MATHEMATICS SYLLABUS D

Paper 4024/11
Paper 11

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 correct mathematical terminology
- draw accurate graphs and diagrams
- apply mathematical techniques to solve problems
- set out their work in clear, logical steps.

General comments

Many candidates produced well-presented scripts of a good standard. Most candidates appeared to have sufficient time to complete the paper.

Many candidates performed well on the straightforward algebra questions but found the cumulative frequency and problem-solving questions challenging.

Candidates should take care to present work carefully and should ensure that all written numbers can be clearly distinguished. They should cross out and replace work if they have made errors rather than overwriting as this cannot be read clearly.

Candidates are to be reminded to think about giving answers that are sensible within the context of the question.

Comments on specific questions

Question 1

(a) Many candidates were unable to gain credit for their answer; often including N in their list of letters or omitting either A or T.

(b) Many candidates had difficulty with this question often including incorrect letters in their list e.g. G and R.

Question 2

Many correct responses were seen. Some made an error in their subtraction and some did not attempt to convert their answer in kilograms to grams or converted incorrectly.

Question 3

(a) Most candidates gained credit for their answer. The most common wrong answer was .06.

(b) The majority of candidates answered correctly. The most common wrong answer was 37.5.

(c) This was answered correctly by most candidates.

Question 4

(a) Most candidates drew an acceptable triangle complete with construction arcs. A few did not seem to use the necessary equipment to do this question correctly.

(b) Many candidates were able to measure angle *BAC* accurately. Some measured the angle and gave the acute angle e.g. 83° as their answer.

Question 5

(a) The majority of candidates completed the table correctly. The most common wrong answers were 17 (from 28 – 11) and 22 (from 28 – 6).

(b) Most candidates gave the correct probability here if they had completed the table correctly. Among the incorrect answers seen were $\frac{3}{28}$, $\frac{1}{9}$ and $\frac{9}{20}$.

Question 6

(a) Most candidates showed that they were able to simplify this expression correctly.

(b) The expression given was almost always correct. Incorrect answers seen were $x + y = 12$ and $12xy$.

Question 7

Most candidates realised that they needed to find the interior angle of the pentagon and many calculated 360° ÷ 5 correctly and knew that this gave them the exterior angle of the pentagon. Others thought that 72° was the interior angle and marked it as such on their diagram.

Question 8

This question was answered correctly by many candidates. Candidates need to read the question carefully as it is asking for the value of the investment after 2 years and not the amount of interest earned. Some candidates, having calculated the interest correctly, did not add it on to the initial investment. A minority of candidates thought that the interest was compound interest and embarked on complicated calculations to try and work this out.

Question 9

(a) Many candidates found this part of the question challenging. Most realised that the distance travelled was 6 km and that the time was 30 minutes but were unable to calculate the speed. Among the calculations seen was $\frac{6}{30}$ with answer 0.2. A few thought the distance travelled was 7 km, 21 km or 27 km.

(b) Most candidates answered this correctly.

Question 10

(a) Many found this challenging. Candidates needed to realise that the marks on the dial indicated that the tank was $\frac{5}{8}$ full with the 40 litres of fuel. Many used $\frac{6}{9}$ working with the marks on the dial rather than with the spacings.

(b) The majority of candidates answered this correctly.

Question 11

Most of the candidates realised that they needed to multiply $\frac{3}{5}$ by 12 successively. They also needed to realise that the correct answer should be a whole number of tins to gain full credit.

Question 12

The majority of candidates solved the equation correctly. Errors sometimes occurred in multiplying out the brackets or rearranging the terms. Most of those candidates earned at least one mark for following through from their error correctly.

Question 13

Most candidates found this question very challenging. The most successful approach was to consider the ratio of junior to senior members and equating that to the ratio of angles for each. Hence if the number of junior members is x then the number of senior members is $x + 120$. The angles for each shown in the pie chart are 60° and 300°. So $\frac{x}{x+120} = \frac{60}{300}$ and hence $x = 30$ and then to the total number of members. Some candidates created similar equations and solved them to find the total number of members. Another approach is to look at the ratio of junior members to senior members i.e. 1:5 so the difference is 4 parts which represent 120 members so 1 part represents 30 members; hence 30 junior members and 150 senior members and the total of 180 members.

Question 14

Most candidates were able to solve the simultaneous equations correctly. Mistakes sometimes occurred when substituting in one of the equations to find the second solution. A few candidates were unable to make much meaningful progress.

Question 15

The majority of candidates answered this question well. A few candidates didn't write the numbers to one significant figure and embarked on unnecessary calculations. Some candidates having written the numbers to one significant figure had difficulty with the resulting arithmetic.

Question 16

(a) Approximately half the candidates were able to give the correct angle and the correct reason here. Those earning one mark here usually gave the correct angle but were unable to give the correct reason.

(b) (i) Many candidates gave the correct answer to this part.

(ii) This part was also mostly well answered.

Question 17

(a) A minority of candidates drew good diagrams. A few drew the cumulative frequencies at the midpoints of the intervals rather than at the end. Some others drew a bar chart and earned a mark for the heights of the bars indicating the correct cumulative frequencies.

(b) (i) Most candidates who had drawn a cumulative frequency diagram were able to read off the median from their diagram.

(ii) Candidates found this more challenging than **(i)**. A few candidates were able to estimate the interquartile range correctly.

(iii) Many candidates realised that they needed to read off the diagram at 80. Some then didn't subtract this figure from 60. A few attempted to answer this from the frequency table obtaining the answer 41 (from 24 + 17) which was not an acceptable estimate.

Question 18

Many candidates answered this question well. Some found the value of the proportionality constant and then had difficulty using it. Others omitted the constant working with $p = q^2$ followed by $a = 7^2$ and $b^2 = 48$. A few had difficulty with the arithmetic involved e.g. evaluating $a = 3 \times 7^2$ and $b^2 = \frac{48}{3}$.

Question 19

(a) Most candidates answered this correctly.

(b) Many candidates had difficulty with this question and attempted to solve the equation $x^2 + x - 11 = 0$. Those who analysed the question obtained the equation $x^2 - x - 6 = 0$ and solved it correctly.

(c) Very few candidates were successful in answering this question part.

Question 20

A few candidates omitted this question. Most of those who answered the question gave the correct matrix **N**. A few obtained a matrix representing 2**N** but didn't divide the elements by 2 and had $\begin{pmatrix} 20 & 0 \\ 30 & -10 \end{pmatrix}$ in their working or gave it as their answer.

Question 21

This question proved challenging for most candidates. Many began correctly by dividing 5000 by 50 which gave the area of cross-section of prism *A*. This can be used to find the ratio of the areas of the two prisms i.e. 100:16 which can then be square-rooted to find the ratio of the lengths of the two prisms. Hence $\sqrt{\frac{100}{16}} = \frac{50}{x}$ giving the correct length of prism B as 20 cm. The common incorrect answer was 8 which was obtained by using the ratio 100:16 as the ratio of the lengths which was followed by $\frac{100}{16} = \frac{50}{x}$ giving the length of prism *B* as 8 cm.

Question 22

Many candidates were able to rearrange the formula correctly. Most were able to gain credit by eliminating the fraction. Errors were sometimes made in multiplying out the bracket. Some made errors in rearranging to isolate the terms in *x* and others made errors in cancelling.

Question 23

(a) Some candidates thought that *C* was the midpoint of *AB* and gave the co-ordinates of *C as* $(-\frac{1}{2}, 4)$.

(b) A large number of candidates found this question challenging. Incorrect methods included

- $\sqrt{(3-5)+(1-(-2))}$
- $\sqrt{8^2 + (-1)^2}$.

(c) Some good answers were seen. Most candidates were able to make a good start on this question by correctly finding the gradient of *AB* and the line perpendicular to *AB* and some went on to find the correct equation of the required line. Many candidates attempted to find the equation of the perpendicular bisector of AB, finding the equation of the line with gradient $\frac{3}{2}$ through their midpoint from **(a)** or (4,1). Candidates needed to realise that they should have been finding the equation of the line with gradient $\frac{3}{2}$ through *A*.

Question 24

This question was attempted by most candidates. Most earned at least one mark and some were fully successful.

(a) Many candidates found the vector correctly. A few omitted to give the vector in its simplest form e.g. $\frac{1}{2}$ (2**a**) + $\frac{1}{2}$ (2**b**).

(b) Candidates found this part more challenging than **(a)** but many gave the correct vector. A few gave the vector $\overrightarrow{DC}$ rather than $\overrightarrow{CD}$ and others made errors in signs e.g. 2**a** + 2**b** – 2**d** or size e.g. **d** – **a** – ***b***.

(c) A few candidates were able to answer this correctly. Others were able to start well by giving the correct route along the lines of the diagram and then made subsequent errors.

MATHEMATICS SYLLABUS 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 correct mathematical terminology
- draw accurate graphs and diagrams
- apply mathematical techniques to solve problems
- set out their work in clear, logical steps.

General comments

In general, candidates were well prepared and demonstrated a sound knowledge of most of the topics covered. Most attempted all the questions.

The questions found to be most challenging were those assessing graphical inequalities, fractional indices, bounds of calculated values, graphical solution, matrix equations and vectors. Candidates were unfamiliar with the conversion between cubic centimetres and litres, and some were unable to carry out calculations involving time differences. Terms used in the syllabus such as mixed number, multiple, bearing, position vector and relative frequency were often misinterpreted.

Many candidates demonstrated sound basic arithmetic skills, although some errors in multiplication tables and simple arithmetic were seen. Candidates often demonstrated good algebraic skills, although sign errors when manipulating algebraic expressions or solving equations were common.

Many candidates presented their work well with working set out legibly and answers clearly stated on the answer line. When several attempts have been made at a solution, the rejected methods should be clearly crossed out to make the intended solution clear. Candidates should take care to ensure that all numbers are written clearly so that there is no confusion between digits, for example 1 and 7.

Most used the appropriate geometrical instruments correctly to draw and take measurements from diagrams. Rulers should be used to draw straight lines for linear graphs, tangents and histograms. A pencil should be used for graphs and diagrams to enable incorrect attempts to be erased. Construction arcs should not be erased.

Comments on specific questions

Question 1

(a) Almost all candidates ordered the list of positive and negative integers correctly.

(b) The majority of candidates ordered the values correctly. The most common strategy was to convert to decimals before attempting to order. The most common errors were from incorrect conversion of 40% to 0.04 or from numerical errors when attempting to divide 3 by 8.

Question 2

(a) Almost all candidates completed the diagram correctly to give one line of symmetry. Most incorrect answers had one incorrect square in the lower half of the diagram shaded.

(b) The majority of candidates completed the diagram correctly to give rotational symmetry of order 2. A common error was to shade a square on the bottom row to give a diagram with line symmetry and not rotational symmetry.

Question 3

Candidates that used all the information given in the question were often able to reach the correct solution. They started by identifying 12 as the median and placing it in the middle of the list. They then used the mode of 11 to place two 11s in the list. The next step was to use the sum of 75 to identify that the remaining two values had a total of 41. This could be used with the range of 10 to give the final two values as 21 and 20. Many candidates reached the stage of writing 11, 11 and 12 but were unable to find the remaining two values. Some candidates were unable to make correct use of the median and mode.

Question 4

(a) Almost all candidates were able to convert from kilograms to grams. The most common error was to give the answer 400 rather than 4000.

(b) A small minority of candidates correctly answered this question.

Question 5

(a) Most candidates found the perimeter correctly. The most common mistakes were to multiply the two lengths together leading to the answer 66 or to add the two lengths leading to the answer 17.

(b) Many candidates made use of the formula to calculate the area of a trapezium and were able to set up and solve the equation successfully. The most common error seen following the correct equation was to expand the bracket incorrectly.

Question 6

(a) Many candidates were able to complete the missing card to give a 2-digit number which was not a prime number. Two common incorrect responses were the prime numbers 13 and 43.

(b) Candidates who used the term ‘multiple’ correctly were mostly successful in this part. As the question asked for an example, showing a sum with a correct result such as 3 + 6 = 9 was sufficient. There was no requirement to give any further justification. Some candidates used factors of 3 or 6 rather than multiples of 3.

Question 7

(a) The majority of candidates divided the fractions correctly. The most common errors were to multiply the given fractions, or to invert $\frac{2}{7}$ rather than $\frac{1}{3}$ before multiplying. Some started by correctly converting the two fractions to a common denominator of 21 but were unable to complete the calculation correctly.

(b) Many candidates added the fractions correctly. Either 12 or 24 was used as a common denominator, usually with correct numerators, so both acceptable answers of $1\frac{7}{12}$ and $1\frac{14}{24}$ were seen. Some candidates did not convert their answer to a mixed number as required and answers of $\frac{19}{12}$ and $\frac{38}{24}$ were common.

Question 8

(a) Many candidates worked out the time taken correctly. A common successful approach was to consider the time in stages: 7.43 to 8.00 = 17 minutes, 8.00 to 10.00 = 2 hours and 10.00 to 10.27

= 27 minutes, then to add these to give 2 hours 44 minutes. The most common incorrect answer was 3 hours 24 minutes, the result of a decimal subtraction of 10.27 – 7.43 = 2.84 and conversion of 84 minutes to 1 hour 24 minutes. Another common error was to subtract the smaller number of minutes from the larger, 43 – 27 = 16, and subtract the hours, 10 – 7 = 3, giving a final answer of 3 hours 16 minutes.

(b) The most successful candidate responses used fractions of an hour, first simplifying $\frac{40}{60}$ to $\frac{2}{3}$, and then evaluating $24 \div \frac{2}{3}$ to find the correct value of 36. An alternative approach used $\frac{24}{40} = \frac{3}{5}$ km/min and then multiplied by 60 to give km/h. Many candidates converted 40 minutes to a decimal of an hour and used the approximate value of 0.6 in the speed calculation leading to the answer 40 km/h. Others used a more accurate decimal, such as 0.66 or 0.67 but then were unable to complete the division to find the speed. This is a non-calculator paper, and candidates should recognise that they are expected to use fractions in a calculation of this type. When a fraction is converted to a recurring decimal and the rounded value used in the calculation, the result is unlikely to be the exact answer required.

Question 9

(a) Many candidates were able to write the correct expressions in terms of x for the number of blue pens and the number of black pens then use these to form and simplify an expression for the total number of pens. Some did not simplify the expression or made errors when simplifying, usually in the expansion of $2(x + 5)$.

(b) Candidates with a correct simplified or unsimplified expression in **part (a)** were almost always able to set up and solve the required equation in this part. Some candidates used their expression from **part (a)** to form a linear equation of the correct form.

Question 10

(a) Most candidates measured the bearing accurately, although it was often given as 70° rather than the 3-figure bearing 070°. Some gave the answer 250°, the bearing of *B* from *C*.

(b) Most candidates were able to construct the quadrilateral correctly using ruler and compasses and showing clear construction arcs. Some gained partial credit for finding the position of *D* correctly without completing the quadrilateral or without showing construction arcs. Some candidates used the scale correctly to find the two lengths 5 cm and 6 cm and were given partial credit for writing these values even if they used them incorrectly or did not attempt the construction.

(c) A minority of candidates correctly identified that the construction required was the angle bisector at *B* and drew it accurately crossing the entire quadrilateral with correct arcs.

Question 11

Most candidates showed correct rounding of at least two of the values in the given calculation. A large proportion of these showed 5, 4 and 900 and completed the calculation to give the correct answer of 0.3 or $\frac{3}{10}$. It should be noted that an answer of 0.30 is not acceptable when working with 1 significant figure. Some incorrectly rounded $\sqrt{878}$ to $\sqrt{9}$ rather than $\sqrt{900}$.

Question 12

(a) Almost all candidates substituted and evaluated the answer correctly. The most common incorrect answers were 17 or 3 resulting from errors when dealing with the negative sign.

(b) The majority of candidates were able to rearrange the formula correctly. The most common incorrect answer was $d = \frac{c - 9}{4}$, the result of an incorrect first step of $c - 9 = 4d$.

Question 13

(a) A large proportion of candidates did not write a relative frequency as a value between 0 and 1. Common incorrect answers were 9, $\frac{9}{5}$, $\frac{5}{9}$ and $\frac{20}{9}$. It is acceptable to give the answer as either a fraction, a decimal or a percentage but the per cent sign must be written for a percentage answer. Some candidates found a correct fraction but then converted incorrectly to a decimal.

(b) Candidates were more successful in this part than in **part (a)** demonstrating that they could use a relative frequency without understanding the term itself. Some misinterpreted the question and used the frequency of 11 to 15 calls, leading to the answer 32, rather than adding the frequencies of the final two groups to give the correct answer 48.

Question 14

(a) Most candidates were able to convert to standard form correctly. The most common incorrect answers were 4.2×10^{-7}, 4.2×10^{-6} and 4.2×10^{6}.

(b) The first step was to convert both numbers to the same power of 10 before adding. Those that did this correctly, either using 74×10^{-4} or 0.13×10^{-3} usually reached the correct answer. Errors were very common in this step, with both 0.74×10^{-4} and 13×10^{-3} frequently seen.

Question 15

Those candidates who used the correct relationship between corresponding sides to set up an equation such as $\frac{BD}{8} = \frac{8}{5}$ usually rearranged correctly to find $BD = \frac{64}{5}$, although some then converted incorrectly to a decimal. The most common incorrect answer was 11.2, the result of using 7 in place of 8 in the starting equation. Some did not use similar triangles and attempted to either use Pythagoras' theorem or the cosine rule.

Question 16

This question required candidates to draw two straight lines accurately and to identify the correct region for the inequalities given. Although some correct answers were seen, candidates who had drawn the correct lines were not always able to identify region R correctly: some didn't account for the inequality $x \geqslant 0$ so their region extended into the 2nd quadrant and others used $y \leqslant 2x$ rather than $y \geqslant 2x$. Candidates were often successful in drawing the line $x + y = 4$ but were unable to draw the line $y = 2x$.

Question 17

(a) Many candidates applied the properties of an isosceles triangle and opposite angles of a cyclic quadrilateral to find this angle correctly. Some indicated the angle $OCD = 20^\circ$ but did not use the cyclic quadrilateral to find angle $BCD = 60^\circ$. The most common incorrect answer was 60°.

(b) Many candidates used the isosceles triangle to find angle $BOC = 140°$ leading to angle $BDC = 70°$. Some had an incorrect value for angle *BOC* but gained partial credit for applying angle at the centre is twice the angle at the circumference correctly to find a value for *y*. A common misconception was that triangle *BCD* was an equilateral triangle leading to an answer of 60°.

Question 18

(a) Many candidates recognised that the index of $\frac{1}{3}$ indicates that the cube root is required and often found the correct answer. Common errors were leaving the answer as 5^{-1} rather than $\frac{1}{5}$ or ignoring the negative sign in the power and giving the answer 5.

(b) This was found to be very challenging and only a minority of candidates reached the correct answer. Some gained partial credit for an answer with either a^3 or 8 correct. Many candidates started by applying the power of $\frac{3}{2}$ to each of the terms inside the bracket rather than cancelling the *a* terms to simplify the expression first. It was common to see an incorrect first step of $\dfrac{a^{\frac{9}{2}}}{4a^{\frac{3}{2}}}$ where the power had not been applied to the 4 on the denominator. Some candidates attempted to cancel powers rather than applying the rules of indices.

Question 19

(a) Many candidates stated the correct lower bound. The most common incorrect answers were 120, 124.9 or 125.5.

(b) Calculating the upper bound of a difference was found to be very challenging for many candidates. It is helpful for candidates to start by writing down the upper and lower bounds of both quantities before selecting the ones to use in their calculation. Some candidates attempted to find the ranges of values for the two quantities using ± 0.5 grams rather than ± 5 grams. Some calculated the difference between the two quantities before considering bounds.

Question 20

(a) A number of candidates found the inverse of a function and those who worked methodically, setting out each stage of their working, often gained full marks. A common equivalent final answer was $\dfrac{5x-2}{-4}$ which was acceptable when the negative sign was clearly in the correct position. A common incorrect answer was $\dfrac{2-5y}{4}$ rather than $\dfrac{2-5x}{4}$, an error avoided by those who swapped the *x* and *y* as the first step. Sign errors were common when swapping algebraic terms to the opposite side of the equation, for example $5y = 2-4x$ rearranged to $5y-2=4x$.

(b) Some candidates interpreted the function notation correctly to give $f(2x) = \dfrac{2-8x}{5}$, however sign errors were common when subtracting the two algebraic fractions leading to the answer $-\dfrac{12x}{5}$ rather than the correct answer of $\dfrac{4x}{5}$. It was common for candidates to misinterpret f(2*x*) as 2f(*x*) leading to $\dfrac{2-4x}{5} - 2\left(\dfrac{2-4x}{5}\right)$.

Question 21

Most candidates managed to draw a fully correct histogram. Some did not use a ruler and freehand bars were often insufficiently accurate to gain full credit. Some candidates made errors in the calculation of one or two frequency densities or misinterpreted the vertical scale. A small number drew a frequency polygon as well as a histogram, in which case they were only given credit for use of the correct frequency densities. Many candidates showed no written calculations or frequency densities which may have been awarded partial credit if the histogram was incorrect.

Question 22

(a) Many good tangents were drawn to the curve at (2, 1.5). A few did not touch or crossed the curve, and some were not ruled. Some tangents were drawn to the curve at the wrong point, often at one of the turning points of the curve or starting from (2, 0) or from (0, 2), and some candidates attempted to find a gradient without drawing a tangent. Those drawing an acceptable tangent usually gave a correct answer for the gradient.

(b) This part was found to be very challenging by almost all candidates. Few candidates were able to rearrange the given equation to $\dfrac{1}{x} + \dfrac{x}{2} = 3x - 1$ but those that did usually drew the line $y = 3x - 1$ accurately on the graph and read the solutions correctly from the points of intersection. Some candidates attempted the rearrangement and gained partial credit for drawing a line with either an intercept of –1 or a gradient of 3. Many candidates attempted to rearrange and solve the given equation: this was not acceptable as the question required a graphical method.

Question 23

(a) Many candidates found the correct inverse matrix. Some found the correct adjoint but made an error with the determinant, often using –2, 5 or 0.5 as the determinant in place of 2. Fewer found the correct determinant and then made an error with the adjoint, usually either swapping the wrong numbers or changing signs incorrectly. A minority of candidates either found the reciprocal of each element or attempted to find A^2 rather than A^{-1}.

(b) This part was found to be very challenging. Some candidates knew that the method involved the inverse matrix but attempted to find $\begin{pmatrix}7\\4\end{pmatrix}\mathbf{A}^{-1}$ rather than $\mathbf{A}^{-1}\begin{pmatrix}7\\4\end{pmatrix}$. The most common error was to use the original matrix A, usually in a subtraction or division with $\begin{pmatrix}7\\4\end{pmatrix}$. Some successfully formed simultaneous equations, but others made errors in this method such as $3x - x = 7$ and $2y = 4$ rather than $3x - y = 7$ and $2x = 4$.

Question 24

Many candidates were able to use the processes required to solve this equation and a large proportion were able to write the left-hand side correctly over a common denominator. The denominator was often eliminated correctly, and the brackets expanded to reach the correct equation $x^2 - 3x - 5x + 5 = x^2 - x - 3x + 3$. Most candidates who reached this equation rearranged correctly to give the correct solution, although some made sign errors when collecting terms. Some candidates attempted incorrect cancellation of individual terms in the numerator and denominator of the algebraic fraction before eliminating the denominator.

Question 25

Candidates found this question very challenging. Vectors used in working were often identified using incorrect notation, such as X used in place of $\overrightarrow{BX}$, or the vectors were not identified at all. The best solutions started by identifying a correct vector route for $\overrightarrow{OX}$, for example *OB* + *BX*. They could then efficiently work out a vector for *BC* and hence *BX* and add **b** to get their solution.

MATHEMATICS SYLLABUS D

Paper 4024/21
Paper 2

Key messages

Candidates should take care to ensure they are answering the question asked rather than answering their own assumed question and giving their answer in the required form.

It is generally expected that candidates 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

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)(i) This part was answered well, with almost all candidates gaining the mark.

(ii) This percentage question was answered much less successfully, as is often the case with reverse percentage questions. Most candidates found either a 4 per cent increase or decrease of the cost of $67.60 which is an incorrect method. Candidates did not seem to realise that 4 per cent of the cost last year is a different quantity to 4 per cent of $67.60.

(b) Most candidates were able to find the percentage of seats that were sold. Occasionally, candidates gave their only answer as 94 per cent which did not gain the mark, as candidates must show answers correct to at least 3 significant figures when these are not exact.

(c) This part caused the most confusion in **Question 1**. Many candidates did not correctly read that 329000 was the total number of seats sold for the first 21 matches. Instead, candidates often multiplied these two values together and thought this was their final answer. Other candidates correctly multiplied 16440 by 41 to find the total number of seats sold for the 41 matches, added this to 329000 and thought this was their final answer. Instead, this total should have then been divided by 20 to gain the mean number of seats sold per match for the last 20 matches.

(d)(i) Candidates were usually successful in this part, with correct answers given in either normal form or standard form, although note that a standard form answer was not a requirement of this question.

(ii) Candidates were often successful in this question. Often a large amount of working was seen, but candidates could have realised a simpler calculation here was to find 2.5 per cent of 4.29×10^6 to find the value of x.

Question 2

(a)(i) Generally candidates were accurate when plotting the four points and two marks were often awarded, although just over a tenth omitted this part of the question.

(ii) Most candidates gained the mark here for stating the correlation was negative. Note that candidates did not need to state the strength of the correlation here to gain the mark.

(iii) Most candidates could draw a ruled line of best fit which was in an appropriate direction and of an appropriate length. Those candidates who omitted **part (a)(i)** often did not draw a line which was long enough, as they only considered the points from the table which had been plotted for them.

(iv) If a candidate had drawn a ruled line of best fit in **(iii)** the mark here was gained for correctly reading from their line at a height of 1000 m. Most candidates could do this correctly, although there were some who misread the vertical scale, and others who failed to notice the temperature was negative at this height.

(b) (i) Candidates were generally successful in this part, having been well prepared in calculating the mean for grouped data. Note that the number of adults is stated in the stem of the question, as some candidates added the figures from the table to reach 80 (and occasionally made an error when doing this).

(ii) Approximately only a fifth of candidates were successful in finding the frequency density in this part. Candidates were expected to note that as the height of the bar representing $5.5 < h \leqslant 6.5$ was 8, that this had been found from the frequency of 8 divided by the width of 1 (6.5 – 5.5 = 1).

Question 3

(a) A small minority of candidates gained full marks in this part.

(b) This question proved very difficult for most candidates. Many did not understand how to prove that two triangles are similar to each other. The main approach to take is that angle *AEB* equals angle *DEC* as they are opposite angles. Then angle *BAE* equals angle *ECD* as they are alternate angles And finally angle *ABE* equals angle *EDC* as they are alternate angles. It is important in ‘show that’ type questions that candidates show all working clearly.

Question 4

(a) This part was answered well, with almost all candidates gaining the mark.

(b) (i) Approximately a third of candidates were successful in this part of the question. Unfortunately, there were some candidates who, having correctly found $2^{x-1} \times 3^y$ then tried to simplify this further, meaning that only one mark was gained.

(ii) Similarly to **part (b)(i)**, there were a few candidates who, having correctly found $2^{x+3} \times 3^{2y} \times 5 \times 7$ then went on to try to simplify this further, therefore gaining only one mark. Approximately a quarter of candidates were successful in finding the lowest common multiple.

Question 5

(a) Those solutions which set up an equation such as $0.5x + 125 = 350$ tend to able to obtain the correct answer, but many candidates just added 0.5 and 125 and divided this into 350 to find the (incorrect) value.

(b) Only about a fifth of candidates gained full marks here. Successful candidates realised that as 770 was given as an exact value, this should not be given a bound. As the upper bound was asked for in the question, and that as the calculation required dividing by the value with bounds, the **lower bound** of 3.5 should be used to divide into 770.

(c) Finding the number of medium boxes appeared more demanding, as candidates then needed to use the other ratio with 90 small boxes to find this. Then, finally, candidates need to add together all the different quantities of boxes found to gain full marks. Presentation was on the whole poor in this part of the question, with this meaning it was often difficult to award partial marks.

Question 6

(a) Approximately half of the candidates gained full marks in this part. One mark was available to those candidates who translated correctly in one direction, but not in the other direction.

(b) There were few candidates who gained full marks in this part. Candidates should take note that as this question part was worth 3 marks, there were 3 items to identify in this section. One mark was gained for stating the transformation was an enlargement, one mark for stating the centre of enlargement was (0, 0) and the final mark for stating the scale factor of the enlargement was –0.5.

(c) This question was expected to challenge candidates, and it did. The combination of more than one transformation confused some candidates. To answer this question successfully, candidates had to firstly carry out the correct reflection (two marks were available for this shown correctly on the grid), followed by the correct rotation.

Question 7

(a) This part was answered well, with almost all candidates gaining the marks, often from setting up a correct equation for the formula of a cuboid and the given volume of the cuboid.

(b) (i) This question was expected to be a straightforward application of right-angled trigonometry, once candidates had identified the right-angled triangle they could use here. Many candidates, however, could not identify this right-angled triangle and found a number of lengths or angles which were not helpful. Candidates needed to draw a vertical line from *B* to the line *AE*, they could then find the length (of 5 cm) from this vertical line to *A*, and then use tan $x = 8 \div 5$ to find the required angle.

(ii) Majority of the candidates were successful in this part of the question compared to **part (b)(i)**, perhaps as the pentagon was already separated into a trapezium and a triangle for them. Candidates were expected to find the area of the trapezium and subtract this from the given area of the pentagon to find the area of the triangle. They could then use the sine formula for the area of a triangle to set up an equation to find the length of *BC*.

Question 8

(a) (i) This part was answered well, with almost all candidates gaining the mark.

(ii) Candidates generally found no difficulties with the scales in this question and were very successful in drawing a smooth curve through all the plotted points.

(iii)(a) Many candidates omitted this part. It was expected that candidates would split the powers on the 2 and then rearrange to gain the given answer. Solutions such as $2^{x+3} = 2^x \times 2^3 = 100$.

(b) Candidates were expected to use the fact they knew from **part (iii)(a)** that if $2^{x+3} = 100$, then $\frac{2^x}{5} = \frac{5}{2}$. So to solve $2^{x+3} = 100$, candidates were expected to draw the line $y = \frac{5}{2}$ on the grid and read where this line intersected the curve $y = \frac{2^x}{5}$. As the question stated 'by drawing a suitable line, solve…' if the correct line was not drawn, no marks were available in solving the question just by using a calculator.

(b) There were very few fully correct answers to this part. Finding the value of *b* proved much more difficult, as was expected. Candidates were expected to use the fact that the product of the two roots of the equation $-x^2 + bx + 7 = 0$ had to be factor pairs of 7, which meant that $-x^2 + bx + 7 = (-x - 7)(x - 1)$ or $(-x + 7)(x + 1)$, and with the maximum of the graph being to the right of the *y*-axis, the factors were $(-x + 7)(x + 1)$, meaning that $b = 6$.

Question 9

(a) Approximately a third of candidates were successful in finding the bearing here. Candidates were not confident in showing the bearings given on the diagram to help them in answering this question.

(b) Again, approximately a third of candidates were successful. The main difficulty seemed to be in finding that angle *CAB* = 85°, as once this was correctly found, using the cosine rule was not, generally, a difficult calculation for candidates.

(c) Approximately a third of candidates were successful in this part of the question. Candidates could often find the length of time for boat *B* to reach port *A* but could not then always relate this correctly to the time of 10.15 am. Candidates should take care to write time in a correct form as a mixture of clock times and time lengths were often used together. Another common error here was to only use one of the times (usually the 7 minutes), and to ignore the different times that boats *B* and *C* left their respective ports. Again, presentation was on the whole poor in this part of the question, with this meaning it was often difficult to award partial marks.

Question 10

(a) This part was answered well, with most candidates gaining both marks.

(b) Candidates generally noted the question had asked them to form an equation in w and usually did this correctly. A common error from this point was in rearranging $5w - 5 = 360$. Some candidates often subtracted the 5 from 360 instead of adding this. Occasionally, candidates found $w = 73$ and thought this was the final answer, rather than finding the largest angle in the quadrilateral as the question asked.

(c) Candidates were often successful in this part, with most realising the need to factorise both numerator and denominator before cancelling common factors. Understandably, factorising the denominator proved easier than the numerator in this part.

(d) Just over half the candidates were successful here, with most recognising the need to either find a common denominator for the fractions, or to multiply both sides of the equation by each denominator. Common errors tended to be purely arithmetical in attempting to find the quadratic equation before trying to solve this.

Question 11

(a)(i) Over half of the candidates understood how to find the expected number of days given the probability. Decimal answers, in addition to those rounded or truncated to the nearest integer were also accepted.

(ii)(a) In general, candidates found the missing probabilities correctly for the tree diagram. There was some confusion about where the 0.35 should go on the second set of branches, but in general, this question was well answered.

(b) As the required probabilities were given on the tree diagram for this question, candidates just had to identify the correct branch and know to multiply the two probabilities together. However, just under half of the candidates understood how to do this.

(c) Even if candidates made an error completing the tree diagram in **part (ii)(a)** they could still gain a mark for attempting to multiply their probabilities from either of the correct branches. To find the probability that the temperature is above 14 °C on only one of the two days, candidates had to multiply the probability that the temperature was above 14 °C on one day by the probability that the temperature was below 14 °C on the other day, then double their answer.

(b) Very few candidates gained full marks in this part. The question was demanding; asking for the probability that the children wear different coloured T-shirts requires a number of different situations to be considered, and without a tree diagram can make this very complicated. There are two main approaches that can be taken here. One method is to consider all the situations where children are wearing different colours; there are six of these. Another method is to look at all the situations where children are wearing the same colour, find the total probabilities of these and subtract the answer from 1. Even those candidates who did not consider all the possible ways usually still gained a mark for correctly calculating the probability of at least 3 of the possible situations.

MATHEMATICS SYLLABUS D

Paper 4024/22
Paper 2

Key messages

Candidates need to appreciate the accuracy required when working out solutions. It was common to see premature approximation of values to 2 significant figures resulting in inaccurate final answers. Where candidates are required to show an answer is 4.80, correct to 2 decimal places then they are required to write down the value to at least 3 decimal places. Care needs to be taken over negative values as these frequently resulted in errors in **Question 10(b)** when candidates chose to use the cosine rule and in **Question 11(a)** where errors were seen in expanding brackets involving negative numbers. When answering questions involving simple and compound interest, candidates need to be clear that when quoting a formula, they know if the formula results in the value in the account or the amount of interest.

General comments

There were several candidates who achieved high scores on this paper but also some candidates who clearly were not ready for the demands of this paper. Most candidates showed clear methods with answers, however, there are still candidates who do not clearly write their numerical digits. A small number of candidates cross out their intermediate working or sometimes part of their working – this can make it difficult to read and decide if this is part of their intended working. Candidates appeared to have enough time to tackle all the questions on the paper.

Comments on specific questions

Question 1

(a) The majority of candidates found the correct amount of change. Occasionally, the cost of the oranges was given, or mistakes were made as candidates appeared not to be using a calculator.

(b) (i) Most candidates were able to use the graph correctly to find the mass of strawberries. Errors included finding the fee for 240 kg of strawberries or mis-reading the scale and giving the mass as 320 kg or 340 kg.

(ii) This part of the question proved more difficult, but a considerable number understood what was required and accurately found the two readings before finding their sum. Some candidates made an error with one of the fees, more usually the one for 220 kg of strawberries. The most common error seen was to think that account had to be taken of the daily payment of $75 without realising that this had already been included in the conversion graph. This meant it was not uncommon to see $75 added to both of the values or occasionally just to one of them.

(iii) Attempts were made by most candidates to draw a straight line to represent the new fee. Many started this line at (0, 90) but not all of these had the correct gradient of the line. Common mistakes were to join this to (500, 400) or to draw a line parallel to the given line. Other mistakes were to start the line at the wrong value, often (0, 0), but other starting points were also seen.

(c) Many candidates appreciated the need to write the three masses in the same unit before attempting to simplify. Most chose to write them all in grams, however some thought that there are only 100 g in a kilogram. Those who had the correct conversion did not always complete the division to its simplest form.

Question 2

(a) (i) A mixed response to this question, with most candidates giving the answer as a fraction with a denominator of 5. Many gave the numerator as 1 but it was not uncommon to see a numerator of 3.

(ii) More candidates gave the correct answer in this part of the question by realising that there are 2 even numbers on the spinner and using this correctly to give the probability.

(b) (i) Over ninety five percent of candidates were able to correctly complete the possibility diagram. Occasionally there was a wrong value, or candidates correctly completed the diagram up to the number 7's but did not complete the rest of the diagram.

(ii) The vast majority of the candidates were able to use the possibility diagram accurately to give the correct probability. However, there were some candidates who had denominators normally of 35 or 36 and also included the relevant number 4's from the result of the first and second spin as well.

(iii) Those candidates who had completed the possibility diagram usually had the number of outcomes greater than 6 as 10 and then used this to give a probability with a denominator of 25, 35 or 36.

Question 3

(a) This question was usually well answered, with the majority of the candidates able to achieve the full 2 marks. The common errors were 4.19 × 179.12 or 179.12 – 4.19 or inverting the division. The workings rarely showed the required division. Inaccuracies occurred in the final answer when premature approximation was seen for $\frac{1}{4.19}$.

(b) Less success was seen in this part of the question with about half of the candidates correctly obtaining the required percentage. A large proportion of the candidates started well and correctly calculated the amount in Farhad's account at the end of the two years. The common mistake was to then equate this to the simple interest formula resulting in a final percentage of 54.08 rather than equate the interest to the simple interest formula. Another error seen frequently was to work the question with one year rather than two for either the simple or compound interest or both.

Question 4

(a) (i) The diagram was clear and correct by over ninety percent of the candidates. In some cases, candidates did not clearly indicate the boundary of their diagram. A very small number of candidates did not shade the triangles or made a mistake with the shading of one or two triangles, often on the bottom row.

(ii) Candidates normally correctly completed the row for the total number of triangles. Errors seen in the other two rows were always because of an incorrect diagram. Some candidates did not use their diagram but instead gave a correct table using the number patterns.

(iii) Most candidates correctly gave the correct expression of n^2. Errors seen included giving a linear sequence or a numerical value such as 81 or 100.

(iv) This part of the question proved to be more challenging. Some candidates recognised the sequence and went straight to the answer. Many others knew the answer was a quadratic but had difficulty going from knowing that the second differences were 1 to finding a correct expression.

(b) (i) This part of the question was answered using a variety of methods. Those who set up simultaneous equations were usually able to complete this correctly to find the first term of the sequence. Those who chose to leave gaps for the missing terms to work out the difference and so then find the first term were less successful.

(ii) Virtually, all the candidates who correctly answered the previous part were able to give the correct answer for this part as well. A common error was to give the position of the first negative term, 12, instead of its value, –2. Nearly a fifth of the candidates did not attempt this question.

Question 5

(a) Some candidates were able to give the correct transformation and line of reflection to describe the single transformation although some included an extra property, usually centre (0, 0). The most common incorrect line of reflection was $y = x$. It was not uncommon for candidates to think this was a rotation, 90° anticlockwise about (0, 0).

(b) (i) The correct centre of enlargement was normally only given by those candidates attaining a high grade. Candidates who knew the *y*-coordinate of the centre was 5 often thought the *x*- coordinate was to the right of the shape *A*.

(ii) Candidates had more success with this part of the question, usually by drawing the shape *C* correctly and using this to find its area, rather than finding the area of shape *A* and then multiplying by 9. Candidates who chose to work out the area of shape *A* often incorrectly multiplied by 3. Not all the candidates who attempted to draw shape *C* did so accurately.

(c) (i) Candidates found it difficult to use the matrix to draw shape *D*. It was unusual to find that the candidate had 3 correct coordinates and made a mistake with one of them. Often shape *D* was seen in the wrong quadrant with the incorrect orientation or no attempt was made to draw the shape.

(ii) Several candidates were able to give a completely correct description of the single transformation, however some had one of the properties missing or incorrect.

Question 6

(a) Three quarters of the candidates shaded the correct region. Most errors involved the intersection of A and B: either excluding it or shading only the intersection.

(b) This question was well answered, usually giving the form $(X \cap Y)'$ with less giving the form $X' \cup Y'$. The majority of incorrect scripts had the intersection and union reversed or gave the answer $X \cap Y$.

(c) (i) Around seventy percent of the candidates gained full marks on this question with a small minority having too many errors to score any marks. By far, the most common error was the omission of 6. The number 5 was a problem on a significant number of scripts – either it was omitted from the intersection, or it was shown in sets *A* and/or *B* only. The number 10 was repeated in some scripts, but few repeated the numbers 1 and 3.

(ii) Many candidates listed the correct elements or used their diagram correctly to list the elements shown on their diagram. The most common error was to include the number 6 with the 3, 7, 9 or to also include the 1 and 5.

(iii) A correct probability was usually given with the common wrong answers being $\frac{1}{10}$ or $\frac{9}{10}$.

Question 7

(a) Nearly all the candidates solved the equation correctly.

(b) Less success was seen in this part of the question. The common mistakes were to fail to multiply 3 by 2 when expanding the brackets or to use the incorrect sign when moving terms from one side of the equation to the other.

(c) Just under three quarters of the candidates factorised the quadratic correctly. Some candidates knew the correct form required for the factorisation, however, obtained a factorisation which when expanded did not give the correct quadratic.

(d) Candidates found this part of the question challenging with under a third able to find the correct values of *a*, *b*, and *c*. The mistakes made were varied, however one of the common ones was to give *a* as 4 and some were then able to follow this through to give the corresponding values for *b* and *c*. Other candidates correctly obtained *a* but failed to appreciate that the need for *b* to be a negative value and so gave it as 3. There were some who thought that b was –6, failing to appreciate the effect that $4x^2$ would have on calculating the value of b and so gave c as 36. Around a tenth of the candidates did not attempt this question.

Question 8

(a) (i) Full marks were awarded to around half of the candidates with the majority of the others only being awarded two marks as they failed to show a value of r to more than 2 decimal places. Candidates need to appreciate that if they are required to show that an answer is 4.80, correct to 2 decimal places, then they need to write a value in the working space correct to at least 3 decimal places. Some candidates equated the curved surface area of the sphere to 145, but correctly rearranged this to the form of $r = \ldots$ or $r^2 = \ldots$ Some candidates started with a totally incorrect formula, such as the volume of a sphere or hemisphere.

(ii) Slightly less success was had with this part of the question. Most candidates did not calculate the height of the cone as 5.2. The most common error was to use 5 (half of the total height, 10) as the height of the cone while others just used the given height of 10 as the height of the cone. It was very common for candidates to use $\frac{4}{3}\pi r^3$ rather than $\frac{2}{3}\pi r^3$ for the volume of the hemisphere. There were also a few incorrect formulas such as $\frac{4}{3}\pi r^2$ seen.

(iii) Candidates who were able to score full marks on the previous part usually received full marks on this question, however some lost the accuracy of their final answer by rounding the slant height of 7.077 to 7.1 or 7.07. There were also other candidates who correctly obtained the height of the cone as 5.2 in the previous part who were not able to find the correct volume but were able to use this value correctly to calculate the curved surface area of the cone. Correct methods were seen on many of the scripts where candidates had the height of the cone as 5, using this correctly in Pythagoras' theorem before using the formula for the curved surface area.

(b) This question was one of the most challenging on the paper and was often left incomplete. Around a tenth of the candidates did not attempt to answer this question. Many candidates were able to write the new angle as $0.8x$ or the new radius as $1.2y$, while many others gave incorrect expressions; the usual ones for the angle were $x - 20$ or $x - 0.2$ or $x - 20$ per cent or $0.2x - x$. Many were able to form the correct expression for the area of sector B but either stopped at this stage or made no further correct progress. A common error was to write $(1.2y)^2$ as $1.2y^2$. Other common errors were to form the equation $\frac{0.8x \times \pi \times (1.2y)^2}{360} = \frac{x \times \pi \times y^2}{360}$ or to divide the sector area of A by the sector area of B.

Question 9

(a) (i)(a) The majority of the candidates use the diagram to find the correct median. The most common mistake was giving the answer 1.35 which is the median of the values on the x-axis.

(b) Less candidates understood how to use the graph to find the 30th percentile, with the most common mistake being to calculate $\frac{30}{80} \times 100$ and then giving the answer as either 37.5 or reading that from the graph and getting 1.32.

(ii) There were only around a third of the candidates who obtained the correct value of y. The vast majority of candidates were able to calculate $\frac{2}{5} \times 80$ to get 32 trees but then did not realise that this needed to be subtracted from 80 in order to be used correctly on the diagram.

(iii) Correct frequencies were seen on over half the scripts. Some candidates managed to get one or two correct values but made mistakes either with their subtraction or their readings of the required values. The most common wrong answers were 58, 76 and 80, giving the cumulative frequencies rather than the frequencies.

(b) This was a challenging question which really tested the understanding of candidates, however, nearly half of them were able to use their knowledge of finding an estimated mean and set up a pair of simultaneous equations, which they then solved correctly. Many of the other candidates having used the midpoints to correctly form an equation by equating to the given estimated mean, failed to write down the simpler equation involving the total frequency.

Question 10

(a) Some candidates were successful in finding the missing angle. Common errors included calculating the interior angle of a regular pentagon, subtracting 360 or 180 from 453 or using another value other than 540, often 720, for the angle sum.

(b) Around two fifths of the candidates correctly calculated the length *ED* with the relevant working shown. The most successful method appeared to be the sine rule approach to find angle *ADE* with many then using the sine rule again to find the required length. Not as many candidates started with the cosine rule and a considerable number of those who did used it incorrectly and so did not arrive at a three-term quadratic equation. Those who correctly set up the cosine rule equation often did not arrive at the correct equation due to the negative value of cos120.

Question 11

(a) Many candidates knew that the correct first step was to set up an equation using Pythagoras' theorem. To process this equation needed care; some candidates lost their way partially due to the difficulty of the question but also by making errors with negative signs and the removal of brackets. The most accurate method of solution appeared to be from the use of the concise way, arriving at the equation $(n + 1)^2 = 25$ before square rooting both sides of this equation. That who attempted to expand the brackets often tried to expand $(-1 - n)^2$ which resulted in incorrect expansions such as $1 - n^2$ or $1 - 2n + n^2$.

(b) This proved to be the most difficult question on the paper. Some candidates had success by drawing a line with the coordinates for *R* and *S* stated, along with an indication of where *T* was. An informal vector approach was then used to find the coordinates of *T*. Very few candidates showed sufficient clarity to gain partial credit. Some candidates attempted to form an equation connecting a combination of the distances *RS*, *ST* and *RT*. A clear diagram was used with success by very few candidates; most tried to solve just using numbers. Some candidate misunderstood the given ratio resulting at times in the use of 7 instead of 3 or 5. This part was not attempted by many candidates.

(c) Nearly half of the candidates were able to find the correct equation of the perpendicular bisector. Candidates appeared to be familiar with finding midpoints and gradients, however some did not arrive at the correct equation often due to multiplying the equation by 3 and failing to amend the constant resulting in the equation $y = \frac{2}{3}x + 13$, while other chose to use rounded decimals instead of fractions. Around a fifth of the candidate did not attempt this question.