MATHEMATICS D

Paper 4024/11
Paper 11

Key messages

In this paper it is important that candidates are familiar with the whole syllabus. Some candidates need to do more work on topics such as nets, the angle properties of a circle, relative frequency, transformations and the conditions for the similarity of two triangles.

All working should be shown and answers clearly written in the appropriate answer space. The use of extra sheets of paper should be discouraged.

Candidates should write in blue or black pen. Work that is done in pencil and then over-written in pen is very difficult to read. It is also time-consuming for the candidates and should be discouraged.

General comments

There were many well presented scripts of a good standard and scripts were seen covering the whole range of marks with candidates showed their working in the space provided. The majority of candidates attempted all the questions and appeared to have sufficient time to complete the paper.

The paper gave all candidates an opportunity to demonstrate their strengths and weaknesses.

The questions that candidates found most difficult were **Question 13**, **Question 14**, **Question 17(b)**, **Question 19** and **Question 21**.

Comments on specific questions

Question 1

(a) Most candidates scored full marks on this part. A few made arithmetic errors e.g. using denominator 40.

(b) Having realised that this was a question about the order of operations, many candidates went on to make basic arithmetic errors e.g. the misplacing of the decimal point in the division. Common incorrect answers were 1.003, 1.03 and 1.3.

Question 2

(a) This part was very well done by most candidates.

(b) This part was also very well done.

Question 3

Many completely correct answers were seen. The most common error was to misplace $\sqrt[3]{63}$.

Question 4

(a) Many candidates scored full marks on this part There were a few instances where the answer $\frac{9}{100}$ was given as the answer.

(b) Many candidates found this part challenging and found it difficult to cope with the per cent and fraction within a question. Some converted the $\frac{3}{4}$ to a decimal and then struggled with the arithmetic while some mistakenly inverted the $\frac{3}{4}$.

Question 5

(a) 180 was a very common incorrect answer here with candidates forgetting that there are, in total, ten parts to the drink and not nine.

(b) Some candidates did not know how many millilitres there are in a litre resulting in incorrect answers such as 10 or 1000.

Question 6

Candidates needed to be confident in the use of fractional and negative indices.

(a) (i) Most candidates answered this correctly but some were unable to cope with fractional index. Incorrect answers included 18, $\frac{1}{36^2}$ and $36 \times \frac{2}{1} = 72$.

(ii) As in **(i)** some did not understand how to apply the negative index and several incorrect answers were seen e.g. 25, −25, $\frac{1}{5^2}$ and $\frac{2}{5} = 0.4$.

(b) The majority of candidates obtained the correct answer. Some did not realise that they needed to replace 8 by 2^3 in order to write the expression as a power of 2 and hence find k. A few got as far as $2^2 \times 2^5$ and then gave the answer $k = 10$.

Question 7

(a) Most candidates answered this question correctly. A few made basic arithmetic errors resulting in answers such as 31.55 and 32.35.

(b) Most candidates understood what they needed to do in this question but only about half gave the correct answer. The incorrect answer of 18 was common because some did not show understanding that 20 and 40 are multiples of both 4 and 5. A few didn't include 4 and 5 in their list of multiples.

Question 8

About half the candidates were able to draw a correct net for the prism. Some were able to draw two correct faces, usually the rectangles, in the correct position but found the triangular faces challenging. A few attempted to draw another 3D drawing of the prism.

Question 9

(a) (i) Almost all candidates were able to complete the frequency table correctly. A few gave frequencies which did not total 30.

(ii) Almost all candidates were able to draw a correct bar chart. A few forgot to label the bars.

(b) (i) The majority of candidates gave the correct answer. A few, having obtained the correct answer, attempted to convert it to a decimal. This is not necessary unless the question specifically asks for the probability as a decimal.

(ii) The question asked for 'the number of candidates......' so candidates needed to realise that an integer answer was required. Incorrect answers such as $\frac{8}{180}$ or the equivalent were fairly common. Candidates needed to read the question carefully as a few answered for an orange rather than an apple.

Question 10

(a) Most candidates answered this part correctly. A few candidates divided by 5 and gave the incorrect answer $5x-1$.

(b) The majority of candidates factorised correctly. As in **(a),** a few divided first and then went on to factorise $x^2 - 9y^2$. Many, who did not manage to factorise fully, earned one mark for $2(x^2 - 9y^2)$ as their final answer.

Question 11

(a) This part was usually answered correctly. Incorrect answers included 8.45×10^5 and 84.5×10^{-6}.

(b)(i) About half of the candidates gave the correct answer here. Incorrect answers were due to misplacing the decimal point so some incorrect answers involving the figures 36 resulted from candidates adding 2.7 and 0.9 while others obtained answers involving the figures 117 which came from adding 9 and 2.7.

(ii) Most candidates who were able to answer **(b)(i)** correctly were also able to obtain the correct answer in this part too. Incorrect answers were a result of misplacing the decimal point e.g. 0.3, 3×10^{-1} and $\frac{1}{3}$.

Question 12

(a) This part was usually correct with candidates showing confidence in finding terms of a sequence given in this format.

(b) Most candidates were successful in finding the correct value of k. A few didn't add on the 2 and gave the answer $\frac{50}{3}$.

Question 13

Some candidates found this question challenging. Many made incorrect assumptions resulting in wrong values for the angles.

(a) Many incorrect answers were seen because candidates did not realise that triangle OEA is isosceles. Some thought that $O\hat{A}E = 90°$ and gave $E\hat{A}D = 138° - 90° = 48°$. A few thought that $E\hat{A}D = 90°$ while others calculated $\frac{180-138}{2} = 21°$.

(b) Candidates were more successful than in **(a)** as many correctly recognised that $O\hat{A}F = 90°$ and subtracted their value in **(a)** from 90°.

(c) Candidates needed to realise that triangle OEA is isosceles with $E\hat{A}D = O\hat{E}A$. Some earned a follow through mark by subtracting 12° from their answer to **(a)**.

(d) Many candidates found this part very challenging but most made a reasonable attempt. Candidates were expected to find $B\hat{D}A = 57°$ and $D\hat{B}A = 90°$ hence $D\hat{A}B = 33°$ and then to $B\hat{C}D$. Some candidates thought that triangle BDA was isosceles and hence gave the incorrect answer of 135°. A few candidates gave a value less than 90°. Candidates are encouraged to consider whether their answer is sensible in any given situation.

Question 14

(a) (i) Many candidates correctly constructed the perpendicular bisector of *AB.* Candidates needed to apply the instructions within the question which stated 'construct the locus of points inside *ABCD*'. Some short bisectors were seen which did not reach *CD* and these did not receive full marks. The construction arcs need to be seen.

(ii) Candidates found this slightly more challenging than **(i)** and some drew the perpendicular bisector of *AD* rather than the correct locus. Some circles centred on *D* were also seen. As in **(i)** some of the bisectors of $A\hat{D}C$ were drawn too short and did not reach *BC.* As in **(i)** construction arcs need to be seen.

(b) Most of the candidates who drew the correct loci were able to shade the correct region.

Question 15

Many candidates answered this correctly. A few obtained $\begin{pmatrix} 5 & -7 \\ -1 & 2 \end{pmatrix}$ correctly but did not find the determinant or made an arithmetic error in finding it. Other incorrect answers involved the reciprocals of the elements e.g. $\begin{pmatrix} \frac{1}{2} & \frac{1}{7} \\ 1 & \frac{1}{5} \end{pmatrix}$

Question 16

Most candidates scored full marks to this part. A few made a sign error in rearranging the formula to $3b^2 = 5c - 2a$ while others, having obtained $b^2 = \frac{5c+2a}{3}$, were unable to correctly make *b* the subject.

Candidates need to ensure that they write the square root sign to include the whole expression.

Question 17

(a) Most candidates found the midpoint correctly.

(b) This proved a challenging question to many candidates and was omitted by some. Those who were unable to find the correct equation successfully found the gradient of *AB* = –2 but were not able to get any further. Others used the gradient –2 but then found the equation of a line with gradient –2 through *A* or *B* rather than through the midpoint of *AB*. A few used the sum of the gradients of perpendicular lines as –1 while others seemed unfamiliar with the demands of the question and found the length *AB*.

Question 18

(a) The majority of candidates completed the tree diagram correctly. Candidates are encouraged to check that the probabilities on each branch add to total 1.

(b) To successfully answer this part candidates needed to realise that Jim may be playing or he may not be playing and these probabilities need to be considered as well as the winning probabilities. Some candidates did this and obtained the correct answer. Others just considered the winning probabilities and 0.8 × 0.6 = 0.48 was a common incorrect answer. A few added 0.8 and 0.6 giving 1.4 as their answer.

Candidates should understand that a probability cannot be greater than 1.

Question 19

(a) Very few candidates were able to earn marks on this question. Candidates can improve on this topic by being aware of the conditions for two triangles to be similar. Candidates need to be finding equal angles and giving reasons but many tried to identify equal lengths.

(b) Candidates were more successful in this part using the ratios of corresponding sides. It was common for candidates to assume that triangle *ABC* was right-angled and to attempt to find *AB* using Pythagoras' Theorem. Another common error was to use $\frac{AB}{6} = \frac{8}{10}$ or $\frac{AB}{10} = \frac{8}{6}$.

Question 20

(a) The majority of candidates shaded the correct region.

(i) Approximately half the candidates completed the Venn diagram correctly. Some candidates forgot to include the 17 people who neither drank tea or coffee, nor ate a pastry in the Venn diagram. Another common error was to insert the numbers straight into the Venn diagram e.g. forgetting to subtract 21 from 40 to find how many drank tea but did not eat a pastry.

(ii) Approximately half the candidates answered correctly. Some incorrect answers were 21 + 18 = 39, 100 – 21 − 18 = 61, 50 and 40 + 30 + 32 = 102.

Question 21

Some candidates omitted all or some parts of this question.

(a) Approximately half the candidates drew the correct image of *A.* Some drew the image of *A* after a translation with the wrong vector e.g. $\begin{pmatrix} -4 \\ -1 \end{pmatrix}$.

(b) Candidates found this part more challenging than **(a)**. Incorrect images resulted from using the wrong centre of enlargement and a scale factor of $\frac{1}{2}$ instead of $-\frac{1}{2}$.

(c) (i) Many candidates described the transformation correctly. A common error was omitting to state the mirror line or to state it incorrectly as $x = 0$.

(ii) This part was often omitted. Incorrect answers included $\begin{pmatrix} 0 & 1 \\ 1 & -1 \end{pmatrix}$, $\begin{pmatrix} 0 & 1 \\ 1 & 0 \end{pmatrix}$ and $\begin{pmatrix} 1 & 0 \\ 0 & 1 \end{pmatrix}$.

Question 22

The majority of candidates solved the simultaneous equations correctly. A few made arithmetic errors but earned some of the marks.

Question 23

The majority of candidates solved the equation correctly.

Incorrect methods included equating $2x + 1$ and $x + 4$ to 22 resulting in $x = 10.5$ or 18. Other errors occurred in multiplying out $(2x + 1)(x + 4)$ and incorrectly factorising $2x^2 + 9x – 18$.

MATHEMATICS D

Paper 4024/12
Paper 12

Key messages

In order to do well in this paper, candidates need to

- be familiar with the content of the entire syllabus
- be competent at basic arithmetic
- produce clear, accurate graphs and diagrams
- set out their work in clear, logical steps
- be able to select a suitable strategy to solve a mathematical problem.

General comments

The majority of candidates were well-prepared for this paper and most attempted all of the questions. Candidates across the ability range were able to demonstrate their understanding of the syllabus content, with some questions accessible to all and others offering challenge to the most able.

Candidates often presented their working clearly and many demonstrated good basic algebraic and arithmetic skills. Diagrams were often clear and accurate, with correct geometrical instruments used. In some cases, a correct method was seen leading to an incorrect answer: arithmetic slips occurred particularly when negative numbers were involved. Candidates would benefit from spending some time checking their working for errors in arithmetic. They should write their final answer clearly on the answer line and cross out any incorrect work rather than overwriting it.

In questions involving problem solving, such as **Questions 7**, **21** and **23**, candidates would benefit from spending some time considering their approach before starting to answer the question. In these questions, work was often difficult to follow and it would benefit from some annotation to clarify the method being used. In some questions, candidates would benefit from starting with a sketch or annotating the diagram provided.

Many candidates were unfamiliar with the topics of completing the square and congruent triangles. Candidates should be able to show that two triangles are congruent, including giving a geometrical reason for each pairing and quoting the correct congruence condition for the pairings used.

Comments on specific questions

Question 1

(a) Most candidates were able to correctly divide the fractions. The most common errors were to invert the first fraction rather than the second fraction or to make an arithmetic slip when multiplying.

(b) Most candidates answered this part correctly. A small number did not evaluate their answer completely, gave the answer as $\sqrt{3}$ rather than 3 or were unable to find $\sqrt[3]{125}$.

Question 2

Most candidates understood that they were required to construct the bisector of angle *B* and most showed correct arcs as part of their construction. The question asked for the locus of points inside the quadrilateral, so those candidates who did not extend their line to reach *AD* did not gain full credit.

Question 3

(a) Some candidates did not know that to find the range they needed to subtract the lowest value from the highest. Common errors were to subtract the first and last numbers in the list to give an answer of 70 or to give the answer as an interval such as $-45 \leqslant x \leqslant 40$ or –40 to 40. Some candidates attempted the correct subtraction, but arithmetic errors led to the common incorrect answers of 95 or –5.

(b) Most candidates showed a correct method to find the mean, however arithmetic errors in dealing with the negative numbers were common. An approach that was often successful was to deal with the positive and negative numbers separately, leading to a calculation of $(-140 + 90) \div 10$ which was usually evaluated correctly. A small number of candidates ignored the negative signs completely which led to a mean of 23.

Question 4

To gain full credit in this question candidates needed to show the three values rounded correctly to one significant figure as well as the correct final answer of 1000. In many cases candidates wrote the numerator as 72 – 32, rounding the values to two significant figures. Some were unable to square 0.2, with 0.4 rather than 0.04 often seen, and some rounded 0.198 to 1 rather than 0.2. Division by a decimal was found to be a challenge and $40 \div 0.04$ often led to an answer of 100. Only a very small number of candidates did not round and attempted to evaluate the exact answer.

Question 5

This question was well answered with many candidates reaching the correct answer. In some cases candidates showed a correct method but made an arithmetic error in their division of 16 000 by 50, with 32 or 3200 common incorrect answers. Some candidates divided 4000 by 50 and did not multiply the result by 4.

Question 6

(a) The most common approach in this question was to calculate 15 per cent of 760 and add the result to 760 which often led to the correct answer. Candidates found calculating 85 per cent of 760 to be more challenging and arithmetic errors were frequently seen in this method. Some gave the answer as \$114, the amount of tax paid, rather than the earnings after tax. A small number used an incorrect method, usually $\frac{760}{15} \times 100$.

(b) Most candidates correctly calculated the amount of interest as \$144, but some gave this as the answer and others subtracted it from the investment to give an answer of \$1056. Only a small number of candidates took 1200 as the interest or attempted to use compound interest rather than simple interest.

Question 7

The most successful approach in this question was to use a common denominator to find equivalent fractions. These were often added to give $\frac{27}{20}$ and then an attempt to divide by 2 was seen, which sometimes led to the answer $\frac{13.5}{20}$ or $\frac{27}{10}$. It was common to see the two fractions correctly converted to decimals, 0.6 and 0.75, but candidates often just gave a value between these two rather than finding the midpoint, 0.675. Of the candidates who found 0.675, many could not convert this to a fraction, although an answer of $\frac{675}{1000}$ was given full credit as the simplest form was not required.

A common incorrect answer was $\frac{7}{10}$, where candidates had just found a fraction lying between the two given values. Another common incorrect answer was $\frac{3}{4.5}$, the result of finding the midpoint of the two denominators. Working in this question was often very difficult to follow with calculations and fractions spread across the page in a disorderly manner.

Question 8

Many candidates understood that 5 parts was 2 litres and so 3 parts would be $\frac{3}{5}\times 2=\frac{6}{5}$ litre. The conversion to millilitres was not always correct and the decimal point was often incorrectly placed: this was due either to not using 1000 ml = 1 litre or incorrectly converting $\frac{6}{5}$ to a decimal.

The common misconception was to assume that there were 2 litres of drink rather than 2 litres of fruit juice, giving the calculation $\frac{3}{8}\times 2$ and an answer of 750 ml.

Question 9

(a) Most candidates answered this correctly, producing a correct graph with accurate, ruled lines. The most common error was to end the horizontal line at (40, 15) rather than (60, 15), a result of assuming that the total time for the journey was 40 seconds, rather than 40 seconds at constant speed.

(b) Most candidates answered this part correctly. Some showed a correct fraction but simplified it incorrectly or converted it into an incorrect decimal. A small number calculated time ÷ speed rather than speed ÷ time.

Question 10

(a) Some candidates were able to use correct set notation to describe the shaded region, although many found this part very challenging. Some poor set notation was used and common incorrect answers were $P \cup R \cap Q'$, with the brackets missing, or $(P \cup R)Q'$, with the intersection symbol missing.

(b) Only a minority of candidates were able to give a correct answer in this part, with most answers being either a number in the range $9 < x < 10$ or, less commonly, an irrational number. Those candidates who answered correctly usually chose a square root of a number between 81 and 99, although some gave the answer 3π. Some candidates realised that irrational numbers involve a square root, so gave an answer of the square root of a number in the range, such as $\sqrt{9.5}$.

It was clear that some candidates did not know what an irrational number is and answers were often improper fractions or attempts at decimals with many decimal places.

Question 11

Many candidates reached the correct solutions by multiplying the second equation by 2 and then adding to eliminate *y*.

A significant number used a substitution method, which involved working with fractions. This often led to errors, particularly when attempting to substitute $y=\frac{-5-9x}{4}$ into the second equation. Some did rearrange the second equation to $y=3x-3$, which they were usually able to substitute to reach the correct solutions. Some candidates inaccurately converted the *x* value of $\frac{1}{3}$ into 0.3 or 0.33 and others wrote $x=\frac{7}{21}=3$. Some candidates, despite having made errors in the method, were able to give two values that satisfied one of the two equations.

Question 12

(a) Many candidates were able to interpret the standard form numbers and order them correctly. The most common errors were to position 4.2×10^{-4} as smaller than 3.5×10^{-4}, to order from largest to smallest or to order the values without considering the power of 10.

(b) (i) Many candidates were able to adjust the powers of 10 and subtract the values, giving a correct answer in standard form. The most common incorrect answers were 1×10^{1} or 1×10^{19}, resulting from a simple subtraction of 5 from 6.

(ii) Candidates found multiplication of the two values less problematic than the subtraction in the previous part. Some did not realise that 30×10^{19} was not in standard form, and some converted incorrectly to 3×10^{18}.

Question 13

(a) Candidates found this question challenging. Some made sign errors leading to $x^2 + 6x - 9$, for example, others wrote the brackets out as $(x+3)(x-3)$ and some expanded them correctly but then factorised them again for their answer. A small number of candidates equated the given expression to 0 and attempted to solve the resulting equation.

(b) Candidates were more successful in this part and many were able to deal with the negative signs and reach a correct answer. The most common error was to write $6(y-3)+5x(3-y)$ leading to a final answer of $(6+5x)(3-y)$. Most candidates showed a correct partial factorisation of the expression.

Question 14

(a) It was clear that many candidates were unfamiliar with the method of completing the square, so did not know how to start to write the expression in the correct form. Some candidates identified that the first bracket would be $\left(x - \frac{7}{2}\right)^2$ but were unable to find a correct value for *b*. The most common incorrect answer was $(x-7)^2 + 5$, a result of putting the numbers in the starting expression into the required format.

(b) Even candidates who had been able to complete the square correctly had difficulty identifying the minimum value of the expression. Some selected the wrong part of their expression, 3.5 was a common answer, and others gave the answer in coordinate form without identifying that –7.25 was the minimum value. Many candidates attempted to use the quadratic formula to find solutions.

Question 15

(a) This part was often answered correctly. Those candidates who did not give the correct product usually showed a partially correct factor tree or a ladder which involved arithmetic errors.

(b) Some candidates were able to identify one of the values of *N* correctly, but it was rare to see both correct. Most answers involved either 210 or 294 together with 252, where candidates had not considered that the highest common factor of 168 and 252 was 84 rather than 42. Some candidates did not understand that the required answers had to be multiples of 42 and attempts to find factors of any numbers in the range 200 to 300 were seen. In some cases, answers were outside the given range.

Question 16

(a) The majority of candidates identified the transformation as a translation but had more difficulty with giving the correct vector. Most vectors involved 3 and 4, but the signs were often incorrect and the 3 and 4 were sometimes reversed. A small number of candidates gave a coordinate pair, rather than a vector, which was not accepted.

(b) Some candidates drew correct rays through (0, 3) and constructed a correct enlargement using the negative scale factor. Some ignored the negative sign in the scale factor and drew an enlargement with scale factor 2 rather than –2. It was common to see small triangles where candidates had taken the negative scale factor to mean a scale factor of $\frac{1}{2}$.

Question 17

(a) Many candidates were able to complete the four fractions correctly on the tree diagram. A small number transposed the $\frac{2}{5}$ and $\frac{4}{5}$ on the second set of branches or used a denominator of 6 rather than 5 on these branches.

(b) Many candidates found the two correct products from the tree diagram and added them to reach a correct answer. Common errors in this part were to find just one product, to add or multiply the two required fractions from the second branches or to confuse when to add and when to multiply. Some candidates made arithmetic errors, particularly $2 \times 1 = 3$.

Question 18

(a) Most candidates correctly substituted $p = -2$ and reached the correct result, giving it either as a decimal or a fraction. Some omitted the negative sign in their answer or made an error in converting their correct fraction to a decimal.

(b) Many candidates were able to rearrange the formula correctly, showing clear steps in their working. Common errors included multiplying out $r(3 - p)$ as $3r - p$ or $3r - 3p$, making sign errors when changing sides of the formula, moving only part of a numerator or denominator and dividing one side of the formula by a term (usually r) but not doing the same to the other side. Some candidates substituted their answer from part **(a)** into the formula before attempting to rearrange.

Question 19

(a) Most candidates understood how to use inverse proportion and usually reached the correct answer. A common error was to evaluate the constant of proportionality correctly as 160 but then to forget to square the 10 in the next calculation, leading to an answer of 16 rather than 1.6. A small number of candidates used direct proportion rather than inverse proportion or took y to be inversely proportional to x rather than to the square of x.

(b) Candidates found this part very challenging and few identified that y would be multiplied by 4 when x was halved. Some understood that 4 was involved but wrote that y was increased by 4 times which was not sufficiently precise. Many stated just that y would increase, or it would double, and a number noted that it would also decrease or would not change.

Question 20

Candidates whose first step was to simplify the terms in the bracket had the most success with this question because they could then take the reciprocal and square root of a simpler expression. Those who attempted to take the reciprocal and then square root before simplifying often made errors in one or more of the terms, as they had difficulty dealing with fractional powers. A common error was to start by inverting the fraction, but to replace the power of $-\frac{1}{2}$ with 2 rather than $\frac{1}{2}$. Some candidates correctly dealt with the indices in the x and y terms but did not take the square root of 9.

Question 21

Those candidates who started by setting up a correct equation for the surface area often reached the correct answer, although some gave the value of y as their answer rather than the height of the cuboid as required. Some candidates attempted to set up an equation for the surface area but without a diagram omitted the areas of some faces. Some did not use the given relationship between height and length so had an equation involving h and y which they could not solve. Some candidates set up an equation for volume and others could not combine terms correctly and reached a linear equation.

Question 22

(a) Most candidates completed the table correctly. Some made errors in the number of lines in the patterns, often using 10 in place of 12 for pattern 3.

(b) Many correct answers were given, usually in the form $5n - 3$, although some were the unsimplified expression $3 + 5(n - 1)$. Common errors were answers of $3n - 5$ or $n + 5$, although some candidates attempted to form a quadratic expression.

(c) Some candidates equated their expression from part **(b)** with 92, solved to find the required pattern number and often went on to find the correct number of dots. Some gave the pattern number, 19, as their answer. Some candidates who had been unable to find the nth term in part **(b)** carried on the patterns and reached the correct answer. The most common misconception was to substitute 92 into their expression as the value of n rather than use it as the number of lines.

Question 23

Some candidates were able to analyse the pattern, identify an efficient approach to find the required area and reach the correct answer. Many candidates did not use an efficient method and calculated many partial areas which were not identified clearly and they had difficulty in combining the correct areas to reach their answer. Many candidates found the smaller shaded area correctly using $\frac{60}{360} \times \pi \times 3^2$. Finding the larger shaded area was more challenging and many candidates gained some credit for finding the area of the large or small circle. Some candidates substituted values of 3.14 or $\frac{22}{7}$ for π leading to very complex calculations, which are not required on a non-calculator paper, and others took the radius of the large circle to be 9 rather than 6. Some incorrect formulas were seen, either the arc length formula or using $2\pi r^2$ for the area of a circle.

Question 24

(a) Few candidates understood the requirements for a correct congruence proof. To gain full credit, candidates needed to give three correct pairs of sides/angles with correct geometrical reasons for each and state the correct congruence condition for the pairs they had used. Many candidates were able to identify two correct pairs of sides. A correct reason for $OA = OC$ (equal radii) was often given, but candidates found it more challenging to give a reason for $AP = CQ$ (midpoints of equal chords) or $OP = OQ$ (equal chords are equidistant from the centre). Candidates who gave the angle pair $\angle APO = \angle CQO$ sometimes gave the correct reason as perpendicular to chords. Even when three correct pairs with reasons had been seen, few candidates gave a congruence condition. Those who gave a congruence condition often used SAS in place of RHS. Some candidates were clearly confused between similarity and congruence and gave three pairs of angles and many gave a lengthy description of the shape in the diagram without any pairings of equal sides or angles.

(b) Candidates who marked the 140° on the diagram correctly often went on to reach the correct answer. It was common however, for candidates to take the reflex angle as 140°, leading to angle COQ = 35° and angle QCO = 55°. Some candidates marked angle ABC as 70° and angle OBQ as 35° on the diagram but did not give the correct answer for angle QCO, perhaps because they did not understand the three-letter notation for the angle. A small number took AOQ to be a straight line leading to angle COQ = 40°. Some candidates showed some unknown angles as 45° or 60° on the diagram and worked with those.

Question 25

(a) Many correct answers were seen in this part. Some candidates had one or two elements incorrect due to arithmetic errors, often a result of incorrect multiplication by 0. The most common misconception was to multiply the corresponding elements together leading to the answer $\begin{pmatrix} 4 & 0 \\ 0 & -3 \end{pmatrix}$.

(b) (i) Many candidates were able to set up a correct equation and solve it to give $k = -2$. The most common error was an answer of $-\frac{2}{3}$, resulting from $3k - 2 = -4$ rather than $3k + 2 = -4$.

(ii) Candidates found this part more challenging. Many did not realise that the determinant had been given so they recalculated it, often incorrectly. Some candidates used the given determinant but used $\frac{1}{4}$ or -4 in place of $-\frac{1}{4}$ in their inverse matrix. Candidates should take care with negative signs when manipulating matrices, as some had a correct inverse matrix, but made errors with signs when trying to simplify it. It should be noted, however, that an answer of $-\frac{1}{4}\begin{pmatrix} -2 & 1 \\ -2 & 3 \end{pmatrix}$ is acceptable and there is no need to simplify it further.

MATHEMATICS D

Paper 4024/21
Paper 21

Key messages

Generally, most candidates understood the need to work with sufficient accuracy throughout their calculations, so that their final answer could be given correct to 3 significant figures. This has been a pleasing trend shown by candidates and there were fewer candidates this year not adhering to this requirement.

Candidates would do well to realise that a multiplicand containing two or more terms must be enclosed in brackets before being multiplied by a multiplier, otherwise candidates will lose marks for not being rigorous enough when developing their answer.

General comments

Candidates performed well on solving quadratic equations, use of the sine rule and cosine rule and on estimating the mean value from grouped data. Candidates' understanding and manipulation of vectors and functions continue to be areas where most improvement could be made.

In the plotting of a cumulative frequency graph, candidates need to remember that the values for the frequencies must be plotted at the upper boundary of each class and not in the middle of the class.

Comments on specific questions

Question 1

(a) This part was very well answered with only a few candidates not scoring here.

(b)(i) There were many fully correct answers seen here also. Some candidates did get as far as $\frac{1180}{1800} \times 100 = 65.55$, but did not then realise it was necessary to subtract this from 100% in order to obtain the correct answer. Some attempts only showed the total outgoings, \$1180, and then subtracted this from \$1800 to arrive at \$620.

(ii) There were not so many correct answers seen here as part **(i)**. There were two common errors generally made; either 500×3.6 giving \$1800 as the answer or $1.036 \times 1800 =$ \$1864.80.

(c) This part question was challenging for many candidates. The common errors seen here were $75\% \times 1800 =$ \$1350 or $125\% \times 1800 =$ \$2250. Only a small percentage of candidates realised that \$1800 was 75% of the monthly income and went on to obtain \$2400 as the answer.

Question 2

(a) The plotting of points was usually very accurate. A small minority of candidates did not attempt this part.

(b) Nearly all candidates knew that the scatter diagram showed a positive correlation.

(c) Most candidates attempted to draw a ruled line of best fit and a good proportion of the lines fell within the allowed limits.

(d) The majority of candidates correctly read at 27.5 seconds on the Time axis for 200 m, and gave a correct follow through reading from their line of best fit for the corresponding time of the 100 m race.

Question 3

(a) (i) There were many fully correct answers seen, with candidates giving the correct reasons as required. However, there was confusion shown by some candidates over 'alternate angles' and 'corresponding angles', and some mixed these up when giving a reason.

A few candidates arrived at angle $BCA = 58°$, but then mixed the base angles of the isosceles triangle up, stating that angle $BAC = 58°$ also.

A small number of candidates used another acceptable approach, in stating that angle *SCD* was corresponding to angle *QBC*, and then used vertically opposite angles to obtain angle $BCA = 58°$.

(ii) Candidates who arrived at angle $BCA = 58°$ usually went on to give the correct answer of 75° for angle *CDE*.

(b) This was a successful part question for many candidates, who showed a good understanding of the properties of a regular pentagon and a regular octagon, leading to them scoring full marks. If not gaining the latter, then many did score the marks for giving either a pair of exterior angles or interior angles. A small number of candidates, having obtained 45° and 72°, incorrectly then thought the required angle $x = 360 - (45 + 72)$, thus giving 243° as their answer.

Question 4

(a) (i) The majority of candidates knew to invert the second fraction and change the sign to multiplication. Thus a good many fully correct answers were seen. Candidates not gaining full marks either did not cancel fully to the simplest form, or made numerical errors in the cancelling, or did not cancel the indices of 'y' correctly.

(ii) This part was answered well by a good proportion of the candidates who gained the full marks available. If not the latter, then the 'difference of two squared terms' was recognised by others who correctly factorised the numerator but made slips with the denominator. The common error seen here was to give $(k + 4)(k - 2)$ as the factors, whilst others thought that it factorised as $k(k - 2) - 8$.

(b) This proved to be another successful question for many of the candidates, with full marks often awarded. For others, removal of the brackets was usually done correctly, but then there were some slips made in collecting like terms together. The answer was sometimes given to 2 significant figures, instead of the 3 significant figures required.

(c) This part was very well answered and again full marks were often awarded. Whilst the majority of candidates employed the quadratic formula to solve the equation, a small percentage of candidates were successful in solving it by using the 'completing the squares' method. It is good to see candidates showing all the method in their answers, regardless of the method they chose, as this will earn marks even if the final solutions are incorrect.

Question 5

(a) (i) Nearly all candidates attempted to use a ruler and a pair of compasses in their constructions. Those who were completely successful showed both pairs of construction arcs required at the points *B* and *C*. Others only gave the arcs at one of the points, usually point *B*, and then completed their construction using just the ruler.

(ii) Good constructions usually led to candidates giving an acceptable answer here. Some candidates gave answers that suggested that they were measuring the wrong angle, e.g. 78° from measuring angle *ABC* or angle *ADC*. In some cases, candidates appear to have misread the angle scale on the protractor.

(iii) Candidates were asked to draw the line *AE* as well as give its measurement. Some candidates lost the mark here for not drawing the line. Candidates would do well to remember that the shortest distance between a point and a line is the perpendicular drawn from the point to that line.

(b) (i) The response to this part was good and a large number of fully correct answers were seen. Most candidates chose to use cos58° to calculate *PS*, but a smaller number did also successfully obtain the correct answer using sin32°. Unfortunately, some candidates did not gain the full marks as they did not give their answer correct to 3 significant figures.

(ii) Many candidates knew to use the sine rule here and were successful in reaching the value of angle *SRQ* = 46.3°. Not all realised that in order to obtain the obtuse value of the angle, it was necessary to subtract this value from 180°.

Question 6

(a) (i) This part was well answered with a good many fully correct answers seen. If not earning full marks, most candidates did gain the marks available for stating either of the two correct end values in their final answer. Candidates could have gained a method mark if, after expanding the brackets, they had done the same thing to both ends of the inequality, as shown here:

e.g. $10 - 3$ […] $3x$ […] $24 - 3$

but most chose to work on one end of the inequality only, thus forfeiting the mark.

(ii) Candidates found this part challenging. The common mistake was to give a list of the terms satisfying the inequality, rather than the number of terms.

(b) Many candidates knew the three equations of the lines that defined the given region, but could not always give the correct inequality sign. Common errors seen were $y \geqslant x$ and $y \leqslant 0$ for two of the inequalities. The inequality $y \leqslant -2x + 6$ was often left out altogether.

Question 7

(a) Most candidates answered this part correctly.

(b) The method for finding the inverse function was well understood by the majority of candidates, with many fully correct answers seen. If not earning the full marks, others gained the mark for reaching one or other of the intermediary stages.

(c) This part was generally answered well. Many candidates knew how to set out the required equation, but then some were not successful in removing the denominator of 3. Having correctly multiplied the left hand side of the equation by 3, some forgot to multiply the –2 on the right hand side by 3 also.

(d) Candidates mostly knew that $g(5x-7)$ was $\frac{5x-7+4}{3}$ which earned the method mark, with some arriving at the correct equation of $5x - 7 + 4 = 3ax + 3b$. Various attempts at solving this equation for 'x' were seen, instead of equating the coefficients as required.

Question 8

(a) Many correct answers were seen for this part.

(b) The method required here was well known, as demonstrated by many candidates gaining the full marks. A common error seen was to multiply class width by frequency. A small percentage of candidates, instead of using the class mid-point value, chose to use a value within each class width and then multiplied these by the respective frequency. In the latter case, if they then performed $\frac{\sum fx}{80}$, the method was earned.

(c) There were many good cumulative frequency graphs seen. A common error was to plot the values for the cumulative frequencies at the middle of each class interval not at the upper class boundary as required.

(d) (i) Candidates showed that they understood that the median value had to be read off their graph at the cumulative frequency value of 40 and there were many correct answers seen.

(ii) Candidates showed, in the majority of cases, that they understood what was required in order to obtain the interquartile range. A small number of candidates misread the scale on the horizontal Distance axis when giving their readings. A common error seen was to read the upper quartile at 60 and the lower quartile at 20 on the cumulative frequency axis, and then incorrectly find 60 – 20 = 40, reading off from their graph at this value; this gave the same outcome that they had reached for their previous answer.

(e) Candidates who had drawn a correct graph usually gave a correct answer. The Distance scale here was misread by some. A method mark was earned by those candidates who had drawn an incorrect graph, if they then proceeded to read correctly at the value of 43 m on the Distance axis.

Question 9

(a) (i)(a) In general, candidates would do well to remember that a vector is a quantity with both magnitude and direction. In this part, better responses showed that the length of *PT* represented only $\frac{2}{3}$ the length of *PS*, so that $PS = 1.5\,x(p + 2q)$. An error sometimes seen was to add $\frac{1}{3}$ of *PT* onto $(p + 2q)$ in order to get the value of *PS*.

(i)(b) Fully correct answers were rarely seen for this part. Whilst some candidates did give an acceptable correct vector route there were many who did not do so. Better responses included a step showing that the vector *SP* = – (vector *PS*).

(ii) Nearly all candidates recognised the quadrilateral as a trapezium. Better responses stated that *PQ* was parallel to *SR*, and that the vectors were multiples of each other, or showed that vector $PQ = 4p$ and vector $SR = 2.5p$.

(iii) Few fully correct answers were seen here. Common incorrect answers seen were 4 : 2.5 or1.6 : 1.

(b) (i) Many correct answers were seen to this part.

(ii) The vast majority of candidates knew they had to use Pythagoras' Theorem here to find the magnitude of vector *BC* and were successful in doing so. Some responses started with the theorem incorrectly stated, going on to give $\sqrt{\left[6^2 - (-2)^2\right]}$. Better responses gave the answer correct to 3 significant figures.

(iii) This part was well answered, with many fully correct answers given. If not gaining full marks, then candidates usually scored for realising that the mid-point of *BC* was given by the vector $\begin{pmatrix} 3 \\ -1 \end{pmatrix}$.

Question 10

(a) Many candidates stated that the area of the cross-section was given by $\frac{1}{2}x(8-x)\sin 30^\circ$, and that this then needed to be multiplied by the length 20 in order to get the volume. Better responses gave a completely rigorous proof, using brackets where they were essential. A common error seen was to multiply $x(8-x)$ by 20 to get the volume.

(b) The graph was correctly drawn by the majority of candidates. Candidates would do well to remember that a freehand curve attempt, even if it is a bit 'wobbly', is preferable to one drawn using a ruler.

(c) Candidates usually gave two acceptable values for x here.

(d) Only a small percentage of candidates knew how to draw the correct line needed here, and went on to obtain the answer from reading the intersection of the curve and the line.

The vast majority of candidates knew that the volume of the cuboid was given by $4 \times 3 \times x$ or $12x$. Fuller responses went on to equate $12x$ with $40x - 5x^2$ and then solve this equation to get x.

Question 11

(a) The method required for this part, use of the cosine rule, was well understood by the majority of candidates and a good number of them earned the full marks available. Others correctly obtained the value for angle BLA, but gave this as their final answer, not realising that they needed to add on 62° as well. Those candidates who misquoted the cosine rule did earn a mark for adding 62° to their angle BLA.

(b) The vast majority of candidates knew that they needed to use Pythagoras' Theorem here and they employed it correctly. Again, there was a small percentage of misquotes of the theorem, i.e. $AC^2 = 13^2 + 11^2$. Better responses gave the answer correct to 3 significant figures.

(c) The vast majority of candidates were aware of the method needed here, namely $t = \frac{d}{s}$, and correctly showed $\frac{13}{3.75}$. From here, the most common answer seen was 3.47. Better responses correctly converted the decimal fraction of an hour into the required minutes.

MATHEMATICS D

Paper 4024/22
Paper 22

Key messages

Presentation of work made some candidates' responses difficult to mark, particularly when they wrote over a first attempt. At times it was difficult to distinguish a candidate's writing, for example, *y* and 4 looking identical. Premature approximation, or answers truncated rather than rounded, could not be awarded accuracy marks.

General comments

Candidates were able to make a reasonable attempt at all questions on the paper in the given time. It was encouraging to see that all candidates were able to attempt some of the questions on the paper. There was an improvement in the quality of candidate responses to angles questions where reasons were required, with many candidates now attempting to give reasons throughout their working. Contexts involving time proved challenging for many candidates, along with the scale in **6(a)** which involved a change of units.

Comments on specific questions

Question 1

(a) Most candidates understood the table of charges and correctly calculated the total cost of the family visit to the zoo. Occasional arithmetic slips were seen in addition to some missing the fact that the 3-year old child, being under 5, was free.

(b) (i) Many candidates correctly obtained \$3.90 as a percentage of \$26. A significant number gave 85 as their response and some stated the reduction of \$3.90 as their answer. Some misread the cost for an adult as \$22; candidates are advised to read the question carefully.

(ii) Most candidates knew how to find the percentage reduction, but unfortunately some errors were made in calculating the total cost in May. The subsequent method was often correct, although a few found the difference as a percentage of the May total and not that of April. A few used the difference as \$3.90, the decrease in one adult price. Many responses could not be awarded full marks due to incorrect rounding, giving the truncated value 9.39 as the most accurate answer.

(c) (i) Calculating the time difference proved challenging for many candidates. Incorrect answers seen included 5 hours 25 minutes, 6 hours 35 minutes and 6 hours 25 minutes.

(ii) Better responses recognised that if the Ferugio family arrived at 10.50 am and left at 4.25 pm, attendance at the first and last shows was not possible. The most common wrong answer was 210 from 6×35, not taking into account the arrival and departure times. Some candidates did not use the 35 minutes but instead worked out the length of time from the start of one show to the start of the next and carried out various calculations with these values.

Question 2

(a) A significant number of candidates did not offer a response to this question. Errors seen included points incorrectly or inaccurately plotted, coordinates transposed and misreading of the scale.

(b) Many candidates appreciated that the scatter diagram showed negative correlation, with many qualifying it with weak or strong. A common error was to mention inversely proportional, while others made comments about temperature.

(c) Candidates who understood the term 'line of best fit' usually drew a satisfactory ruled line through the points. There were some lines that did not cover the range of the points and others were drawn with a positive gradient, many of these attempting to go through the origin. Some candidates chose to draw an S shape, by joining the points, while others joined the points in order and created a loop.

(d) Most candidates who had drawn a ruled line of best fit read correctly from their line, although some misinterpreted the scale.

Question 3

(a) Candidates found this question challenging. The expectation here was that candidates would use an open circle above –3 and a closed circle above 2 and join the two with a single line. Many of the candidates who had the correct notation chose to draw a line from each of the circles of varying lengths, with it being unclear where the candidate intended these lines to stop. They appeared to be treating this as two separate inequalities rather than a region between two values. Some tried to identify the region by shading.

(b) A significant number of candidates scored full marks for this part and most scored at least one mark. Common errors included reversing the inequality signs, interchanging the x and y and confusing $y = \frac{1}{2}x$ with $y = 2x$. Most candidates went directly to the inequalities rather than using the equations first. It was often difficult in this question to distinguish when candidates had written a number 4 and when they had written the letter y.

(c) Many candidates scored full marks when solving this double inequality. The best responses then listed the integer values as their answer. Some responses showed arithmetic errors on one side of the inequality. Other responses reversed one of the inequalities, usually the one involving negative values. The two most common errors was either for the candidate to expand $4(m – 2)$ and then add 8 to one side of the inequality and divide the other side by 4 or to bring the –12 and 10 to the same side of the inequality at some point during their working.

Question 4

(a) (i) Better responses stated clearly the geometrical reason why angles are supplementary and that two angles that are adjacent means the two angles are next to each other. A common error was to give an incorrect reason for angle *AEB*, referring to parallel lines or stating that the angles were alternate. Some responses omitted to give the reason 'angles on a straight line'. Reasons which were seen but not satisfactory included 'adjacent' and 'supplementary'. Many responses quoted incorrect reasons, such as opposite angles in a quadrilateral (or trapezium) are equal or add to 180 and final answers of 110 and 70 were common. It was good to note that the use of terminology such as F angles was rarely seen.

(ii) Success in this part was dependent on the recognition that the two triangles were similar and that triangle *ADC* is isosceles. Better responses recognised both these facts and in many cases methods such as ratios of corresponding sides, sine rule, cosine rule and the use of Pythagoras' Theorem were seen. Use of ratios was the most common method employed and usually led to the correct answer, although in some cases incorrect ratios were used.

(b) Candidates found this question challenging. Many assumed that the sum of the interior angles of a pentagon was 360°. A few candidates used values which were not multiples of 180, particularly 450°. Some candidates equated the sum of the angles involving a to the sum of the other angles.

(c) A variety of methods were used as a starting point in this question. Most opted to use the efficient method of simple trigonometry and calculated either angle *PQM* or angle *QPM*. Some did not realise that triangle *QRM* was congruent and repeated the process a second time. Having found a correct value for the angle *PQR*, most candidates opted to use the formula for the sum of the angles in a polygon rather than work with the exterior angle. More efficient methods used the cosine ratio, a significant number of responses involved the calculation of *PM* before using the sine or tangent ratio. Others used *PM* to find *PR* before using the cosine rule. In most cases, the less efficient methods resulted in a loss of accuracy for angle *PQR* because of premature rounding in the intermediate values.

Question 5

(a) (i) A minority of candidates worked with the most efficient common denominator of 12b. Many of the candidates attempted to get a common denominator of (4b)(6b). An error seen at this stage involved simplification of the denominator, usually to 24b. Some responses did not give the final answer as a single fraction as required, leaving the numerator as $9a – 2a$ or $a(9 – 2)$.

(ii) Candidates who noticed the numerator of the first fraction was the difference of two squares were usually able to factorise correctly and complete to a single fraction in its simplest form. Occasionally candidates did not cancel the fraction by dividing the numerator and denominator by 2. It was not uncommon to see individual components of the numerator being incorrectly cancelled with individual components of the denominator, often resulting in a final answer of $\frac{b-3}{3}$.

(b) Many candidates attempted to correctly expand the right-hand side of the equation. Errors seen expanding $–5(x + 4)$ were usually $–5x + 20$ or $–5x + 4$. Most were able to correctly gather the terms involving x and the numbers onto separate sides of the equation in order to complete the solution. Occasionally arithmetic errors were seen with the collection of the constant terms. There were a minority who did not understand the order of operations on the right-hand side of the equation with some writing the first step as $x \times 4 – 5(x + 4)$ or $–4\ (x + 4)$.

(c) Generally, this part of the question was well done with candidates correctly forming a quadratic equation, showing their method for solving and going on to give the dimensions of the card. Common errors when forming the equation were to forget to subtract the unshaded area, to have the unshaded area as y or $2y$, to add the unshaded area or to write $2y \times y + 3$ and obtain a two-term quadratic. The method of solving the quadratic was not always shown but is necessary when the candidate has been asked to ‘Show all your working’. Some candidates attempted to use the quadratic formula to solve their equation, however the fraction did not always include both parts of the correct numerator. Occasionally candidates gave the two solutions of their quadratic equation as the dimensions of the card, even when one of them was negative. Other candidates who solved their equation were able to use their positive solution to calculate the dimensions of their card.

Question 6

(a) Better responses converted the two distances into the same unit in order to obtain the scale in the correct form. Some responses show an incorrect conversation of 4 km into centimetres. Others, having converted to 400 000 cm, did not state the ratio in the correct form. Many responses started with the ratio 4:5, or implied this with an answer obtain from use of 1.25.

(b) Many candidates knew how to find a bearing and measure it accurately. Common errors were to measure in an anticlockwise direction or to give the bearing of *B* from *A*.

(c) There were a high proportion of diagrams where *C* was positioned correctly. A smaller number succeeded with one or other of the bearings, the 120° from *A* being most often correct. Some responses did not include an attempt at the bearings while others showed a lack of understanding of how to measure a bearing correctly.

(d) Most candidates who correctly positioned *C* were able to find the actual distance. Many other candidates demonstrated the ability to accurately measure the distance between two points.

(e) (i) Knowledge of how to use the sine rule was demonstrated by many candidates. Not all of these candidates showed the explicit sine rule, and went straight to an answer which was often not correct to one decimal place. Premature approximation was often noticed when candidates showed intermediate working, resulting in an inaccurate final answer. Some candidates assumed the triangle was isosceles while others treated it as a right-angled triangle.

(ii) Understanding of finding the speed by dividing a distance by a time was seen in many responses. A common misunderstanding was evident in attempts to convert 12 minutes 20 seconds into a time in hours; responses including times of 12.2 or 12 to calculate the speed were often seen. Some responses involved calculations in seconds, with some showing no attempt to convert to hours and others making an incorrect attempt. A few responses were based on the wrong distance, the most common values being 4 km and 4.8 km. Premature approximation often resulted in an inaccurate value for the speed.

Question 7

(a) Nearly all candidates evaluated the *y*-coordinate correctly.

(b) The majority of the candidates were able to plot the points and join them with a smooth curve. Some errors were seen with plotting, usually involving the last three points plotted lower than needed. Better responses used a curve and included the first or last section of the curve.

(c) A good understanding of finding the equation of a straight line was demonstrated by many candidates. Arithmetic errors were sometimes present when calculating the gradient or when rearranging the equation to find the value of *c*. Accuracy was sometimes lost when candidates drew the line and attempted to use two points on it to determine the gradient, rather than use the values given in the table.

(d) Only a minority of candidates scored both marks for this part of the question. Many attempts to draw the line were seen passing through (1, 3) but with the incorrect gradient. Occasionally there were slight inaccuracies with the gradient of the line which led to a value for *k* outside the range permitted. Some attempts to solve the problem algebraically were seen, rarely with success, rather than drawing the line as indicated in the question.

Question 8

(a) Most candidates understood how to find the required probability. A common wrong answer was $\frac{46}{75}$, from including an extra interval.

(b) This was well answered with few errors made in stating the frequencies or the midpoints. Attempts to reach the answer by multiplying by the class width or dividing by the number of intervals were rarely seen. Occasionally arithmetic slips were made.

(c) There were generally three types of graph drawn for this cumulative frequency graph. There were responses in which the points were plotted correctly scoring full marks. There were some responses in which the correct cumulative frequency values were plotted at either the midpoint or the lower bound of each interval. In some cases, either a bar chart or a frequency polygon were drawn.

(d) Many of the candidates knew the median was the middle value, however several thought that the total frequency was 80 and so read their graph at 40.

(e) Candidates found this part challenging. A common error seen was due to reading from the graph at 15 and not 60. Some responses used the total frequency as 80, resulting in readings of 16 or 64.

(f) Those who had drawn the correct cumulative frequency curve usually scored in this part, although on occasion a non-integer value was given. An incorrect value of 18 was often seen from reading from a displaced graph. Candidates are encouraged to consider if their answer is reasonable in the context of the question.

Question 9

(a) Many candidates recognised the need to use the cosine rule and were able to calculate the length of *AB* correctly. Better responses observed the rules of accuracy, common yet inaccurate values seen were either 6.8 or 6.83. Writing cos 27 as 0.89 and using this truncated value also led to inaccurate answers. A small number of candidates drew a perpendicular from *B* to *AC* and used a combination of trigonometry and Pythagoras' Theorem, with better responses working to appropriate levels of accuracy throughout. The incorrect use of the sine rule or use of an incorrect cosine rule were common errors.

(b) Although many candidates seem familiar with the formula for the volume of a prism, the interpretation of the area of the cross section caused some difficulty. Some correctly worked out the area of the triangle, but there were candidates who truncated their final answer. A common error involved the omission of 0.5 in the formula for the area of the triangle.

(c) Candidates found this part challenging. Many candidates equated the volume of the prism to the volume of the carton, not realising that the cuboid carton would only be half full. Those who realised that they only needed to work out the height of the triangle usually did so correctly.

Question 10

(a) (i) Most candidates answered this correctly. A common incorrect answer was $\begin{pmatrix} -7 \\ -11 \end{pmatrix}$.

(ii) The majority of the candidates knew how to find the magnitude of a vector and many of these went on to give a comparison of lengths. Common errors seen included comparing the values within the vectors or adding each vector component to compare the total.

(b) (i) This part was generally well answered, although some candidates made a slip with the signs in the expression. Some responses stated the answer in terms of $\overrightarrow{OA}$ and $\overrightarrow{OB}$ instead of **a** and **b**.

(ii) Many candidates obtained a correct vector route and went on to reach the vector required. Candidates who chose to go via *P* tended to fare better than those who chose to go via *B*.

(iii) Better responses demonstrated a good command of vector algebra and included a correct vector for $\overrightarrow{AR}$, however not all went on to complete the proof. Some responses included the vector $\overrightarrow{OR}$ and did not go on to find $\overrightarrow{AR}$. Some working included a step interpreting $QR = 2OQ$ to mean that $\overrightarrow{OR} = 2\overrightarrow{OQ}$. Arithmetic errors were often seen, as was reversing the vector direction. Several candidates chose not to attempt this question.

Question 11

(a) Most candidates seemed familiar with the function notation and were able to correctly substitute.

(b) Few responses led to correctly finding inverse function. The most common slip was to start this question by rearranging it to $4y = 7x - 1$. There were a few responses that showed correct rearrangement but then did not express the inverse in terms of *x*.

(c) A large number of candidates who successfully equated $3(t - 2) = 6$ were able to obtain $t = 4$. A common incorrect answer was 12 from $3(6 - 2)$.

(d) About a third of the candidates were able to obtain the correct values for *p* and *q*. Many candidates were able to obtain a correct expression but made slips when rearranging it into the correct form. Other candidates rearranged it into the correct form but did not state the values of *p* and *q*. Answers of 21 and –36 were also seen where candidates multiplied by 4 at some stage in their working.