MATHEMATICS D

Paper 4024/11
Paper 11

Key messages

To do well in this paper, candidates need to demonstrate that they have a good understanding across the whole syllabus. As it is a non-calculator paper, candidates need to be competent in basic numeracy skills, particularly in multiplication and division of whole numbers as well as decimals, and be able to convert from one form to another with a suitable degree of accuracy where necessary. All working needs to be shown clearly as in most questions method marks are available even if the final answer is incorrect.

General comments

Overall, there were some very good responses with many candidates demonstrating a range of mathematical skills and knowledge across the syllabus. Candidates completed the paper with sufficient time, making an attempt at most questions and the scripts covered the whole range of marks. Many candidates displayed a reasonable standard of presentation although some improvement could be made. The amount of working shown was usually good although sometimes the working appeared randomly within the workspace (**Question 14(b)**).

Candidates generally showed good skills in basic numeracy. Arithmetic slips were seen quite frequently, so candidates should take care to avoid these by checking their working carefully.

Candidates showed good skills in managing simple fractions and ordering numbers involving conversion to another form.

Candidates dealt with basic algebra well although some sign errors were quite common and improvement could be made in managing expressions when eliminating fractions (**Questions 22(b), 22(c), 24**).

The questions that candidates found most difficult were finding the range from a bar chart (**Question 5(a)**), conversion of units (**Question 8(b)**), set notation (**Question 18(b)**), speed-time graph (**Question 19(b)**) and vectors (**Question 23**).

Comments on specific questions

Question 1

(a) A large majority of candidates gave the correct answer. Some of the weaker candidates did not apply the correct order of operations and worked out first 6 + 4 = 10 then 10 ÷ 2 = 5, and a few wrote 6 ÷ 2 + 4 = 7.

(b) A large majority of candidates multiplied correctly. Errors were made by some who misplaced the decimal point, usually 1.2 or 120.

Question 2

A large majority of candidates converted the numbers to decimals, percentages or to fractions with common denominator 100 and used them to order the numbers correctly. Most of the other candidates were awarded a partial mark for having three in the correct order. Hardly anyone wrote them in reverse order.

Question 3

(a) Whilst the large majority worked out the correct temperature, the common errors were giving the answer –8 or combining the temperatures 20 and –12 to get 32 (sometimes written as 20 – $^{-}$12) or –32.

(b) This part was answered correctly by a large majority. Some worked out the difference incorrectly as 6 or –6.

Question 4

This part was answered very well with the large majority finding the correct answer. Most others were awarded partial credit. These included having an answer with the correct figures; often 780 or 78 and occasionally 7800, or for converting their answer in cents to dollars.

Question 5

(a) This question was a challenge for the vast majority. A relatively small minority of candidates were able to find the correct range for the number of pets by interpreting the bar chart. A few left the answer as 0 – 4 which is incorrect. Most candidates calculated the difference in the highest and lowest bar frequencies, 7 – 1 = 6. Others gave the highest bar frequency as 7, or the total sum of the frequencies as 20. A few gave the answer as 8 by subtracting the highest and lowest numbers on the frequency scale: 8 – 0.

(b) The majority of candidates gave the correct answer. A common error was $\frac{3}{20}$, just writing the numbers given in the question as a fraction without interpreting the bar chart.

Question 6

(a) This part was answered correctly by the large majority of candidates.

(b) This part was also answered correctly by the large majority of candidates. The common error was to have the answers to **(a)** and **(b)** reversed.

Question 7

This question was answered well. The majority of candidates followed the instruction in the question to round the numbers to 1 significant figure in order to estimate a value for the calculation and were awarded full marks. Those who did not often rounded 53.7 to 54 and/or 7.48 to 8. Many gained the partial mark if two numbers were rounded correctly. A few added the given values in the denominator then rounded their total and a few attempted an exact calculation; neither method was awarded a mark.

Question 8

(a) The large majority of candidates gave the correct answer. The common errors were to give the answer 780 (with some writing 1 mm = 10 cm in the working) or to give the answer 0.78. A few gave the answer 7800.

(b) This was not answered well overall. The correct answer was usually given by most of the highest scoring candidates only. The most common errors were to give the answer 300 from knowing 1 cm = 100 m but only applying this in one dimension or to give the answer as 3000.

Question 9

(a) The majority correctly stated that the correlation was positive. Candidates are not required to elaborate on this by describing it as ‘strong’, for example (although this is not penalised), but just ‘strong correlation’ without reference to it being positive is insufficient to gain the mark. The majority of candidates who were not awarded a mark tried to give an interpretation or an incorrect statement such as ‘proportional’, ‘scatter’ etc.

(b) Many candidates drew an acceptable line of best fit. Some lines were too short. Candidates should aim to draw the line long enough to cover the location of all the plotted points at the very least, and longer if possible. It was common for candidates to join the given points freehand or to draw a line that although had plots either side, did not follow their trend and so were not awarded the mark. Many were able to accurately read off from their straight line with a positive gradient and were awarded the mark for this.

Question 10

(a) A high proportion of candidates were able to calculate the missing angle. The common error was to think the total sum of the exterior angles of the pentagon was 540° and to subtract the sum of the given angles from this. A few thought the total was 720°. Others gained a method mark for just making an arithmetic slip in adding.

(b) Whilst some candidates answered this well, there were a number of common errors. The most common was to find the total number of degrees (10 – 2) × 180 = 1440 and give this as the final answer, forgetting the need to divide by 10. Similarly, those who took the approach of finding an exterior angle got as far as 360 ÷ 10 = 36 but did not subtract this from 180 to get the interior angle. A few did not multiply 8 × 180 correctly or they used the incorrect formula $\frac{(n-1)180}{10}$.

Question 11

(a) A very large majority gave the correct answer. Weaker candidates made the common error of writing $\sqrt[3]{27} = 9$ and a few calculated $4^2 = 8$.

(b) Many candidates gave the correct answer. Many others were awarded the partial mark for reaching the answer 5^2. A few were awarded the method mark followed by an incorrect evaluation. Some evaluated $5^3 = 125$ but dealt with 5^{-1} as multiplying 125 by –5 then giving the answer as 625 or –625. The weakest candidates did not seem to know how to do this question.

Question 12

(a) Nearly all candidates measured the line accurately but most were unable to convert this to an actual distance in kilometres. Most just used the scale to give the distance in centimetres 9 × 20 000 = 180 000 and hence scored the partial mark. A few who did attempt to convert often used an incorrect conversion method, for example 9 × 1000 or 180 000 ÷ 1000.

(b) A good proportion of candidates were able to construct the perpendicular bisector of the line *AB*. Some could draw the line in the correct position but did so without using a compass and were only awarded a partial mark. Some had no understanding of the requirement of the question and many incorrect lines were drawn somewhere on the diagram.

(c) A majority of the better candidates were able to mark the position of *S* accurately on the scale drawing. Most others did not. Some candidates plotted a path for *S* that was on the correct bearing but not at the correct distance. Many varied and seemingly random incorrect positions for *S* were seen.

Question 13

This question was answered very well with clear working shown. The majority of candidates gave the correct answer. It was common for some of the weaker candidates to start correctly with $\frac{8}{5} \times \frac{3}{5}$ but calculate the answer incorrectly, for example $\frac{24}{5}$, or to start incorrectly and multiply $\frac{8}{5} \times \frac{5}{3} = \frac{8}{3} = 2\frac{2}{3}$.

Question 14

(a) This question was answered very well and a large majority of candidates gave the correct answer. A few found factors of 36 or made an error in their factor tree/ladder method.

(b) Candidates found this question quite difficult. The correct answer was usually given by better candidates only. Most tackled the problem by listing times. The few who used the LCM method usually found the correct final answer. Working was often disorganised with times for the two buses often written randomly all over the workspace rather than in separate lists for each bus. Many errors in calculating times were made and hence the common time of 11 54 was not found. Some candidates listed times for both buses beyond 11 54 without realising they had bypassed the correct answer and then gave up. There were several common errors; some just found the next time for each bus, some added 36 + 48 = 84 minutes and then added 1 hour 24 minutes to 9 30, whilst some found the mean $\frac{36+48}{2} = 42$ minutes hence giving the answer 10 12.

Question 15

(a) Many candidates found the correct angle. There were many different incorrect answers but the most common were 38° and 90°.

(b) Many candidates found the correct angle and there were many different incorrect answers, a common one being 2 × 38 = 76°.

(c) This part was slightly more successful with many candidates applying the circle theorem 'angle at the centre is twice the angle at the circumference' to find the correct answer or the correct follow through answer.

Question 16

Relatively few candidates scored full marks in this question and these tended to be the higher scoring candidates overall. Many were able to draw the pairs of vertical and/or horizontal lines and some could draw the sloping line and hence scored 1 or 2 marks and occasionally 3 marks. Many candidates only drew one of the vertical and/or horizontal lines and drew the sloping line from (0, 1) with an incorrect gradient, sometimes horizontal. Some candidates drew the horizontal and vertical lines the wrong way round. A few candidates thought, for example, $2 \leqslant y \leqslant 3$ meant they needed to draw the horizontal line through the middle, at $y = 2.5$. Others interpreted this as drawing a line from 3 on the y-axis to 2 on the x-axis or vice-versa. Similar errors were made for $1 \leqslant x \leqslant 3$, for example joining (0, 3) to (1, 0) or joining (0, 1) to (3, 0).

Question 17

The majority of candidates answered this question well. Many were able to score a method mark for using their incorrect value for k correctly in $k \times \sqrt{25}$; for example, a few reached $2 = 4k$ then slipped up and wrote $k = 2$. A common error was to forget to square root 25 and evaluate *their* $k \times 25$. Other errors were made by those who did not set up the correct statement for the proportionality, often just using direct proportion or writing $y = kx^2$. Some of the weakest candidates did not know how to tackle this question, sometimes just evaluating $\sqrt{16}$ and/or $\sqrt{25}$.

Question 18

(a) Few candidates scored full marks. Many scored a partial mark for four correct placements (usually 6, 9, 5 and 3). Many others just omitted the 1 remaining member who did none of the activities. Candidates should not place the numbers 22, 24 and 14 inside the circles for run, cycle and sail; they can be placed by the respective letters outside the circles, preferably $R = 22$ for example. It was very common for only 3 numbers to be placed correctly, but this was insufficient.

(b) Many of the better candidates were able to use the correct set notation to describe the shaded region. Many others had a good idea of what was required but were unable to write the answer with the correct notation, for example $(G \cap H)F'$ or $(G \cap H) \cup F'$ were common. A very common incorrect answer was $G \cap H$, excluding F completely.

Question 19

(a) This question was answered very well with the majority finding the correct acceleration. The most common incorrect answer was 20, others included finding the area of the triangle as 100, writing $D \times T = 20 \times 10 = 200$, $\frac{1}{2}$ or –2.

(b) The majority of the better candidates found the correct value of *T*, but others struggled. Both methods of using the full area of the trapezium or splitting the area into a triangle and rectangle were seen. Some just found the correct area of the triangle. Some were confused with the labelling of the dimensions and set up the area as $\frac{1}{2} \times 10 \times 20 + T \times 20 = 700$ which led to $T = 30$. Some recovered, realising they had found the length of the rectangle rather than the final value of *T*. However, most candidates did not know the area under the graph represented the distance travelled and used the incorrect method $T = \frac{D}{S} = \frac{700}{20} = 35$, which was not awarded any marks.

Question 20

(a) Many fully correct answers were found. Many others were awarded a partial mark for $\begin{pmatrix} 3 & -1 \\ -4 & -2 \end{pmatrix}$ or for $-\frac{1}{10}\begin{pmatrix} \dots & \dots \\ \dots & \dots \end{pmatrix}$. Some candidates omitted $-\frac{1}{10}$ while others wrote $\frac{1}{10}$ or miscalculated the determinant. A number of candidates swapped the signs or moved the elements incorrectly in matrix **A**.

(b) This was answered well. The majority gave the correct answer and many were awarded the partial mark having made an arithmetic slip. An error made by some was to multiply the four elements in matrix **A** by the corresponding four in matrix **B** leading to $\begin{pmatrix} -6 & 2 \\ -4 & 3 \end{pmatrix}$.

Question 21

(a) This question was answered very well with a large majority of candidates able to expand the bracket correctly.

(b) The majority of candidates were able to factorise the difference of two squares. Errors made were very varied rather than common errors.

(c) The better candidates knew they needed to factorise both the numerator and denominator and usually did so successfully, giving the correct answer. Many scored a partial mark for correctly factorising the numerator and leaving the denominator either unchanged or as $2c(c - 5) - 12$ for example. By far the most common error made by weaker candidates was to cancel $2c^2$ from the numerator and denominator leaving $\frac{-8c}{-5c - 12}$ as the answer, or going further and cancelling the *c*'s also or the 8 and 12.

Question 22

(a) This part was answered very well and the majority of candidates gave the correct answer.

(b) Many candidates found the correct inverse function. It was very common for many to start correctly with $y = \frac{x}{4} + 3$ or $x = \frac{y}{4} + 3$ but then forget to multiply the 3 when multiplying throughout by 4, leading to the incorrect answer of $4x - 3$.

(c) Only a minority of candidates were able to find the correct value for *p* as most were unable to set up the correct initial equation. Some candidates got as far as $g(p + 5) = 2((p + 5) - 1)$ then wrote this as $-2p - 10$, multiplying by the –1. However most candidates were not able to write the correct expression for $g(p + 5)$. Those who had made an attempt to write an equation of the form '$\frac{p}{4} + 3 =$ an attempt at $g(p + 5)$ using 5 and –1' could have been awarded a method mark if they could follow through correctly to isolate the terms in p. Some were awarded this mark but many equations did not have the left-hand side correct. As in the previous part, some errors were made when multiplying throughout by 4; as before, the 3 was not multiplied.

Question 23

(a) The majority gave the correct answer were given for this part. A common error was **a** – **c**.

(b) Few candidates gave the correct answer. Candidates seemed to not understand the meaning of 'position vector'. The large majority had the misunderstanding that the answer was just $\frac{1}{2}\overrightarrow{AC}$ and wrote $X = \frac{1}{2}(\mathbf{c} - \mathbf{a})$ which did not score. Weaker candidates did not score any marks in this part and some did not attempt it.

(c) A small minority were able to give the correct answer. Some candidates were able to give a correct vector route e.g. $\overrightarrow{YA} + \overrightarrow{AX}$ or $\overrightarrow{YB} + \overrightarrow{BC} + \overrightarrow{CX}$ but then could not proceed to give the correct final answer as they had made sign errors, slips in arithmetic or did not simplify their expression. As in the previous part, weaker candidates did not score any marks and some did not attempt it.

Question 24

Candidates made a good attempt to solve the equation and many correct solutions were given. Many others were able to write the fractions over a common denominator and scored partial marks. A few slips were made when expanding the brackets. A common error when expanding $3(x - 1)(x + 1)$ was to think this was equal to $3x - 3 + 3x + 3$. Others knew it was $3(x^2 - 1)$ but then expanded this as $3x^2 - 1$. When expanding the numerator $3x(x - 1) - 2(x + 1)$ a common error was to write the last term as $+2x$ rather than $-2x$.

MATHEMATICS D

Paper 4024/12
Paper 12

Key messages

To do well in this paper, candidates need to

- be familiar with all the syllabus content
- be able to carry out basic calculations without a calculator
- understand and use common mathematical terms and notation
- be able to draw and interpret graphs and diagrams
- set out their work in clear, logical steps.

General comments

Most candidates were prepared for many of the topics on the question paper and had time to attempt all questions. In general, working was well presented with answers written clearly on the answer line. The topics that offered the most challenge to candidates were transformations, matrices, vectors and arc lengths. As in previous sessions, candidates found those questions that required an element of problem solving more challenging than those that were in a familiar style.

It is important that candidates read each question carefully and make sure their answer meets the requirements of the question. For example, some candidates gave an answer as a fraction when the question asked for a decimal or gave an answer as a value when the question asked for an expression. If the question asks for a result to be shown, the working should lead to the result given in the question rather than starting by using the required result.

In a non-calculator paper, it is important that candidates have sound arithmetic skills and more practice using non-calculator methods would be beneficial to all. Errors were seen in simple multiplications such as 9 × 5 and simple subtractions such as 96 – 45. Candidates often made errors when calculating with negative numbers and decimals.

Comments on specific questions

Question 1

(a) Many candidates multiplied the decimals correctly. Incorrect answers usually involved the figures 15 with incorrect place value for example 0.0015, 1.5 or 15.0 .

(b) Some candidates divided the decimals correctly. Incorrect answers usually involved the figure 3 with incorrect place value for example 30 or 300.

(c) Many candidates used the correct order of operations to find the correct answer of 14. The most common error was to carry out the operations from left to right, (20 – 12) ÷ 2 with the answer 4.

Question 2

Those candidates who started by splitting the shape into 21 equal small squares usually gave the correct answer of $\frac{5}{21}$. It was very common for candidates to ignore the sizes of the squares and identify 2 shaded squares and 10 unshaded squares leading to an answer of $\frac{2}{12}$ or $\frac{1}{6}$.

Question 3

(a) Many candidates identified that they needed to find the difference between the two given numbers and halve it to find the required value. Candidates who attempted to calculate the mean of the two values often made errors. A more successful approach was to convert both values to the decimals 0.6 and 0.68, and then to use inspection to find the decimal halfway between these values. The question required the answer to be given as a decimal, and some candidates found a correct value but gave the answer 64% or $\frac{16}{25}$ rather than the correct decimal, 0.64 . Some candidates gave the difference, 0.04, as their answer.

(b) Many candidates wrote the number correct to three decimal places. The most common errors were to write the number correct to two decimal places or to include trailing zeros, giving the answer 4.07400 rather than 4.074 .

(c) Many candidates found the cube root correctly. Answers of 4^3 or $4 \times 4 \times 4$ are not acceptable in place of 4. A small number of candidates attempted to cube 64 or to find the square root of 64.

Question 4

(a) The numbers in the list were written in order, so it was straightforward to find the range. Many candidates found the difference correctly as 13, although some wrote the incorrect answer of –13. A minority of candidates did not evaluate the range and gave an answer such as –6 to 7. A common incorrect answer was 1, the result of 7 – 6 rather than $7 - {}^{-}6$.

(b) The correct answer of 3 can be found by identifying the middle two values in the list as –1 and *T* and understanding that the given median of 1 is halfway between these. Some candidates found it difficult to work with the median of an even number of values and others used mean in place of median. Those candidates that appreciated the values were written in order gave an answer in the range –1 to 5.

Question 5

This question was found to be challenging. Those candidates who used an algebraic approach and identified that the ratio 5:9 was equivalent to $x:x + 8$ often set up a correct equation and found the correct answer. Some solved the equation to reach $x = 10$ and gave that as their answer rather than finding the total amount of money as required. Another successful approach was to draw a block of 5 squares for Anna and a block of 9 squares for Ria which led to identifying that the difference of 4 squares was equivalent to \$8 so 1 square was equivalent to \$2. Common incorrect approaches involved dividing by 8 by 14 rather than by 4 or using the ratio $5:9 = x:8$.

Question 6

(a) Many candidates recognised the corresponding angles and gave the answer as 73°. The common wrong answer was 107°, indicating that candidates had not identified the angle on the diagram was acute.

(b) Many answers were correct or followed through from **part (a)** correctly by using their answer subtracted from 180. Some candidates gave the same answer in both parts, even though it was clear from the diagram that one angle was acute and the other obtuse.

Question 7

(a) The majority of candidates identified that the transformation was a rotation. Many identified that it was rotated through 90°, but some did not state that the direction was clockwise. It was common to either omit the centre of rotation or give an incorrect centre. A small number of candidates stated more than one transformation when the question asked for a single transformation.

(b) This question was challenging for many. Few candidates started by using the given information to write down that the scale factor of the enlargement was 3. Some drew rays from the given centre of enlargement $(5, 5)$ and this often led to a correct shape in the correct position. Some candidates drew a 3 times enlargement in the wrong position on the grid. It was common to see a 2 times enlargement of shape *A* drawn, often using an incorrect centre of enlargement. Many shapes drawn were not enlargements of shape *A*. Some candidates attempted a lengthy vector method involving transforming each of the coordinates of the vertices of shape *A* rather than using a graphical approach which was usually more successful.

Question 8

(a) Many candidates were able to write the number in standard form. The most common error was an incorrect power of 10, usually 4.93×10^3 rather than 4.93×10^{-3}.

(b) Many candidates completed the calculation correctly and gave the answer in standard form. The most common error was an incorrect power of 10, usually 8×10^9 or 8×10^{11}. A small proportion of candidates gave an answer with a negative power.

Question 9

(a) Most candidates wrote the correct product of primes. A small number made arithmetic errors in their factor tree or factor ladder, but most showed a correct method.

(b) This part was more challenging. Some candidates were able to identify the answer 5 by inspection using the information given in this part and their answer to **part (a)**. Others used much longer methods to reach the correct answer. The most common incorrect answer was 15, often the result of equating *N* with 180.

Question 10

Many candidates were able to round the values correctly to 1 significant figure, although some gave the answer as 400 rather than completing the calculation of $\sqrt{400} = 20$. The most common errors were to round 1240 to 1200 rather than 1000 and 11.2 to 11 rather than 10. Some candidates misunderstood the term 1 significant figure and corrected the values to a single digit, giving $\sqrt{\frac{1 \times 4}{1}}$. A small proportion of candidates attempted to work out the exact answer to the given calculation.

Question 11

Candidates should be aware that when solving an inequality, they must write an inequality on the answer line. Although many correct answers were seen, it was common to see the final answer given as 3 or $m = 3$ rather than m $\leqslant$ 3. Some candidates reversed the inequality when dividing and gave the answer $m \geqslant 3$.

Question 12

Candidates who equated coefficients were more likely to solve these equations correctly than those who used a substitution method. The most common error in the substitution method was to forget to multiply every term when eliminating the denominator in the rearranged equation. Those equating coefficients usually eliminated *y*, but some subtracted the two equations rather than adding them. Very few candidates checked their solutions to confirm the values were correct: this would help them to identify missing negative signs between the working and the answer line. Those candidates who had made an error when finding their first solution were often able to use this value correctly to find a pair of values fitting one of the starting equations.

Question 13

Many candidates were unable to identify an appropriate strategy to solve this problem. Some understood that the sum of all eight numbers is found using 8 × 12, the sum of the first five using 5 × 9 and the sum of the remaining three from the difference between these two values. The arithmetic was straightforward, but many errors were seen in either the products or the subtraction. Some candidates added the two products rather than subtracting. The most common incorrect answer was 3 from 12 – 9.

Question 14

(a) Many candidates measured the angle accurately. Some misinterpreted the meaning of angle *ABC* so measured all three angles in the triangle and gave their answer as 180°, the sum of these angles. Some candidates misread the scale on their protractor giving an answer greater than 90° when the angle can be seen to be acute.

(b) Many candidates constructed an accurate perpendicular bisector of *AC* although some did not extend it as far as the opposite side of the triangle. Construction arcs should be clearly shown. Some candidates drew an angle bisector or measured to find the midpoint of *AC* and then drew any line through this point.

(c) Some candidates drew a correct arc with centre *B*, but the radius was not always 6 cm. Some found the point 6 cm from *B* along line *AB* and drew a straight line from here to *AC* or to *BC*. Most candidates identified the correct side of the bisector to shade, but the boundaries of the region were often incorrect. Candidates should take care to identify the whole region required by clearly using the bisector rather than their construction arcs as part of the boundary.

Question 15

(a) Many candidates were able to interpret the information and identify the terms of the sequence. Some found the difference between the second and fifth terms as 28 – 16 = 12 but divided this by 4 or 2 rather than by 3 to find the common difference between the terms.

(b) This question was a challenge for the majority of candidates. Although some candidates identified that there was a common second difference of 4 between the terms of the sequence, few understood that this meant that the sequence was quadratic. It was common to see an answer of the form $4n + k$, the result of incorrect application of the second difference. Some candidates attempted to work out another term in the sequence rather than giving an expression for the *n*th term.

Question 16

(a) Most candidates gave the correct answer. Common errors were answers of 36, $\sqrt{36}$ or 6^2.

(b) Many candidates did not realise that the first step in the rearrangement is to square both sides, leading to $T^2 = P - 4$. Those who started with this step usually rearranged correctly to $P = T^2 + 4$. Common incorrect first steps were $T = \sqrt{P} - 2$, $T = P - 2$ or $T + 4 = \sqrt{P}$. Some candidates substituted values into the formula.

Question 17

(a) Many candidates plotted the points accurately and joined the points with a correct cumulative frequency curve. A significant proportion of candidates were confused about what statistical diagram was required. Some plotted the points correctly but drew a line of best fit through the points. Others drew a histogram with bar widths of 2 cm.

(b) Some candidates who had drawn a cumulative frequency diagram understood that to find the interquartile range they had to read the heights for the upper and lower quartiles from the graph and subtract these values. A common error was to identify the upper quartile as 60 and the lower quartile as 20 then subtract these to read the diagram at 40, thus finding the median. Another common error was to subtract the highest and lowest cumulative frequencies from the table, 80 – 4 = 76.

(c) Many candidates did not read the question carefully to see that 28 plants were **taller** than H cm. The most common error was to read the height for cumulative frequency 28 rather than for cumulative frequency 80 – 28 = 52. Those that identified 52 usually gave the correct answer although some misinterpreted the scale to give an answer of 6.5 cm rather than 7 cm.

Question 18

(a) Those candidates who understood that acceleration = speed ÷ time and related this to the gradient of the line usually found the correct answer. Some converted $\frac{6}{20}$ incorrectly to a decimal. The most common errors in the gradient calculation were $\frac{7}{20}$, $\frac{7+1}{20}$ or $\frac{7-1}{20-1}$. The most common misconception was to use acceleration = speed × time, leading to an answer of 120 or 140.

(b) Candidates found it difficult to interpret this speed–time graph showing the journeys of two separate cyclists. Many understood that distance travelled is equal to the area under the graph, but they were often unable to identify the area required for each cyclist.

Many calculated the distance for B correctly using 20 × 5 = 100. The distance for A was more challenging with errors such as $\frac{1}{2}\times 7\times 20 = 70$, $\frac{1}{2}\times 6\times 20 = 60$, 7 × 20 = 140 or 6 × 20 = 120 seen as often as the correct method $\frac{1}{2}(1+7)\times 20 = 80$. There was some confusion about what was required on the answer line, with some writing the distance travelled by A or B rather than the difference between the two distances.

Question 19

Many candidates demonstrated their understanding of how to use a common denominator with algebraic fractions. They often reached the correct answer of $\frac{9x+2}{16}$ but many went on to cancel this incorrectly to either $\frac{9x+1}{8}$ or $\frac{9x}{8}$. Those that used a common denominator of 16 throughout generally made fewer errors than those who attempted to combine two of the fractions before combining the result with the third, when denominators of 32, 64 and 512 were common. Some candidates made slips when expanding brackets such as $2(x+1) = 2x+1$ and others made sign errors from one line of working to the next.

Question 20

(a) Many candidates were able to correctly factorise the given expression. Some had difficulty with the negative terms and factorised to $2d(c-3)+e(c+3)$ and could make no further progress.

(b) This factorisation was found to be challenging. The answer $3(v^2 - 9t^2)$ was common when candidates recognised the common factor of 3 but did not recognise $(v^2 - 9t^2)$ as the difference of two squares. Some candidates factorised to $(v+3t)(3v-9t)$ but did not recognise the common factor of 3 in the second bracket. Common incorrect answers were $3(v-9t)(v+9t)$ and $3(v-27t)(v+27t)$.

Question 21

(a) This question was found challenging by most candidates and fully correct solutions were rare. Those who started with a correct equation often rearranged it correctly to reach the required solution of x = 20. Those who did not start by cancelling 360, π and y to simplify the equation often used very long methods that contained errors. Candidates who knew the correct formula for the length of an arc often used 6x rather than 360 – 6x for the angle of the major arc in diagram A.

Some candidates had learnt a formula for arc length using angles in radians and did not understand that, as the angles in the question were given in degrees, they first needed to convert from degrees to radians in order to use this formula.

It was common to see candidates attempting to work with sector areas rather than arc lengths or to start by substituting the value of 20 into a formula.

(b) Candidates had more success in this part than in **part (a)**. Some set up a correct equation $\frac{20\pi y^2}{360} = 2\pi$ using the value of 20 from the previous part and correctly rearranged to find $y = 6$.

Common errors in this part were to use the arc length formula or to use radius $\frac{3}{4}y$ rather than y.

Question 22

This question required candidates to solve a problem involving matrices and many candidates found this challenging and were unable to make meaningful progress.

(a) Some candidates were able to use their understanding of matrix multiplication to form the matrix equation $\begin{pmatrix} x(x-1)+3\times 2 \\ 2(x-1)+2(x+1) \end{pmatrix} = \begin{pmatrix} 2x+6 \\ y \end{pmatrix}$ and extract the top row which could be rearranged to $x^2 - 3x = 0$ as required. Some multiplied the two matrices correctly but did not know how to make any further progress. Some candidates ignored the matrix and attempted to solve the quadratic equation in this part.

(b) (i) This quadratic equation has a common factor, so the most straightforward method of solution is to take out the common factor leading to $x(x – 3) = 0$ and $x = 0$ or 3. Many candidates attempted to use the quadratic formula, but often had difficulty applying this to a two-term quadratic equation. Some candidates rearranged the equation to $x^2 = 3x$ then divided through by x, leading to the single solution $x = 3$. The answer of 3 was common, often the result of a trial-and-error approach.

(ii) Some candidates recognised that they needed to use the second row of the combined matrices, which had often been found in **part (a)**, to find the value of y. Those who had the correct solution in **part (b)** often then reached the correct answer here. Many seemed to not know where to start with this part and omitted it.

Question 23

(a) There was a lot of information given in this question and many candidates interpreted some of it correctly to position 2 in the centre of the Venn diagram. Some also identified that 4 people bought a scarf and gloves and positioned this correctly in the Venn diagram. Finding the values for the remaining two regions was much more challenging. Some found the correct value for gloves only as 16 but did not write 0 in the final region. However it was more common to have values with a sum of 16 in the remaining two regions, with no evidence to show how these values had been found.

(b) This part was also challenging with the incorrect answer of 1 seen as often as the correct answer of 10. This is perhaps from misinterpreting the Venn diagram and identifying that there is only one value in the required region. Some used incorrect notation and gave the answer n(10) in place of 10.

Question 24

(a) (i) Candidates with some understanding of vectors often gave the correct answer in this part, although some did not simplify the answer as required. The most common wrong answer was 7**a** + 2**b** the result of 3**a** + 2**b** + 4**a** rather than 3**a** + 2**b** – 4**a**.

(ii) Candidates are advised to write down a vector route for the required vector as a first step. Those who identified $\overrightarrow{OB} = \overrightarrow{OA} + \overrightarrow{AB}$ or $\overrightarrow{OB} = \overrightarrow{OP} + \overrightarrow{PB}$, for example, gained a method mark even if they were unable to make further progress with the question. Many candidates had difficulty interpreting the ratio *AP*:*PB* = 2:3 as $PB = \frac{3}{2}AP$ or $AB = \frac{5}{2}AP$ and denominators of 5 or 3 were more common than the correct denominator of 2.

(b) Few candidates answered this part correctly. The most common response was to copy the answer from **part (a)(ii)** demonstrating confusion between parallel vectors and equal vectors. Some candidates gave the answer $k\left(\frac{3}{2}\mathbf{a} + 5\mathbf{b}\right)$ when they knew there would be a multiplier, but they did not know how to find it.

MATHEMATICS D

Paper 4024/21
Paper 21

Key messages

Candidates should read the question carefully and take care to ensure they are answering the question and giving their answer in the required form (**Question 1(d)(i)**, **Question 3(b)(i)**, **Question 5(c)** and **Question 6(b)**).

Candidates should also take care in 'show that' type questions to show all their working clearly (**Question 1(d)(ii)**, **Question 6(b)**, **Question 7(c)**, **Question 9(a)(ii)** and **Question 10(a)**).

General comments

In some places, candidates gave an inaccurate final answer due to inappropriate rounding of intermediate results. Typically, intermediate values should be rounded to at least one more significant figure than given in the question. It is important that candidates retain sufficient figures in their working and only round their final answer to three significant figures if their answer is not exact.

Comments on specific questions

Question 1

(a) Most candidates gained full marks in this part. There were some answers where the number of people aged 18 and under were found, rather than those aged over 18. Candidates generally showed correct working and found this question a straightforward start to the paper.

(b) This question seemed to cause confusion among some candidates. This may have been due to the population that was given being only part of the total population, rather than the full population, as is often the case. Successful candidates tended to divide 890 by 5 to find the population of one part for the ratio first. Some candidates tried to use the population given in **part (a)**, others used the figures of 18 or 60 from the ages to try to find the required number of people.

(c) (i) Candidates tended to be more successful in this part. The common error here was to divide by 678202 rather than the initial population of 702800. Again candidates generally showed correct working and correctly remembered to multiply by 100 to find the percentage rather than leave their answer as a decimal.

(ii) This reverse percentage question, as is often the case, was a challenge for most candidates. Most candidates found either a 12 per cent increase or decrease of the population in 2015, which is an incorrect method. Candidates did not seem to realise that 12 per cent of the 2015 population is a different quantity to 12 per cent of the 1980 population. Those solutions which set up an equation stating that 112 per cent of the required amount is equal to 702800 then tended to be able to obtain the correct answer.

(d) (i) Most candidates were able to read the table correctly, perform the subtraction, and state the answer in standard form as required. The mark was not awarded if standard form was not used correctly. Although the answer had 4 non-zero significant figures, as this was an exact value all 4 of these figures should be displayed in the answer and not be rounded to 3 significant figures.

(ii) Roughly half the candidates were successful in this part. Note the question asks candidates to show how they decided on the highest population density, therefore the population densities of all 4 countries should be evaluated and shown. Also on the answer line the country, rather than the population density, should be stated.

Question 2

(a) (i) Again, roughly half the candidates were successful in this part. Common errors were to write $y = 2$, $y = 2x$, or just the answer 2 rather than $x = 2$ for the equation of the line.

(ii) Although most candidates drew a correct reflection in a vertical line, a significant proportion of these did not use the mirror line $x = 2$ as instructed. The use of tracing paper, which is allowed, can make reflection in a mirror line easier for candidates to complete.

(b) Again, tracing paper can make a question such as this easier for candidates to attempt. The 3 marks awarded can give an indication to candidates that 3 correct statements are required for full marks in this question.

Question 3

(a) (i) This question was a challenge for a large number of candidates. There were many attempts to rearrange the given equation. This was often done correctly, but candidates did not then always go on to state the gradient of the line as required by the question. Some candidates did not attempt to rearrange the equation and wrote down the given x coefficient of 1.

(ii) This part also caused confusion amongst candidates. Many found where the line crossed both the x-axis and the y-axis, and used the non-zero values in both of these coordinates as their answer. There were also sign errors in answers, and many candidates seemed to be unsure how to attempt this question.

(b) (i) Roughly a third of candidates were successful in this part. There were some attempts with sign errors, and a significant proportion of attempts seemed to be trying to find the gradient of the line rather than the length.

(ii) This was the most successfully attempted part of **Question 3**. Many of the candidates who did not achieve a fully correct equation of the line AB were still able to obtain partial marks by finding a correct gradient of the line. Some candidates found the gradient of the line and then decided to use the perpendicular gradient. Other candidates found the midpoint of AB and used this to find the equation of the line. Although this was not incorrect, it was unnecessary as candidates could use either point A or point B, which were both given in the question.

Question 4

(a) (i) Almost all candidates gained the mark in this part.

(ii) Roughly half of the candidates were successful here, with many finding the correct expression for the nth term of the sequence. Candidates were not asked to simplify their expression, so any correct expression gained full marks.

(iii) This part was found challenging by most candidates and successful solutions were rarely seen. Candidates did not realise they needed to use their expression from **part (ii)** and substitute k and $k + 1$ into this for n, then add the two expressions and equate to 703. Candidates should then solve the resulting equation to find the value of k. The most common error was to just write down $k + k + 1 = 703$ and to solve this equation, which gained no marks.

(b) This part was also very challenging for most. There seemed to be a lot of confusion amongst candidates who assumed the value for a in the expression for the nth term had the value 3. Another incorrect assumption was that the sequence was linear, despite the expression for the nth term being of a quadratic form. Correct solutions saw candidates substitute 1 in for n to find an expression which was equated to 3, and also substitute 3 in for n to find an expression which was equated to 19. Candidates should then solve the resulting simultaneous equations for a and b, which meant they could then find the sixth term of the sequence.

Question 5

(a) (i) Approximately two thirds of candidates could use the timetable correctly to find the time required. It was hoped that this question would be accessible to the majority.

(ii) Only about one third of candidates answered this question correctly. Of the incorrect answers, there were a large number which gave a time of arrival at the airport which did not match any of the times given in the timetable. It seemed candidates were not generally familiar with how a timetable is used.

(b) (i) The most common error in this part appeared to arise from candidates not being able to read the vertical axis correctly. Candidates generally drew a vertical line at 30 minutes, although a small minority appeared to be drawing a line at 28 minutes instead.

(ii) As in **part (b)(i)**, it seemed the most common error here was in reading the scales incorrectly, here on the horizontal axis. Candidates generally understood how to find the interquartile range, but calculations such as 58 – 28, rather than 54 – 24, were frequently seen. Another common error was to show the upper quartile was at 120, the lower quartile was at 40, but then incorrectly find 120 – 40 = 80 for the interquartile range.

(iii) This part was attempted much more successfully. Those candidates who still showed difficulties with the scales were often able to achieve a mark based on the correct calculation of a percentage within an acceptable range.

(c) As expected, this part was the most demanding part of **Question 5**. Candidates who were unable to fine the correct bounds for the question were still able to achieve a method mark for finding an average speed in kilometres per hour, provided their distance and time were in an acceptable range. Common errors came from not attempting to find a bound for the distance or time, or failing to convert the time in minutes to a time in hours.

Question 6

(a) Less than one third of candidates were able to find an expression for *BC* in terms of *x*. It was expected that as candidates were told the area of the rectangle was 30 and one length was *x*, candidates would be able to find the other dimension using area divided by length.

(b) Understandably, given the difficulty candidates found with **part (a)**, this part was challenging for a large proportion of candidates. Candidates found it difficult to apply their knowledge of area to this problem involving algebra and area. Some candidates seemed to think they had to try to solve an equation rather than use the diagram to find an expression for the shaded area, as the question asked.

(c) Candidates seemed well prepared to find the missing value in the table using the given equation. Approximately 75 per cent of candidates were able to do this successfully.

(d) Again, candidates were well practised in plotting points and joining them with a smooth curve. The vertical scale was more challenging, but most candidates were able to plot and draw the graph within the acceptable tolerance.

(e) This part was expected to be challenging for candidates. Many candidates did not realise the question was connected to the graph they had just drawn. However, even those candidates who found a dimension unrelated to the graph could still achieve 1 mark by ensuring that their values gave an area of 30 for rectangle *ABCD*.

Question 7

(a) Many candidates gained both marks here. For those who did not, a common error was in linking the negative signs with the wrong terms.

(b) Again, in this part, roughly 80 per cent of candidates gained both marks. For those candidates who did not, most correctly expanded the brackets, but then when finding –9 + 10, gave the answer as –1 rather than +1.

(c) About half the candidates were successful in this part. Most were well prepared in showing all their working as required. Common errors were wrong signs in the formula, and a surprising number of solutions wrote –(–2) at the start of the formula on the first line which inexplicably became +4 on the second line. The majority chose to use the quadratic equation formula rather than completing the square, and were usually successful in doing so.

(d) (i) Candidates coped well with dividing the algebraic fractions here, roughly $\frac{3}{4}$ of answers were correct.

(ii) Despite this question being of a higher demand than some of the earlier work, candidates were well practised in this type of algebra and often gained full marks. The most common error was not considering the double negative when expanding the second bracket.

Question 8

(a) (i) Roughly two thirds of the candidates gained the mark in this part. Note the instruction to 'write down' the mode ought to lead candidates to realising it could be found just by looking at the table.

(ii) Just under half the candidates found the median incorrectly. Again, the instruction to 'find' the median should lead candidates to realise some thinking was needed, but no calculation was necessary.

(iii) Just over half the candidates found the mean correctly. The instruction here is to 'calculate' which should lead candidates to realise some calculator work was necessary here. As the answer to the mean is exact, it should be left as 1.95 rather than rounding to 2.

(iv) Approximately half of the candidates could answer this part correctly. A small proportion correctly showed the probability correctly as $\frac{6+2}{40}$, but went on to calculate this incorrectly as $\frac{10}{40}$.

(b) (i) Possibly due to the lack of a given tree diagram, this part was found difficult by a large proportion of candidates. Common errors were to assume the question was without replacement, or to add the probabilities rather than multiply them. Some candidates thought the probabilities were $\frac{1}{7}$ and $\frac{1}{3}$ rather than $\frac{7}{10}$ and $\frac{3}{10}$. Another common error was to find the probability that the first book is fiction and the second book is non-fiction and not consider the reverse order, which could still gain 1 mark by candidates.

(ii) Again, many candidates found this part difficult, possibly due to a lack of a tree diagram. Common errors were to have probabilities of $\frac{1}{7}$ and $\frac{1}{3}$ again, assume the probabilities were with replacement, and again to add the probabilities rather than multiply them. Candidates did not seem concerned if their method gave a probability of 1 or even a probability greater than 1.

Question 9

(a) (i) Roughly half the candidates were successful in this part. Even those candidates who seemed to not know how to find the volume of the triangular prism were able to gain a mark by completing the units of volume correctly.

(ii) Although a large proportion of candidates understood the need for the use of the sine method for the area of triangle *ABC* to find the value of *AC*, in a 'show that' question of this type, candidates should find the answer to at least one more significant figure than that required in the question.

(iii) A good proportion of candidates understood how to calculate the surface area of the prism, but many did not appreciate the need for the cosine rule in calculating length *BC*. A very small proportion of candidates used the cosine rule to find length *BC* together with a correct calculation of all five faces of the prism.

(b) The key to this question was to find the length of one edge of the square base of the cuboid. Candidates often calculated 98 ÷ 8 to get an answer of 12.25, but did not realise this was the area of the square base rather than the length of one edge. Candidates often realised this edge was then used in Pythagoras to calculate the length of *PQ*, but often Pythagoras was used only once and in 2 dimensions, rather than twice or in 3 dimensions.

Question 10

(a) This question proved very difficult for most candidates. Most did not understand how to prove that two triangles are congruent to each other. There were a number of approaches that could be taken here. For example, candidates could say angle *AOB* equals angle *DOC* as they are opposite angles. Then *OA* equals *OD* as both are radii. Then *OB* equals *OC* as both are radii. And finally, triangle *OAB* is congruent to triangle *ODC* by SAS.

(b) As expected, this question was very challenging for most candidates. The main issue was that candidates seemed to not realise the need to find angle *BOC* or an equivalent angle. The use of trigonometry in finding a required angle was essential in this question to gain any marks. Candidates could use right-angled trigonometry or the cosine rule to find an angle, but assuming the size of an angle did not lead to any marks being awarded.

MATHEMATICS D

Paper 4024/22
Paper 22

Key messages

Inaccurate final answers were seen when candidates rounded calculations before the next stage of the working. Candidates should keep the full value on their calculator within multi-step methods until the final answer. Candidates should also be aware that questions involving money should be given correct to the nearest cent. Candidates should note that when directed to use a particular method within a question, for example **4(b)** and **4(c)**, then that method should be used.

General comments

All candidates were able to access some marks on the paper and there was also some excellent work shown by candidates.

The following topics were generally answered well.
- Interpreting a pie chart
- Drawing a histogram
- Solving a linear equation
- Simple probability and expected values
- Drawing an exponential graph
- Standard work with functions

The following topics were found more challenging.
- Angles and geometrical reasoning
- Interpreting the roots of a quadratic graph
- Work involving perpendicular lines
- Bearings and trigonometry
- Multi-step extended trigonometry
- Mensuration involving cones
- Problems involving bounds

Comments on specific questions

Question 1

(a) (i) Around three quarters of the candidates worked out the correct charge for the repair. The most common wrong answer was 112 obtained by doubling the charge for the first hour. A surprising number had the correct method of 56 + 49 but did not evaluate it correctly.

(ii) This part of the question proved to be more challenging with just over a half finding the correct time the repair was completed. Various approaches were seen with some choosing to find the length of repair as 3.25 hours and then attempt to add this to the start time. A misunderstanding was sometimes seen when candidates used 3.25 hours as 3 hours 25 minutes, so a common wrong final answer was 4.55 pm. Some candidates worked out the length of time after the first hour as 2.25 hours but then forgot to add on the first hour so gave 4.45 pm as the time the repair was completed. The previous answer was used by some candidates but not all of these added the needed 2 hours either to the start time or to the length of time.

(b) Under half the candidates calculated the correct total amount of interest. Many of the candidates used the compound interest formula correctly but stated the amount in the account at the end of 4 years rather than the interest. Some candidates chose to work out the interest each year but that often led to errors due to premature approximation. The most common error was to calculate the simple interest.

(c) More success was seen in the last part of the question. Errors included not giving an answer in dollars or giving an inaccurate answer due to premature rounding. Candidates often correctly converted €760 into dollars and then calculated the tax rather than the amount paid including the tax. Some chose to calculate the tax first and then found the amount in dollars of the tax. Misunderstandings of multiplying by 0.84 or dividing by 0.025 were not uncommon.

Question 2

(a) (i) The answers given here were mixed. Almost all the candidates who answered this correctly approached it by calculating the angle sum of the polygon and then divided this by 15. A significant number of candidates could not recall the method to find the interior angle sum of a polygon. The most common incorrect answers were to give the exterior angle of 24° or to give the interior angle sum of 2340°. A significant number of candidates did not attempt this question.

(ii) This question required candidates to use their answer from the previous part and to relate the triangle in the diagram to the polygon and to appreciate that it was isosceles. Under a third of the candidates arrived at the correct answer. One of the more common incorrect answers was 156°, usually following an answer of 24° for the previous part. Some candidates recognised the base angle of the isosceles triangle was 12°, but then did not go on to find the required angle. A significant number of candidates did not attempt this question.

(b) This question required candidates to use circle theorems to find an angle and to give geometrical reasons for their answer. Only a quarter of the candidates gained full marks on this question. Many candidates earned partial marks for either giving the required angle as 114° from a correct method or recognising that angle *ACB* was 90°. Some candidates arrived at an answer of 114° but did so by incorrectly assuming that angle *ACB* was 24°. The geometrical reasoning required to justify the angles lacked precision and most did not use the required mathematical vocabulary. Common errors in the reasoning for angle *ACB* being 90° was that it was a right-angled triangle or 'from a diameter'. For the reasons associating angle *ABC* with angle *ADC*, the correct justification of 'angles in opposite segments' or 'opposite angles of a cyclic quadrilateral are supplementary' was required. For most the appropriate language was not used, and candidates should use the correct mathematical language given on the syllabus in their reasoning.

Question 3

(a) (i) This was well answered by many candidates. Incorrect answers were often a result of confusion of how to apply the ratio between the angle and the number of people, multiplying rather than dividing resulting in an answer of 540. Other wrong answers included 150, the number of people not running.

(ii) The most common method seen to answer this question was to work out the missing angle and then simplify $\frac{75}{360}$. Most candidates realised the need to give a simplified fraction and unsimplified fractions or decimal answers were rare. Having just worked out the total number of people in the previous part, some used the method of the number of people rather than the number of degrees. As this method depended on correct working in the previous part, candidates who used this method had less success.

(b) (i) Most candidates attempted to draw an accurate histogram, with any inaccuracies usually being the height of the last bar. Those who did not get the correct diagram had not usually understood how to find the correct frequency densities; for example, some used the class width for the bar height.

(ii) This was found to be very challenging with around a tenth of the candidates answering correctly and a significant number not attempting this question. Many candidates did not understand that the required percentage related to the number of days and tried to use the 11 000 steps in their calculation. Those candidates who knew they should be looking for the number of days on which that target was achieved made some progress, however they often chose the incorrect number of days to sum. As a result, incorrect answers of $\frac{4+15+6}{60}$, $\frac{7}{60}$, $\frac{14}{60}$ and $\frac{14+15+6}{60}$ were often seen.

Question 4

(a) Over three quarters of the candidates gave the correct response in this part. The most common error was not to deal with the isolation of the x terms correctly leading to $5x - 3x = 6$. Some candidates obtained the correct answer of –3 in their working but then gave the final answer as 3 in the answer space.

(b) Candidates who were able to form the correct equation from the given information were usually able to correctly solve it. Some candidates did not form any equation in n but a number of these were able to deduce the correct answer from the given information to earn partial marks. The most common error was to miss a term or incorrectly collect terms, for example forming the equation $n + 2n + 50 = 450$ or giving $2n + 50$ as $52n$.

(c) This question required candidates to solve a quadratic equation by factorisation. A number chose to solve by use of the quadratic formula and no credit was given for using this method. Those that factorised usually gave the correct factors and expressed them as a product before giving the correct answers. A few made sign errors and gave $(x + 7)(x - 3)$. A significant number of candidates attempted to factorise using grids and never expressed the factors as a product; although they often scored partial credit it should be noted that when the factors are found they should be expressed as a product $(x - 7)(x + 3)$ before giving the solutions.

Question 5

(a) (i) Around three quarters of the candidates answered this correctly. Some seemed to get confused over replacement and gave the answer as either $\frac{11}{40}$ or $\frac{11}{39}$, while others gave the answer as 12 for the number of green balls and not the probability that the ball was green.

(ii) Slightly less were able to find the number of times she expected to take a green ball. There were a surprising number who produced impossible answers over 200, often $12 \times 200 = 2400$. Some who did not get a correct probability in the previous part then started again and were able to get the correct number of times she expected to get a green ball.

(b) (i) Many candidates completed the tree diagram with the correct probabilities. The first branch of the tree was usually correct along with the $\frac{6}{15}$ on the next branch. Less success was had with the middle two probabilities for the second ball. It was not uncommon to see denominators of 16 and 14 for the second ball or to see the probabilities on the top branch for the second ball being the same as the probabilities for the bottom branch.

(ii) The correct probability was given by half the candidates. Many candidates knew that a product of probabilities was needed but not all realised that there were two routes that could be taken. A few candidates chose to add rather than multiply the probabilities. A considerable number did not answer this part of the question.

Question 6

(a) (i) The majority of candidates were able to correctly complete the table although a few had difficulty with the value of 4^0: some gave the answer 0, others left it blank and a small number gave 0.4 as the answer.

(ii) The points for this graph were usually plotted accurately, but the value $(0, 0.1)$ proved the most difficult, partly due to errors in the table but others tried to ensure their graph went through the origin. Examiners require candidates to plot the points within $\frac{1}{2}$ small square of the correct position in order to award the plot marks.

(iii) Candidates were required to work within a tolerance of ± 0.25 of their reading where the line $y = 5$ crossed their graph, and some were not accurate enough with their answers. Some candidates misread the scale using each small square as 0.1 and some incorrectly attempted to solve the equation $\frac{4^x}{10} = 5$ and gave an answer of 12.5 from 50 ÷ 4.

(iv) There was a mixed response here with under half of the candidates drawing an accurate tangent and giving an acceptable gradient. Many candidates did not attempt to draw a tangent. A common misconception was to give an answer of 1.6 which was the *y*-coordinate at $x = 2$. There were some candidates that attempted to draw a tangent but were inaccurate; the candidates should aim to make sure their ruled line touched the curve at $x = 2$ only when drawing.

(b) Only a fifth of the candidates gave the correct values for *a* and *b*. The majority of these candidates realised that the most efficient way to express the curve as a quadratic was to use the roots from the sketch in the form $y = (x - 2)(x - 5)$. The majority of the candidates that attempted this question substituted $x = 2$ and $x = 5$ into the given equation, but many of them did not use $y = 0$ and were unable to obtain answers for *a* and *b*. Some candidates used only one of the roots and so did not progress far. A quarter of the candidates did not attempt this question.

Question 7

(a) (i) The majority of the candidates selected one correct position for *C*, but only half of them managed to get both of them. The point $(6, 1)$ was more likely to be selected than $(-2, -1)$. Few candidates used the grid to check if the triangle was isosceles.

(ii) The majority of the candidates gave a column vector with components 5 and 3, however common errors were to have these the wrong way round or have minus signs on one or both of the components. Occasionally candidates used the coordinates in the column vector or even as a matrix.

(iii) Few candidates realised that $\overrightarrow{DB}$ was twice $\overrightarrow{AB}$ or that *DB* would be twice as long as *AB* and so did not utilise the previous part or the diagram to calculate the required length. Instead, candidates tried to find the coordinates of *D* but often found the midpoint of *AB*. A quarter of the candidates made no attempt at this part of the question.

(b) This part was exceptionally challenging and it was rare to see correct answers. Many did not state the gradient of line *L* as $-\frac{1}{4}$, with many working with a gradient of 4. Substituting $(6, 4)$ into their equation seemed more familiar. Where a correct equation for line *L* was seen, few candidates knew how to proceed as they did not realise that a point on the *x*-axis would have coordinates $(x, 0)$. As with the previous part, about a quarter of the candidates made no attempt at this part of the question.

Question 8

(a) Those that were most successful in this part equated the product of the inner rectangle's width $x - 6$ and length $4x - 6$ to the given area of 80. These candidates were usually able to correctly rearrange the equation into the required form. Candidates should note that in questions like this that ask to show a particular result, every step of the working must be shown and that there must be no omissions once the equation has been set up. For many candidates, setting up an initial equation proved difficult and expressions such as $(x - 3)(4x - 3)$ or $4x \times x$ were occasionally seen. Those who attempted to work with the area of the shaded section were fewer and considerably less successful. A substantial number omitted this part of the question.

(b) Candidates who chose to use, and were able to recall, the quadratic formula usually did well in this part of the question. A few could not recall the correct formula and some others attempted to factorise. The most common errors amongst those using the correct formula had -15 in the numerator instead of $-(-15)$ or similarly 22 instead of -22. Candidates should note that brackets are needed when squaring a negative number as -15^2 was frequently seen without a recovery to 225. For the solutions, most rounded correctly although the truncated values of 8.75 and -1.25 were not uncommon.

(c) The candidates that used the method 4× (their positive x value)^2 – 80 were the most successful here. Most of the candidates that struggled on this part of the question did not relate their previous solution to the shaded area and attempted simple calculations involving multiplication or addition of 3's or sometimes 4's. A considerable number of candidates made no attempt at this part.

Question 9

(a) (i) Most candidates made some progress with this question. The majority of candidates used the formula $s = \frac{d}{t}$ but not all were able to use the correct conversion to minutes with several dividing by 60 instead of multiplying. Many who knew the correct conversion did not give their answer to the nearest minute. Other common errors included using half of the perimeter or using the incorrect formula for speed, for example $s = \frac{t}{d}$.

(ii) Candidates found this question difficult and it was one of the most omitted question on the paper. Some candidates did not use the most direct route, first finding the hypotenuse and then using either sine or cosine rather than using tangent directly. This often led to inaccurate answers. Other inaccuracies resulted from calculating more angles than necessary, for example calculating the bearing of *B* from *A*, angle *CAB* and angle *DAC*. Candidates need to identify angles using the three-letter format to make it clear the method they are using. Candidates who made their method clear often approximated their values too soon rather than arriving at a value for the bearing of *D* from *A* to more than 3 significant figures before showing it rounds to 245°. It was common to see candidates give answers which involved no use of trigonometry.

(b) Just under a third of the candidates were able to calculate an accurate value for the length *QS*. Candidates did not always use the cosine rule in the most useful format for finding a side and this sometimes resulted in incorrect rearrangements or inaccuracies. Several candidates made some progress by correctly calculating *PQ* or *PR*, however, not all were then able to proceed correctly as assumptions were made. Assumptions included assuming that either triangle *PQS* or *QRS* was isosceles. Candidates who attempted solutions but made no progress often assumed *PQR* was a right-angled triangle or thought that *QS* could be calculated directly through use of the sine rule. Candidates should be aware that a question that is worth 5 marks will be a multi-step question.

Question 10

(a) (i) The majority of candidates found the correct volume for the larger cone but many did not show working to justify the radius of the smaller cone as 6 cm. Some candidates evaluated their volumes to a decimal rather than leaving them in terms of π to establish the given result. A small number attempted to find and use the slant height of the cone within the volume formula for this part.

(ii) This part was well answered by the more able candidates with clear structured working shown. Some candidates having found the curved surface areas subtracted them rather than added them, with many assuming that the total surface area could be found by subtracting the total surface area of the small cone from the total surface area of the large cone. Weaker candidates often used the vertical heights instead of the slant heights to find the curved surface areas but often gained credit for the shaded area on the diagram. This was one of the most omitted questions on the paper.

(b) This part was challenging for most and a minority of candidates gave the correct answer. Many candidates gained partial credit for considering the value 13.5 or 4.55 in their working. It was common to see candidates using the wrong formula for the volume of a cylinder, for example, $\frac{1}{3}\pi r^2 h$, $2\pi r^2 h$, $2\pi rh + \pi r^2$. A number attempted a calculation with 4.5 and 13 and then tried to add or subtract 0.5 or 0.05 in an attempt to deal with the bounds. Again, a large number of candidates omitted this question.

Question 11

(a) A large proportion of the candidates got this part correct. Occasionally mistakes were made with the minus sign.

(b) Over half the candidates were able to give the correct expression for the required inverse.

Common mistakes were an incorrect first step of $y - 3 = 2x$, writing the answer as $\frac{y+3}{2}$ or thinking the reciprocal of $g(x)$ was required.

(c) This question required candidates to replace $f(x)$ and $g(x)$ in the expression and write this as a single fraction before simplifying. Most of the candidates were able to get as far as either writing the expression as a single fraction with a common denominator or two fractions with the same common denominator. Having obtained the correct unsimplified single fraction some candidates then made errors by cancelling, for example, cancelling $4x + 1$ from the numerator and denominator, or made errors in the expansion of the numerator. Other errors included a common denominator of $2x + 3 + 4x + 1$ or not substituting $f(x)$ and $g(x)$ and so leaving their answer in terms of these functions and not in terms of x.