates were able to correctly interpret the given ratio and deduce that for example $\overrightarrow{HK} = \frac{2}{7}\overrightarrow{HG}$, although the error $\frac{2}{5}\overrightarrow{HG}$ was occasionally seen. Most candidates could deduce that $\overrightarrow{MH} = \frac{1}{2}\boldsymbol{h}$. The most common errors stemmed from a lack of attention to the directional nature of vectors. It was common to use, for example, $\overrightarrow{GH} = \boldsymbol{g} - \boldsymbol{h}$ or sometimes $\overrightarrow{GH} = g + h$ or on other occasions to correctly write $\overrightarrow{GH} = h - g$ but then follow this with $\overrightarrow{HK} = \frac{2}{7}(h - g)$. Candidates who chose the route $\overrightarrow{MK} = \overrightarrow{MO} + \overrightarrow{OG} + \overrightarrow{GK}$ sometimes made an error with $\overrightarrow{MO}$ and wrote $\overrightarrow{MK} = \frac{h}{2} + g + \frac{5}{7}(h - g)$. Some other candidates wrote a correct unsimplified expression for $\overrightarrow{MK}$ but then made errors when adding or subtracting fractions to get single terms in ***h*** and ***g***.

Question 7

(a) (i) This question part was well answered.

(ii) This question part on composite functions was also answered well. Occasionally the errors $\mathrm{h}(\frac{1}{2}) \times \mathrm{g}\left(\frac{1}{2}\right)$ or $\mathrm{gh}\left(\frac{1}{2}\right)$ were seen.

(b) This question part was well answered.

(c) This was another well answered question part. Many candidates wrote down the equation $\frac{2}{x} = 2^3$ and solved it correctly. Some candidates began with the correct equation but then after reaching $\frac{2}{x} = 8$ concluded that $x = 16$ or $x = 4$.

(d) This question part on finding the inverse of a function was more of a challenge for some candidates but many fully correct answers were seen. A significant number of candidates understood the required process but made a sign error when re-arranging their equation, for example, $x = 5 - 2y$ was followed by $x - 5 = 2y$. Other candidates completed their re-arrangement of $y = 5 - 2x$ to $x = \frac{5 - y}{2}$ but then left their answer in terms of y. A small number of candidates interpreted $\mathrm{j}^{-1}(x)$ as $\frac{1}{\mathrm{j}(x)}$.

(e) Most candidates were able to begin with the correct expression $10 - x + \frac{2}{x} + 1$ but arriving at the correct simplified single fraction was challenging for many. The common error seen was $\frac{x(10 - x) + 2 + 1}{x}$ or occasionally $\frac{x(10 - x) + 2x + x}{x}$. Other candidates reached the correct fraction $\frac{-x^2 + 2 + 11x}{x}$ but then followed this with $\frac{x^2 - 2 - 11x}{x}$, or omitted the denominator.

(f) This question part required candidates to be rigorous with their use of brackets. Many candidates understood that $(\mathrm{f}(x))^2$ was $(10 - x)^2$ and that $\mathrm{ff}(x)$ was $10 - (10 - x)$ but the most common first line of working for $(\mathrm{f}(x))^2 - \mathrm{ff}(x)$ from candidates of all abilities was $(10 - x)^2 - 10 - (10 - x)$. From here many candidates were able to expand $(10 - x)^2$ correctly but the omission of the brackets around $10 - (10 - x)$ meant that sign errors followed. Other errors seen from weaker candidates included expanding $(10 - x)^2$ to $100 - x^2$ or to $100 - 10x - 10x - x^2$. The expression $10 - (10 - x)$ was also misinterpreted as $10(10 - x)$. Some candidates misinterpreted $\mathrm{ff}(x)$ as $(\mathrm{f}(x))^2$.

(g) Most candidates did not recall that the most efficient way to solve $h^{-1}(x) = 10$ is to evaluate $h(10)$. Many candidates attempted to find the inverse function and inevitably were unsuccessful as logarithms are not on the syllabus. Another common error was to try to solve $h(x) = 10$ or $\frac{1}{h(x)} = 10$ using trial and error.

Question 8

(a)(Many candidates identified the need for, and showed excellent recall of, the cosine rule. Some candidates began with *cos* as the subject while others began with $20^2 = 15^2 + 8^2 - 2\times15\times8\cos C$ and re-arranged. Many candidates completed this re-arrangement successfully but for others there were sign errors and the error $20^2 = (15^2 + 8^2 - 2\times15\times8)\cos C$ was seen. Most candidates who successfully completed the re-arrangement to make *cos* the subject then wrote down the value of cos *C* either as a fraction or as a decimal, but it was then common to jump to the given answer of 117.5 without showing a more accurate value for the angle. For full marks a value to more than 1 decimal place must be seen to complete the process of showing that angle ACB 117.5 to 1 decimal place. Candidates who, after writing $\cos = \frac{15^2 + 8^2 - 20^2}{2\times15\times8}$, then omitted both the value of the cosine and the more accurate value of the angle were unable to be awarded the two available accuracy marks for this question. Candidates should also be aware that the general formula $\cos C = \frac{a^2 + b^2 - c^2}{2\times a\times b}$ does not gain any credit until appropriate numerical substitutions are made.

(b) Many candidates applied the formula $\frac{1}{2}ab\sin C$ correctly to triangle *ABC* to find the area. Some candidates did not use the efficient method of the sides 8 and 15 with the given angle 117.5 but still completed a correct method. Some candidates used an incorrect pair of sides with the angle 117.5 or omitted multiplication by $\frac{1}{2}$ from the formula. Weaker candidates treated the triangle as right-angled and gave the answer 60 from the calculation $0.5\times15\times8$.

(c) This question part was well answered with most candidates applying Pythagoras' theorem correctly to find the length of the side. The error $15^2 - 4^2$ was seen occasionally.

(d) Candidates who completed this question part successfully usually used the given diagram to draw a line from *P* to *QC*, parallel to *BC*, to identify the required angle. They were then able to deduce that the relevant triangle had sides of 1 m and 8 m and usually applied right-angled trigonometry correctly to find the angle of elevation. After a correct diagram a few candidates found the wrong angle in the right-angled triangle. Many candidates found this question part challenging. It was common to see a line drawn from *P* to *C* and attempts to find angle *QPC* then followed. Another common error was to work in a right-angled triangle with base 8 m and height 4 m instead of 1 m.

(e) This question part involving 3D trigonometry proved to be one of the most challenging on the paper. Many candidates were unable to identify the required angle and a significant number omitted the question completely or were unable to produce any relevant working. Candidates who identified the relevant right-angled triangle and angle were often unable to deduce that the height of the triangle was 3.5 m. Denoting the mid-point of *PQ* as *M* and the mid-point of *BC* as *N*, attempts to find *AM* or *AN* often involved the misconceptions that *AM* = *AQ*, *AN* bisected the angle *CAB*, angle *ANB* = 90°, angle *AQM* = 90° or angle *AQM* = 117.5°.

Question 9

(a) (i) Most candidates found this 'show that' part quite straightforward and earned full marks. Some candidates lost both marks because of not starting with bracketed expressions and a few candidates lost the accuracy mark through omitting a term from the equation, often the zero. A few other candidates equated the areas instead of adding them. A small number of candidates misinterpreted the question as they solved the equation.

(ii) The solving of the quadratic equation was well done with many candidates using the formula and showing their working. Some candidates lost one mark due to not giving their answers correct to four significant figures. A few candidates did not show their working as they started with the exact answers from their calculator. A small number of candidates did not know the quadratic equation formula.

(iii) In this question part a numerical value for the perimeter using the positive value of x found in **part (ii)** was expected and many correct answers were seen. It was also common to give the perimeter in terms of x which was not sufficient.

(b) This was a discriminating question requiring candidates to set up a quadratic equation and solve it by factorising.

As three variables were in the question, the setting up of the equation proved to be very challenging with many candidates only obtaining equations containing more than one of these variables. The efficient method used by the stronger candidates was to find both H and h in terms of y and then use $H - h = 1$. A few candidates did manage to obtain a correct equation in terms of H or in terms of h.

Candidates who were able to reach a correct quadratic equation were usually successful in factorising and solving it, although a few used the formula and lost the marks for factorising. Candidates who obtained an incorrect quadratic equation were usually unable to make further progress as their quadratic would not be likely to factorise.

Some candidates tried various integer values of the three variables, and a few found the correct value of y. This only earned one mark.

Many candidates earned only one mark by stating $H(y - 2) = 15$ or $hy = 20$.

A few candidates thought the rectangles were similar. The whole question was occasionally not attempted.

Question 10

(a) (i) Candidates who drew horizontal lines on the graph were usually successful in finding an appropriate value for k although some non-integer values were seen. There was evidence that many candidates did not understand this graph or know what the question was asking them to do. Common errors seen included –1, 2, 3, 10 and 6 as well as many non-integer values.

(ii) Many candidates did not understand what was required in this question related to solving equations graphically. A common response was to write –1.5 and 6 from the interval given in the question. Correct responses were seen but some other candidates transposed the values of a and b.

(b) Many candidates recognised that in this question about finding stationary points, differentiation was required, and most were able to successfully perform the differentiation process. Some candidates went on to equate their first derivative to 0 but of these, some had difficulty factorising to find the solutions for x and others omitted the final step of substituting their x values into the given equation to find the y values. A common error seen was to continue to find the 2nd, 3rd, and 4th derivatives before equating to 0 and attempting to solve the quadratic equation obtained.

MATHEMATICS

Paper 0580/42
Paper 42 (Extended)

Key messages

To do well in this paper, candidates need to be familiar with all aspects of the syllabus including correct terminology and interpretation of symbols. 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 and only the final answer rounded to the appropriate degree of accuracy.

Candidates should show full working with their answers to ensure that method marks are considered where answers are incorrect.

General comments

Many candidates were well prepared for the paper and their solutions were usually well presented. All candidates appeared to have sufficient time to answer the questions.

In some cases, candidates rounded or truncated values prematurely in their working, leading to inaccurate final answers and the loss of method marks.

When drawing graphs of polynomial functions candidates should use a sharp pencil and join points with a curve and not straight lines. When describing single transformations, the correct language should be used and candidates should not provide more than one transformation in their answer. When calculating with π, candidates should use the calculator value of π or 3.142.

Candidates should be aware that if they are directed to use a particular method in the question then credit for method is not given if an alternate method is used.

The topics that were answered very well included:

- working with ratio and percentages
- graphs of functions
- working with linear equations and basic algebraic manipulation including expanding three brackets
- estimated mean from grouped data
- three-dimensional trigonometry
- area of a sector.

The weakest areas included:

- dependent probabilities
- showing a given equation involving perimeters of minor and major arcs
- finding the position vector of a point using similar triangles.

Comments on specific questions

Question 1

(a) (i) Most candidates answered this part correctly. The common errors were to divide 45 by 5 or 8.

(ii) Almost all candidates answered this correctly. Common errors included an increase by 12 per cent or division by 1.12. Some lost accuracy by rounding to 2.3 without showing a more accurate answer previously. A small number correctly worked out 12 per cent as 0.318 but then either failed to complete or added it to 2.65 instead.

(iii) The majority answered this well. Common errors included an answer of 90.9 from 1455×0.0625, 1364 from 1455×0.9375 and 1546 from 1455×1.0625. A few did not give the answer accurately by rounding this exact answer to 3 significant figures.

(iv) A minority earned 3 marks on this part. Many made the error of decreasing instead of increasing either by using a multiplier of $(1 - 0.04)^3$ or by repeated reduction of 4 per cent for the 3 years usually resulting in an answer of 1443. Another common error was to use 12 per cent instead of 4 per cent in 3 successive operations. Some recognised that $(1 + 0.04)^3$ should be used but then multiplied by 1631. Some candidates set up a correct equation involving the multiplier but then made errors in completing the solution.

(b) (i) Many candidates answered this correctly. Common errors included $\frac{7x}{9}$, $\frac{2x}{7}$ or $7x$.

(ii) Most candidates gained credit for $x + 12$ but fewer were successful with the other expression, where adding 26 was the most common error.

(iii) Those with correct expressions in **part (b)(ii)** usually scored all 4 marks in this part, whilst those with incorrect expressions often gained the method marks for writing down and solving their equation. Common errors in forming the equation were to multiply the wrong term by 3, and there were a number of errors in dealing with the bracket and the fractions correctly. Where candidates try to do more than one operation in a single step, they can often make errors.

Question 2

(a) (i) This was almost always answered correctly.

(ii) Most candidates plotted the points correctly and drew an acceptable curve. Common errors included ruled lines instead of curves and thick lines.

(iii) This part was linked to the graph and candidates were expected to read off the values of x from their graph where $V = 44$. Many did this well, but a number attempted a calculation from $44 = x^2(9 - x)$ and a number made errors in solving this.

(b) (i) Many candidates attempted this in several parts, adding each separate area, usually successfully. The common errors were usually omission of brackets with $9 - x.x$ seen instead of $(9 - x)x$, or miscopying terms from one line to the next.

(ii) The strongest answers were when candidates used the graph and stated that the maximum volume occurred at $x = 6$. They then used the formula from **part (b)(i)** to obtain their answer. Many candidates did not use this approach and did not identify the value of x when the volume was maximum and then tried, often unsuccessfully, to calculate the maximum using calculus or by finding the individual areas again.

Question 3

(a) (i) This was very well answered by almost all candidates. Errors include using the class intervals, instead of mid-values, or using class boundaries, as well as occasional arithmetical errors after a correct method had been written.

(ii) Many candidates found this very challenging, with only a few using the method of comparing the averages in each final column $(32 \times 350 - 32 \times 330) \div 200$. Some candidates did compare these totals, but then omitted to divide by 200. The most common attempt was to calculate the mean for Ann's data, and subtract it from their previous answer, usually in its rounded form, resulting in an inaccurate final answer.

(iii) A minority gave three correct heights. The key to this question was to first find the frequency densities, which a number of candidates did, and then use the given information to scale the frequency densities to the required heights.

A significant number of candidates gave answers of 0.35, 3.8 and 1.6 which indicated that they were not considering frequency densities at all, but simply dividing by 20.

(b) This part was answered very well.

(c) These two parts proved more difficult for candidates, with many not grasping the concept of non-replacement. As a result, many answers incorrectly involved two fractions with denominator 200.

Candidates who gave answers as decimals or percentages correct only to 2 significant figures, without showing the fraction first, or in some cases without any working at all did not gain any credit.

(c) (i) Not all candidates selected the correct values from the frequency table and did not use $\frac{40}{200} \times \frac{39}{199}$.
Some incorrectly approached the problem as with replacement. Others added the two fractions or multiplied the correct product by 2.

(ii) In this problem there were two pairs of products needed before adding. A number of candidates only considered one of the required products and gave an answer of $\frac{147}{9950}$. Similar errors were also made in this part as in the previous part, including adding instead of multiplying, as well as treating the problem as with replacement.

Question 4

(a) (i) Most gave the correct term translation with a few using incorrect language, translocation, transition and move were the most common errors. Candidates were less successful with the vector often reversing the numbers and signs.

(ii) Many gave the correct term rotation and also gave the angle although some used clockwise instead of anticlockwise. A number still use incorrect language, the most common being turn. There was less success in giving the centre of the rotation with a number omitting this property.

A number of candidates also gave more than one transformation, e.g. a translation as following the rotation, ignoring the instruction that a **single** transformation was required.

(iii) The majority of the candidates correctly identified the enlargement although, once again, there were a few cases of incorrect language used such as diminish and smaller. Most gave the correct scale factor but there were some errors with answers of 2, –2 and $-\frac{1}{2}$ also given. Those who also gave a centre for the enlargement were frequently correct but there were some sign errors.

(b) Most candidates gave the correct image. A number drew the correct line of reflection, although some could go no further, and some reflected the original shape in a wrong line, most commonly a vertical line.

There were a number of candidates who made no attempt at this part.

Question 5

(a) (i) Most candidates gave a correct expression for the acceleration. Some incorrect answers such as 24/10 or 24/18 were seen. A significant number did not give their answer to a sufficient degree of accuracy at any stage, usually going straight from their expression to 0.78. An answer given as a fraction or a decimal written to at least 3 significant figures, is required.

(ii) Many candidates were successful in this part. Some made errors in calculating the area, with several attempting to treat the entire area as a trapezium and others who gave an incorrect side for an area calculation. Others gave an area of 960. A few candidates did not subtract the value of 134 from the distance travelled by the car. Those who had not earned any marks up to this point often earned a method mark by dividing their area by 40. Those who used the value of 134 as the distance travelled by the car and divided this by 40 were not awarded this mark.

(b) This was answered well by many candidates who gave a correct fraction for the average speed and then converted this to the units required. A common error was to give an incorrect method to convert 10 minutes 30 seconds into hours. For example, using 10.3 minutes. A small number of candidates divided the time by the distance or multiplied the distance by the time.

Question 6

(a) This first part was answered correctly by the vast majority of the candidates. The most common mistake was to subtract 9 from 15 leading to an answer of 1.5.

(b) Most candidates were able to recognise this as a 'difference of two squares' factorisation and gave the correct response. Some did not take the square root of 9 so gave (a – 9)(a + 9) and others gave $(a - 3)^2$.

(c) Almost all candidates made the correct first step by inverting the second fraction and multiplying the two fractions. A small proportion attempted to add the two fractions but the most common errors were as the result of incorrect or incomplete cancelling.

(d) Most candidates found this part challenging with only a very small proportion giving the correct answer. The most common incorrect answer was $5n$ from simply adding the indices. Of those who did recognise the left-hand side as 5×5^n, only a small number took the next step and added the indices.

(e) Quite a high number disregarded the instruction to solve by factorisation and applied the quadratic formula which did not receive any credit for the method. Of those who did use factorisation most did so correctly, with only a small number making a sign error. Most were able to give the correct answers to earn 1 mark.

(f) (i) Most candidates were successful in this part with clear working shown. Common errors included using an inverse proportion, or not including a constant of proportionality and then being unable to progress. Several candidates correctly calculated the constant of proportionality, k, but then used $y = kx$ or $y = kx^3$ in the second stage of the working. Some who completed the first two stages correctly by giving $108 = 0.108(x + 3)^3$ then made errors for example by trying to expand $(x + 3^3$ in an attempt to find x.

(ii) This proved to be a challenge for most candidates. Many candidates correctly wrote down the inverse relationship but could not make any further progress. The most common incorrect answers were 2 or $\frac{1}{2}$, usually obtained from omitting brackets and so failing to square the 2 or $\frac{1}{2}$. A small number of candidates attempted to incorporate their value of k from the previous part of the question.

(g) This was generally answered well with many candidates carrying out the multiplication correctly. The most common errors were sign errors when expanding the first bracket, including writing $-2x + 3x = -x$ or expanding two pairs of brackets separately and adding the results. A few candidates obtained the correct answer but then went on to do further work such as attempting to factorise. These cases were awarded two of the three marks.

(h) This was answered very well. A few candidates did further work such as equating their derivative to 0 and solving it or, occasionally, finding the second derivative. There was evidence of a very small number who appeared to have no knowledge of differentiation.

Question 7

(a) (i) This part involved using the cosine rule and was generally done well, particularly by those who quoted the version of the rule with cos *P* as the subject. There were a small number who assumed that triangle *PQR* is right-angled so did not use the cosine rule and others who calculated either angle *Q* or *R*. Also a few candidates misquoted the rule such as making a sign error or omitting the '2'. Those who used the implicit version of the cosine rule were less successful as it is necessary to transpose the equation after the values have been substituted leading to possible errors, such as not collecting the terms correctly.

(ii) There were a mixture of responses. Those who drew the perpendicular from *Q* to *PR* and marked the right angle generally resulted in the use of trigonometry, in which a side and an angle were known, to give the correct answer. Some used a longer method usually involving the sine rule, either in the right-angled triangle or to find angle *R* and then use the alternative right-angled triangle with *QR*. There were quite a number who incorrectly used the line from *R* to the midpoint of *PQ*.

(b) (i) A minority of candidates who used the direct approach by taking the square root of the sum of the squares of 29, 21 and 20 were usually successful. Those using the two stage method were also often successful but a common error was to give $\sqrt{29^2 + 21^2}$ as 35.8 and then use this value in the second stage. This leads to a value for *AG* that is outside of the acceptable range. Candidates should be made aware that intermediate values used in a calculation of this type should have at least 4 significant figures or better still have full values 'held' in the calculator.

(ii) Most candidates identified angle *GAC* as the angle between *GA* and the base *ABCD* either by marking it on the diagram or using the correct trigonometrical ratio in the right-angled triangle *ACG*. Some used an incorrect trig ratio and others used a longer method which involved using the sine rule.

(c) The key to answering both parts of this question is to find angle *LKM* using geometrical properties which lead to 10 + 25 = 35. Those that found this angle correctly did not always give the correct bearing with 106 sometimes given but usually they did find the correct distance for *ML* by using the sine rule. There were quite large number of candidates who gave an incorrect value for angle *LKM* and the most common errors were 25 or 10. Many of these candidates were able to earn marks for using the sine rule with angle *LKM* clearly identified either on the diagram or in the working. There was a significant number who did not offer a response to this part.

Question 8

(a) This part was well answered by most candidates The most common error was to find the midpoint of *A* and *M* leading to and answer of (7, 5).

(b) This question involved a number of steps, the first of which was to find the gradient of *AB*. Most candidates did this correctly with a variety of methods used. Many used the coordinates of *A* with those of *B* found in **part (a)** and others used the coordinates of *A* with those of *M*. A further method used occasionally was to use the general equation of the line to set up a pair of simultaneous equations with two sets of coordinates of points on the line *AB* and then solve to find the gradient. The second step was then to find the gradient of the perpendicular to *AB* using the fact that the product of the gradients is equal to –1 and many did this well. The third step involved substitution $x = 12$ and $y = 7$ into their equation to find the constant. The most common error was to use the coordinates of *A* for the substitution. Finally, the equation needed to be manipulated to the form required in the question. This was completed successfully by most of those who had completed the third step. There were a small number who wrote down the given equation and then rearranged it to find the gradient of the perpendicular, which did not receive any credit.

(c) Many candidates were successful in this part by substituting $x = 2$ into the equation of the perpendicular bisector of AB given in the previous part, but there were a significant number who did not know how to proceed.

(d) This part proved challenging for many and often there was no attempt to draw a sketch, which might have helped to identify the horizontal line from (12,7), perpendicular to *AN* and of length 10. This gives a relatively straightforward method to find the area of triangle *AMN* using $\frac{1}{2} \times$ base $\times$ height. Most attempted to use the coordinates of the vertices to find the lengths of *AM* and *MN* using Pythagoras with varying success. A few candidates used the determinant of a matrix method, again using the coordinates of the vertices. There were some correct answers but a number of candidates either set up the matrix incorrectly or made an error in evaluating the determinant.

Question 9

(a) Most candidates knew the basic sine curve and gained full marks with an acceptable sketch. Some gained partial credit when their sketch strayed outside the limits of period or amplitude or when a negative sine curve was drawn. Infrequent errors seen were cosine or tangent sketches.

(b) Many candidates answered this correctly. Some gave one correct value and scored partial credit. Others gained credit for correctly rearranging the equation to give sin $x = -0.8$ but then did not identify the angles in the correct quadrant and gave –53.1 as their answer.

Question 10

(a) Many candidates were successful, but a number did not deal correctly with the bounds of the lengths. All candidates understood the term perimeter and that for the upper bound there needed to be an increase. A common error was to add 0.5 to each value rather than 0.05. Others added the three given lengths then added 0.05 to the total. Some reached the correct answer but rounded it to 42.1 rather than giving the exact answer.

(b) This was very well answered. The main common errors were in giving an inaccurate final answer by using a value of π as 3.14 or $\frac{22}{7}$. For this exam, candidates are instructed to use π or 3.142. Some did an arc length calculation or found the area of the major sector.

(c) This part was more challenging with fewer fully correct responses seen and many candidates not accessing this part. It did enabled candidates to show their skills with algebraic manipulation and a great variety of different routes to the correct answer were seen. Some correct solutions were reached efficiently in a few lines while others took much longer. The first mark was usually awarded for the arc length of the minor sector. The common errors when setting up the equation were not including the two radii in the perimeters or equating the minor sector to three times the major sector perimeter. More able candidates who got this far were often able to isolate *x* and get to the given expression, but errors were frequent for many when rearranging the equation.

Question 11

(a) Many candidates found this question challenging, although a significant number were successful. Some did not understand the meaning of the modulus sign in the context of a column vector. Those that did, made use of Pythagoras but in many cases, considered $9\,m^2 + 40\,m^2$ rather than $(9\,\text{m})^2 + (40\,\text{m})^2$. A few candidates who used Pythagoras correctly, failed to equate this to the square of $\frac{205}{2}$.

(b) (i) The three parts of **(i)** were answered correctly by the majority of candidates. Those candidates who were not successful showed a limited understanding of the nature of vectors or did not deal with the ratio 3 : 1 correctly.

(ii) **Part (ii)** was much more challenging and fewer candidates were successful. Those who were successful generally used, if informally, the fact that triangle *PBQ* was similar to triangle *OCP* with a scale factor of $\frac{1}{3}$. They went on to state that $\overrightarrow{BQ} = \frac{1}{3}\mathbf{c}$ or $\overrightarrow{AQ} = \frac{4}{3}\mathbf{c}$ before giving the correct position vector of *Q*. Other candidates were given credit if they gave a correct vector route for $\overrightarrow{OQ}$.

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 a clear knowledge of the wide range of topics tested. However, there were some poorer scripts in which a lack of expertise was evident and a lack of familiarity with some topics that resulted in high numbers of no responses. The standard of presentation was generally good, however there were occasions when a lack of clear working made it difficult to award some method marks. There was no evidence that candidates were short of time, as most candidates attempted nearly all the later questions.

The areas that proved to be most accessible were:
- Simple proportion
- Rules of indices
- Formula for *n*th term of a linear sequence
- Solving linear equations
- Rate of flow and time
- Substitution into a formula
- Change of subject of a formula.

The most challenging areas were:
- Calculations involving bounds
- Identifying points in a region
- Harder probability
- Sketching an exponential graph
- Applications of calculus to coordinate geometry
- Harder vector work.

Comments on specific questions

Question 1

(a) (i) Many candidates had no difficulty in expressing one amount as a percentage of another. Rounding answers to two significant figures without showing a more accurate value was a common error.

(ii) Most candidates had a good understanding of direct proportion and obtained the correct answer. Accuracy was sometimes lost by carrying out the calculation in stages with 250 ÷ 12 often truncated as 20.83 giving a final answer of 374.94 . In a small number of cases candidates used an ingredient other than butter.

(iii) Fewer candidates were successful in reaching the correct answer. Those that understood what was required had no difficulty in scaling up the number of people, although some of these did so for all the ingredients before choosing the appropriate answer. Some worked out the number of people for milk only and gave 33 as their answer. The statement '1.5 g of each other ingredient' confused some candidates. For these candidates, the number of people was proportionately calculated using the total masses of the other ingredients, with 1.59 kg compared with the new total of 6 kg.

(b) (i) Many fully correct solutions were seen. The calculation 2.40×0.75 was the most common error with 2.40 – 0.25 also seen several times.

(ii) This part proved more of a challenge and only a minority of candidates had a fully correct answer. The efficient method of using the percentage multipliers, 1.25×1.15, was rarely seen with most opting to use the actual costs. Many of those with an incorrect answer in the previous part used a correct method to earn some credit. In some cases, candidates started correctly but missed the final step, e.g. reaching 143.75 and forgetting to subtract 100, while others reached 0.4375 and forgetting to multiply by 100. Adding 25 per cent and 15 per cent was a common error with some weaker responses.

(c) This was the most challenging part of the question and few candidates were able to identify the correct bounds and find the number of packets. It was common to see the width given values in the range 11.0 to 12.0 and the length in the range 1.90 to 2.10. When the ranges were correct candidates quite often used an incorrect pair of bounds. The different units used rarely presented a problem.

Question 2

(a) (i) Almost all candidates gave the correct answer.

(ii) Slightly fewer correct answers were seen in this part. Common errors included dividing the powers and giving the answer as $6m^3$, cancelling out the variable and giving the answer as 6^4 and leaving the answers as a fraction, $\frac{6m^4}{1}$.

(iii) This proved more of a challenge and correct answers were achieved by a minority of candidates. Candidates dealt with the algebraic terms better than the two numbers. It was common to see a final answer with $\frac{1}{3}$ in the numerator and $\frac{1}{4}$ in the denominator. In some cases, candidates converted the fractions to decimals with $\frac{1}{3}$ usually truncated to 0.33.

A higher-than-average proportion of candidates made no attempt at a response.

(b) Many correct answers were seen. The most common error was evaluating $(3n)^2$.

(c) (i) Candidates were only slightly less successful in finding an expression for the *n*th term than they were in finding the terms when an expression is given. Some identified the common difference of 3 but then gave their answer as $3 + n$. Those that realised $3n$ was needed usually identified the constant term as well. The expression $10n + 3$ was a common error.

(ii) Fewer correct answers were seen. Many candidates attempted the method of differences but not all completed the third set. Some of those that found the third differences did not link them to a cubic expression, usually opting for quadratic sequence. When the link was known candidates usually obtained a correct expression.

A higher-than-average proportion of candidates made no attempt at a response.

(d) Many correct answers were seen. Writing $\frac{3x}{4} = 23 + 22$ as a first step and subtracting 22 from 92 were the two common errors.

(e) Those candidates that use the correct formula were generally clear and precise in their presentation and gave their answers to the required accuracy. The discriminant was sometimes written as $b^2 + 4ac$ or $b^2 - 2ac$ and the $-b$ term was sometimes written as $-b^2$. A significant number of candidates wrote down the correct answers with no working or with incorrect working. Some weaker responses involved attempts to factorise.

Question 3

(a) A good number of accurately drawn histograms were seen, the majority of which were neatly ruled. Where errors were seen it was more likely to be with the first block, usually drawn with a height of 1.85. The top of the block needed to be somewhere in the square above rather than on the gridline. Calculations for the frequency densities were rarely seen and if two or all the blocks were incorrect, it was often impossible to spot where the candidates had gone wrong.

(b) Many candidates set out their calculations clearly and went on to obtain the correct value of the mean. Others, also using the correct method, made slips, either with a midpoint or with the numeracy work. Some candidates mistakenly use the interval boundaries or the interval widths in an otherwise correct method.

Question 4

(a) Many candidates demonstrated a good understanding of reflection in $y = -2$. Incorrect identification of $y = -2$ resulted in most of the errors with reflection in any horizontal line more likely than reflection in the line $x = -2$.

(b) Drawing an enlargement with a fractional scale factor proved more challenging and was reflected by fewer correct answers. Candidates that drew construction lines through the centre of enlargement tended to be more successful in terms of correct location. Others used the construction lines incorrectly by drawing an enlargement with negative scale factor, ending up with an image partially off the grid. There was no evidence to suggest any of these candidates tried to correct their error.

(c) Many candidates gave clear descriptions of the transformation but these were a minority of all the answers. Answers that were not fully correct often included the correct name of the transformation usually with the correct angle of rotation and to a lesser extent the centre of the rotation. A significant number stated a rotation followed by a translation.

Question 5

(a) Many candidates understood the method required to find the volume of water. Not all went on to give a fully correct solution. When finding the area of the cross-section a significant number of candidates opted to sub-divide the area into a rectangle and two triangles rather than use the trapezium formula. Most of these candidates obtained a correct area but, in a few cases, slips in the numeracy gave an incorrect area. Having calculated the volume, the conversion to litres was often not shown. In other cases, candidates did not convert the lengths to the same units or did so incorrectly.

A higher-than-average proportion of candidates made no attempt at a response.

(b) Calculating the time to empty the trough proved less of a challenge and many correct answers were seen. Common errors include a final answer of 3 minutes 44 seconds and also 5 minutes 43 seconds after first converting to 5.73 minutes.

(c) (i) If candidates understood the method required then a successful outcome was dependent on dealing with the mix of units correctly. Many opted to use the volume in litres or cubic metres and the depth in centimetres. In some weaker responses, no progress was made resulting from the use of an incorrect formula for the volume of a cylinder.

A higher-than-average proportion of candidates made no attempt at a response.

(ii) Only a minority of candidates calculated the correct height of the tank. Many calculated 60 per cent of 84 or the equivalent 60 per cent of the volume of water and used this to calculate the depth. Some did realise that a simple reverse percentage calculation was all that was needed. Some used the less efficient method of calculating the volume when full and used that to find the height. This tended to lead to slightly inaccurate answers.

A higher-than-average proportion of candidates made no attempt at a response.

(d) Candidates often struggled to identify the correct right-angled triangle with the length of the steel rod as one of its sides. It was common to see half of 50 used rather than half of 36. Having identified a triangle most did attempt to use Pythagoras, usually applying it in two dimensions in stages. A small number of candidates attempted to use trigonometry without any success.

A higher-than-average proportion of candidates made no attempt at a response.

Question 6

(a) (i) Almost all candidates calculated the correct value of P.

(ii) Many candidates rearranged the formula correctly. Misapplication of the square root was the most common error leading to $k = \frac{\sqrt{P+7}}{5}$. Some candidates took the square at an earlier stage which often led to later errors.

(b) (i) Most candidates were able to manipulate the inequality correctly to isolate the x term, sometimes by treating it as an equation. From this point, many were able to give the correct answer but a significant number either had the inequality sign reversed or used an equal sign.

(ii) Some candidates had no difficulty in representing their previous answer on the number line, using a closed circle either with an arrow pointing in the correct direction or with a line that extended to 6 or beyond. Common errors included the use of open circles, using a closed circle with no arrow or line and in some cases treating the answer as an interval from –2.5 to 6.

(c)(i) This proved challenging and fully correct answers were in the minority. If all three lines were drawn correctly, and within tolerance, then the region was usually identified correctly. Many were able to draw the line $x = 2$, usually as a solid line instead of a broken line. Most attempted the line $x + y = 32$ and some were accurately drawn. Some candidates attempted to draw their line based on two points, such as (0, 32) and (10, 22). Correct lines for $2x + 3y = 72$ were less common. Partial credit was awarded for those identifying a region that satisfied three of the four inequalities.

(ii) With a correct region some candidates were able to identify the correct point. Many gave a pair of coordinates, almost always with no working or justification. A very high proportion of candidates made no attempt at a response.

Question 7

(a)(i) Most candidates recognised that 5 and 7 were the required numbers and many obtained the correct probability by using products. Some did not recognise that 5 and 7 could be picked in two ways and $\frac{1}{30}$ was a common error. Some obtained the correct answer by listing or illustrating the scores in a table. When listing scores in a table it was more likely that candidates would treat the question as replacement with many forgetting to rule out the scores along the diagonal.

(ii) With more possible outcomes this proved more demanding than the previous part. Most candidates could list some possible pairs but, quite often, some were omitted, usually –2 and –3. Lists of seven possible combinations were seen with not all candidates realising that each combination led to two possible outcomes. Some used a table and, as in the previous part, forgot to rule out the scores along the diagonal was a common error.

(b) Most candidates recognised the two combinations that gave the given total. Many of these used $\frac{1}{6}\times\frac{1}{5}\times\frac{1}{4}$ for each combination, not recognising that the 3 numbers could be obtained in six different ways. Others produced a methodical list of the 20 possible outcomes and obtained the correct answer. Other attempts often omitted one or more of the possible outcomes. It was not uncommon for some candidates to continue to work with two cards rather than three.

Question 8

(a) Many candidates realised that the cosine formula was needed but slips, and especially omissions, resulted in only a minority of fully correct solutions. Many opted to start with the method for cos*ABC* with others starting with the implicit form which was sometimes rearranged incorrectly. Some of those that had a correct formula evaluated it as a decimal or fraction. A significant number of candidates that reached this far gave their answer as 70.2 instead of giving a more accurate value that could be shown to round to the value given in the question. Some candidates attempted less efficient methods, such as using the cosine formula for angle *BAC* and then applying the sine formula. Premature rounding and a lack of accuracy in the final answer were common errors.

A higher-than-average proportion of candidates made no attempt at a response.

(b) (i) Many correct responses were seen. Common errors included 70.2 and 35.1. Having found the correct angle some rounded their answer to 140 which had an adverse effect on the accuracy of answers in later parts of the question. A higher-than-average proportion of candidates made no attempt at a response in all parts of **(b)**.

(ii) Many candidates used the isosceles triangle correctly and obtained the correct angle.

(iii) Those candidates successful in the previous two parts almost always found the correct angle, either from the tangent radius property or from the alternate segment theorem.

(c) Successful candidates usually opted to apply the sine rule to triangle *OAC* with a few opting to use simple trigonometry by considering one half of triangle *OAC*. Only a minority were able to find the correct radius. A very high proportion of candidates made no attempt at a response.

(d) Almost all fully correct solutions resulted from the use of $\frac{1}{2}ab\sin C$. Some candidates used the method but either errors in previous parts or a lack of accuracy or both meant that only a minority reached a correct answer. Some inefficient methods were seen. A significant number attempted to calculate the area of the triangle by summing the areas of three separate isosceles triangles usually by calculating the perpendicular height and using $\frac{1}{2}bh$. With so many steps involved the final answer was often inaccurate or usually incorrect because of errors in some part of the method. Calculation of the area of the circle was almost always correct if the candidate had a correct radius from the previous part. If a candidate had an area for the triangle and for the circle they usually used a correct method to find the percentage. A very high proportion of candidates made no attempt at a response.

Question 9

(a) (i) Many candidates drew a correct sketch of the line but not all of the candidates labelled the intercepts with the axes. Others mistakenly thought that the *y*-intercept was 3 rather than – 3 which led to a line with a negative gradient.

(ii) Some good sketches of a quadratic were seen with clearly labelled intercepts. A significant number of candidates were not confident with curve sketching, opting to complete a table of values and plot these on the given axes. Some were successful and produced an acceptable sketch. Not all sketches had the intercepts labelled. Having found the intercepts some thought that (0, – 4) was the minimum point resulting in a sketch with no clear line of symmetry. Some drew a sketch with the correct shape but could not determine where the intercepts should be. Others were able to determine the intercepts but did not draw a sketch. A number of straight lines were seen as well as some cubic graphs. A high proportion of candidates made no attempt at a response.

(iii) A few good sketches of an exponential graph were seen with the intercept clearly labelled. Many others seemed unaware of the correct shape with some sketches drawn in the first quadrant only and some that crossed the *x*-axis. A high proportion of candidates made no attempt at a response.

(b) (i) Many good attempts were seen. Differentiating $\frac{4}{3}x^3$ as $\frac{4}{3}x^2$ was the most common error. Other errors include the inclusion of a third term, occasionally using $8x$ and slips with the signs. Some found this challenging and this was reflected in the very high proportion of candidates making no attempt at a response.

(ii) Some good attempts at the gradient were seen. In many cases, weaker responses involved substitution of $x = –1$ to find the value of *y* or occasionally finding the value of the second derivative. Some found this challenging and this was reflected in the high proportion of candidates making no attempt at a response.

(iii) For many candidates this proved very demanding and this was reflected in the very high proportion of scripts with no attempt at a response. Only the strongest of responses found the required coordinates. Those with the correct derivative equated to –28 often continued to obtain the correct answers. Many attempts showed a lack of understanding, often equating *y* as –28, *y* as 0 or the first derivative as 0. Some introduced a term of $–28x$.

Question 10

(a) (i) Some correct vectors were drawn. Some candidates drew a straight line that could just as easily have represented $\begin{pmatrix} -2 \\ -4 \end{pmatrix}$ as $\begin{pmatrix} 2 \\ 4 \end{pmatrix}$. It was a requirement that an arrow was drawn to show the direction of the vector. Some candidates drew two lines representing the individual components of the vector which was not acceptable.

(ii) Many candidates were able to find the vector **a** – **b** and draw an appropriate line. As in the previous part some did not add an arrow to the line to show the direction of the vector.

(b) (i)(a) Many correct answers were seen. The most common error was **q** + **p**, mistakenly thinking that either $\overrightarrow{CB}$ = **p** or that $\overrightarrow{AB}$ = **q**.

(i)(b) Some correct answers were seen. Other candidates had a correct route but either did not give their answer in its simplest form or worked with an incorrect expression from the previous part. Giving the answer as **q** was a common error.

(i)(c) Some correct simplified expressions for $\overrightarrow{MN}$ were seen. Some candidates gave a correct route but often forgot to take direction into account. For example, $\overrightarrow{MN} = \overrightarrow{MB} + \overrightarrow{BN}$ was a common correct start but many slipped up by using $\overrightarrow{BN} = \frac{2}{3}\overrightarrow{AB}$ instead of $\overrightarrow{BN} = -\frac{2}{3}\overrightarrow{AB}$. For many this proved challenging and this was reflected in the high proportion of candidates that made no attempt at a response.

(ii) This proved challenging and this was reflected in the very high proportion of candidates that made no attempt at a response. Few correct answers were seen as many candidates did not realise that triangles *AGN* and *BMN* were similar offering a straightforward method for finding $\overrightarrow{AG}$, one step from the answer.