MATHEMATICS SYLLABUS D

Paper 4024/11
Paper 11

Key messages

Candidates should ensure they are showing all working and answers are clearly written in the appropriate answer space. Candidates should also take extra care to write numbers clearly. The use of extra sheets of paper should be discouraged.

Candidates need to take notice of instructions given within a question, e.g. **Question 12** instructs the candidates to write each number correct to 1 significant figure, **Question 13(b)** requires the answer to be in its simplest form and **Question 15(c)** asks for the answer in the form $2^a \times 3^b \times 5^c$.

General comments

The performance on this paper was generally good. The majority of candidates attempted all the questions and appeared to have sufficient time to complete the paper.

The questions that seemed to prove a higher level of challenge were **Questions 2**, **5**, **6(b)**, **15(c)**, **16**, **24** and **25**.

Generally candidates did particularly well on the algebra questions but found the questions involving symmetry and vectors more of a challenge.

Comments on specific questions

Question 1

(a) Most candidates answered this correctly. A common incomplete answer was ten thousands.

(b) Most candidates answered this correctly. Common incorrect answers were 35 680, 3569, 35 000 and 36 000.

Question 2

(a) Many candidates found this question challenging and gave the incorrect answer 2.

(b) The majority of candidates found this part challenging and a variety of incorrect answers were seen.

Question 3

(a) Most candidates answered this part correctly.

(b) Many candidates answered this correctly. The incorrect answer 45 was given by a few candidates. Some candidates misread the table and did not realise that the temperatures in this question were averages. Candidates then added temperatures together and divided by the number of temperatures in an attempt to find the average February temperature in Yakutsk.

Question 4

(a) Some candidates had difficulty with this question. Many candidates calculated the volume of the cube with edge 5 cm (125 cm^3) but then did not subtract this from the total volume to find the volume of the other cube and hence the length of its edge.

(b) Those candidates who gained 2 marks in part **(a)** were usually able to answer this part correctly showing a good understanding of the topic. Some candidates made an error when counting the number of edges of a cube.

Question 5

Most candidates were able to describe the solid as a cylinder but some made errors when describing its dimensions.

Question 6

(a) This part was answered correctly by almost all candidates.

(b) Candidates found this part more challenging than part **(a)**. Many gave an irrational number as their answer but one outside the given range, e.g. $\sqrt{11}$.

Question 7

(a) Many correct answers were seen. 3 was a common incorrect answer and 2.5 from $\frac{2+3}{2}$ was also seen.

(b) Most candidates answered this part well. Some made arithmetic errors, e.g. $0\times3=3$, $0\times4=4$ or divided the total number of pets by 6 instead of 36. $\frac{0+1+2+3+4+5}{6}=2\frac{1}{2}$ was seen as well as $\frac{3+8+3+4+2}{6}$.

Question 8

(a) Most candidates answered this question correctly.

(b) Most candidates answered this question correctly. A few made arithmetic errors, e.g. $\frac{3}{5}\times\frac{3}{2}=\frac{6}{10}$.

Question 9

Many candidates answered this correctly and most earned at least one mark, misplacing one of the lengths.

Question 10

(a) Candidates usually answered this question correctly and plotted the points accurately.

(b) Not all candidates were able to describe the correlation as negative.

(c) Almost all candidates drew an acceptable line of best fit. A very few joined the points with a zig-zag line or omitted to draw a line of best fit.

(d) The majority of candidates correctly estimated the monthly rent from their line of best fit.

Question 11

(a) Most candidates answered this part correctly. A minority gave the answer 23.

(b) Most candidates answered this part correctly. A small number carried out the wrong calculation, e.g. $1200 \div 0.3$ or $0.3 \div 1200$.

Question 12

Many candidates observed the instructions in this question and answered it correctly. Some candidates omitted the question or tried to work with the given numbers leading to lengthy and complicated calculations. Some candidates incorrectly rounded 0.28 to 0.2 instead of 0.3 while others made the arithmetic error of writing $\frac{0.3 \times 40}{80} = \frac{3 \times 400}{800} = \frac{3}{2} = 1.5$.

Question 13

(a) (i) Most candidates answered this part correctly**.** Some incorrect answers seen were $x^2 + x - 12$, $x^2 - 12$ and $(x^2 + 4x)(3x - 12)$.

(ii) Most candidates answered this correctly. The most common error was to end the expansion with –1 or –2 or +1 leading to the incorrect answers $x + 9$, $x + 8$ and $x + 11$.

(b) This part was answered correctly by most candidates. Some gave their answer as $\frac{51b}{27}$ omitting to write it in its simplest form.

Incorrect cancelling was also seen by some candidates, e.g. $\frac{24b + 10b}{18} = \frac{4b + 10b}{3} = \frac{14b}{3}$ or $\frac{4b + 5b}{3 + 9} = \frac{9b}{12}$.

Question 14

(a) Many candidates found this question challenging. Some incorrect answers involved 0.863, 86.3 and 863 multiplied by different powers of 10.

(b) (i) Many gave correct answers to this part whilst Sahara was a common wrong answer.

(ii) Some candidates found this part challenging and ignored the different powers of 10 and simply added 9.0 and 2.3 giving the answer 11.3×10^{11} or 1.13×10^{12}. The answer 9.23×10^6 was also seen.

Question 15

(a) Most candidates answered this correctly. Some candidates seemed unsure how to work with the indices –3 and –4 resulting in many different incorrect answers, e.g. 1, –1, 7^{-7}, 7^{-2}, $\frac{3}{4}$ and $\frac{4}{3}$.

(b) Most candidates answered this correctly. A common incorrect answer was $k = -4$.

(c) Many candidates found this part challenging. Some ignored the instruction and left their answer as $3(2^4 \times 3^6 \times 5^8)$. Many earned 1 mark for getting 2^4 and 5^8 but the wrong power for 3.

Question 16

Many candidates found this question challenging.

(a) There were a variety of common mistakes on this part. Some candidates drew axes on the grid and then marked **p** as (2,3). Others drew a horizontal line 2 units long and then a vertical line 3 units long. A few drew the correct vector but did not indicate the direction of the vector with an arrow.

(b) Similar errors were made in this part as in **(a)**. Some candidates marked (–6, 4) on axes while others drew horizontal and vertical lines. A few drew the correct vector but again without the direction indicated by an arrow.

(c) A minority of candidates earned the full 2 marks on this part but some gained 1 mark by calculating the vector $\begin{pmatrix} 5 \\ 1 \end{pmatrix}$.

Question 17

Some candidates answered this correctly. Errors occurred often because candidates forgot to square the scale in order to find the relationship between cm² and km² resulting in the common incorrect answer of 3.

Question 18

(a) Most candidates shaded the correct region in the Venn diagram.

(b) Many candidates incorrectly indicated that $n(F \cap B) = 5$: nine females did not have black hair and six males have black hair but candidates then omitted to show that 12 members are not in *F* or *B*. It is suggested that candidates check the given data against their Venn diagram to ensure that they have shown it all correctly.

Question 19

Many candidates did very well on this question.

(a) A common error was to think that angle *DEG* was equal to angle *ABG* and to write angle *DEG* = 48°.

(b) Some candidates seemed to have difficulty identifying the required angle. Some incorrect responses were 180° − 96° = 84°, or 360° − 150° = 210°.

(c) It was very common for candidates to assume that angle *DBC* = angle *ABG* and give the answer 48°. Others thought that the opposite angles of a cyclic quadrilateral were equal and gave the answer 75° and some assumed that angle *DBG* was 90°.

Question 20

(a) Most candidates gave the correct answer.

(b) Many candidates were able to identify the inverse function. Some did not seem to recognise the notation and took it to mean $\frac{1}{f(x)}$. Some incorrect answers were $\frac{6^{-1}x+2}{5}$ and $\frac{1}{\frac{6x+2}{5}}$.

A few candidates left their answer as $\frac{5y-2}{6}$, forgetting to replace the *y* with *x*.

Question 21

Some candidates found this question challenging. Some used 'y is proportional to $(x + 1)^2$' to obtain $y = \frac{k}{9}$ or $y = \frac{k}{(x+1)^2}$ but got no further. Several candidates complicated the calculation $(9 + 1)^2$ using $9^2 + 2 \times 1 \times 9 + 1$ and making an arithmetic error instead of recognising that $(9 + 1)^2 = 10^2 = 100$

Question 22

(a) Many candidates answered this part correctly or earned at least 1 mark for correct partial factorisation. Some incorrect answers seen were $(5x + 3y)(a - 2c)$ and $(5x + 3y)(2c - a)$.

(b) Most candidates found this part more difficult than **(a)**. Some were able to factorise so as to get two of the terms correct, e.g. $(3x - 1)(5x + 4)$, $(3x - 4)(5x + 1)$ and $(15x + 4)(x - 1)$. A few candidates attempted to use the quadratic formula to solve the equation $15x^2 - 7x - 4 = 0$

Question 23

Many candidates rearranged the formula correctly and earned full marks.

Most rearranged the fraction correctly but then various errors were seen, e.g.

$$\begin{aligned} (2x-1)y &= 3x+2 \\ 2xy - y &= 3x+2 \\ 2xy - y - 2 &= 3x \\ \frac{2xy - y - 2}{3} &= x \end{aligned} \qquad \begin{aligned} (2x-1)y &= 3x+2 \\ 2xy - 3x &= y+2 \\ 2x - 3x &= \frac{y+2}{y} \\ x &= -\frac{y+2}{y} \end{aligned} \qquad \begin{aligned} (2x-1)y &= 3x+2 \\ 2x - 1 - 3x &= 2 - y \\ -x &= 3 - y \\ x &= y - 3 \end{aligned}$$

A few candidates omitted this question.

Question 24

Some candidates found this question demanding and had difficulty multiplying the matrices together, possibly because they contained letters. However, this is not unsurprising given where the question is in the paper. **MN** was often calculated correctly.

Some incorrect products included $\begin{pmatrix} k & 0 \\ 0 & 12 \end{pmatrix}$ and $\begin{pmatrix} k & 0 \\ 4k+3 & 12 \end{pmatrix} \Rightarrow \begin{pmatrix} k & 0 \\ 7k & 12 \end{pmatrix}$.

More candidates had problems evaluating **NM** and **NM** = $\begin{pmatrix} k & 0 \\ 16 & 12 \end{pmatrix}$ was a common error. Some candidates equated $4k + 3 = 0$ or $4k + 3 = 16$ instead of $4k + 3 = 17$. A common incorrect answer arising from no relevant working was $k = 3$.

Question 25

Most candidates found this question challenging, which is to be expected given it is the final question of the paper. Some good answers were seen but a number of candidates omitted this question.

(a) (i) Many candidates expressed $\overrightarrow{AC}$ correctly. A few did not realise that B was the midpoint of AC and gave the answer $6\mathbf{a} + 3\mathbf{b} + \overrightarrow{BC}$, with some making an error in doubling $6\mathbf{a} + 3\mathbf{b}$.

(ii) Some candidates did not realise that the direction of the arrow on $\overrightarrow{DC}$ is important and equated $\overrightarrow{AD}$ to $\overrightarrow{AC} + \overrightarrow{DC}$, i.e. 12**a** + 6**b** + 5**a** + 2**b** = 17**a** + 8**b**. Others tried to work out 12**a** + 6**b** − (5**a** + 2**b**) but forgot to subtract both 2**b** and 5**a**, giving $\overrightarrow{AD}$ = 7**a** + 8**b**.

(b) Some candidates attempted to answer this part by stating equal angles or by stating that *E* is the midpoint of *AD* and *B* is the midpoint of *AC* so $\overrightarrow{EB}$ is parallel to $\overrightarrow{DC}$. Candidates needed to find the vector expressions for both $\overrightarrow{EB}$ and $\overrightarrow{DC}$; some took this approach and managed to find the correct expressions but found it more challenging when stating the link between them and hence showing that they were parallel.

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 and interpret graphs and diagrams
- set out their work in clear, logical steps.

General comments

In general, candidates were well prepared for most of the topics covered by this paper and most attempted all the questions. The topic areas that offered most challenge to candidates were standard form, ratio and vectors.

Many candidates presented their work well with workings set out legibly and answers clearly stated on the answer line. Most used the appropriate geometrical instruments correctly to draw and take measurements from diagrams.

Most candidates demonstrated sound basic arithmetic skills, although dealing with negative values caused some difficulty. Candidates had good algebraic skills, although the manipulation of negative fractional indices was found to be a challenge.

Many candidates would benefit from a greater understanding of mathematical terms used in the syllabus such as congruent and irrational number. Candidates should be able to state angle facts correctly when giving geometrical reasons.

Candidates should take care to ensure that their work is legible and should ensure that numbers such as 1, 4 and 7 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.

Comments on specific questions

Question 1

(a) Most candidates were able to add the two fractions using a common denominator of either 6 or 18.

(b) Most candidates were able to multiply the decimals correctly. The most common incorrect answer was 0.8. Some candidates converted the decimals to fractions and usually multiplied these correctly, although some made errors when attempting to cancel the result.

Question 2

(a) Most candidates used the key to complete the table and pictogram correctly. In some cases, the quarter circle for orange was unclear or incorrect and equilateral triangles, half circles or three-quarter circles were seen. Some candidates may not have read the key that showed a circle representing 4 people and used a circle to represent 1 person.

(b) Many candidates correctly identified banana as the mode, although incorrectly gave the frequency, 12, as the answer rather than the category, banana.

Question 3

Many candidates gave the correct coordinates for the two reflected points with only a small proportion transposing the *x*- and *y*-coordinates. The most appropriate first step in this question is to mark the other two vertices of the quadrilateral on the diagram but many candidates did not do this. Some candidates gave the coordinates of the two points given on the diagram, which may indicate that they were unfamiliar with the term 'line of symmetry'.

Question 4

(a) Most candidates gave the correct answer, although some stated the difference as –21 rather than 21. The most common incorrect answer was 15, the result of 18 – 3 rather than 18 – (–3).

(b) Candidates who understood the concept of bounds were able to identify that the bounds are –6.5 and –5.5. In some cases, the negative values caused confusion and the upper bound was given as –6.5 rather than –5.5.

Question 5

(a) Many candidates were able to measure the line accurately and use the scale to find the distance in kilometres. Some candidates did not read the scale on their ruler accurately, with 9 cm sometimes seen, but partial credit was given when the measured value was stated and then scaled correctly to give the answer. A small number of candidates divided their length by 2 rather than multiplying by 2.

(b) Many candidates could use their protractor to measure the bearing within the acceptable tolerance. Some candidates were not confident with how to find a bearing and measured the angle correctly but then added or subtracted it from 90, 180 or 360. Some candidates gave a distance rather than an angle in this part.

Question 6

The idea of simple interest was well understood, but many candidates gave the answer as the total amount in the account at the end of 4 years rather than the total amount of interest. Some candidates wrote down the correct calculation but made arithmetic errors in cancelling or in multiplying by 1.5. In some cases, the calculation $250 \times 1.5 \times 4$ was seen without the division by 100. Very few candidates attempted to use compound interest in place of simple interest.

Question 7

Most candidates identified that the two areas were given in different units and that a unit conversion was required. Those who correctly converted 85 mm^2 to 0.85 cm^2 usually completed the subtraction correctly. It was common to see the answer 0.5 which was the result of dividing 85 by 10 rather than 100 when candidates did not appreciate the difference in converting between length and area units.

Question 8

Most candidates understood that they needed to add the given interior angles and subtract this from the sum of angles in the pentagon. Some were able to recall that the sum of angles in a pentagon is 540 and others used the formula $180(n – 2)$ to calculate it. It was common to see 450 or 720 used as the angle sum, a result of use of an incorrect formula. Some treated the polygon as a regular pentagon and divided 540 by 5. It was also common to see candidates treat the shape as a quadrilateral or a triangle and subtract 395, the sum of the given angles, from 360 or 180 without appreciating that this gave a negative result.

Question 9

(a) Most candidates completed the table correctly.

(b) Candidates who are familiar with finding the *n*th term of a linear sequence usually found the correct expression. Many knew the formula for the *n*th term as $a + (n - 1)d$ which led to $5 + 3(n - 1)$ although this was sometimes simplified incorrectly. Some candidates identified that the sequence was increasing by 3 each time and gave the incorrect answer of $n + 3$.

(c) Most candidates were able to attempt to solve this problem but there was some confusion about what was required as the answer. Many found that pattern 20 used 62 counters, which results in 38 counters left from the initial 100. This was often given as the final answer, with candidates not finding the pattern number with 38 counters. Some candidates attempted to find the 20th term by multiplying 17, the number of counters in the 5th pattern, by 4 which is an incorrect method.

Question 10

This question was found to be very challenging for many candidates. A common misconception was to find the fraction of blue from each given ratio as $\frac{8}{11}$ and $\frac{5}{11}$, and either add or multiply these fractions. The other common error was to add the blue parts of the two ratios leading to a combined ratio of red : blue : green of 3 : 13 : 2 and the fraction of blue counters as $\frac{13}{18}$.

Question 11

(a) Most candidates were able to use ruler and compasses to construct the angle bisector showing two sets of correct arcs and drawing the bisector long enough to reach side *QR*. Very few candidates drew a correct bisector without showing appropriate arcs or drew a bisector that did not reach side *QR*. A small number of candidates attempted to bisect sides *SP*, *SR* or *RQ*.

(b) Most candidates identified the correct region using clear shading. Shading needs to reach all the boundary lines and right up to the vertices of the region. In some cases, the intended region was unclear because the shading did not cover the complete region and the construction arcs appeared to form part of its border.

Question 12

(a) This question demonstrated the confusion between decimal places and significant figures with an answer of 0.002, correct to 3 decimal places, commonly seen when the answer 0.00204, correct to 3 significant figures, was required. Sometimes the answer was truncated to 0.00203 or the value 204 given rather than the required decimal. When rounding decimals, trailing zeros should not be included, so the answer 0.00204 000 was not accepted. Some candidates gave the answer in standard form, which was accepted.

(b) Candidates are familiar with this type of question, and many started by attempting to write the given numbers correct to 1 significant figure. The most common error was to round 63.7 to 64 instead of 60 which led to the answer of 320. Only a few candidates rounded 0.425 to either 1 or 0. Some candidates rounded all three values correctly but made arithmetic errors, usually when dividing by 0.4. Several candidates attempted to work out the exact answer without rounding any of the numbers which was not what the question required.

Question 13

(a) Many correct answers were seen in this part. Some candidates found the square root rather than the cube root of 64 leading to $(3 \times 8)^2$ and the answer 576 but some errors were also seen when evaluating $(3 \times 4)^2$ with answers such as 124 or 24 seen. Some candidates attempted to cancel the power of 2 outside the bracket with the square root leading to working such as $9 \times 4 = 36$.

(b) Only a small minority of candidates seemed familiar with irrational numbers, and answers of decimals, fractions, or integers were commonly seen. Those candidates who did know the definition of an irrational number often gave the square root of an integer in the range $\sqrt{21}$ to $\sqrt{30}$ although some wrote $\sqrt{25}$ without realising that this is not irrational. Answers of $\sqrt{5}$ or $\sqrt{20}$ were also seen, but these are not within the required range. Very few answers in terms of π were given.

Question 14

(a) Many candidates were able to interpret the standard form and order these numbers correctly.

(b) This part was found to be very challenging for most candidates. Candidates who had a good understanding of standard form calculations used the approach of rearranging the given calculation to $a \times 10^{-7} = 4 \times 10^{-16} \times 5 \times 10^{-b}$ leading to $a \times 10^{-7} = 20 \times 10^{-16-b}$. This often led to the partial solution of $a = 20$ and $b = 9$ because candidates did not realise that the value of a had to be in the range $1 < a \leqslant 10$ to give a number in standard form. This approach also often led to the incorrect answer of $a = 20$ and $b = -9$. Some candidates realised that a had to be 2 rather than 20 but then were usually unable to adjust the power correctly with $b = -8$ or 10 commonly seen.

Question 15

Many candidates are familiar with the topic of proportion and answered this question correctly. Most candidates began with the correct proportional relationship $y = k(x-1)^2$. The method for calculating k and then using this to find the value of y when $x = -2$ was understood well but arithmetical errors, particularly when calculating k or squaring a negative number, led to incorrect answers. Some candidates used incorrect proportional relationships such as y proportional to x or y inversely proportional to $(x-1)^2$. Others did not use a proportional relationship and simply substituted $x = -2$ into $y = (x-1)^2$. Some attempted to expand the bracket $(x-1)^2$ before substituting the value of x and this often led to errors.

Question 16

(a) Those candidates who understood what a tangent was usually made a good attempt at drawing a tangent to the curve at the correct point. In some cases, the tangent did not quite touch the curve at $x = -1$ or was drawn at $x = 1$ rather than $x = -1$. There was usually an attempt to find the gradient using change in y divided by change in x, but errors were sometimes seen when reading values from the graph and the gradient was often given as positive rather than negative. A few candidates found change in x divided by change in y. Some candidates found a gradient without drawing a tangent which was not acceptable.

(b) Those candidates who realised that the solutions could be found by drawing the line $y = 2$ on the given graph often found all three solutions correctly, although in some cases $x = 0$ was omitted or the scale was not read accurately. A small number of candidates gave the solutions as coordinates rather than just the x-values. The most common error by candidates who were attempting to use a correct method was to draw the line $y = -2$ in place of $y = 2$. Some candidates ignored the demand to draw a line on the graph and attempted to solve the equation algebraically which was not acceptable.

Question 17

(a) This question was found to be challenging by those candidates who did not identify that the triangles formed had to be both congruent and isosceles. Those candidates who did select both square and rhombus often also selected kite as well. Candidates who sketched the six quadrilaterals and divided them into triangles were often more successful than those who drew no diagrams.

(b) The best answers for this question were presented with one line for each of the three relevant pairs and their reasons followed by a valid conclusion. Many candidates understood that they needed to pair up either sides or angles from the two triangles, but they did not always give reasons or gave incorrect reasons, and few went on to give the concluding congruence condition. Some gave three pairs of angles which shows that the triangles are similar but not congruent. Candidates often gave inappropriate pairs of sides for example *AC* = *BD* with the reason that they were parallel or gave incorrect reasons such as angle *ACX* = angle *DBX* = 90°. The three letters to identify an angle were sometimes in the wrong order so could not score any marks. Correct three-letter notation should be used for angles: it is not sufficient to state that the angles at *X* are the same without specifying that they are angles *AXC* and *BXD*. Reasons should be stated using correct language so alternating, alternative or Z-angles are not acceptable for alternate angles and X-angles is not acceptable for opposite angles.

Question 18

Many candidates were able to find the inverse function correctly although some gave the final answer as $\frac{y+7}{3}$ rather than $\frac{x+7}{3}$. The most common error was the incorrect first step of $y - 7 = 3x$. A small number thought that the inverse function was the reciprocal of the function and gave the answer $\frac{1}{3x-7}$.

Question 19

(a) (i) Most candidates answered this question well. The most common errors were to include i twice as it is included in both *P* and *Q*; to give just i as the answer, the intersection rather than union of the sets; or to give {b, c, d} as the answer, the complement of $P \cup Q$.

(ii) Candidates who understood that the notation used meant the number of elements was required often gave the correct answer. It was common to see the correct elements listed rather than the number. Some candidates gave the answer as n(6) which was not accepted.

(b) Candidates found it difficult to describe the shaded subset with each of the following commonly seen: $A \cap C$, $(A \cup C) \cap B'$, $(A \cap C) \cup B'$ and $(A \cap C)\ B'$.

Question 20

(a) Many candidates identified that angle at the centre is twice the angle at the circumference was required here and gave the correct answer. The most common error was to use this fact incorrectly and give the answer 140°.

(b) This part was more of a challenge although many candidates used the isosceles triangle *OAB* to find angle *OAB* as 55° which could then be used with the given 25° and angles in opposite segments to find angle *BCD*. Some candidates showed 55° in their working, but it had to be associated with angle *OAB* or *OBA* either by marking on the diagram or labelling in the working to gain credit. The most common error was to assume that angle *BD* was a diameter leading to the answer 90°.

Question 21

(a) Many candidates factorised the expression correctly. The most common errors were incorrect signs in the brackets with $(4x + 3)(x - 2)$ and $(4x - 3)(x - 2)$ both commonly seen. A small number of candidates misread the question and thought that solutions to a quadratic equation were required.

(b) Some candidates made a good attempt at this part and reached the correct answer or an answer with either x^3 or 4 positioned correctly. A small number did not completely simplify the answer and left it as $\frac{x^3}{2^2}$ or $\frac{4^{-1}}{x^{-3}}$. Some showed a correct first step of dealing with the negative power and wrote $\left(\frac{x^6}{16}\right)^{\frac{1}{2}}$ but made errors in the next step, usually cancelling the 2 in the power with one of the numbers in the bracket. It was also common to make errors in the first step and $\left(\frac{x^6}{16}\right)^2$ was often seen. Few candidates started by simplifying to $\left(\frac{4}{x^3}\right)^{-1}$.

Question 22

(a) Many candidates gave the correct probability. The most common error was the answer $\frac{2}{9}$, the probability of taking E rather than not taking E.

(b) Many candidates found working with combined probability very challenging. Those who understood that the letters were taken without replacement and that they needed to consider the probabilities of two Ss and two Es often showed the sum of the correct two products and reached the answer with no arithmetic errors. Some candidates showed only one correct product, usually $\frac{2}{9}\times\frac{1}{8}$ and others found probabilities with replacement. Others acknowledged the instruction 'without replacement' and decreased the numerator but did not adjust the denominators and gave the products $\frac{3}{9}\times\frac{2}{9}$ and/or $\frac{2}{9}\times\frac{1}{9}$. Those who were not confident with combined probability added instead of multiplying or gave the answer $\frac{5}{9}$, the probability of selecting one of the repeated letters.

Question 23

Many candidates knew the formula for the area of a sector. Some found the area of the minor sector using the 80° given in the question rather than subtracting this from 360° to find the major sector angle. Arithmetic errors in 360 – 80 or in cancelling the fraction were sometimes seen. Some candidates worked out the area of the whole circle and others used the formula for the arc length rather than the sector area. Very few candidates attempted to substitute a value of π into their formula.

Question 24

(a) Many candidates solved the equation correctly. The first step of eliminating the fraction was usually correct although a small number expanded the bracket incorrectly as $3x + 10$ rather than $3x + 30$. Those who showed all steps in their working usually rearranged correctly to $2 - 30 = 9x + 5x$. Some simplified this to $28 = 14x$, others correctly wrote $-28x = 14x$ but some still gave the final answer of 2 rather than –2. A small number of candidates attempted to cancel values on the left-hand side of the equation before eliminating the fraction.

(b) Most candidates used the correct approach of writing the two fractions with a common denominator and then expanding and simplifying the numerator. The main error in this part was in expanding the brackets on the numerator to give $-5x - 10$ rather than $-5x + 10$. Those candidates who showed intermediate working were more successful in reaching the correct result. Some candidates wrote the denominator without brackets or expanded it incorrectly. A small number of candidates subtracted the expressions in the numerator and the denominator.

Question 25

(a) Many candidates found interpreting the vector notation and ratios used throughout this question a challenge. Some mixed vector notation with either numbers or vector routes and answers such as **c** + 3 or **c** + $\overrightarrow{CR}$ were seen in this part. Those who attempted to use the ratio of 2 : 3 correctly often reached the correct answer of 2.5**c**. Common incorrect answers using the correct notation were 5**c**, 1.5**c** and 0.6**c** which were a result of misinterpretation of the ratio $\overrightarrow{OC} : \overrightarrow{CR} = 2 : 3$.

(b) Finding the correct answer in this part was a challenge for most. An appropriate first step in this type of question is to identify a route on the diagram that can be used to find the required vector, for example, $\overrightarrow{CR} + \overrightarrow{RQ}$ or $\overrightarrow{CO} + \overrightarrow{OP} + \overrightarrow{PQ}$, although some candidates did not appreciate that the letters must be ordered correctly so $\overrightarrow{CR} + \overrightarrow{QR}$ is not acceptable. Many were able to reach a partially correct vector with either 4**a** or 1.5**c** in their answer. It was common to see $\overrightarrow{AP} = 5\mathbf{a}$ rather than 4**a** and $\overrightarrow{CR} = 3\mathbf{c}$ rather than 1.5**c**.

(c) This part was found to be challenging even for the most able candidates. An answer of 1 : 16 was often given from use of $\left(\frac{\overrightarrow{OA}}{\overrightarrow{OP}}\right)^2 = \left(\frac{\mathbf{a}}{4\mathbf{a}}\right)^2$. The other most common answer was 2 : 25 from use of $2.5\mathbf{c} \times 5\mathbf{a}$.

MATHEMATICS SYLLABUS D

Paper 4024/21
Paper 21

Key messages

Candidates should take care to ensure they are reading the question fully and responding to what is being asked rather than making false assumptions (**Question 1(a)(i)**, **Question 1(a)(ii)** and **Question 2(e)**).

Candidates should take care in 'show that' type questions to work with exact values when an exact answer is required (**Question 4(b)**).

Candidates should use a suitable degree of accuracy in their working and in their final answer (**Question 1(b)(i)** and **Question 1(b)(iii)**). Final answers should be rounded correct to three significant figures where appropriate or when non-exact, or to the degree of accuracy specified in the question.

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) Almost all candidates correctly found the amount spent on insurance, however a reasonable proportion then subtracted this amount from the running cost before finding $\frac{3}{25}$ of this figure, rather than finding $\frac{3}{25}$ of the running cost as requested. Candidates should take care to ensure they are responding to the information in the question (**Key messages**).

(ii) Those candidates who read the question carefully were usually correct in finding the increased tax amount. However, again some misread the question (**Key messages**) and included the running cost amount of $5200 in this part rather than just the tax amount of $740 given in the question.

(b) (i) This part was usually answered correctly. However, as the answer was exact and money, the answer should be left as 85.14, rather than 85.1 (**Key messages**).

(ii) This part was challenging for some candidates. Common errors were not multiplying by 100 to find the number of kilometres driven or leaving the answer as 98 (litres) and not including the rate of 7 litres per 100 km to calculate the number of kilometres driven.

(iii) The main error here was in dividing the cost increase by 2.24 instead of by 2.20. Answers were often incorrectly rounded to 1.8 (2 significant figures) rather than to 1.82 (3 significant figures) (**Key messages**).

Question 2

(a) This question was generally well answered by candidates. On a very small number of occasions the squares were mis-counted.

(b) If candidates spotted this was a linear sequence of the form $4n + k$, they often went on to find the correct expression for the *n*th term. Many candidates used the standard method to find the *n*th term for a linear sequence of $a + (n - 1)d$ with $a = 6$ and $d = 4$.

(c) A few candidates thought the 98 in the question was *n* rather than trying to find the value of *n*. Some candidates who could not answer **part (b)** correctly were successful in this part, often by repeated addition to get to a value of 98.

(d) This was a more challenging *n*th term question with fewer candidates successful than in **part (b)**. Some candidates recognised this was a quadratic sequence and substituted appropriate values into $an^2 + bn + c$ = term value. Others used $a + (n-1)d + \frac{1}{2}(n-1)(n-2)c$ = term number. The question seemed to prove easier for those candidates who recognised the sequence was just the square number sequence doubled.

(e) Candidates should ensure they pay attention to any words written in bold in a question. In this question the emboldened word was to highlight that the total number of tiles in Pattern 20 was required, rather than just the number of white (or grey) tiles. A substantial number of candidates made the error of finding just the white (or the grey) tiles (**Key messages**).

Question 3

(a) (i) This part was extremely well answered, with almost all candidates gaining the mark. The only error tended to be in misreading the scale and giving an answer of 20.8 rather than 28.

(ii) Some candidates seemed to misunderstand the graph here and created a ratio with the \$20 and \$1.50. Most candidates, however, correctly subtracted the \$1.50 to then read off the length of fabric corresponding to \$18.50.

(b) Again, this part was extremely well answered, with almost all candidates gaining full marks. The working was well set out and having a three-part ratio did not disconcert candidates.

(c) There was a large proportion of candidates who correctly recognised this as a bounds question. Using the given area, and the upper bound for the width, the upper bound for the length could be found and then the value of *d* could then be calculated.

Question 4

(a) Many candidates successfully found the value of *x*. There were a large number who correctly set up an equation in *x* for the volume but did not get the final correct value. For these candidates this equation, often written in a form such as $x \times x \times 10 = 62.5$ was then incorrectly simplified to a form such as, $2x \times 10 = 62.5$.

(b) (i) As this is a 'show that' question, candidates must ensure all working is shown to gain the mark. In addition, as this question requires an exact answer to be derived, candidates should not use decimals in any part of their working and should use the symbol π throughout rather than an approximation (**Key messages**).

(ii) This question was challenging for many candidates. It was expected that the given arc length in **part (b)(i)** would be equated to the circumference of the base of the cone, and then the radius of the cone found. Candidates should remember that even if they cannot derive the required figure in **part (b)(i)** they can still use this in any following parts.

(iii) Many candidates, including those who were unsuccessful in **part (b)(ii)**, realised the need for Pythagoras' Theorem in this part.

(c) Knowledge of the formula for the volume of a cylinder would have helped many candidates, although use of the rate with the volume found was generally done well. Rounding excessively during working often led to inaccurate final answers (**General comments**). The question asked for the answer to be given correct to the nearest second but not all candidates did this.

Question 5

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

(b) A considerable proportion of candidates gained full marks in this part. The scale used on the vertical axis did cause minor problems for some, but on the whole plotting was careful and accurate. The points should be joined with a smooth curve. Occasionally candidates made the mistake of joining points with straight lines, or drawing a line of best fit.

(c) Few candidates gained full marks here. Few candidates seemingly made the connection between the given equation and the graph and did not rearrange the given equation to the form of the graph's equation. Solving the original cubic equation on a calculator did not gain full marks, as the question specifically asked for a suitable straight line ($y = 5$) to be drawn on the graph.

Question 6

(a) Drawing the path from *D* to the midpoint of *AB* was usually done well and measuring the angle did not cause many problems for most candidates. Some candidates did not see the second request for the angle and did not fully complete the question.

(b) This proved much more difficult than **part (a)**, perhaps due to the number of demands within the question. The request for the area to be less than 325 metres from *B* was usually done well, with candidates using the scale correctly and understanding the need for an arc with centre *B*. The next request was often done incorrectly or not at all. Candidates should have constructed an angle bisector of angle *BCD,* but this was very often absent. If candidates did manage both constructions, they often then went on to shade the correct required region.

(c) This part involved candidates correctly completing most of **part (b)**. If **part (b)** was correct, the measurement and the conversion using the scale of the diagram was usually correctly completed.

Question 7

(a) (i) Candidates had no difficulties with this part.

(ii) Few candidates answered this questions correctly, with many being unsure whether to multiply, add or divide the probabilities given in the table. Very few of those who knew to multiply 0.26 and 0.4 then went on to multiply this product by two.

(iii) Similar to **part (a)(ii)**, although this was more challenging for candidates. Candidates again were unsure as to what to do with the probabilities from the table, and some wrongly included the figure 7, maybe due to 7 days in a week, and tried to use this to calculate new probabilities. The easiest method was to find the probability the bus was not used on either Wednesday or Thursday (0.6×0.6) and subtract this from 1.

(b) (i) Few candidates showed calculations for frequency density here and a sizeable proportion of candidates ignored the frequency density given on the vertical axis and used the frequency instead in their diagram. Some candidates found the correct frequency densities but struggled to find $8\frac{3}{4}$ on the horizontal axis.

(ii) This was perhaps the most difficult part for candidates. Many added 18 and 10 without considering the proportion of the 18 that is required. Although some did find there were 8.25 hours between the two times given, they used the full figure of 18 rather than finding $\frac{2}{3} \times 18 = 12$ and adding this to 10.

Question 8

(a) (i) Many candidates created an equation connecting *x* and *y*, and divided this by 5 to attain the required equation. Note that as the final answer is given, it is important to fully show all working to gain the mark.

(ii) Many candidates were successful here. Candidates should again note the demand in the question to show working, meaning answers found purely using a calculator would not gain full marks. However, the great majority of candidates showed clear and careful working. As the answers represented costs in dollars, final answers should be given in decimals rather than as fractions.

(b) Many candidates struggled with the double inequality. The algebra itself did not seem to cause problems, rather candidates seemed to find having to apply the same calculation to all three components at the same time more challenging. The final answer should be given as a double inequality, not as a list of integers or as a single figure.

(c) Many candidates appreciated the initial method needed to eliminate the fractions, although there were errors made with expanding brackets and negative values seen. Candidates should note the demand in the question to show working, meaning answers found from their quadratic equation which did not have working would not gain the method mark for solving. Note also the requirement to give answers to 2 decimal places, meaning answers should be converted from surd form to the decimal equivalent.

Question 9

(a) This question was challenging for a number of candidates. It was expected candidates would use properties of angles within parallel lines and the bearing of *C* from *A* to find the required bearing.

(b) Those candidates who realised that angle *BAC* was 78 degrees and could use the cosine rule usually scored full marks here. However, those who did not know how to find angle *BAC*, or did not realise this was needed, tended to not score any marks.

(c) This part was challenging to most candidates. Some scored a mark by drawing an appropriate diagram, as was suggested in the question, and many candidates were able to use the sine rule to calculate the angle from *A* symmetrically either side of the line *AB* of 24.7 degrees. It then tended to be the issue of finding the two possible bearings which was difficult for candidates and very few candidates managed to do this successfully along with the required accuracy of 3 significant figures.

Question 10

(a) Many candidates noted the transformation was a translation, or wrote down the correct translation vector, but a minority wrote both of these.

(b) This question was challenging for many candidates and success seemed to come from candidates learning the matrix required for such a transformation.

(c) There was a lot more success in this part than the previous two. Many candidates not only found the correctly enlarged triangle but also used the correct centre of enlargement. Some used a scale factor of 2, whereas others added 3 onto the lengths of the triangle rather than multiplying by 3.

Question 11

(a) There were many correct answers to this part, but candidates should note that the answer of 8.2 is not to 3 significant figures and is therefore an incorrect final value. Many candidates realised Pythagoras' Theorem was required but there were some problems with subtracting negatives. The vast majority of candidates showed working in this question.

(b) Many candidates correctly found the gradient of the line joining *P* and *Q*. Some candidates found finding the gradient of the line perpendicular to *PQ* a challenge and a great number assumed that the perpendicular bisector of *PQ* passed through *P* or *Q* rather than the midpoint of *PQ*. There were some fully correct answers, but as this was the last part of the last question, it was expected to be a challenging part for many.

MATHEMATICS SYLLABUS D

Paper 4024/22
Paper 22

Key messages

Premature rounding continues to cause some candidates a loss of accuracy in the final answer. This was particularly evident in **Questions 1(a)(ii)**, **4(b)**, **9(b)** and **9(c)**. The same is true when the accuracy is defined in the question, such as in **Question 9(a)** where the answer was required to be correct to 2 decimal places. This is also evident in the working of a question. Candidates frequently show the correct working and will have the correct answer on their calculator but a value to at least 3 decimal places is not being written in the working space. Some candidates are also losing accuracy when they are required to draw a straight line from a given equation. Here candidates are choosing *x* values that are close together at the start of the grid rather than ones that are spread through the range of *x* on the grid. The resulting line then tends to be outside an acceptable tolerance for the larger values of *x*.

General comments

Generally, candidates performed well at the start of this paper and many of the candidates made some attempt at the whole of the paper, with variable success particularly on **Questions 9** and **10**. The majority of candidates demonstrated good algebraic skills, particularly on **Question 2**, however there was confusion that when rearranging an expression, an expression needs to be given as the final answer. Candidates should also be aware that when a bracket is squared to produce a quadratic, this quadratic has four terms and not two. **Question 7(b)**, where the candidates were required to find an upper bound, was completed well and many candidates were using the correct bounds for the distance and the time and using these to find the upper bound for the speed.

Comments on specific questions

Question 1

(a) (i) A large majority of the candidates calculated the correct answer. The most common incorrect answer was 163 800, mixing cents and dollars, or 1638 with a misplaced decimal point.

(ii) Just over two thirds of the candidates calculated the correct percentage increase. A common error was to find the increase as a percentage of 96 rather than of the original amount of 84. From those who used the correct method, a few candidates lost the accuracy of their final answer, truncating to 114.2 or 114 during the method and writing the answer as 14.2 or just 14.

(b) Many candidates were awarded full credit in this part, often showing clear and concise solutions. Of the candidates not awarded full credit, many were able to calculate the postage cost for Company A. For some, there was confusion as to what was required in the final step and various incorrect methods for this stage were seen. A few made arithmetic slips when finding 15 per cent discount, such as using 0.75 as the multiplier.

(c) Just over half the candidates were able to correctly find the cost of posting the parcel. Many seemingly misunderstood the question leading to three main method errors. Some read the question as $4.60 per kilogram leading to 3 × 4.6 and then added $1.10 for the extra half kilogram. Some did not work out the number of half kilograms and so had 4.6 + 2.5 × 1.1. Others had (4.6 + 1.1) × 3.5, not breaking down the 3.5 into parts.

(d) Slightly more candidates were able to successfully complete this part than the previous part. The most common error was to decrease the cost by 7.2 per cent. Occasionally the candidate increased the cost by 7.2 per cent.

Question 2

(a) The vast majority of candidates were able to obtain the correct value for *q*. Common mistakes were obtained from $q = 15 - 23$ or $q = \frac{23}{15}$.

(b) Many candidates were able to correctly expand and simplify the expression with relatively few mistakes made with the multiplication compared with previous years. Occasionally candidates treated the expression as an equation and they then attempted to solve the equation as their final step.

(c) A large proportion of the candidates found the correct solution to the equation. Mistakes were seen after an incorrect first step of either $5y = 3 - 1$ or $5y = 1 + 3$. Some candidates found the correct answer of $y = -0.4$ but then wrote a final incorrect answer of $y = 0.4$.

(d) This part proved to be more difficult for candidates. Some candidates gave a partial factorisation, usually $2r(6r - 4s)$. Another common mistake was to factorise the expression as a difference of two squares with the answer involving two brackets.

(e) Candidates were normally able to rearrange the equation to make *b* the subject, however many gave their answer as the expression $\frac{a}{3}$ rather than the equation $b = \frac{a}{3}$. Occasionally incorrect rearrangements such as $b = 3a$ or $b = \frac{3}{a}$ were seen.

Question 3

(a) Around three fifths of the candidates were able to use the information from the table to correctly calculate the angle of the sector. Two common errors were seen: calculating $\frac{35}{360} \times 200$ or $\frac{35}{200} \times 100$. A small number of candidates attempted a calculation involving the area of a sector.

(b) More candidates were able to use the information given to estimate the probability of the spinner landing on a 3, usually giving the probability either as an unsimplified/simplified fraction or a decimal. Occasionally wrong answers of either $\frac{1}{5}$ or $\frac{3}{5}$ were given.

(c) Over half the candidates were able to correctly find all the factors of 30 and then use this information to estimate the required probability. A common mistake was to overlook 1 as a factor of 30. It was not uncommon to see a final answer of $\frac{4}{5}$, usually without any indication of 1, 2, 3 and 5 being factors of 30.

(d) This part proved to be the most difficult of this question, with many candidates writing a probability as the final answer rather than a number. Many knew to add 19 and 35, but then were unsure as to what to do with the 200 and the 3000. A final answer of $\frac{810}{3000}$ was quite common, as was an answer of $\frac{27}{100}$.

Question 4

(a) (i) Candidates generally opted for one of two methods – a 4 by 15 rectangle and a small triangle or a 4 by 9 rectangle and a trapezium, with the former being the more popular. Many candidates were successful in calculating the area but those using the latter method tended to make fewer mistakes. Calculating the base length of the small triangle proved difficult for some with 12 being the common incorrect base length, and to a lesser extent 6. Some confused area with perimeter and attempts were made to sum the sides. Others multiplied all four given dimensions.

(ii) Most of those candidates who drew a line separating the large rectangle from the small triangle recognised that Pythagoras' Theorem would be needed to find the one missing length. As with the area, finding the length of the two shorter sides proved difficult for some. A majority used 8 and 6 but use of 12 and 6 was a common error as were the use of 6 and 6 and the use of 12 and 15. Some candidates simply added the four given lengths and 40 was a common error.

(b) The majority of candidates set up a correct equation and solved it without too much difficulty. The rearrangement to an equation of '$r^3 = \ldots$.' usually took place in three stages. Occasionally when attempts were made to combine some stages of rearrangement, π was then seen in the numerator rather than the denominator. Premature rounding of $\frac{4}{3}$ to 1.3 or 1.33 or of $\frac{4}{3}\pi$ to 4.2 or 4.18 by some candidates led to an inaccurate value of r being given. The use of values of π other than the recommended values also led to incorrect answers. A common mistake after finding an explicit form of r^3 was to then take the square root.

(c) (i) A good attempt to find the surface area was made by many candidates, with a great number of correct answers. Mistakes included assuming that it was an open cuboid or miscalculating the area of two of the faces, usually 2 × 2. Common mistakes seen arose from the candidate either calculating the volume or finding the total length of all the edges or finding the area of one or more faces using the formula for the area of a triangle.

(ii) Under half the candidates were able to set up a correct equation and solve it to find the length of the edge of the cuboid. Some candidates did not use 6 faces for a cuboid, with 4 being the common mistake. Of those who considered 6 faces, a few equated $6x$ to 384. Some equated the volume of the cuboid to the surface area and then solved that equation.

Question 5

(a) (i) About two thirds of the candidates correctly answered this question. The most common wrong answer was 26, forgetting to include those who took 2 minutes or less. Occasionally a probability rather than a number was given.

(ii) Many candidates knew how to calculate the estimated mean however occasionally a mistake was made with one of the midpoints. A few candidates did not calculate the midpoints but used either the upper or lower bound of the interval. Common mistakes included dividing by the number of intervals rather than the total frequency or using the class widths rather than the midpoints.

(b) (i) Only around a third of candidates were able to correctly complete the frequency table. Occasionally candidates who understood the method to be used made a mistake with two of the frequencies, but usually would correctly record the first and last frequencies. The majority of candidates gave the cumulative frequency answers of 30, 66, 112 and 120.

(ii) Many candidates knew how to find the median and correctly read the information from the graph.

(iii) This part of the question proved challenging for many candidates. Many of the candidates who did not score full marks were able to calculate 55 per cent of 120, however several misinterpreted what was required and calculated 55 per cent of 125. The majority of candidates were unsure how to proceed further and recorded the time with a cumulative frequency of 66.

Question 6

(a) Over half the candidates were able to draw the correct line, many with minimal working. Some candidates chose to work out two or three points however the ones they chose were close together leading to inaccuracies once the line had been drawn through the whole grid. Common mistakes were to draw the line $y = 2$ or a line through (0, 2) and (7, 0).

(b) A correct solution was given by many candidates, however not all used the method detailed in the question and instead attempted to find the solutions algebraically, leading to errors in at least one of the values. Some candidates were not able to relate this question to their diagram and gave answers that were not on the given grid.

(c) (i) Many candidates identified the region they thought was R either by shading and/or labelling. Around two thirds were able to obtain full marks by identifying this region using the inequalities, some involving a follow through from an incorrect line in **part (a)**. The common error of drawing $y = 5$ was seen but not frequently.

(ii)(a) Under half the candidates were able to state the correct number of possible positions. Some recorded the coordinates of these points instead. A small but significant number of candidates did not attempt this question.

(b) Slightly more success was had with this question, however many candidates gave several coordinates which did not satisfy the given condition that the *y*-coordinate had to be one more than the *x*-coordinate. Again, a small but significant number of candidates did not attempt this question.

Question 7

(a) (i) A large majority of the candidates found the correct value for the acceleration. A few candidates gave the inverted form of the answer. A very small number applied an incorrect method to the left-hand triangle such as Pythagoras' Theorem or found its area.

(ii) Many candidates gave a correct description of the motion of the cyclist, usually stating the speed was constant, however some also referred to the acceleration. Occasionally additional statements were given that were incorrect, for example, reference to the cyclist being at rest. Some candidates gave the answer as 'constant' or 'uniform' with no reference to speed.

(iii) Around half the candidates were able to find the correct value of T, with the vast majority achieving this by finding three individual areas, rather than the most efficient method of finding the area of the whole trapezium. Many candidates correctly found the area of the left-hand triangle and the rectangle. A common misunderstanding was giving the length of the base of the right-hand triangle as $90 - T$, rather than $T - 90$. A common wrong answer was 93 resulting from use of Time = Distance ÷ Speed = 558 ÷ 6.

(iv) Candidates found this question challenging with many not completely converting from metres per second into kilometres per hour. Conversions to kilometres per second and kilometres per minute were frequently seen. Common wrong conversions seen were $\frac{6\times1000}{3600}$ and $\frac{6}{1000\times3600}$.

(b) Many candidates understood that a distance of 352 km, correct to the nearest kilometre, meant that the distance was between 351.5 and 352.5. Similarly, the given time was between 4.15 and 4.25. The majority of the candidates also knew that to calculate the speed they would use Distance ÷ Time. Over half the candidates knew that the upper bound for the average speed was found by dividing the upper bound for the distance by the lower bound for the time. Common mistakes were to use the upper bound of both the distance and the time or to divide the given distance and time and then attempt to deal with the bounds after the calculation.

Question 8

(a) Few candidates correctly found the required matrix when it was seen as part of a matrix equation. Some were able to correctly find the matrix for either 3**A** or –3**A** while others thought it was found by the multiplication $\begin{pmatrix} 5 & 3 \\ -4 & -1 \end{pmatrix}\begin{pmatrix} 2 & 3 \\ 5 & 2 \end{pmatrix}$. Some candidates who correctly found 3**A** or –3**A** then thought that the required matrix could be found by multiplying this matrix by 3 or –3. Of those candidates who knew the correct method, mistakes were sometimes made with one of the steps in their working.

(b) Understanding of the requirements for this question were seen by about half the candidates. Others were able to correctly evaluate *p*, however when writing down the inverse they did not multiply the matrix by $\frac{1}{2}$ or multiplied the matrix by $-\frac{1}{3}$. A common mistake in trying to evaluate *p* was to attempt to use the equation $2p - 8 = 2$.

(c) (i) Around half the candidates were able to correctly describe the single transformation. Many knew it was a translation but did not give the correct vector instead recording a vector involving 4 or –4 and 3 or –3. A minority described the transformation as a reflection or rotation.

(ii) The correct trapezium was seen on around two fifths of the scripts. A small number of candidates knew this matrix represented an enlargement scale factor –2 about the origin and then used this information to draw the trapezium. Instead, many candidates multiplied the matrix by the coordinates. Common errors included a trapezium of the same size as the original and any orientation on the grid or the triangle (–2, 0) (0, –2) and (0, 0).

Question 9

(a) Half of the candidates were able to correctly show the value of *PQ* correct to 2 decimal places, normally using Pythagoras' Theorem. Many used a correct method but then did not record values to at least 3 decimal places before rounding to 2 decimal places. Occasionally less efficient methods were seen involving right-angled trigonometry to find an angle first. These responses were usually correctly worked through but with more steps in the working, the candidates were more likely to lose accuracy in their final answer. Very occasionally the hypotenuse of 20 was taken as one of the shorter sides and the resulting Pythagorean calculation was incorrect.

(b) Most candidates used the angle of elevation in its correct position and many calculated *QS* correctly, either using tan or the sine rule. Many of these candidates then attempted to find the required angle using the cosine rule, however this was not always correctly stated or rearranged. Incorrect methods involved assuming *RQS* was a right-angled triangle to find *QS* and then using this angle in the cosine rule to calculate the required angle as 90°. Other common mistakes involved assuming that *QS* was 11 or 30 or incorrectly using 20 as another length on the given diagram. Appreciation that this question involved three-dimensional trigonometry caused problems for some candidates.

(c) Many candidates made good attempts at this question. Not all candidates found the third angle in the triangle but those who did usually found the application of the sine rule a straightforward process. Inaccurate final answers often resulted from premature approximation of some values in the calculation. The most common error was to assume that the triangle was isosceles and then use the sine rule.

Question 10

(a) Many candidates were able to set up a correct equation and some were able to do the algebraic manipulation required and solve the quadratic. Around a third of the candidates were then able to give the possible coordinates of *E*. Errors seen in this working were incorrectly squaring the brackets, incorrect rearrangement to a three-term quadratic, no method seen for solving the quadratic and, for those who correctly found the values of *e*, incorrectly using these to give the coordinates. Incorrect starting points of solution involved using (*x*, *y*) instead of (*e*, *e*), using the length of *DE* as one of the shorter sides rather then the hypotenuse and using a midpoint rather than a distance. A significant number of candidates made no attempt at this question.

(b) (i) The most common correct solution was to start with the gradient of the perpendicular and equate this to the gradient of a line joining two points. A sketch of the two points was used by some candidates to check that their gradient expression was correct. Some candidates used the product of gradients to form a correct expression. The algebra to then reach a solution was usually accurate. The most common mistake using this method was to obtain an expression for the gradient of *DF* and equate this to $\frac{3}{2}$. The alternative method of substituting points into $y = mx + c$ appeared to be more challenging as candidates did not always use the point *D* to find *c* first. A minority of candidates who chose to work with *F* first on this method were able to correctly process the algebra. Again, a significant number made no attempt at this question.

(ii) This proved to be the most challenging part on the paper with many candidates not considering the word bisector and finding the value of *k* for the line perpendicular to *DF* passing through either *D* or *F*. A small proportion of candidates were able to follow through from an incorrect value of *f* to find their midpoint and then their value of *k*. Some candidates chose to work with the equation $y = \frac{3}{2}x + c$, however not all of them realised that $k = 2c$. Again, a significant number of candidates made no attempt at this question.