

MATHEMATICS D

Paper 4024/11
Paper 11

Key messages

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

General comments

To do well in this paper candidates needed to know basic techniques, formulas or expressions. These include finding the n^{th} term of a sequence, the midpoint and gradient of a line, the inter-quartile range, writing a number in standard form, finding upper and lower bounds of a number given to a specific degree of accuracy and writing numbers correct to one significant figure. In many cases, incorrect methods for these were used as described in detail below.

Candidates need to ensure they follow the instructions given in the question. For example, writing numbers to one significant figure rather than to the nearest integer in **Question 7** and drawing a *line* of best fit and not lots of individual line segments in **Question 6(b)**. In transformation questions the directive states to describe a **single** transformation and so answers with two of enlargement, rotation, reflection or translation will automatically score no marks. Nor must candidates imply a second transformation so having stated 'enlargement' in **Question 9(a)** they must not then say '...and move...'. As an aid, candidates could look at the number of marks and know that one mark is awarded for the correct transformation, and the remaining marks are allocated one for each of the properties they need to state.

In this paper there were several questions that involved arithmetic dealing with negative signs. Many errors were made as evidenced in **Question 1** (temperature change), **Question 3(b)** (re-ordering negative numbers), **Question 11** (midpoint and gradient), regularly displaying an error such as $-2 - 4 = 2$, **Question 12(b)** (power of 10), **Question 16a** with errors such as $(2 \times -1) - 3 = -2 - 3 = 1$ and **Question 16(b)** (described below). When expanding brackets in **Question 26**, some candidates slipped up with the double negative in the numerator $x(2x - 1) - 3(x - 1) = 2x^2 - x - 3x - 3$.

Candidates need to practice setting up the correct initial expression for proportionality, **Question 19**.

Comments on specific questions

Question 1

- (a) The large majority gave the correct answer. The common incorrect answer was $4 - 2 = 2$.
- (b) The large majority gave the correct answer ($-2 - 9 = -11$). A few errors were made such as omitting the minus sign or some incorrect calculations such as $-2 - 9 = -7$, $2 - 9 = -7$, $9 - 2 = 7$ or $9 - -2 = 11$ were given.

Question 2

Candidates had an excellent understanding of this question, and a very large majority gained full marks. The common error was to divide 280 by the 5 parts for Pablo's share and some calculated Amber's share.

Question 3

- (a) The majority of candidates found the mode correctly. Those who did not re-order the numbers in the list usually gave the middle number -3 or the largest number 2 and some gave a different calculation; the median, range or mean.
- (b) Many candidates gave the correct value. A common error was to give the answer -3 , the median of the unordered list or a value that derived incorrectly from this, for example $-3 + -3 = 0$. Those who did try to re-order the numbers sometimes mis-placed the 2 , giving $-1, -1, -1, -3, -3, -5, -7, 2$ from which they could not recover.

Question 4

- (a) This question, on line of symmetry, was found to be quite difficult with only a small majority of the diagrams shaded correctly. Many different incorrect shaded squares were drawn and a notable amount left blank.
- (b) This question on finding the order of rotational symmetry was also found to be quite difficult, with only a minority giving the correct answer, 3 . Most incorrect answers were 2 or 6 although $0, 1, 4$ and 5 did appear regularly.

Question 5

- (a) A large majority gave the correct answer. Errors dealing with the minus signs were common; some of these resulted in the answer $-3a - b$ and often there were various combinations of coefficients of 7 ; $\pm 7a \pm 7b$ or either of these with one correct term.
- (b) This part was nearly always correct. A few did not multiply both terms in the bracket resulting in $15x - 2$.

Question 6

- (a) Nearly all candidates plotted the four points with perfect accuracy. Only a very small number plotted one of the points incorrectly, usually $(70, 7)$ plotted at $(70, 8)$ or omitted a point.
- (b) Only a minority of the lines of best fit were acceptable. Candidates need to check their line follows the trend of the plotted points as well as it passing between the plots all the way along. Many lines were drawn between the plots at one end but with little or no regard for its position at the opposite end, so it was too steep or too shallow. Some candidates joined all the points with individual line segments or freehand. Some lines were drawn too short or had a positive gradient and some just joined opposite corners on the grid.
- (c) Responses for this part were excellent, with nearly all giving an accurate reading from their line. Those who had drawn a line with a positive gradient or joined individual plots in the previous part were unable to score the mark in this part.

Question 7

The majority followed the instruction to estimate the value of the calculation by rounding the numbers to 1 significant figure. Some rounded to the nearest integer as evidenced by the most common error of 26.7 being rounded to 27 rather than 30 . Only a small number ignored this instruction and tried to work out an exact answer, losing valuable examination time for no gain. Some rounded 26.7 to 3 . Candidates should not include extra zeros such as 30.0 for 30 when asked to round to 1 significant figure.

Question 8

- (a) Almost all gave the correct answer.
- (b) The majority of better candidates gave the correct expression for the n^{th} term. Others who had tried to use $a + d(n - 1)$ had quoted it incorrectly as $a(n - 1)d$ or $a + d(1 - n)$ or used the formula for S_n . A few started well with $2 + 6(n - 1)$ but continued with the error $8(n - 1)$. A common answer was $n + 6$.

Question 9

- (a) Almost all recognised the shape had been enlarged and many gave a completely correct description of the transformation. Some of the properties were incorrect or omitted. It was common for candidates to say the shape was enlarged but then spoil this by including references to how the shape or points on the shape had moved and some explicitly stated 'translation', ignoring the clear instruction to give a **single** transformation.
- (b) While many translated the shape correctly there was a lot of confusion in this question. A few picked one of the bottom corners of triangle A and counted 3 left and 2 up from the origin to reposition the triangle. A few thought the vector $\begin{pmatrix} -3 \\ 2 \end{pmatrix}$ meant 3 down and 2 right. Triangles were drawn in many incorrect locations on the grid, sometimes involving a reflection, rotation and often candidates had drawn these triangles with different dimensions. A recurring error was to draw a triangle joining the point (0, -3) with (2, 0) or joining (-3, 0) with (0, 2) to form the hypotenuse of a 3 by 2 right-angled triangle, taking these numbers from the translation vector.

Question 10

This question was answered correctly by the large majority using both elimination and substitution methods. Some errors were made by those who added/subtracted terms inconsistently in the elimination method, resulting in sign errors. Other sign errors were made when rearranging equations. Many of those who had not scored full marks were able to pick up the SC1 partial mark.

Question 11

- (a) Many correct answers were given. Various errors were made. Using $\left(\frac{x_1 - x_2}{2}, \frac{y_1 - y_2}{2} \right)$ was the most common while others included using $(x_1 + x_2, y_1 + y_2)$ or $\left(\frac{x_1 x_2}{2}, \frac{y_1 y_2}{2} \right)$. Other errors included arithmetic slips, using the y coordinates 4 and -2 (e.g. $-2 + 4 = -6$), reading off from a sketch diagram or confusion with a calculation for gradient.
- (b) This part was answered very well with the majority finding the correct gradient. Some used the incorrect inverted method $\frac{x_1 - x_2}{y_1 - y_2}$, and again errors were made when dealing with negative signs.

Question 12

- (a) Many correct answers were given. Errors varied but included 257×10^{-6} , 2.57×10^{-6} and 2.57×10^4 regularly.
- (b) Candidates struggled with this question with only a minority of correct answers given by the better candidates. Many varied errors were made. Those who approached the question by dealing with $\frac{2}{4}$ and $\frac{10^4}{10^{-5}}$ separately did reasonably well but some arithmetic errors were made, for example 2 instead of 0.5 and the rules of indices on $\frac{10^4}{10^{-5}}$ caught many out. Those who started with $\frac{20000}{0.00004}$ were not usually successful. It was quite common for candidates to reach 2×10^9 and were awarded a partial mark.

Question 13

This was answered very well with the majority of answers being correct. Some got as far as $\frac{11}{5} \times \frac{4}{3}$ or $\frac{44}{15}$ and gained a partial mark. Some errors following this stage were made; some just arithmetic errors such as

$3\frac{14}{15}$, but some misconceptions were evident also, such as using cross multiplication $\frac{33+20}{15}$. This was also evident in errors such as $\frac{11}{5} \times \frac{4}{3} = \frac{33}{20}$ and $\frac{11}{5} \div \frac{3}{4} = \frac{44 \times / \div 15}{20}$.

Question 14

- (a) This question was answered correctly by the large majority who mostly opted to use a factor ladder/table method rather than a factor tree, but both methods were equally successful. Some did not give a complete list of prime factors with some being left as $2 \times 2 \times 3 \times 3 \times 10$ for example. Others did not understand prime factors and listed factor pairs instead.
- (b) Very few candidates gave the correct answer. Incorrect answers were very varied with no common errors apparent. Candidates did not realise they could use the previous answer to help solve this part.

Question 15

Although some good solutions were seen, candidates struggled with this question. Few realised it needed to be approached in two stages: firstly, to equate the given arc length $4\pi = \frac{60}{360} \times 2\pi r$ to find r , then to substitute this into the correct expression for the area of the sector. Many went straight into an incorrect substitution such as $\frac{60}{360} \times 4\pi$ or one loosely based on area such as $\frac{60}{360} \times \pi \times (4\pi)^2$ or $\frac{60}{360} \times \pi 4^2$ or similar. Others just multiplied using the 60 and 4π .

Question 16

- (a) This part was answered very well with many correct answers given. Most others were awarded a partial mark as they had usually made just an arithmetic slip dealing with the double negatives at the final answer stage. Most of those who had more than two elements incorrect in the final answer were able to score the partial mark as they had correctly multiplied the first matrix by 2. A few misconceptions were apparent such as subtracting the matrices first then multiplying by 2 or multiplying both matrices by 2 then subtracting, but these errors were rare.
- (b)(i) This was answered reasonably well with many finding the correct value of k . Errors were made by those who had a sign error; using $ad + bc$ instead of $ad - bc$ in their calculation, giving rise to the answer 3 and a few gave the incorrect answer $k = \frac{1}{10}$. Some errors in solving the correct equation were seen, for example $4 - 2k = 10$ then $2k = 10 - 4$ also giving the answer $k = 3$.
- (ii) This part was also answered reasonably well. Errors were made by those who omitted $\frac{1}{10}$ in front of the otherwise correct matrix or had written this as 10 or as $-\frac{1}{3}$. Other errors were made within the matrix with incorrect transposition and/or signs of the elements.

Question 17

- (a) Many of the better candidates identified the correct region. Many others were awarded a partial mark if they had drawn the line $y = -2$ or had identified a region between the two given boundary lines. Many varied incorrect responses were seen.
- (b) Again, there were many varied incorrect responses listing combinations of values, anything from one to four values, usually from the range -3 to 2 . Only a minority scored marks in this part as many had not understood the requirement of the question.

Question 18

- (a) A minority gave a correct answer. Some knew they had to find the upper and lower quartiles and correctly calculated the cumulative frequency values to read off from, 37.5 and 12.5. Some attempts at reading off from these values were inaccurate and gave rise to answers that were out of range. In some cases, 37.5 and 12.5 were subtracted and the reading was taken from 25 on the cumulative frequency scale or 25 was given as the answer. In some cases, the wrong scale was used and readings were taken from scores of 37.5 and 12.5 to the curve and then subtracted. Some read off from $\frac{3}{4}$ and $\frac{1}{4}$ along the way of the horizontal scale and subtracted these readings. Many other incorrect answers were given, often with no working shown.
- (b) Few candidates gave an answer in the correct range. Many calculated 20 per cent of 50 correctly and read off the cumulative frequency at 10 instead of 40 ($50 - 10$) or gave the answer as 10. Many random incorrect answers were seen, often with no working.
- (c) A minority scored full marks in this part. Some were awarded partial credit for one or two correct values, but many incorrect answers were given. A common error was to give the cumulative frequency reading for the scores 20, 40, 60 and 80, the right-hand end of each interval in the table (i.e. 14, 27, 35, 42). Weaker candidates filled in the table with a sequence of numbers such as 0, 2, 4, 6, 8 (which sometimes had derived from the working $0 \div 10 = 0$, $20 \div 10 = 2$...etc...) or 0, 1, 2, 4, 8 or 4, 5, 6, 7, 8 or 1, 2, 4, 6, 8. Others omitted this part.

Question 19

Candidates found this question very difficult with a minority giving the correct answer. Many started well, setting up the correct equation for proportionality and found the correct value for the constant of proportionality, 8. They were able to substitute this with $x = 32$ into the equation but were unable to solve

$32 = \frac{8}{\sqrt{y}}$. Some got as far as $\sqrt{y} = \frac{1}{4}$ then found the square root of $\frac{1}{4}$ or said $y = \left(\frac{1}{4}\right)^2 = \frac{1}{8}$. Candidates

were often unable to start with a correct equation, and equations such as $x = \frac{k}{y}$, $x = k\sqrt{y}$, $x = ky^2$, $x = \frac{k}{y^2}$ were used. Some had no idea how to start, and no indication of any type of proportionality was seen.

Question 20

Few candidates found both correct values. Most candidates were unable to make the initial start of equating $a^{\frac{2}{3}} = 4$ and $\frac{2}{3}n = 10$. The second equation was seen more often though, and when a partial mark was awarded, it was usually for $n = 15$. A common error was to give $a = 4$ just ignoring the power $\frac{2}{3}$ being relevant to 'a'. A large variety of incorrect answers were given.

Question 21

Most candidates knew they needed to find the area and many correct answers were given. When splitting the shape into three separate areas, errors were often made finding one or more of these areas. Most found the area of the left-hand triangle correctly although a few just worked out 10×10 . The central rectangle was often calculated using 10×30 instead of 10×20 , not dealing with the horizontal scale properly. A very common incorrect answer was 'distance = speed $\times$ time = $10 \times 60 = 600$ '.

Question 22

- (a) Many found the correct answer. Arithmetic errors involving negative signs and squaring spoilt some solutions with errors such as $3(-1)^2 + 5 = -3 + 5 = 2$ or $3(-1)^2 + 5 = -3^2 + 5 = 9 + 5 = 14$. Some had no idea how to do this part.
- (b) Common errors were starting correctly with $3(2x)^2 + 5 = 17$ but expanding this incorrectly as $6x^2 + 5 = 17$. Also, starting with $2(3x^2 + 5) = 17$. Other errors occurred such as $2(3x + 5) = 17$, $3x^2 + 5 = 17$.

Question 23

- (a) Many correct answers were given. A common incorrect answer was 32.4.
- (b) Few correct answers were given. The most common answers in this part were 17 and 17.5. The answer 17 came from $32 - 15$ or from $32.5 - 15.5$ or occasionally from $32.4 - 15.4$. The answer 17.5 came from $32 - 15 = 17$ then $+ 0.5$ for the upper bound or sometimes 0.4 was added for the upper bound, 17.4.

Question 24

Many candidates simplified the expression correctly. Most others gained a partial mark for factorising the denominator. Problems tended to occur with incorrect factorisation of the numerator. For weaker candidates a common error was to cancel the $2x^2$ term from the numerator and denominator as the first step and this of course, could lead nowhere. Having reached the correct answer a few candidates went on to spoil it by cancelling the $2x$ term from the numerator and denominator.

Question 25

A minority of candidates scored full marks in this question. Many got as far as $\sqrt{6^2 + 2^2} = \sqrt{40}$ or $\sqrt{7^2 - 6^2} = \sqrt{13}$ but then could not continue correctly. Many did not recognise they needed to use Pythagoras' theorem and went down a completely incorrect route, for example multiplying the numbers from the diagram.

Question 26

Many correct answers were seen with clear working. Most others scored either 1, 2 or 3 of the partial marks. The most successful approach was to put the LHS over the common denominator then expand the brackets and cross multiply or cross multiply and then expand the brackets. This produced a linear equation which nearly all candidates who had reached this stage solved correctly. A fairly common wrong method was to expand the numerator and denominator on the LHS, then incorrectly cancel the $2x^2$ term from the numerator and denominator.

MATHEMATICS D

Paper 4024/12
Paper 12

Key messages

To do well in this paper, candidates need

- to be familiar with all the syllabus content.
- to be competent at basic arithmetic without a calculator.
- to be able to use and understand common mathematical terms and notation.
- to be able to use geometrical instruments accurately.
- to be able to interpret graphs and diagrams.
- to set out their work in clear, logical steps.

General comments

In general, candidates attempted most of the questions and demonstrated a good understanding of many of the topics covered. Work was usually well presented and the paper discriminated between candidates of different abilities: the straightforward questions were accessible to all, but some questions offered challenge to the most able. It was noticeable that many candidates lost marks due to basic numeracy errors in addition, subtraction, multiplication and cancelling. The topics that candidates found most challenging were angles of a polygon, volumes of similar shapes, matrices, equation of a perpendicular line, set notation and vectors.

Candidates should read each question carefully and make sure their answer meets the requirements of the question. For example, some candidates gave an algebraic answer when the question asked for a value or gave an unsimplified fraction when the question required a fraction in its simplest form. It is important to show a clear method so that part marks can be awarded if the final answer is incorrect. The mark allocation for a question is a guide to the amount of work required to reach the answer, so a 4-mark question will require several steps of working which should all be shown.

Candidates should have access to geometrical instruments and be able to use them to produce neat, accurate diagrams. Some candidates were not able to measure angles correctly for the pie chart, some did not use compasses to construct the angle bisector, and some did not use a ruler when constructing the histogram.

In a non-calculator paper, it is important that candidates have sound arithmetic skills and more practice using non-calculator methods would be beneficial to all. Candidates should have a good grasp of multiplication tables, be confident in cancelling fractions to simplify calculations, and be able to calculate with negative numbers.

Comments on specific questions

Question 1

The rounding to three decimal places required in this question proved to be more challenging than expected. Common incorrect answers were 43.1 (rounding to three significant figures), 43.078 (truncating to three decimal places) and 43.07900 (including superfluous zeros). Some candidates removed the decimal point and gave the answer 43 079.

Question 2

Many candidates answered this correctly. The most common errors were -19 from $-7 - 12$, 5 from $12 - 7$, and -5 from $7 - 12$.

Question 3

Some candidates ordered the values correctly, often following conversion to a common format. Conversion to either decimals or percentages was usually more successful than any attempt to use a common denominator. Some candidates were unable to convert $\frac{2}{3}$ and $\frac{16}{25}$ to decimals. In some cases, $\frac{2}{3}$ was written as 0.66 , so a correct comparison with 66 per cent was not possible, or it was converted to 1.5 . Candidates who did not show conversion to a common form often wrote $\frac{2}{3}$ first in the list or $\frac{16}{25}$ last in the list.

Question 4

- (a) Many candidates simplified the expression as far as $\frac{t^7}{t^{10}}$ but did not complete the simplification or simplified incorrectly to t^3 . Some applied index laws incorrectly to give $\frac{t^{12}}{t^{10}} = t^2$ or $\frac{t^6}{t^5}$.
- (b) Many candidates answered this part correctly. Common incorrect answers were 36 , $\sqrt{36}$ and 9 .

Question 5

- (a) Many candidates completed the table correctly, usually by using the first row of the table to identify that 4° represents one person. Some candidates found one value correctly, often 180° , and then completed the table with any two other values to give a total of 360° , although not all were aware that the sum of all angles should be 360° . In many cases there was no working to indicate how the values had been found, so credit could not be given for showing a correct method if the values were incorrect.
- (b) There were many well-drawn pie charts with three correct angles. Candidates should take care to measure angles accurately and ensure that their radii meet at the centre of the pie chart. Those candidates whose table was incorrect were often able to draw a pie chart with at least one angle following through correctly from their table, however some of these pie charts had 5 sectors if the angles in the table did not sum to 360° . Some candidates did not recognise whether an angle should be acute or obtuse, for example drawing an obtuse angle but labelling it 40° . Candidates who did not have access to rulers or protractors were unable to answer this question.

Question 6

Most candidates calculated the percentage reduction correctly. The most common method was to find 15 per cent of 800 as 120 and subtract this from 800 rather than attempting to find 85 per cent of 800 in a single step. Some misread the question and gave 120 as the answer. Some basic arithmetic errors were seen, such as $800 - 120 = 780$. A small proportion of candidates attempted a reverse percentage calculation, such as $800 \div 0.85$, and some simply calculated $800 - 15 = 785$.

Question 7

Most candidates were able to write the two fractions correctly with a common denominator, leading to the improper fraction $\frac{19}{12}$ or $\frac{38}{24}$. The question required an answer given as a mixed number in its simplest form and many converted correctly to the required form. Those who used 24 as a common denominator often gave the answer $1\frac{14}{24}$, having ignored the instruction requiring to give the answer in its simplest form. Some

candidates were unable to convert an improper fraction to a mixed number correctly and answers such as $7\frac{1}{12}$ were seen. A small proportion of candidates added the numerators and denominators of the fractions.

Question 8

Many candidates attempted to find the time using distance divided by speed. Most of these reached $\frac{13}{4}$ or 3.25 but they were not always able to convert this correctly into hours and minutes. Many candidates did not recognise 0.25 hours as 15 minutes, and an answer of 3 hours 25 minutes was common. Some candidates calculated 13×4 or attempted $4 \div 13$. Some candidates used a repeated addition method as far as $4 + 4 + 4 = 12$ leading to 3 hours, but then could not identify that the remaining 1 km would take 15 minutes.

Question 9

- (a) Most candidates drew the pattern correctly.
- (b) Most candidates completed the table correctly. The most common errors were in the numbers of circles, with candidates either doubling the values to give 24 and 48 or assuming the sequence was linear to give 20 and 28.
- (c) Many candidates substituted 35 into the expression and evaluated the answer correctly. Errors were usually due to incorrect arithmetic or incorrect order of operations, such as 74 from $2(35 + 2)$. A small number of candidates attempted to solve $35 = 2n + 2$.
- (d) This part was found to be challenging, and few candidates found a correct expression for the n th term. It was common to see a linear expression or value given as the answer. Some candidates found differences between terms of the sequence and gained credit for showing the second differences of 2 which identify this as a quadratic sequence. Comparison with a table of values of n^2 would have helped candidates to identify the n th term as $n^2 + n$. Some candidates had learnt a formula to find the n th term of a quadratic sequence, but they were not always able to use this to reach the correct sequence and variables other than n were often left in their expression.

Question 10

- (a) Many candidates measured the radius as 3 cm and applied the scale correctly to give an answer of 7.5 m. Some measured either side BC or CD , or found the perimeter of the shape rather than measuring the radius, but they often applied the scale correctly to their chosen measurement.
- (b)(i) Candidates who identified that the required construction was the bisector of angle E usually drew an accurate bisector with correct arcs. As the question had not identified the construction required, many candidates drew an incorrect line which was often a perpendicular bisector of one of the sides or a random line across the diagram.
- (ii) Candidates who had drawn an angle bisector in **part (b)(i)** generally shaded the correct region. In some cases, part of the stage was included in the region or shading was missed in part of the region inside a construction arc.
- (c) Most candidates attempted to work out 30.75×8 and many correct answers were seen. Some candidates were unable to multiply decimals correctly, leading to answers such as 240.60, and others made arithmetic slips in their multiplication.

Question 11

Many candidates factorised the expression correctly although some did not factorise fully. Common incorrect answers were $2m(m - 7)$, with the 2 inside the bracket omitted, $m(2m - 7)$, with the 2 outside the bracket omitted or $(2m - 7)(2m + 7)$, an attempt to use the difference of two squares.

Question 12

Many candidates appeared unfamiliar with the term 'irrational number' and appeared to select an answer at random from the list. Some candidates did not realise that the question asked for one number only and gave a list of several. Of those candidates who realised that a surd answer was likely to be needed, many included $\sqrt{4}$ as well as $\sqrt{5}$, because they did not notice that $\sqrt{4}$ is equivalent to 2 and hence rational.

Question 13

The first step in this calculation was either to write the two values in standard form with the same power or to write both as ordinary numbers so that the subtraction could be carried out. Some candidates did this correctly and gave a correct answer in standard form, however others left the answer as 42×10^6 . Many candidates were unable to adjust the powers correctly and 0.5×10^6 was often used in place of 50×10^6 . Candidates who wrote both values as ordinary numbers often did this correctly, but they did not always align the digits correctly when carrying out the subtraction. Some candidates converted numbers incorrectly, for example 0.000 000 5 in place of 50 000 000. A common incorrect answer was -3×10^{13} , the result of an attempt to deal with the subtraction and the standard form separately.

Question 14

The question gave 120 and 126 as products of prime numbers and stated that 2520 was the LCM of these two numbers. This information could be used to write 2520 as a product of prime factors without the need to do any division. Few candidates identified this, hence most used repeated division to identify the prime factors. Some did reach the correct product of primes, but many made errors and missed one or more factors in their product or made errors in their division such as $315 \div 3 = 15$ rather than 105.

Question 15

Candidates found this question challenging. The most straightforward approach was to find the exterior angle of the polygon using $(180 - 160)$ and then to calculate $360 \div 20$. Candidates who worked with the formula for the interior angle of the polygon often started with an incorrect equation such as $180(n - 2) = 160$ or $180(n - 1) = 160n$. Some used a trial-and-error method, but rarely showed enough trials to reach 18. Some candidates wrote down a value, often 5, with no working to justify the answer.

Question 16

- (a) Some candidates translated the shape correctly. Incorrect answers often involved a shape with one vertex at $(3, -5)$ although these shapes were often rotations rather than translations of shape A. Some shapes drawn were not congruent to shape A.
- (b) Most candidates identified that the transformation was a rotation. The angle of rotation was usually identified as 90° but candidates did not always state that the direction was clockwise, and some thought it was an anticlockwise rotation of 90° . Finding the centre of rotation was more challenging and many candidates either stated the centre was $(0, 0)$ or omitted the centre completely. Note that the centre of rotation should be written as a pair of coordinates, not as a vector. A small number of candidates ignored the demand for a single transformation and gave a rotation followed by a translation which gained no credit.

Question 17

- (a) Some candidates wrote two correct inequalities with the correct $\leq$ symbols, although in some cases $<$ was used in place of $\leq$. Candidates should be aware that use of a solid line for a boundary indicates an inclusive inequality ($\leq$) while a broken line for a boundary represents a strict inequality ($<$). Some candidates wrote $y \leq 4$ in place of $x \leq 4$ and many used an incorrect equation for the line $y = x + 1$.
- (b) Some candidates found the correct area of the triangle. The triangle was often split into two rather than using the vertical line BC as the 'base' of the triangle. Some candidates used incorrect

measurements for the sides of the triangle or found the area of part of the shape. Others counted squares, but did not always reach the correct total.

Question 18

- (a) There was clear confusion about how to find the interquartile range. Many candidates started correctly by identifying that the 15th and 45th cumulative frequencies were needed and some read the appropriate masses correctly from the graph then subtracted to reach the correct answer of 95. It was very common, however, for candidates to subtract the cumulative frequencies, $45 - 15 = 30$ and then read the mass for a cumulative frequency 30 from the graph, thus giving the median value of 240 as their answer. Some candidates gave either the upper quartile or lower quartile as their answer. Some found the range of masses, using $350 - 100 = 250$.
- (b) The most common answer in this part was 225 from reading the mass for a cumulative frequency of 24. Some candidates calculated $60 - 24 = 36$ and read the graph correctly to give the correct answer of 260, although some misread the scale or gave 36 as their answer. It was common to see candidates attempt to use $24 \div 60$ or $60 \div 24$ as part of an incorrect method.

Question 19

This question was found to be very challenging. Few candidates recognised that the capacity in ml is a measure of volume, so the most common approach was to use the linear scale factor incorrectly to find the required width. This approach led to the common incorrect answer of 3.375. Those candidates who recognised that the ratio of volumes was required often reached the correct answer. In an attempt at a correct method, some candidates cubed the wrong side of the equation others did not cancel $\frac{270}{640}$ to $\frac{27}{64}$ and so were unable to find the cube root.

Question 20

- (a) Candidates were often able to apply the fractional index correctly to one part of the expression, but correct answers were rare. The most common answer was $16a^{15}$, where the index was only applied to the algebraic term. Some found $\frac{3}{4}$ of 16, leading to the answer $12a^{15}$.
- (b) Candidates were often able to expand the brackets to give the correct four-term expression, but some then made errors when collecting terms. Errors often involved incorrect collection of the negative terms, so answers of $8c^2 - 30cd - 27d^2$, $8c^2 + 36cd - 27d^2$ and $8c^2 + 30cd + 27d^2$ were common. Some expansions included $+36cd$ and $-6dc$ which candidates did not realise could be collected to give $+30cd$. Some candidates refactorised their expression after expanding the brackets correctly.

Question 21

This was not a standard matrix question which meant that many candidates did not know how to approach the problem. There were few completely correct answers. Those that recognised the determinant of matrix **A** could be found using $20 = mk - (7 \times -1)$ often reached $mk = 13$, although some made a sign error leading to $mk = 27$. Some used $mk = 13$ to find values for m and k but they did not always use the information that the numbers were both positive integers with $m < k$ to find $m = 1$ and $k = 13$. Some candidates used the inverse matrix correctly to identify that in matrix **A** the positions of m and k would be interchanged and the signs of the two numbers reversed.

Question 22

- (a) Many candidates gave the correct answer, but some gave the answer $-\frac{22}{2}$, rather than fully evaluating this to -11 , or omitted the negative sign. Some candidates found $f(7)$ rather than $f(-7)$.

- (b) Most candidates were familiar with a method to find the inverse function and many correct answers were given. Common errors were to give an answer in terms of y , $\frac{2y+1}{3}$, or to make a sign error when rearranging, usually leading to $\frac{2x-1}{3}$. Many candidates gained at least part marks for showing a correct first step.
- (c) Candidates found this part very challenging. Although many showed the correct first step of substituting $x = \frac{9}{25}$ into $f(x)$ and equating with 5^x , few were able to simplify this as far as $5^x = \frac{1}{25}$ and hence were unable to identify the value of x as -2 . Some did find $5^x = 0.04$ or $\frac{2}{50}$ but neither was enough to identify the required power of 5. Errors were often seen when simplifying $3 \times \frac{9}{25}$, for example $\frac{3}{25}$ or $\frac{27}{75}$, and 5^x was sometimes multiplied by 2 to give 10^x . Candidates should take care when writing powers as 5^x was sometimes written as $5x$.

Question 23

- (a) Most candidates placed 3 and 7 correctly in the Venn diagram but many had difficulty in using the information to complete the remaining values. Some identified that the other numbers in the singing subsets should be 8 and 2, but these were often placed the wrong way round, and others recognised that one value was four times the other. Many placed 19 in the singing only subset and left the centre subset blank. Few candidates placed 4 correctly and this subset was often left blank.
- (b) Few candidates gave a correct answer to this difficult set notation question. There was a lack of understanding that set notation was needed to separate the sets, for example giving $(S \cup D)' \cap A$ in place of $(S \cup D)' \cap A$. Common incorrect answers included $A \cup (S \cup D)'$ and $(S \cup D)'$. Some candidates included incorrect notation such as n or $\subset$ and others gave a description in words.

Question 24

- (a) Some candidates found the midpoint correctly. Errors were more common when finding the y -coordinate, with 3 or -3 often seen in place of 1.
- (b) Many candidates showed a correct method to find the gradient of the line PQ , although sign errors were common when evaluating leading to -3 in place of 3. Some then used a correct method to find the gradient of the line perpendicular to PQ . The most common error in the next step was to assume that the required perpendicular line passed through the midpoint found in **part (a)** rather than through point P . Some candidates found the equation of line PQ rather than the equation of the perpendicular line. Many candidates made arithmetic errors or sign errors at some point in their method meaning that fully correct answers were rare. A small proportion of candidates found the distance between points P and Q rather than the equation of the line.

Question 25

Many candidates completed the histogram correctly. The most common error was to divide all frequencies by 5 rather than by the appropriate class width, which gave the correct height for $5 < t \leq 10$ but incorrect heights for the final two bars where the frequencies should have been divided by 10 and 20 respectively. Other incorrect methods involved using the upper end of the class interval, the midpoint or cumulative frequencies. Candidates should use a ruler to draw all lines in a histogram, including a vertical line to complete the final bar and they should not leave gaps between the bars.

Question 26

- (a) Many candidates can carry out simple vector addition and correct answers were common. The most common incorrect answers were $\mathbf{a} - 2\mathbf{b}$ or $\mathbf{a} + 2\mathbf{b}$.

- (b) Strong candidates were usually able to show a complete method leading to the required result. They usually started by finding $\overrightarrow{AB} = 4(2\mathbf{b} - \mathbf{a})$ or $\overrightarrow{BC} = 3(2\mathbf{b} - \mathbf{a})$ and then used this in a correct route for $\overrightarrow{OC}$. Some candidates started by writing a correct route such as $\overrightarrow{OC} = \overrightarrow{OA} + \overrightarrow{AB} + \overrightarrow{BC}$ but then used the ratio incorrectly, for example $\overrightarrow{BC} = \frac{3}{4}\overrightarrow{AB}$. Weaker candidates were rarely able to make any progress with this question.
- (c) This question was very challenging, and correct answers were rare. The question asked for the value of k , but many candidates gave a vector as their answer. It should have been clear from the diagram that k was a fraction less than one, but numerical answers given were often greater than one. Many candidates attempted to equate a vector route for $\overrightarrow{AD}$ with $k(8\mathbf{b} - 3\mathbf{a})$ with no success. A common error was to assume that $\overrightarrow{BD} = \mathbf{b}$.

MATHEMATICS D

Paper 4024/21
Paper 21

Key messages

Candidates should be encouraged to use brackets correctly on their calculators when attempting a calculation using negative numbers (**Question 3(a)** and **Question 5(b)(i)**).

Candidates ought to be encouraged to produce their own table to help them to draw any graph (**Question 3(d)**).

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.

There was an error in **Question 6(c)** where the incorrect units were given on the answer line. The units should have been cm^2 rather than cm^3 . This has been corrected in the published version of the paper.

Comments on specific questions

Question 1

- (a) Most candidates found this question part difficult. Assuming there were 100 minutes in an hour rather than 60 was a common error, and the combination of two different times across two different sets of days was also problematic for candidates.
- (b) The amount of information given in the question proved a problem for a large number of candidates. In solving, candidates should find the total amount paid to the 5 sales assistants for 30 hours of work. This amount should then be subtracted from the total amount paid to all 7 employees so that the amount paid to each Supervisor per hour can then be found. In solving this question, even those candidates who understood the method behind the solution often omitted multiplying by the 5 sales assistants or dividing by the 2 Supervisors.
- (c) Again, the amount of information given in the question proved problematic for a large number of candidates. This part needed three calculations to correctly solve the question; these were the percentage calculation, the currency conversion and the scaling from 50 games to 1 game. The mark scheme gave three marks for all three calculations, two marks for any two of these and one mark for either the percentage calculation or the currency conversion.
- (d) Perhaps due to the two investments made to the account, this question was difficult for a large number of candidates. Candidates often did not know how many years to apply compound interest to the initial \$12,000 invested, nor to the second investment of \$12,000. It was common to see \$24,000 having compound interest applied for 4 years. Those candidates who did approach the question with the correct method were usually successful in gaining the answer of \$5284.50.

Question 2

- (a) (i) Candidates were usually successful in this part, although those that were not failed to show any working and it was therefore rather difficult to give partial credit.

- (ii) For those candidates who had pie chart angles summing to 270° in **part(i)**, the mark was usually gained successfully here.
- (b)(i) Very few candidates could successfully explain why the range may not be 50 km/h. There were a few candidates who wrongly said Sanjay was correct. Many wrong answers related to the histogram containing frequency density rather than frequency, or that speed could not be found from a histogram. Candidates were expected to say the highest speed and lowest speed were unknown as the data had been grouped for the histogram, therefore the range cannot be calculated.
- (ii) Candidates needed to correctly find at least two of the frequencies to gain any marks in this part. This prevented the many candidates who multiplied all of the frequency densities by 10, rather than by the width of each speed group. There was occasionally some incorrect reading of the frequency densities, but generally, if candidates understood how to find the frequency from a histogram, all three marks were awarded.

Question 3

- (a) Many candidates were successful in completing the table, although substitution of -2 for x was generally less well done than substitution of 2 for x , as might have been expected, although with the use of a calculator this should be prevented. Candidates should be encouraged to use brackets correctly on their calculators when attempting a calculation using negative numbers (see **Key messages**).
- (b) Candidates were well practised in plotting points from a table onto a graph, with misreading of the scales rare. Follow through marks from their values found in **part (a)** were available, and generally candidates correctly joined these points with a smooth curve with ruled lines rarely seen.
- (c) Finding the equation of the line of symmetry was successfully done by roughly one third of candidates, although many more did have a symmetrical graph but were unable to describe the line of symmetry using a correct equation.
- (d) Drawing the straight line on the grid was done much less successfully than drawing the curve on the grid. It seems that when candidates are provided a table of values, as in **part (b)**, they are able to plot these points and draw the subsequent graph. However, when candidates have to produce their own table of values, as in **part (d)**, they seem much less likely to do so. Candidates ought to be encouraged to produce their own table to help them to draw any graph (see **Key messages**).
- (e) Candidates who produced a curve in **part (b)** and a straight line in **part (d)** were able to gain the mark here, even if one or both of their graphs were incorrect. Occasionally the horizontal axis was read incorrectly, particularly for the negative x value, and some candidates ignored the negative sign for this value completely.

Question 4

- (a) Although the vast majority of candidates appeared to understand what a multiple of 3 is, it was fairly common to incorrectly see the number 1 included, or one or more multiples missing.
- (b) There were many candidates who gained at least one mark here; often the values outside of the A and B regions were omitted, or one or two values were placed in an incorrect region.
- (c) For those candidates who omitted the values outside the A and B regions, this part was difficult to achieve the mark as they needed to go back to the original set statements in order to answer this successfully. Those candidates who had values in this region could gain the mark as long as they chose the smallest value from within their region on the Venn diagram.
- (d) As in **part (c)**, candidates who had values in the required region could gain the mark as long as they counted the number of values within this particular region on their Venn diagram.

Question 5

- (a)(i) Almost all candidates were successful in answering this part. A common wrong answer was $y = 2$, where candidates had divided 8 by 4 rather than multiplying.

- (ii) Another part which was well answered by candidates. Some were confused by the negative answer, and unfortunately omitted this sign on the answer line. Candidates who correctly rearranged the equation to isolate the terms in x , sometimes then lost the negative sign in working out the value of x .
- (b)(i) Another part which was well answered by candidates. Even those candidates who did not gain the correct final answer usually wrote down a correct expression for w with a correct substitution of the given values. Again, candidates should be encouraged to use brackets correctly on their calculators when attempting a calculation using negative numbers (see **Key messages**).
- (ii) A large number of candidates correctly rearranged the given formula. Some candidates who did not understand what was required used the expression they had obtained in **part (b)(i)** and tried to rearrange this with numerical values rather than using the formula given at the start of the question.
- (c) Another part which was well answered by candidates. Occasionally candidates were confused with the negative signs, and some gained only the partial mark for correctly completing a partial factorisation of the expression.
- (d) Candidates tended to not find this simplification straightforward. Although many could combine the first two terms as a single fraction with a common denominator, having the third term of 1 caused much confusion. A large number of candidates either ignored the 1 completely, or added it into the combined fraction as a 1 in the numerator, rather than as $(x + 3)(x - 3)$.

Question 6

- (a) Many candidates could not find the radius of the sphere correctly. There were many different values substituted in, for this radius, into the volume of a sphere formula, with 343, 6 and 7 the most common values seen. Candidates were expected to understand they needed to cube root 343 to find an edge length of the cube, and then half this value to find the radius of the sphere. It was this beginning of the method which candidates found the most difficult. Using the formula for the volume of a sphere was usually done correctly.
- (b) Very few candidates gained marks in this part. The most common incorrect method was to divide the two volumes and multiply this answer by the height of 15. This gained no marks. Candidates need to understand that dividing the two volumes gives a volume factor, and this needs cube rooting in order to find the scale factor of $\frac{4}{3}$. The height of 15 then needs to be multiplied by this scale factor to give the correct height of 20.
- (c) Due to an issue with **Question 6(c)** as outlined in the **General comments**, full marks have been awarded to all candidates for this question to make sure that no candidates were disadvantaged.

Question 7

- (a) Those candidates who drew a sketch of parallelogram $ABCD$ tended to be more successful in finding the coordinates of point D . Although the question does not ask them to draw a sketch, one can often be helpful in such questions so candidates can understand which sides are parallel to each other, and which direction vector is given in the question. As the question gave the coordinates of point A and $\overrightarrow{AD}$, candidates needed to add these together to gain the correct answer.
- (b) As $\overrightarrow{AD}$ was given in the question, candidates needed to use this, and apply Pythagoras, to find the modulus of this vector. Some candidates tried to use their incorrect coordinates of point D which was unnecessary.
- (c) As in **part (a)**, a sketch of parallelogram $ABCD$ can make this part much more accessible to candidates. There were two main methods to find the required vector. One way is to find the coordinates of point C , by using point B and $\overrightarrow{AD}$. Candidates can then find $\overrightarrow{AC}$ as they know the coordinates of point A and point C .

- (d) Many candidates found this part difficult, with around one quarter omitting it completely. Of those who did attempt it, many could only find the correct gradient of AB , and often went on to use this value, rather than the perpendicular gradient, to find the equation of line L . Even those who correctly found the perpendicular gradient, often assumed the question was asking them to find the equation of the perpendicular bisector and used the midpoint of AB rather than point D to find the equation of the line. Candidates should be encouraged to read the question carefully, and to answer what is asked of them rather than what they assume will be asked.

Question 8

- (a) Those candidates who understood that average speed is the total distance divided by the total time usually answered this question well. These candidates understood they needed to find the time taken from A to B and add this to the time taken from B to C in order to find the total time. However, there were many wrong attempts which found the average of the values 1.6 and 2.8, or who simply added them.
- (b) A common error in this part was to assume that both triangles were right angled, or to assume they could find the bearing of B from A using only the given value of 243° . Candidates were expected to firstly calculate the length BD using Pythagoras. They could then go on to use the cosine rule in triangle DAB to find angle DAB . The bearing of B from A could then be found using the bearing of D from A .

Question 9

- (a) A large proportion of candidates were successful in finding both angles in this part. It was sometimes difficult to award partial marks to those candidates who did not find x or y correctly, due to the lack of working shown. Candidates should note that correct angles placed on the diagram in the correct place can sometimes earn partial marks.
- (b) The first step in answering this question is to recognise angle ORQ is 90° by a circle theorem. Many candidates did not realise this and failed to progress very far in this part. Another point to note is that triangle POR is isosceles, as it consists of two radii. Once these two facts had been noted, candidates were usually successful in using trigonometry to find appropriate sides to help them calculate the area of the triangle PQR . There were various approaches which could be taken, including finding sides PR , PQ , or PO and OQ .

Question 10

- (a) There were very few correct attempts here. Even those candidates who realised the total number of balls was $\text{red} + \text{red} + 6$ usually used x to represent the number of red balls, and therefore formed an equation which did not make sense. Candidates needed to introduce a different letter to x to form an equation for the total number of balls, rearrange this to find the number of red balls in terms of x , and could then find the fraction of balls that are red in bag A .
- (b) Understandably, this question was less well done than **part (a)**. There were various ways of finding the number of green balls in bag A , a common method was to take the expression for the number of red balls found in **part (a)** and add 6 to this. The resulting expression needed to be multiplied by 4 to find the number of green balls in bag B , then adding x gave the total number of balls in bag B .
- (c) This part was usually done much more successfully, with most candidates understanding the need to eliminate the fractions by cross multiplying, and then rearranging after expanding brackets to produce all the terms on one side of the equation. Candidates should be aware that in a show that question it is important that every step of working is shown and be careful to include all necessary brackets in their working.
- (d) This part was also done well, with common errors being the negative sign in the wrong position when factorising or trying to use the quadratic formula to solve the quadratic equation even though the question stated to solve by factorisation.
- (e) Few candidates were able to find the number of green balls in bag A , partly due to not being able to answer **part (d)**. Candidates needed to divide their positive solution by 2 and then add 3 to the result. A follow through mark was available even if a wrong value was used from **part (d)**.

Question 11

- (a) in this questions candidates struggled with Mia only taking one of the triangles, rather than one of the shapes, although a large proportion of candidates scored at least one mark here. A common wrong answer was $\frac{4}{25}$, rather than $\frac{4}{9}$, as the question states that only the triangles need to be considered in this part.
- (b) Although few candidates gained full marks here, the partial mark of gaining $\frac{16}{25}$ was often awarded. Candidates then did not usually know what to do with this fraction, often not realising it needed multiplying by $\frac{15}{24}$ to gain full marks.
- (c) A small proportion of candidates successfully completed this part, although occasionally a partial mark was given for achieving correct denominators for taking three shapes without replacement. Obtaining the numerators proved more difficult than denominators and recognising there were three ways of selecting only one triangle was often omitted.

MATHEMATICS D

Paper 4024/22
Paper 22

Key messages

Candidates need to be familiar with all aspects of the syllabus. The recall and application of formulae is required as well as the ability to interpret situations mathematically and problem solve with unstructured questions.

Work should be clearly and concisely expressed with intermediate values in calculations not rounded and only the final answer rounded to the appropriate degree of accuracy.

Candidates should show full working with their answers to ensure that method marks are considered when answers are incorrect.

General comments

There were a number of candidates that demonstrated strong knowledge and skills across the breadth of the paper. Most candidates appeared well prepared for the paper and their solutions were usually well presented. There were also a number of candidates that struggled with larger areas of the content in the paper. There were, a small number of candidates who wrote down their numbers that were very difficult, or impossible to read and in a few of these cases the candidates misread their own numbers.

All candidates appeared to have sufficient time to answer the questions.

When answering 'show that' questions, all steps in working must be clearly shown without any omissions. It should also be noted that when answering 'show that' questions, where the answer is given, they must not use the given answer in their solution e.g. **Question 8(b)**.

When a question asks candidates to show all of their working, each step must be shown as answers obtained from calculators only will not be credited for method marks e.g. **Question 10(c)**.

Premature rounding of values within calculations continues to be an area to address for a number of candidates and leads to a loss of marks for inaccurate final answers. Where a method step is not shown and values are given instead, two significant figure values are insufficient to imply a correct method.

The topics that were answered well included:

- Percentages
- Plotting points and lines of best fit on scatter diagrams
- Volume of a cuboid
- Money and shopping problem
- Simple probability
- Drawing a cubic graph
- Solving linear equations.

The weaker areas included:

- Working with bounds
- Surface area of a prism
- Compound interest problem
- Solving equations related to graphs
- Reasoning with geometry and use of geometrical language

- Working with unstructured problems involving circles and trigonometry
- Forming expressions from problems and setting up equations and manipulating algebraic fractions
- Answering 'show that' questions.

Comments on specific questions

Question 1

- (a) Almost all candidates found the required percentage $\frac{84}{240} \times 100\%$ correctly. Occasional errors seen included omitting the multiplication by 100, finding 84 per cent or 16 per cent of the total mass 240, subtracting the mass of the mango from the total mass of the fruit before expressing as a percentage, giving the answer 84 per cent or using the mass of pineapple instead of the mass of mango.
- (b) Many candidates found the amount of juice in millilitres correctly and a significant number processed the ratio correctly but made an error in their conversion to millilitres. The most common error seen was to find $\frac{3}{7}$ of the drink instead of $\frac{3}{10}$ or occasionally to find only $\frac{1}{10}$ or $\frac{1}{3}$ of the drink. Many of these candidates were still able to gain partial credit for a correct conversion to millilitres.
- (c) Candidates had more success with this proportion question than **part (b)** and there were many fully correct answers. Candidates should use correct mathematical operators in their statements e.g. $\frac{x}{175} = \frac{1.50}{125}$ would gain a method mark. It is common to see the equality replaced with crossed arrows and the fraction lines omitted. In this case method marks are not awarded until a correct multiplication or division is seen. Many candidates worked successfully starting from $y = kx$ and finding the constant of proportionality to be $83\frac{1}{3}$. Some of these candidates rounded prematurely to 83.3 and so lost accuracy. Others made the error $175 \times 83\frac{1}{3}$ instead of $175 \div 83\frac{1}{3}$. Weaker candidates found the difference between 175ml and 125 ml and then added 50 cents to \$1.50.
- (d) In this part candidates were required to equate the 285g of raisins with 38 per cent and process this to find the mass of nuts (62 per cent). Many correct answers were given but there were also many common errors such as candidates finding 62 per cent of 285 and 38 per cent of 285 and then sometimes adding this to 285 or subtracting this from 285. Some showed the error $\frac{285}{62} \times 38$ instead of $\frac{285}{38} \times 62$.
- (e) Candidates found this question on calculations with bounds challenging with stronger candidates sometimes unable to gain full marks here. Good candidates were able to find all four correct bounds for the mass of mixed nuts and seeds, 505g and 495g, and the mass of nuts, 352.5g and 347.5g but then combined these incorrectly when attempting to find the bounds for the mass of seeds. The error, upper bound = $505 - 352.5$ and lower bound = $495 - 347.5$ was very common. Another common error was to subtract the mass of nuts, 350g, from the mass of mixed nuts and seeds, 500g, first to get 150g and then either add and subtract 5g or 2.5g to get the upper and lower bounds. A minority of candidates found the correct bounds for mixed nuts and seeds and for nuts but then performed an addition instead of a subtraction to find the bounds for the seeds. Errors such as using 490 and 510 and 345 and 355 for the bounds, were also seen.

Question 2

- (a) (i) Almost all candidates were able to plot the four points on the scatter graph accurately. A few candidates omitted this part and in subsequent parts worked only with the points already plotted on the graph.

- (ii) Most drew an acceptable line of best fit and a few others drew a ruled line that was inaccurate. A few candidates drew the line from (0,7000) to (12,0) and a very small minority joined the individual points or omitted this part.
 - (iii) Almost all candidates were able to use their line of best fit correctly to read the value of a car aged 7 years. Occasionally the scale of the y-axis was misinterpreted, for example a value of 2400 read as 2200.
 - (iv) There was a mixed response to this question which needed a clear explanation. The best explanations used the correct mathematical vocabulary such as data or line of best fit, that was appropriate to their chosen reason. For example, 'the line of best fit does not reach 12' is acceptable but 'the graph does not reach 12' is not. Many correct explanations referred to the value of a 12-year-old car being 0 or negative. Common explanations that were not acceptable included for example 'it only gives an estimated value', 'it is a negative correlation', 'the older the car the lower its value is' or just restating that the scatter diagram was not suitable without giving a reason.
- (b) (i) This question part proved to be more challenging than perhaps expected and although many correct answers were seen there was also a wide variety of errors including answers that were not fractions and incorrect values being selected from the table. For example, some candidates gave the fraction of cars that travelled more than 40 000km or 60 000km, or only cars that travelled between 50 000km and 60 000km. Some candidates began correctly with the fraction $\frac{28}{50}$ then gave their answer as a decimal or did not simplify.
- (ii) Many candidates correctly identified the interval from 50 to 60 as containing the median but the error of interval 40 to 50 was also common. Some candidates gave a frequency such as 14 or 11 as their answer which was not acceptable. Another common error was to order the frequencies 8, 11, 14 and 17 and find the mean of 11 and 14.
 - (iii) Many candidates used the correct midpoints and frequencies to find the estimate for the mean from this grouped data. A minority of candidates used the upper or lower limit of each interval instead of midpoints but otherwise completed the method correctly. However, the error of using the interval widths instead of the midpoints was very common. Other candidates identified the midpoints but did not multiply by the relevant frequency and/or divided by 4 instead of 50. Almost all candidates showed their working out clearly so that when numerical errors or small slips were made it was still possible to award method marks.

Question 3

- (a) (i) This was generally well answered. Some candidates gave a correct equation $1.8 = 1.2 \times 0.6 \times h$, but then did not rearrange it correctly. Other errors included multiplying the three given values together or attempts at finding the surface area of the cuboid.
 - (ii) Although there were many correct answers, these were not the majority. A high number of candidates got as far as 8.1 minutes but did not convert the decimal part correctly to 6 seconds. Many started incorrectly by finding 90 per cent of the flow rate of 0.2 and did not use the given volume at all. Others tried to work with the height found in the previous part. Sometimes a candidate would work out 90 per cent of 1.8 correctly but then were confused by what to do with the flow rate, often multiplying instead of dividing.
- (b) Most candidates made some progress with this unstructured question, but it was rare to see a completely correct answer.

A very common error, when finding the area of the front face, was to assume the height was 70, so not considering Pythagoras at all when finding the vertical height; some of these candidates still managed to get partial credit for the areas of the base and other sides.

Of those who recognised the need to use Pythagoras to find the trapezium height, many used a triangular base length of 30 and not 15. Most of these went on to apply the area of a trapezium correctly using their height. However, some then assumed all four sides of the tank had the same area of the trapezium.

Question 4

- (a) This part was answered well, with many correct answers being seen. The most common error was to overlook subtracting either \$21.50 or $3 \times \$13.50$ from \$100.
- (b) There were many good attempts at this question, with many candidates applying the correct method. However, there were many inaccurate answers of 3.8 and 3.84. Some worked out $150 \div 0.91$ instead of $140 \div 0.91$, and others worked in euros showing $140 - 150 \times 0.91 = 3.5$ without going any further.
- (c) A minority of candidates answered this part correctly. A very common error was to work with the simple interest formula. Some used compound interest but equated $600 \times \left(1 + \frac{r}{100}\right)^3$ to 21.86 rather than 621.86. Of those who set up a correct equation, some did not manage to solve it correctly, often by doing inverse operations in the incorrect order. Some made approximations of the intermediate values prematurely to give an inaccurate final answer.

Question 5

- (a) Most candidates answered this part correctly giving their answer as a fraction. Some gave $\frac{3}{9}$ or $\frac{5}{9}$ and others gave answers that were not probabilities e.g. 4. Some candidates attempted to convert their fractions into decimals in all three parts of this question when this was not required in the question.
- (b) Many candidates answered this correctly. A common incorrect method was to add $\frac{2}{9}$ to $\frac{2}{9}$ instead of multiplying the probabilities. Some used $\frac{1}{9}$ instead of $\frac{2}{9}$ and others treated the problem as without replacement and gave $\frac{2}{9} \times \frac{1}{8}$.
- (c) A minority were successful in this part. Those that did give a correct answer often used a tree diagram or table to record outcomes and/or probabilities and others used the product $\frac{5}{9} \times \frac{4}{8}$.

A larger number of candidates were at least able to gain partial credit by recognising that a related multiplication of a pair of probabilities without replacement was required e.g. for the combination of the cards 2 with 1 the product $\frac{3}{9} \times \frac{2}{8}$ was required.

Many other candidates made little or no progress with this part and did not understand how to combine probabilities of combined events. Candidates are advised to represent problems involving combining probabilities using a diagram as a first step.

Question 6

- (a) Most candidates calculated the value -8.25 correctly. There were issues for some in calculating with a negative value resulting in incorrect answers.
- (b) Candidates were often able to plot the points from the table with the required accuracy and almost all candidates gained partial credit at least. Fewer gave a correct curve. Some curves had poor curvature with ruled sections or vertical sections at either end of the graph. A few candidates plotted the points but did not attempt to draw the curve.
- (c) Many candidates did not attempt this part, and others did not understand they needed to give the x-value at the minimum and maximum points on their graph. Common errors included giving the x-values from where the curve crossed the x-axis while others attempted calculations.

- (d) A significant number of candidates did not attempt this part. Most that made an attempt were unable to manipulate the given equation to recognise that the line $y = \frac{1}{2}x - 1$ was required to be drawn. The common error was to draw the line $y = 2x - 4$ with many missing the last step to divide $(2x - 4)$ by 4. There was also a number that did not attempt to draw a line and they either attempted to solve the equation algebraically or gave three often random values as their answers.

Question 7

- (a) This was answered correctly by the vast majority of candidates. Errors included an incorrect first step of $16 + 7$ or $7 - 16$ or having done the correct first step then calculating $16 - 7$ as 11.
- (b) This part of the question proved slightly more challenging resulting in slightly fewer correct answers. Many gave a correct first step of $20 - 5y = 30$. Some then set $5y = 30 - 20$ resulting in an answer of 2, while others wrote $5y = 30 + 20$.
- (c) A very mixed response to this question. Some had completely correct answers with the four integer values, some gave the four integer values but had an additional one, usually -1.5 and some gave three integer values with one missing, often 0. A number omitted this part.
- (d) Candidates often struggled with this part and multiple methods were sometimes seen, although there were a small number of correct answers. Many gave a correct first step of $3xy = 4y - x$ but many then did not proceed to collect the terms in x on one side of the equation. It was common to see the next step as either $3xy - 4y = x$ or $3x - x = \frac{4y}{y}$. A number of candidates gave solutions that also included a term in x in the answer and they should be aware that where the subject appears twice in a formula then a technique of gathering the terms of the subject and factorising is required. Candidates should also be aware that when they show multiple attempts at a problem then Examiners will only mark the method that leads to their answer and in the absence of an answer, then the worst of the methods is marked.
- (e) Some candidates were able to simplify this algebraic fraction correctly, however, there were many who correctly factorised the denominator, but proceeded no further than factorising the numerator as $3(4x^2 - y^2)$ resulting in no cancelling of terms. A common error for those attempting to further factorise the numerator was to give $3(2x - y)^2$. Some candidates made errors factorising the denominator but showed a correct partial factorisation. For weaker candidates the initial step was to use incorrect algebra to cancel individual letters or numbers in the numerator with the same letter or number in the denominator.

Question 8

- (a) Only a few candidates gave a fully correct answer using the correct geometrical terminology. Many candidates earned partial credit for identifying the three correct angles. Common errors in giving the geometrical reasons included 'because they are parallel' or 'common angle' or 'similar angle'.
- (b) Many candidates found this part difficult and only a minority of candidates gave a fully correct explanation. A common error was for candidates to use the given values 3.6 and 5.2 within their method and in questions that ask candidates to show a particular value then the given values should be established and not used. A significant number of candidates did obtain partial credit for showing the ratio 5.6:9.8 in some form within their method. A few candidates incorrectly attempted to show $AD = 3.6$ and $AE = 5.2$ by incorrectly using trigonometry. A significant number omitted this part.
- (c) Only those candidates that recognised that the cosine rule was the most appropriate method to find angle DAE made progress in this part. Of those that did, many gave the implicit version of the cosine rule for finding the side and had difficulty in rearranging it to the angle version. Those that used the explicit cosine rule for the angle had much greater success. A few used the cosine rule but for the incorrect angle and many more attempted right-angled trigonometry with the misconception that the perpendicular from point A bisected DE . A significant number omitted this part.

- (d) Those candidates who used the cosine rule to solve **part (c)**, usually gave a correct method to find the area of the triangle in this part. Examiners awarded a method mark for the correct use of the angle to **part (c)** within this method. Of the other candidates, many did not attempt this part or incorrectly gave e.g. $\frac{6.3 \times 9.1}{2}$. A few candidates attempting to use the formula $\frac{1}{2}ab \sin C$ used the incorrect combination of sides and angles and a small number attempted to find the area of triangle *ADE*.

Question 9

- (a) This question was attempted by most candidates. Many recognised that angle *ODE* was a right angle but much fewer recognised the cyclic quadrilateral *ABCD* to find angle *ODC* = 54° leading to angle *DOC* = 72°. A common error was to treat triangle *DOC* as equilateral leading to angle *DOC* = 60°. Examiners awarded method marks for trigonometrical methods involving triangle *DOE* that used incorrect angles provided they had been identified or marked on the diagram and there were a number of creative longer solutions for finding the radius. Most involved basic trigonometry but some, for example, used the sine rule in triangle *ECD* and then triangle *OCD* or used Pythagoras' Theorem. Some candidates made premature approximations of values within their method which led to an inaccurate answer. A common incorrect approach by weaker candidates was to attempt to find sector areas.

- (b) This proved challenging for many candidates and a number could not recall the correct method for finding the arc length or sector area of a circle. The candidates that were more successful showed step by step reasoning starting with a statement using the given arc length $\frac{82}{360} \times 2 \times \pi \times r = 7.3$. Almost all of those then went on to give the correct radius.

Examiners awarded follow through method marks for those using their stated radius correctly to find the area of the major sector. Many did not recognise that the angle required for the major sector was 360 – 82 and a number found the area of the minor sector. The most common errors included using incorrect formulae for the area or circumference of a circle.

A few candidates attempted to work in radians and in all cases this proved unsuccessful. The use of radians is not on the syllabus for 4024 O-level and candidates are advised to always work in degrees.

Question 10

- (a) There were very few correct answers seen. Many worked in dollars and not cents and the most common incorrect answer was $\frac{9}{x}$, $\frac{x}{9}$ or $9x$.
- (b) A small number of candidates correctly constructed a correct algebraic equation involving the required terms. Those that did, often went on to manipulate the equation correctly to the given three-term quadratic equation. Examiners awarded follow through marks for those that used their expressions for **parts (a)** and **(b)** provided their equation involved different algebraic denominators. The common error for a few was to use $\frac{9}{x}$ and $\frac{9}{x+40}$ which could earn partial credit. Many candidates did not start from an equation containing algebraic fractions however and made little progress. Many candidates omitted this part.
- (c) The majority used the quadratic formula to solve the equation, and many were successful. On occasions an incorrect formula was used. The most common errors in using the formula were to have a short division line or to make an error in the substitution either for the $-b$ term (–40) or for the c term (–48000). A few correctly factorised the equation to find the solutions. Weaker candidates often tried to rearrange the equation to reach an answer.
- (d) Many candidates did not attempt this part. Of those attempting this, many did not realise they need to use their positive answer to **part (c)** as the cost per kg of the apples. For those that used their positive answer to **part (c)**, a common error was not to add 40 cents when multiplying by 0.8 in finding the cost of the pears within this method.