MATHEMATICS D

Paper 4024/11
Paper 1

Key messages

To do well in this paper, candidates need to demonstrate that they have a good understanding across the whole syllabus. As it is a non-calculator paper, candidates need to be competent in basic numeracy skills, particularly in multiplication and division of whole numbers as well as decimals, and be able to convert from one form to another with a suitable degree of accuracy where necessary. All working needs to be shown clearly as in most questions method marks are available even if the final answer is incorrect. Candidates should also be encouraged to read each question again when they have completed their response to ensure the answer they give is in the required format and answers the question set. Candidates need to write digits clearly and distinctly.

General comments

Many candidates displayed a reasonable standard of presentation although some improvement could be made. The amount of working shown was usually good but sometimes the working appeared without clear structure within the workspace.

Candidates generally showed good skills in basic numeracy. Arithmetic slips were seen quite frequently; candidates should take care to avoid these by checking their working carefully. Candidates showed good skills in managing simple fractions and ordering numbers involving conversion to another form. Some improvement is needed in questions that require manipulating standard form. Candidates dealt with basic algebra well but some sign errors were quite common and improvement could be made in applying the rules of indices.

The questions that candidates found most difficult were set notation **(Question 9(b)(ii))**, finding the formula for the *n*th term **(Question 13b)**, area of a similar triangle **(Question 15b)**, proving congruent triangles **(Question 19),** completing the square **(Question 22)** and volume and surface area **(Question 23)**.

Comments on specific questions

Question 1

(a) A large majority of candidates gave the correct answer. A few gave the answer as +10 and a few wrote –2 + 8 = 6.

(b) The majority of candidates gave the correct answer. Some wrote –5 + 3 = –2 and a very small number of candidates gave the answer as –8.

Question 2

Most candidates started with the correct method. Often an answer with the digits 54 was given with the decimal point misplaced. This was seen regularly in responses from candidates who had started by working in cents, $\frac{45}{100}\times 120$. Others made arithmetic errors when cancelling the fractions or multiplying the decimals. A few left the answer as a fraction, which was not appropriate for this question about money.

Question 3

Many candidates gave the correct ordered list and many others managed to order three of the fractions if one misplaced fraction was ignored. Candidates who rewrote the fractions with a common denominator did well on this question. Those who tried to write equivalent decimals were less successful.

Question 4

(a) Candidates answered this question well with the majority scoring full marks. Most others scored partial credit usually for measuring the distance accurately in centimetres and sometimes for using the scale factor accurately with an incorrect distance.

(b) Many correct bearings were found. Some candidates gave answers around 55°, either from reading off the wrong scale on their protractor or for measuring the acute angle from *B* anticlockwise to *A*. Other incorrect answers included bearings of *A* from *B*, the distance *AB* in centimetres or inaccurate bearings of *B* from *A*. Candidates should only give numerical answers for bearings and should not include, for example, 125° North East.

(c) Many candidates located the correct position for the point. Most others plotted a point that had one of the bearings correct; more often this was the bearing from *A*. Errors included plotting the point 164° on the horizontal line through *A* or plotting 164° anticlockwise from *A*.

Question 5

(a) (i) Most candidates gave the correct answer. A few truncated the decimal to 306.24 and a few gave the answer to 1 decimal place.

(ii) Many correct answers were given. Common errors were 31 (losing the value of the original number), 30, 300 or including incorrect trailing zeros 310.000.

(b) Many candidates showed the correct working and gave the correct answer. A very common error was to write $\sqrt[3]{1046}$ as $\sqrt[3]{1}$ resulting in 81 – 1 = 80. A few candidates did not round the given numbers and attempted to find an exact answer.

Question 6

(a) A large majority of candidates gave the correct answer. A few evaluated the product giving the incorrect answer of 1024.

(b) A large majority of candidates gave the correct answer. Incorrect answers included 25, $\sqrt{5}\times\sqrt{5}$, $\sqrt{25}$.

(c) A minority of candidates gave the correct answer. Many were unsure whether to add or multiply the powers or to apply these rules to the coefficient 2 as well as the x. A common incorrect answer was $2x^{12}$. Various other incorrect answers were seen regularly including $8x^{12}$, $8x^4$, $8x^7$, $2x^7$ and $16x^7$.

Question 7

(a) This part was almost always correct.

(b) This part was also answered very well with a large majority of candidates giving the correct answer. Most others started with the correct method and either left the answer as an improper fraction, usually $\frac{14}{5}$, or a few made an arithmetic slip within the working.

Question 8

A large majority of candidates gave the correct answer. A few gave a correct partial factorisation and were awarded one mark. A small number of answers were $15a^3$ or $15a^2$.

Question 9

(a) A large majority of candidates shaded the correct region.

(b) (i) Although many correct answers were given it was very common for candidates to give the number of candidates who studied English or German as well as both languages excluding Spanish and so they gave the answer 11 + 5 + 8 = 24.

(ii) Only a few candidates gave the correct answer and many different incorrect answers were given.

Question 10

(a) A large majority of candidates gave the correct answer. Recurring errors were 32×10^7 and 3.2×10^7.

(b) Candidates found this part of the question more difficult with only a minority being awarded full marks. Some candidates were awarded one mark for reaching 0.5×10^{-12}; this was often their final answer or it was sometimes followed by 5×10^{-11}. A common incorrect answer was 2×10^{-12}. Some multiplied the 2 and 4 giving answers such as 8×10^{-12}, while others made an error with the powers $0.5 \times 10^{9- -3}$.

Question 11

(a) This question was answered correctly by a large majority of candidates. Working was usually clearly presented in a factor table or factor tree.

(b) Few candidates gave the correct answer in this part. Many different incorrect answers were offered with 3^2 and 9 seen regularly.

Question 12

(a) Most candidates gave the correct answer. The most common incorrect answer was $-2x + 9$ which resulted from a sign error when expanding the second bracket $-2(4x + 3)$ as $-8x + 6$. A few candidates reordered the terms $6x + 3 - 8x - 6$ incorrectly as $6x + 8x + 3 - 6$.

(b) Nearly all candidates knew the method for expanding double brackets and the majority gave the correct simplified answer. Most others were able to expand the brackets with at least three terms correct and were awarded one mark. Errors collecting the *x* terms or sign errors with the –15 were the usual cause for the final answer being incorrect.

Question 13

(a) Many correct answers were given. A few arithmetic errors were made when working out the substitutions. Some of the candidates who did not know what to do gave expressions in *n* for the three terms and a minority did not answer this part.

(b) Candidates struggled with this part and very few were able to reach the correct answer. Many found the differences between the consecutive terms by looking for a linear connection or the second differences by looking for a quadratic expression, but this did not lead to an expression for this type of sequence. Many realised 3 was involved but were unable to generate the required solution. Again, a minority left this part blank.

Question 14

Many candidates struggled to give correct algebraic expressions for the angles in this question.

(a) A minority of candidates gave the correct answer, but many others did not make the connection that the angle at the centre was twice the angle at the circumference. Many incorrect expressions were given and some candidates incorrectly assumed triangle *OCB* was equilateral and gave the answer as 60°.

(b) A minority answered this part correctly having been unable to answer the previous part. Many stated that angle *OBA* was 90° and were awarded a mark for this. A significant minority omitted this part.

(c) Again, only a few candidates answered this part correctly. Some candidates were awarded a method mark for using the angles in the isosceles triangle (*COB*) to find angle *CBO,* leaving their answer unsimplified. Many stated that angle *DCB* was 90° and were awarded a mark for this. A significant minority omitted this part.

Question 15

(a) Most candidates successfully used a correct ratio to find the missing side of the similar triangle. A few thought they needed to use Pythagoras' theorem even though the triangles did not contain a right angle.

(b) A minority of candidates found the correct area for the smaller of the two similar triangles. The majority used the linear scale factor, $\frac{1}{4}$, to multiply the area of the large triangle, 160, giving the answer 40. Another common error was to work out $\frac{1}{2} \times 3 \times 7 = 10.5$ for triangle *CDE* even though the sides 3 and 7 were not perpendicular, or give the answer as $\frac{1}{2} \times 160 = 80$.

Question 16

(a) Most candidates found the correct gradient of the line.

(b) Few candidates were able to find all three correct inequalities. Many found one or both of $x \geqslant 1$ or $y \leqslant 5$ but often these were given as $x > 1$ and $y < 5$. Common errors were having the x and y swapped in these equations or the inequality signs reversed or put as =. Similar errors were seen with the sloping line. The majority of candidates were unable to find the correct equation for this sloping line.

Question 17

(a) Some candidates were able to find the correct gradient which represented the acceleration of the journey. Some incorrect answers included 6 from $\frac{120}{20}$, 10 from $\frac{20}{2}$ and 20.

(b) Many candidates understood they needed to find the area under the graph and some proceeded to find the correct average speed. Some errors were made finding the area between $t = 120$ and $t = 480$ by those candidates who split the area into two triangles and a rectangle with the base taken as 480 rather than 360. Some incorrectly used $\text{speed} = \frac{\text{distance}}{\text{time}}$ with 20/600.

Question 18

This question was answered well by most candidates. The most common incorrect answer was 30 which came from those who started with *b* proportional to *a.* Some candidates correctly found the constant $k = 2$, then used it in direct proportion to get $2 \times 5 = 10$.

Question 19

Few candidates gave a complete proof of congruency. Many were able to give a correct pair of angles, either *ACD* = *ACB* or *ADC* = *ABC,* with a correct reason and some gave both. Many gave either one or both pairs without the correct reasons. Some stated *AC* was a common side. All these were awarded partial marks. Many candidates tended to write general rather than specific descriptions of the diagram and its symmetry and included statements such as "the line *AC* bisects the base", "*AC* splits the triangle into halves", "triangle *ADC* is equal to triangle *ABC*" "all sides are equal" or "they are both right-angled triangles".

Question 20

(a) Many correct answers were given. Many different incorrect answers were also given, including the interval width of 5, adding the ends of the interval 15 + 20 = 35 and the cumulative frequency 5 + 20 = 25.

(b) Many correct histograms were drawn. It was common for the first bar to be drawn correctly with the second bar drawn the correct width but with height 2 rather than 1.

Question 21

(a) Many candidates gave the correct answer. Others were awarded partial marks for two or three correct elements or for finding the matrix representing 2**B**. A few assumed matrix **B** was $\begin{pmatrix} 1 & 5 \\ 10 & 12 \end{pmatrix}$ and worked out **A** plus two times this matrix.

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

Question 22

(a) Candidates found this question very challenging. Many expanded the brackets on the right-hand side of the equation but then did not know how to proceed. Only a small minority made an attempt to complete the square, sometimes with the incorrect sign $(x + 3)^2$.

(b) Very few candidates gave a fully correct solution in this part. A large majority of candidates solved the equation by factorising it or by using the quadratic formula but this did not score full marks. Even those who had completed the square correctly in the previous part often ignored this method and used factorisation or the formula.

Question 23

(a) A few candidates were able to show the correct expression for y. A large majority were unable to write a correct expression for the slant height of the cone. Errors included $y + \frac{25}{100}$ and $\frac{25}{100}y$. Some used the formula for the volume of the cone instead of the surface area of the sphere and some missed out the area of the base of the cone when writing their expression for its total surface area. A significant number of candidates did not attempt this part.

(b) Very few candidates found the correct expression for the volume of the cone. Few realised they needed to use Pythagoras' theorem to find the vertical height of the cone. Some candidates wrote the volume of the cone with the substitution $y = \frac{4R}{3}$ for the radius and left the height as h, but this did not score any marks. A significant number of candidates did not attempt this part.

MATHEMATICS D

Paper 4024/12
Paper 1

Key messages

To do well in this paper, candidates need to:

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

General comments

In general, candidates were well prepared for most of the topics covered on this paper and attempted most of the questions. The topic areas that offered most challenge to candidates were vectors, graphical inequalities, and functions. Candidates would benefit from more experience in answering questions that require an element of problem solving as many found **Questions 7** and **8** difficult to answer.

In most cases candidates showed their method clearly in the answer space for the question and transferred their answer correctly to the answer line. If a method is replaced, candidates should cross out the working that is no longer required as part of their solution to make it clear which working they intend to be marked. Candidates should take care to ensure that their writing is legible and should ensure that numbers such as 1 and 7, and 5 and 6 can be clearly distinguished. Candidates usually had access to the geometrical equipment required to produce a correct diagram.

In a non-calculator paper, it is a key requirement that candidates have good arithmetic skills. Many candidates were able to calculate with fractions. More errors were seen when negative numbers and decimals were involved, particularly dividing by decimals in **Question 1(a)** and **Question 13**. Candidates often made errors when simplifying numeric and algebraic fractions in **Questions 6(b)**, **19** and **25**.

Candidates are expected to understand mathematical terms such as highest common factor and relative frequency. Candidates should know basic geometrical facts such as the number of sides in a hexagon or an octagon.

Comments on specific questions

Question 1

(a) Some candidates correctly removed the decimal in the division $80 \div 0.02$ and used the equivalent division $8000 \div 2$ to reach the correct answer. Another strategy used successfully was to write 0.02 as the fraction $\frac{2}{100}$ leading to the calculation $80 \times \frac{100}{2}$. Many incorrect answers such as 0.40 were seen, usually resulting from calculating $80 \div 2 = 40$ and then inserting a decimal point in an attempt to adjust this back to the original calculation.

(b) Many candidates stated the cube root of 1000 correctly. Some gave the answer 10^3 which was not acceptable for this question.

Question 2

(a) Many correct answers were seen. A small minority of candidates inserted more than one pair of brackets into the calculation which was not accepted for this question.

(b) Most candidates were able to use the correct order of operations in this calculation involving negative numbers. A small number gave the answer 24 in place of –24. Some made the calculation more complex by expanding the bracket first. Rather than simplifying (–3 + 7) first leading to –6 × 4 they calculated –6 × –3 + –6 × 7 and this method led to more arithmetic errors.

Question 3

Candidates were often able to write the number as a decimal correctly. The most common errors were to include the wrong number of zeros, 0.00754 was common, or to ignore the negative sign in the power leading to the answer 75 400.

Question 4

(a) Many candidates were able to identify the correct pair of tiles to give a rectangle with one line of symmetry. Some did not read the question carefully and gave only one letter in their answer.

(b) Identifying two tiles that would give a rectangle with rotational symmetry of order 2 was more challenging and the incorrect answers *C* and *D* were common. Candidates who sketched the patterns to check the symmetry were often more successful in both parts of this question.

Question 5

Candidates who knew that an octagon has 8 sides and a hexagon has 6 sides often correctly calculated the perimeter of the octagon using 9 × 8 = 72 and then used this to find the length of a side of the hexagon. It was common to see 9 or 10 used as the number of sides in an octagon or 5 or 7 sides in a hexagon. Some candidates gave the answer 72, the perimeter of the octagon. Other common errors were to use (9 × 6) ÷ 8 or to attempt to find the interior angles of the shapes.

Question 6

(a) Many candidates subtracted the fractions correctly. Most worked with a common denominator of 15 but others successfully worked with a common denominator of 45, although $\frac{3}{45}$ was occasionally then simplified to 15 rather than $\frac{1}{15}$. Some candidates subtracted the numerators and the denominators leading to the incorrect answer $\frac{9}{12}$.

(b) Many candidates carried out the division correctly. Some answers were given as an unsimplified fraction or as a decimal, rather than a fraction in its simplest form as required by the question. Some candidates simplified $\frac{3}{60}$ incorrectly. Common errors in the method were to find $\frac{3}{10}\times\frac{6}{1}$, $\frac{10}{3}\times 6$ or $\frac{10}{3}\times\frac{1}{6}$. Some candidates who reached $\frac{3}{10}\times\frac{1}{6}$ then cross multiplied the numbers leading to an answer of $\frac{18}{10}$.

Question 7

(a) Candidates who knew that a pentagon had 5 sides and could recall a formula for the interior angles of a polygon usually applied it correctly to reach the answer 108°. Some arithmetic errors were seen, usually in evaluating 3 × 180. Some candidates misinterpreted the question and used $n = 4$ instead of $n = 5$ in the interior angle formula and others misremembered the formula as $\frac{(n-1)180}{n}$. Some found the exterior angle using $\frac{360}{5}$ rather than the interior angle. It was common to see an answer of 110°, a result of measuring the angle on the diagram, despite the diagram being clearly indicated as not to scale. Some candidates gave the algebraic answer $(180 - y)$ rather than finding the size of the angle as required.

(b) Some candidates recognised that the parallel sides mean that the sum of angle x and angle y is 180° and gave an answer that followed through correctly from their answer in **(a)**. However, this part was not attempted by many.

Question 8

Many candidates had difficulty using the information given in the question correctly. They needed to recognise that, as the triangle was isosceles, the ratio 2:5 meant that the 3 angles in the triangle were in the ratio 2:5:5 so the angle sum of 180° should be divided into 12 parts. A common incorrect method was to use 2 + 5 = 7 parts and divide 180 by 7. A small number of candidates misinterpreted the isosceles triangle and used 2:2:5 as the ratio of the three angles. In some cases, 360 was used as the angle sum instead of 180. Other candidates did not use the angle sum and considered the ratios only, resulting in answers such as 2:10 = 1:5.

Question 9

Many candidates rounded the given numbers to 1 significant figure correctly. This was often followed by the correct answer of 30. Some made calculation errors, often 60 ÷ 20 = 30 rather than 3, which led to the common incorrect final answer of 3. Some rounded one or more values to the nearest integer rather than to 1 significant figure, for example rounding 17.7 to 18 rather than to 20. Some rounded all values to the nearest integer giving the calculation $\frac{48+36}{65 \div 18}$ which led to some complex and unnecessary arithmetic. In a question of this type, any attempt at a calculation without first rounding values to the required accuracy will gain no credit.

Question 10

(a) Many candidates answered this correctly using either a factor tree or the ladder method. Common errors included incorrectly dividing 210 by 2 to get 15 rather than 105 or omitting one of the factors obtained when using a factor tree. Answers occasionally contained numbers which were not prime, including 1.

(b) Some candidates were able to use their answer to **(a)** and the given prime factorisation of 1512 to find the correct highest common factor. This was sometimes given as $2^2 \times 3 \times 7$ rather than evaluated as 84. Some gave a factor such as 7 or 12 in place of the highest common factor and others attempted to find the lowest common multiple.

Question 11

(a) Many candidates understood that the relative frequency for green is found by subtracting the sum of the other relative frequencies from 1. Those that could add the three decimals 0.15, 0.3 and 0.2 correctly to give 0.65 usually reached the correct answer. Many arithmetic errors were seen, in particular 0.15 + 0.2 + 0.3 = 0.2, which gained the method mark if both the intended addition and the subtraction from 1 were shown. Many candidates carried out the calculations mentally without writing down their method so this method mark could not be awarded. Other common errors were to divide the sum of the three probabilities by 4 or to attempt to follow a sequence in the numbers given in the table, often leading to an answer of 0.1.

(b) Some candidates attempted the correct calculation of 150 × 0.3 but it was common to see errors in arithmetic or place value when evaluating the result. In some cases, the answer was given as $\frac{45}{500}$ rather than the correct answer of 45. Some candidates used an incorrect operation with the correct numbers such as 150 ÷ 0.3 or 0.3 ÷ 150.

Question 12

(a) Many candidates were unfamiliar with the notation required to represent the inequality on the number line. The correct answer has a solid circle at –4, an open circle at 2, and a single line joining the two circles. Many diagrams showed a line with no circle at either end point, used a box to illustrate the inequality, or included arrows on the line thus indicating an open-ended inequality. Some candidates drew two separate lines, one starting at –4 with an arrow extending to the right and the second starting at 2 with an arrow extending to the left past –4. Some candidates marked the upper end at 1 rather than 2.

(b) Those candidates who rearranged the inequality to collect the terms in n on the right-hand side of the inequality giving $10 + 5 < 2n + n$ were more successful in reaching the correct answer. Those who collected the terms in n on the left-hand side of the inequality giving $-2n - n < -5 - 10$ often gave an incorrect answer of $n < 5$. Some candidates gave a final answer of $n = 5$ or just 5, even when a correct inequality had been seen in the working. A small minority attempted to split the given inequality into two inequalities to be solved separately.

Question 13

Most candidates attempted to use the formula speed = distance ÷ time, but many were not able to correctly convert the units for both distance and time. Those candidates who converted 2600 m to 2.6 km and 12 minutes to $\frac{1}{5}$ hours or 0.2 hours before attempting the speed calculation were often more successful than those who attempted to combine these conversions with the speed calculation. Candidates who reached the calculation speed in km/h = 2.6 ÷ 0.2 were not always able to complete the division correctly and answers of 1.3 and 0.13 were common. Some errors in conversion of units were seen, for example 2600 ÷ 100 rather than 2600 ÷ 1000 or 12 ÷ 3600, or 12 × 60 rather than 12 ÷ 60.

Question 14

(a) Many angle bisectors were accurately drawn with correct arcs, but some candidates drew an angle bisector that did not reach *PQ* which was expected for the complete response. A few drew very small arcs which could be difficult to see. Some sets of arcs were inaccurate, resulting in the bisector being outside the tolerance allowed. Some candidates drew a perpendicular bisector of *PS*, *SR* or *PR*, or the line *SQ* rather than the required angle bisector.

(b) (i) Some candidates drew the bearing of 104° at *P* correctly but some measured 140° and others measured the angle from *PS* rather than North. Others drew a line from *P* to *R* or drew a line outside the quadrilateral.

(ii) Those candidates who had drawn a correct angle bisector and bearing were usually able to measure the line accurately and then use the scale to find the actual distance correctly. Candidates should write down their measurement of the distance as well as their final answer so that it is clear where their answer comes from. Those who wrote down the length of the line they had measured then multiplied it by 20 to reach their final answer gained credit for demonstrating correct use of the scale even when it was unclear which line they had measured. Some candidates were unable to multiply by 20 correctly.

(c) This part was found to be challenging by many, and only a minority of candidates gave the correct answer. Many used the scale factor 20 rather than the area factor of 20^2 to reach their answer. Some attempted to use measurements of lengths from the diagram to calculate an area rather than scaling up the given area.

Question 15

(a) This question was very challenging for many candidates. Some candidates realised that they needed to substitute the coordinates of point B into the given equation and rearranged it to find $p = 4.5$. Common errors were to substitute $x = 0$ and $y = p$, leading to the answer 6 or to substitute the coordinates of point C, $x = p$, $y = 6$, leading to the answer 0 or 4.

(b) Some candidates attempted to write three inequalities, but in many cases one or more of the inequality symbols was incorrect. Often one of the inequalities $y < 6$ or $x <$ *their* 4.5 was correct, but there were more errors seen in the third inequality. The simplest way to write this inequality was to use the given equation and replace the = with an inequality symbol giving $3y + 4x > 18$. However, many candidates attempted to rearrange to $y > -\frac{4}{3}x + 6$ and made errors in their rearrangement.

Some candidates stated inequalities such as $x > 0$ or $y > 0$ that were not part of the boundaries of triangle ABC and others gave coordinates as answers.

Question 16

(a) Many candidates found the correct coordinates of the midpoint. A few confused the x- and y-coordinates whilst others considered the differences in the coordinates rather than their sums leading to answers of (4, 6) or (8, 12).

(b) (i) Many candidates calculated the gradient correctly. Some showed a correct calculation of $\frac{13-1}{6--2}$ but made errors when simplifying $\frac{12}{8}$ or when carrying out the subtraction, for example 14 seen as the numerator and 4 as the denominator. Some found (change in x) ÷ (change in y) when calculating the gradient. A small number of candidates gave the equation of the line as their answer rather than its gradient as required.

(ii) Some candidates knew the relationship between the gradients of two perpendicular lines and used this correctly with their answer from **(b)(i)** to find the gradient of the perpendicular. Common errors were to restate their previous gradient, to find its reciprocal, or to change its sign. Some started with a new gradient calculation rather than using their previous answer. A significant minority omitted this part.

Question 17

(a) Many candidates answered this part correctly. The most common error was to add the indices leading to the answer x^5.

(b) This part was found to be more of a challenge with the incorrect answers 3, 81 and $\frac{1}{81}$ often seen.

(c) Candidates had more success with this part, but the incorrect answers 2, 0 and 1 were often seen.

Question 18

Many candidates are well prepared for questions assessing proportion and the correct answer was often seen. Some set up a correct equation, usually $x = k(y+1)^2$, and substituted $y = 2$ and $x = 45$ to find the constant. Some made errors when rearranging this to find the constant but were able to gain a method mark for using their value of the constant correctly in $x = 5(4+1)^2$. Most candidates attempted direct proportion, but some set up an equation with x proportional to $(y + 1)$ rather than $(y + 1)^2$, some started with a correct equation then omitted the square when evaluating x, and others set up an equation with y proportional to $(x + 1)^2$. It was noticeable that some candidates opted to evaluate $(2 + 1)^2$ or $(4 + 1)^2$ by first expanding the brackets, which often led to errors, or by squaring each term in the bracket.

Question 19

Many candidates had a clear understanding of the method required to solve this equation and started by using a correct common denominator before eliminating fractions and rearranging to reach a correct solution. In some cases, having reached a correct fraction such as $\frac{96}{54}$ there were errors in the final simplification. After the introduction of the common denominator, most candidates multiplied out at least one bracket correctly on the numerator. It was not acceptable to write $3x - 1(4)$ in place of $4(3x - 1)$. It was common for candidates to make errors in signs when collecting terms after the brackets had been expanded: $\frac{12x-4+6x+12}{24}=\frac{5}{3}$ was often followed by $\frac{18x-8}{24}=\frac{5}{3}$ rather than $\frac{18x+8}{24}=\frac{5}{3}$. Other common errors were to use a common denominator of 6 + 4 = 10, or to cancel inappropriately such as cancelling 8 and 24 in the fraction $\frac{18x+8}{24}$. Some candidates made more than one attempt at the solution in which case they needed to cross out the work that they had rejected.

Question 20

(a) There were many correct answers but common wrong answers were 0, 15, 20 and 30. Some candidates confused the range of 20 for the first group in the table with its lower bound of 10 for the answer in this part but then correctly used $x = 10$ when drawing the histogram.

(b) Most candidates drew a correct histogram using their value of x found in **(a)**. Some candidates were unable to calculate the frequency densities for the final two bars. Although the height of 3 was often correct for the third bar, the height of the final bar was sometimes incorrect. Most candidates used correct bar widths, but some started the first bar at $t = 0$, some drew all bars the same width and a small proportion left gaps between the bars. A small number attempted to draw a frequency polygon rather than a histogram.

Question 21

(a) Many candidates knew the correct process for finding the inverse function and some reached the correct answer. The most common error seen was in the first step of the rearrangement when attempting to eliminate the fraction, writing $2y = 1+3x$ rather than the correct $2y = 2+3x$ which led to the very common incorrect final answer of $\frac{2x-1}{3}$ rather than $\frac{2x-2}{3}$.

Candidates whose first step was $y-1=\frac{3x}{2}$, isolating the term in x before eliminating the fraction, were more likely to reach the correct answer. Candidates whose first step was $x=1+\frac{3y}{2}$ gained at least one mark.

(b) This part was found to be challenging. Some candidates were able to start by setting up a correct equation $\frac{2}{1-x}=1+\frac{3\times -4}{2}$, but many made errors when evaluating the right-hand side. Even candidates who got to the stage of $2=-5(1-x)$ often made sign errors when expanding the bracket. Some candidates started by evaluating f(–4) = –5 but then found g(–5). Other candidates found g(–4) = $\frac{2}{5}$ and did not use f(x) at all in their solution.

Question 22

(a) Many candidates identified the difference of two squares and gave the correct answer. Common incorrect answers were $(3p-q)^2$, $(9p-q)(9p+q)$, $(p-q)(9p-q)$ and some candidates made attempts to remove a common factor, for example $pq(9p-q)$.

(b) Candidates were more successful with the factorisation in this part. Some candidates factorised to the stage $c(a-3b)+a-3b$ but were then unable to complete the factorisation correctly because they did not understand that this was equivalent to $c(a-3b)+1(a-3b)$. In some cases, candidates made sign errors when factorising.

Question 23

(a) Almost all candidates completed the matrix correctly. A small number of candidates added lines to show the values as fractions or commas to show the values as coordinates.

(b) (i) Candidates who understood the process of matrix multiplication usually reached the correct 2 by 1 matrix with no arithmetic errors. Many candidates processed the matrices incorrectly, giving a 2 by 2 matrix, usually $\begin{pmatrix} 55 & 120 \\ 77 & 270 \end{pmatrix}$, as their answer.

(ii) Some candidates were able to give a clear and unambiguous answer that identified that the top element was the total cost of Adam's tickets, and the bottom element was the total cost of Ben's tickets. Many answers referred to both Adam and Ben as well as cinema tickets and theatre tickets and these explanations were rarely clear enough to identify that cinema and theatre had been combined and that Adam and Ben had been separated. Some explanations were clearly incorrect and referred to the total cinema cost and the total theatre cost with no mention of Adam and Ben. A small proportion referred to the number, rather than the cost, of tickets.

Question 24

Candidates found this question very challenging, with very few being able to use the relationship between the sine of an acute and an obtuse angle correctly to find the answer of 130°. Many omitted the question, but the most common incorrect answer was 135, the value midway between 90 and 180.

Question 25

Some candidates were able to correctly factorise both the numerator and the denominator and then cancel common factors to reach the correct answer. It was common to see attempts to factorise the numerator into two brackets, for example $(x-2x)(x+2x)$ or $(x-2)(x+2)$. Candidates had more success factorising the denominator but some made sign errors. Some candidates cancelled individual terms with no factorising, for example cancelling the x^2 in the numerator and denominator.

Question 26

(a) This question was very challenging for all candidates. Many were able to state a correct vector route for $\overrightarrow{OC}$, usually $\overrightarrow{OC}=\overrightarrow{OA}+\overrightarrow{AC}$ or $\overrightarrow{OC}=\overrightarrow{OB}+\overrightarrow{BC}$. Few were able to use the ratio AB:BC = 3:2 correctly to identify that $BC=\frac{2}{3}AB$. It was more common to see fractions with denominator 5 than 3, the result of using $BC=\frac{2}{5}AC$ and confusion between the vectors *AB* and *AC*.

(b) Very few candidates gained credit in this part, and many omitted it completely. Some started by sketching a trapezium but did not know how vectors should be used in their answer. Some were able to find vector *DB* correctly but very few were able to follow this by showing that *DB* is a multiple of *OA* and then stating that *DB* and *OA* are parallel.

MATHEMATICS D

Paper 4024/21
Paper 2

Key messages

Candidates should take care to use brackets around expressions, particularly in 'show that' type questions which involve algebraic manipulation. (**Question 8(b)**).

Candidates should take care to ensure they are working in consistent units, in particular where the question deals with time (**Question 1(a)**, **Question 8(b)** and **8(d)**).

Candidates should use a suitable degree of accuracy in their working. (**Question 1(b)**, **(c) (e)**, and **Question 2(b)(i)**). Final answers should be rounded correct to three significant figures where appropriate or to the degree of accuracy specified in the question. 'Show that' questions which require an answer to be shown to be correct to a given degree of accuracy should always include an answer to a greater degree of accuracy than that in the given answer (**Question 11(a)**).

General comments

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

Comments on specific questions

Question 1

(a) Most responses found the correct total time worked per day. However, many gave this as the total time for one week or did not correctly find the total time worked in one week. A small proportion of responses used 100 minutes in an hour.

(b) This question was well answered, with many correct responses seen. A small proportion of responses showed correct working but gave the answer to three significant figures. The answer of \$14.91 is exact and should have been given as the final answer. Monetary answers should be given to 2 decimal places (the nearest cent) unless the question requires otherwise.

(c) The intention of the question was for candidates to convert either the percentage or fraction to an equivalent form, find the percentage or fraction for savings as required, and finally find the ratio in its simplest form. However, many responses attempted to find the total amount of earnings and to calculate the amount of money spent on rent, bills and savings. These were very often inaccurate due to rounding errors. These responses could still gain credit for using a correct method.

(d) Those candidates who knew the difference between simple and compound interest generally answered this question very well. However, some candidates attempted to solve the question incorrectly using compound interest or included the original investment when trying to calculate the percentage rate of interest.

(e) Candidates who set up the initial equation correctly involving compound interest and the unknown amount of money invested tended to rearrange this correctly, but often with a rounding error. This problem occurred when 1.014^5 was rounded before being divided into \$1822.38. If this happened, candidates gained credit for a valid method, but did not gain full credit as the final answer was not correct to the nearest cent.

Question 2

(a) (i) This question was very well answered, with the four points usually plotted accurately.

(ii) Most candidates drew a ruled line of best fit which was in an appropriate direction and of an appropriate length. Some candidates thought the line of best fit had to pass through the bottom left corner of the graph, in this case the point (6, 100). Others joined each point to the next on the scatter diagram.

(iii) Most candidates who had drawn a ruled line of best fit in **(ii)** correctly read the height from their line at age 14. However, some candidates misread the vertical scale.

(iv) This part proved to be challenging for candidates. Candidates were expected to comment that 22 years was outside the range of the data given in the table, meaning the line of best fit would not be appropriate to estimate Simon's height. Comments relating to the line of best fit not passing through 22 years dd not gain credit.

(b) (i) This question was generally well answered, with responses adding 62 and 24 together and dividing by the total frequency of 180. The most common error was giving an answer of 47.7 rather than 47.8 or a more accurate value.

(ii) Candidates who realised midpoints were required in order to find an estimate of the mean height usually gave a fully correct solution. There were a few candidates who, having found the midpoints, used them incorrectly, but this was uncommon. There were some candidates who used the width of the groups rather than the midpoint and others who divided by the number of groups, 5, rather than the total frequency of 180.

Question 3

(a) The table was usually completed correctly. However, a common incorrect answer was 2.5. This may have been candidates assuming it would be the same as the answer for $x = -3$ but of the opposite sign. Another reason for this incorrect answer could have been subtracting both 9 and 2 from $\frac{27}{2}$ rather than subtracting 9 and adding 2.

(b) Points were usually plotted correctly, although occasionally –2.5 was plotted at +2.5 and similarly with –0.5. Points were usually correctly joined with a smooth curve, with ruled lines to join the points rarely seen.

(c) Providing the graph drawn in **(b)** contained a single minimum below the *x*-axis for $x > 0$, credit could be awarded for writing down the coordinates of this minimum point. Some candidates did not take account of the condition for $x > 0$ and incorrectly gave the minimum point as (–3, –2.5).

(d) This question required candidates to compare the equation given here with the equation of the graph drawn in **(b)**. In fact, the two equations are the same apart from one being equal to 0 and the other being equal to *y*. The equation could therefore be solved by finding where the graph was equal to $y = 0$, in other words reading the three *x*-values where the graph crossed the *x*-axis. The candidates who realised this were often very accurate with all 3 of their values.

Question 4

(a) This question was very well answered, with the vast majority of responses giving the correct answer.

(b) Similarly, this question was very well answered, with the majority of answers correct.

(c) Candidates who knew a method for finding an inverse function were usually successful in reaching the required function. However, a few candidates made errors with negative signs when rearranging. There were some candidates who did not understand how to find an inverse function and some who were unable to rearrange the resulting equation.

(d) Some candidates demonstrated understanding of function notation and solved the quadratic equation correctly. However, there were many candidates who did not know that to answer this question, they should replace x with $2x - 1$ in the $f(x)$ function, add 3 and equate to 0 to obtain a quadratic equation which should then be solved.

Question 5

(a) (i) Many responses gave the probability of obtaining a black ball from each of the two bags, although some used an incorrect number of black or white balls for one of the bags. Very few responses gave both probabilities in a comparable form and included a suitable comparison statement. The probabilities could be given as fractions, percentages or decimals, and a statement that the probability of taking a black ball from bag 2 was greater than the probability of taking a black ball from bag 1 was required.

(ii) This question was usually correctly answered if candidates had counted the balls correctly in bag 2. Responses generally demonstrated understanding of the requirement to find the probability of taking a white ball from bag 2 and multiply this by the number of times the experiment was repeated.

(b) (i) The majority of responses gave the correct missing probabilities for the tree diagram. There was some miscounting, and some fractions did not have a denominator of 15, but generally this question was well answered.

(ii) This question proved to be very challenging. It was a demanding question, which required several different branches of the tree diagram to be considered. Various approaches could be taken. One method is to consider all the branches which have at least one red counter; there are five of these. Another method is to look at all the branches which do not have any red counters and subtract the total probabilities of these from 1. Many responses gained partial credit for calculating the probability of an appropriate branch even if the solution was not complete.

Question 6

(a) (i) Many unsuccessful attempts to find the vector were seen. Candidates often added the position vectors for points A and B or subtracted them the wrong way round.

(ii) Most candidates used their answer from **(i)** to find the distance from point A to point B. Those with an incorrect column vector from **(i)** were still able to gain credit for a correct method here. As this question was not in a physical context, either a decimal or a surd answer was acceptable for full credit.

(iii) This question proved to be very challenging, with very few fully correct responses seen. Candidates who sketched a parallelogram with known coordinates and vectors tended to be more successful than those who did not. Candidates could use the given vector from B to C and apply this to point A to find the coordinates of point D. Similarly, the vector from A to B from **(i)** could be applied to point D to find the coordinates of point C

(b) Candidates who knew how to find a midpoint tended to make better progress than those who only used the gradient. Using the y-coordinate of 3 of the midpoint allowed candidates to find u immediately. Using the gradient of the line joining P and the midpoint allowed candidates to find r immediately. The value of t could then be found either using the x-coordinate of 1 of the midpoint or a second equation involving the gradient. Other approaches are equally valid, and were seen used successfully, including solving simultaneous equations in t and r.

Question 7

(a) Many responses correctly identified the transformation as a translation but often gave the wrong vector. Sometimes the vector was for the opposite direction. In other responses, squares were incorrectly counted.

(b) In some responses, shape A was reflected in the wrong line, often the *y*-axis or a line other than, but parallel to, the *x*-axis.

(c) In many responses the shape was enlarged by the correct scale factor, but often from an incorrect centre. To answer this question correctly, candidates needed to count squares from the given centre to a corner of shape *A*, then double this number of squares to find the corresponding corner of the enlarged shape.

(d) (i) Candidates could either recognise that the matrix represented a rotation 90º anticlockwise with centre (0, 0) or apply the matrix to the coordinates of the corners of shape *A* to find the coordinates of the corners of shape *C*. A few correct solutions were seen, but this question was challenging for many.

(ii) This question also proved challenging. Candidates could generally identify that a rotation was needed, but the centre, the angle and the direction of the rotation were often incorrect.

(iii) Again, candidates found this question very challenging, and a significant number of candidates did not attempt this question.

Question 8

(a) The majority of responses gave a correct expression for the time.

(b) This part was omitted by a significant number of candidates, and many others found forming the equation and rearranging it to the given quadratic difficult. Candidates needed to find an expression for the time Marco took to complete the trail, change both times to minutes, and form an equation which showed that Marco took 15 minutes longer than Lara. Alternatively, the equation could be formed in hours. The resulting equation needed to be clearly manipulated to show that it simplified to the given quadratic.

(c) Despite not always being able to complete **(b)** successfully, many candidates still persevered with this part and solved the given quadratic successfully. Candidates should note this question required answers to be given to two decimal places and that all working needed to be shown for full credit to be awarded.

(d) This part proved to be very challenging and was omitted by a significant number of candidates. The question required the positive *x*-value found in **(c)** to be substituted into the expression for Marco's time from **(b)** and the resulting time given in hours and minutes, correct to the nearest minute.

Question 9

(a) Some responses demonstrated confusion with the wording here. The question asked for an equation to be formed and solved. However, some candidates interpreted 'the answer is 11 less than the number she thought of' as meaning they should set their initial expression to less than 11 and try to solve the resulting inequality. The rearrangement of candidates' equations was usually correctly done after a correct equation was formed. More practice in forming equations may be of benefit to candidates.

(b) Responses usually demonstrated understanding of how to divide fractions in this part. The difficulty for some was in recognising how to factorise the difference of two squares or how to factorise the quadratic which required only one bracket.

Question 10

(a) Although most candidates attempted this part, very few correct responses were seen. A large proportion did not realise that the distances between the towns and use of the cosine rule were needed to find the interior angle of the given triangle at point *Q*. This angle and 128º then needed to be subtracted from 360º to find the required bearing of *R* from *Q*.

(b) Some candidates recognised this as a bounds question and gained credit for using an angle of 67.5º or a distance of 44.5 metres. Others recognised this as a trigonometry question and gained credit for correct use of right-angled trigonometry. This question was very challenging for many candidates, but a few fully correct solutions were seen.

Question 11

(a) The diagram in the stem of the question was intended to help candidates to visualise the problem and to allow candidates to add lines and/or angles to the diagram. Some candidates did this, but many did not. Candidates were equally successful whether they considered the angles at the centre of the pentagon or the interior angles of the pentagon. Many candidates used appropriate right-angled trigonometry to find length *d*. However, few candidates showed the value of *d* to at least 3 decimal places. As this is a 'show that' question with *d* given to 2 decimal places, responses needed to give the answer to a greater degree of accuracy.

(b) This question proved to be the most challenging on the paper, particularly finding the base area of the pyramid. Those candidates who drew a separate triangle *OAB* were often successful in finding the area of this triangle and multiplying this area by 5 to find the base area of the pyramid. Many candidates incorrectly used 14 as the height of the pyramid rather than using Pythagoras in triangle *OAF*, for example, to find the length of *OF*.

MATHEMATICS D

Paper 4024/22
Paper 2

Key messages

The presentation of answers was not always clear, particularly in **Question 5b** where it was difficult to follow the calculations being used to obtain the answer.

Candidates should be aware that the number of marks awarded for a question is an indication of the amount of work required. For example, 5 marks being awarded for **Question 5b** indicated that it is more than the usual describing of a transformation and 4 marks being awarded for **Question 7b** required the use of more than one trigonometric equation.

It was apparent from **Question 5** that there was a limited of understanding of simultaneous equations by some candidates who did not recognise that $5x + 10y$ could not equal 130 as well as 815 or $x + y$ could not equal 130 as well as 815. Obtaining these two equations should have indicated to candidates that mistakes had been made when setting up at least one of the equations.

General comments

Most candidates made an attempt at the majority of the paper. There were some questions that were quite challenging for all but a small minority of the candidates. Candidates performed very well on **Question 8**, which tested simplification and rearranging algebraic expressions and solving a quadratic equation. Some candidates found it difficult to provide succinct comments in **Question 2aiii** or mathematically correct reasons in **Question 10a**.

Comments on specific questions

Question 1

(a) (i) Most candidates were able to get one of the correct times, usually finding the Marseille arrival time correctly. Common errors often involved a one-hour difference, for example, London departure time of 14 22 or Marseille arrival time of 22 01.

(ii) Many candidates correctly calculated the time difference required but some candidates gave either the hour as 3 or the minutes as 21.

(b) Candidates usually understood the requirements of this question and many were able to use the correct method to calculate the value of r. Premature approximation led to some inaccuracies in this value. Candidates who did not show the correct complete method were often able to change £250 to dollars or to find the exchange rate of £1 in euros.

(c)(i) The majority of candidates were able to find the amount that Josef paid as the deposit. Some candidates did not use the fact that the amount for the holiday was per person while others calculated the remaining cost of the holiday after the deposit had been paid.

(ii) Candidates who recognised that this was a reverse percentage question were usually able to correctly calculate the full price of airport parking for 1 day, with a minority finding the full price of airport parking for 8 days. Many candidates did not use reverse percentages but used 115 per cent or 85 per cent to incorrectly find the cost of airport parking for 1 day.

Question 2

(a) (i) This part was often well answered and there were few errors on the total number of tomatoes and the total frequency when the correct method was used. Common errors included dividing the total number of tomatoes by the sum of the first row leading to an answer of 3.23 or dividing the sum of the first row by 6 (the number of different categories) leading to an answer of 19.5.

(ii) A number of candidates did not know how to calculate the range. The most common incorrect answer was 6, obtained by subtracting the lowest frequency from the highest frequency.

(iii) There were very few candidates who gave two completely correct comments in this part. It was common for candidates to state which type had the greater mean and which type had the greater range without any interpretation of the meaning of mean and range. Candidates who gave one correct comment usually made a valid comment about the higher mean implying a higher number of tomatoes per plant (or equivalent), but it was extremely rare to see a correct interpretation of the range.

(b) (i) Many candidates did not know how to calculate cumulative frequency and often formed a bar chart or a graph from the given frequencies. Some of those that calculated the cumulative frequencies did not plot them at the upper bounds of the intervals, usually plotting at the mid-values. Those that attempted a correct cumulative frequency diagram usually plotted all points accurately and drew an accurate curve.

(ii) Those candidates who plotted the frequencies as opposed to the cumulative frequencies could not meaningfully access this part of the question. Many who did have cumulative frequency curves read their curves at $m = 20.5$ and not at $m = 21$, presumably misinterpreting the horizontal scale. Some who read the correct value from their curve did not then subtract this value from 120 before finding the percentage and so found the percentage of strawberries that were not used to make jam.

Question 3

(a) Many candidates did not realise what was required for this question and calculations to find a numerical value were common. Some candidates knew how to find an algebraic expression for the surface area in terms of x and h however, they did not have a second equation involving the volume in order to eliminate h. Other candidates had an equation for the volume but did not recognise the need to rearrange this equation into an acceptable form in order to find an equation in x.

(b) The vast majority of candidates scored full marks on this part of the question.

(c) A significant number of candidates correctly plotted the required graph. However, a number of candidates did not manage to use the vertical scale of 4 units to 1 small square correctly leading to inaccurate plotting of some of the points. The most common incorrect plots were (6, 112) plotted at (6, 104) and (1, 242) plotted at (0.5, 242). Unusually, there were several candidates who plotted bar charts when answering this question.

(d) Many correct answers were seen in this part.

(e) Some candidates understood the need to read the graph at $A = 120$, but not all gave the minimum value with some choosing to give both values in their dimensions. Having obtained a value for x, many candidates did not know how to use this value correctly in relation to the question to obtain the other two dimensions. It was common to see a dimension of 2, possibly from assuming the values had to be integers. Dimensions of 4, 5 and 6 were common, as were other sets of dimensions where two of the dimensions were not the same.

Question 4

(a) (i) This part of the question was well answered by many candidates. However, it was quite common for candidates to miss out at least one of the elements, and sometimes they added extra element. Quite a few candidates had 36 as the only element.

(ii) Many candidates did not realise that it was a quantity required and 16 or25, with or without brackets, was a common wrong answer.

(b) Although most candidates made an attempt at set notation, it was quite rare to see a correct answer. Many got close to the correct answer with $B'(C \cup D)$ or omitted the brackets with $B' \cap C \cup D$.

(c) (i) Again, it was rare to see a completely correct answer. The value of 7 for *F* alone in the diagram was most commonly correct. Some candidates then went on to get 3 for *A* alone, but this was often given as 8. It was unusual to see a 3 in the intercept between *F* and *S*.

(ii) There were a number of correct answers to this part of the question. However, some candidates who identified $\frac{5}{25}$ and $\frac{4}{24}$ as the two correct probabilities then added them instead of multiplying them. Other incorrect answers included $\frac{5}{25}$ and $2 \times \frac{5}{25}$.

(iii) Very few correct answers to this part of the question were given. Many candidates did not recognise that the starting total for the first probability was the number of elements in *F* which should have been 15, or a correct follow through from their diagram, with many denominators of 25 or 24 often seen. For those who did start with the correct set, some managed to get appropriate denominators, but most could not identify the appropriate numerators in the multiplication. The majority of candidates did not realise that they needed to combine 3 probabilities as there were 3 choices to be made.

Question 5

(a) (i) Candidates found this part challenging. Several wrote an expression, usually $x + y$, rather than an equation. Others thought consideration was needed of the value of each coin with many writing $5x + 10y = 130$ or $0.05x + 0.1y = 130$. Equations set equal to 815 or 8.15 were also seen in this part of the question. Some candidates attempted to solve an equation here and gave two numerical answers on the answer line.

(ii) Many candidates wrote an expression here rather than equation, as well as equations which were a mixture of cents and dollars, usually $5x + 10y = 8.15$. Numerical answers were also common in this part of the question.

(iii) Candidates who had correct equations in the previous two parts or equations where the only error was a confusion between cents and dollars usually demonstrated the algebraic skills required to solve these equations. However, many candidates had two equations in the previous parts which were impossible to solve e.g. $5x + 10y = 130$ and $5x + 10y = 815$ or $x + y = 130$ and $x + y = 8.15$. Some candidates did not consider the previous equations and attempted to get two values that satisfied one or both of the conditions.

(b) Very few candidates were able to use all the information given in the question to find the total value of the coins and then give the answer in standard form correct to 3 significant figures. Where a correct value for the coins was seen, the conversion to standard form was often incorrect or not to the required accuracy. Frequently one or more parts of the multiplication was missing or an additional multiplication was seen, usually an additional multiplication by 60. For some candidates here, the presentation of their work and hence the communication of their understanding was unclear, making it difficult to follow which numbers were being multiplied together.

(c) Candidates found this bounds question challenging. The most common incorrect answer was 33, usually obtained when candidates found the correct upper bound for the diameter of both the coins. There were some candidates who recognised the need to use the upper bound for the five-cent coin and the lower bound for the ten-cent coin, but they did not use the fact that the lines had 10 of each coin, producing an answer of 3.4. Many candidates found the difference between the diameter of either one or ten of each coin and then attempted to consider the upper bound later.

Question 6

(a) Many candidates showed a clear understanding of what a reflection was, but did not always use the correct line of reflection. Those who drew the line $x = 1$ were more likely to draw the correct image. The most common incorrect lines of reflection were $x = 0$, $x = -\frac{1}{2}$ or occasionally $y = 1$.

(b) There were some candidates who gave a correct description of transformation Y, normally having drawn triangle *C* on the grid. Occasionally one of the required parts of the description was missing, usually the angle or the centre of rotation. It often seemed that candidates were attempting to describe the transformation that mapped triangle *A* onto triangle *D*. Some candidates made errors with the translation given and drew triangle *C* as a translation of $\begin{pmatrix} 1 \\ 6 \end{pmatrix}$. Many candidates did not attempt this part of the question.

Question 7

(a) Many candidates were able to find the correct angle of this two-stage problem, normally using Pythagoras' theorem to find *BD* and then the cosine rule to find angle *BCD*. A common error was to assume that triangle *BCD* was right-angled using $\sqrt{107^2 + 165^2}$ to find *BD*, before then, having previously assumed that angle *BCD* was a right angle, using the cosine rule to find angle *BCD*. Some candidates had errors when quoting the cosine rule, while others used *BD* as 160 or 95. Other misunderstandings included attempting to use the sine rule within the triangle or quadrilateral.

(b) Candidates who drew diagrams of this problem were usually able to obtain the correct angle of elevation, but many did not appear to be able to visualise the problem and so could not apply the right-angled tangent trigonometry required. Candidates who used correct trigonometry requiring a complex approach involving more stages usually found the angle of elevation that was not of the required accuracy. Common misunderstandings were to use the lengths 107 and 95 as the hypotenuse in both triangles or to assume that there was only one triangle involved and use the sine rule to find the angle.

Question 8

(a) This part was usually answered correctly. Common incorrect answers included $7v - 2w$, $5v + 2w$ and $5v - 8w$. Some candidates attempted to factorise the expression and gave their final answer as $(6 - 1)v + (3 - 5)w$.

(b) Correct answers were seen on the vast majority of scripts. The most common incorrect answer was 0.6, coming from an incorrect first step of $5x = 10 - 7$.

(c) (i) This was generally answered correctly but there were some candidates who did not simplify completely. Some candidates gave the answer as 4 while quite a few gave the answer as $3a^2$ following a mixture of multiplying and adding the variable *a*.

(ii) Correct answers, usually of the form b^{-2} rather than the fraction form, were given by the majority of candidates. The most common incorrect answer was b^2.

(d) (i) This was a well answered question with the most common mistake being an answer of 13 from 28 – 15.

(ii) Although most candidates were able to correctly rearrange the formula, a significant number were confused by the numbers substituted in the previous part and used them here as well, leading to a numeric rather than algebraic answer.

(e) Most candidates knew the correct formula for solving a quadratic and used it effectively. Common errors were substituting 6 for *c* instead of –6, using a fraction line that only went below the discriminant and not giving their answer to the required accuracy. When the formula was misquoted it usually either involved an addition in the discriminant, 2*ac,* or *b* and b^2 interchanged.

Question 9

(a) Many candidates knew how to work out the surface area of the large hemisphere but only a minority showed correct working for the total surface area. It was then common to see candidates attempt to get to the correct answer of 364π but not by the correct method with many appearing to add the area of the two circles to the area of the large hemisphere. Incorrect radii of 20, 18, 16 and 9 were seen in this part as well as use of the volume formulae for either the sphere or the hemisphere.

(b) Only a minority of candidates were able to calculate the correct mass of the bowl. Errors included trying to use the surface area, using the volume of the sphere/hemisphere for a bowl without the sphere/hemisphere removed, using a wrong radius for the sphere/hemisphere with 9 or 2 often used or dividing by 0.74 rather than multiplying.

(c) Only a small minority of candidates were able to use the information given to find the mass of the second bowl. Often candidates had a linear connection between the volumes or used either a connection involving square rooting or cubing but rarely both. Frequently candidates did not refer back to the mass of the first bowl and had a calculation involving just 546π, usually equated to an expression involving πr^2.

Question 10

(a) (i) Most candidates gained credit identifying two relevant pairs of corresponding angles or lengths. Candidates found the justifications more difficult, with many of their reasons being incomplete; for example, saying the angles at *B* and *D* were 90° because they touched the circumference or saying *AC* = *AC* as it is the diameter or the hypotenuse. Only a small minority of candidates were able to give complete justification for congruency including the congruency condition.

(ii) It was very rare to see a complete and correctly reasoned answer. Most answers consisted of quoting the properties of a rectangle (equal parallel sides, four angles of 90 degrees) without giving any reasons why these applied in this case. Occasionally candidates explained that *AB* and *CD* were parallel with a correct reason of the alternate angles that had been given.

(b) More correct answers were seen in this part of the question. Accuracy was sometimes lost due to premature approximation, often by those finding the height and base of the triangle to find its area. Many candidates seemed confident in finding the area of the segment by first finding the area of the sector and then subtracting the area of the triangle. Some used long methods of right-angled trigonometry and Pythagoras' theorem but most of these understood the overall method. Correct angles in triangle *HOG* were often seen, but mistakes included angle *OHG* as 30° or angle *HOG* as 116°. Mistakes when finding the area included the area of the sector as $\frac{1}{2}\times\pi\times 6^2$ or the area of the triangle as $\frac{1}{2}\times 6^2\times\sin 34$.