MATHEMATICS

Paper 0980/11
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 $\frac{110 \times 240}{360}$ = 73.3 instead of $\frac{110 \times 360}{240}$ = 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 0980/21
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 0980/31
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 × 15 = 75, 3 × 15 = 45 and 2 × 15 = 30.

(d) (i) This part was generally answered well. The most common errors came from using (6 + 4) / 150 × 100, giving an answer of 6.7%, or (6 + 4) × 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 0980/41
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.