

Principal examiner reports for teachers

Principal examiner reports for teachers summarise what candidates did well and what candidates needed to improve for this examination series only.

This report is to be used in conjunction with the question paper and mark scheme.

For guidance on teaching and learning we provide resources for many of our syllabuses.

Resource	Where to find it
Grade descriptions – Grade descriptions describe the level of performance typically demonstrated by candidates achieving the different grades awarded for a qualification.	School support hub Select: Subject > Resource finder > Syllabus and specimen materials
Schemes of work – Schemes of work are designed to support you in your teaching and lesson planning.	School support hub Select: Subject > Resource finder > Teaching and learning
Lesson planning – Guidance on how to plan a lesson.	Lesson planning
Resource plus – There may be additional resources such as teaching packs containing lesson plans, resources and worksheets and videos for aspects of your syllabus.	School support hub Select: Subject > Resource finder > Teaching and learning
Teaching tools	Teaching Tools
Exemplar candidate responses	School support hub Select: Subject > Resource finder > Teaching and learning
Learner guide – A guide for students to help them understand what the course involves.	School support hub Select: Subject > Resource finder > Teaching and learning
Community forums – Do you have a question or something to share? Our online forums are great way to keep up to date with your subject and the global Cambridge community.	Community forum on the school support hub
Access to scripts for this series.	Access to scripts service
Results analysis is available for some syllabuses.	Results analysis
Test maker is available for some subjects.	Test maker

Other services from Cambridge International Education

- [Digital mocks service](#)
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 - [Focus on assessment](#)
 - [Online marking workshops](#)

MATHEMATICS SYLLABUS D

Paper 4024/12 Non-Calculator

Key messages

What candidates did well

- Many candidates showed a secure understanding of the syllabus content and communicated their solutions clearly.
- Many candidates showed competence in routine algebraic manipulation and arithmetic.
- Many candidates constructed accurate mathematical diagrams.
- Many candidates understood the mathematical vocabulary used in the questions and interpreted the command words correctly.

What candidates needed to improve

- Candidates should show each step in their method when they are required to show a given result. Each line of working should contain only one change. The given result should not be used as part of the method.
- Candidates should be familiar with standard mathematical notation including three-letter angle notation and correct vector notation.
- Candidates should read each question carefully to ensure that the required method is used and that answers are given in the required form.
- Candidates should use precise mathematical terminology in questions requiring reasoning or proof, for example in **Question 8(a)** and **Question 16(a)**.
- Candidates should take care to use brackets appropriately in expressions. For example, they should be aware of the difference between $2x^2$ and $(2x)^2$ or the difference between $2x + 3(4 - x)$ and $(2x + 3)(4 - x)$.
- Candidates should present their work clearly and unambiguously. Fractions should be written in the form $\frac{a}{b}$ rather than a/b , and errors should be crossed out rather than overwritten.
- Candidates would benefit from further practice with topics such as surds, indices, exponential graphs and asymptotes.

Comments on specific questions

Question 1

(a) Comprehensive responses

- Most candidates were able to recall the cube of 5.

Limited responses

- A few candidates used the wrong process, leading to incorrect answers of 15, 25 and 75.
- A few candidates made arithmetic errors in calculating $5 \times 5 \times 5$.

(b) Comprehensive responses

- Most candidates were able to recall the square root of 121.

Limited responses

- A few candidates wrote 11^2 or 11×11 or $\sqrt{11 \times 11}$.
- A few candidates attempted to use prime factors to find the square root.

Question 2

(a) Comprehensive responses

- Most candidates gave the correct arrival time in an appropriate format, for example 11 30.

Limited responses

- A few candidates subtracted 1 hour 25 minutes from 10 05, leading to the answer 08 40.
- A few candidates added only the minutes or only the hours to 10 05, leading to answers 10 30 or 11 05.

(b) Comprehensive responses

- Many candidates subtracted the duration of the journey from the arrival time to give the correct departure time in an appropriate format, for example 14 45.
- Some candidates used a timeline to add the time in steps.

Limited responses

- A few candidates wrote their final answer as 2 45 without indicating pm, resulting in an ambiguous answer.
- A common error was to add the duration of the journey to the arrival time, leading to the answer 17 55.
- Another common error was to work with the hours and minutes separately, evaluating $16 - 1 = 15$ and $35 - 20 = 15$, leading to a final answer of 15 15.
- Some candidates attempted a formal subtraction method of $1620 - 135$, leading to 14 85, which was then converted to 15 25.

Question 3

(a) Comprehensive responses

- Many candidates gave the correct median of 8.5.
- Many candidates reordered the list to ensure the correct middle pair was used to find the median.

Limited responses

- Some candidates identified the middle pair as 7 and 10 and did not find the average of these two values.
- Some candidates omitted one of the data values in their reordered list.
- Some candidates used the middle two values of the unordered list, leading to the answer 6.
- A few candidates found either the mean or the mode.

(b) Comprehensive responses

- Many candidates gave the correct mean of 9.
- Some candidates combined the data to simplify the addition, for example $13 + 7 = 20$ or $10 + 21 + 20 + 11 + 13 + 15$.

Limited responses

- Some candidates showed a correct method with one of the data values omitted or made an arithmetic error in the addition.
- Some candidates showed an incorrect total divided by 10 with no evidence to show they had attempted to add the given values.
- A few candidates divided the total by 2 rather than by 10.

Question 4

(a) Comprehensive responses

- Many candidates worked with the given total of 60 and the ratio 2:1 to show the number of green cards as 20. They recognised that the ratio represented three parts and divided the total of 60 by 3 to give the number of green cards as 20.
- Some candidates used an algebraic method and formed the equation $3x = 60$, which they solved to give $x = 20$.
- A few candidates showed a correct method: finding two-thirds of 60 gives 40 red cards, then subtracting this from 60 to show 20 green cards.

Limited responses

- Some candidates used 20 in their method rather than showing a method leading to the value of 20, for example using the value of 20 green cards in the given ratio to show that 2:1 is equivalent to 40:20.
- A few candidates used 20 green cards to show that there were 40 red cards, then divided by 2, leading to an answer of 20.

(b) Comprehensive responses

- Some candidates used the information about squares and triangles to divide the 60 cards in the ratio 5:1. They completed the total column of the table with 50 and 10, then completed the other missing values in the table.

Limited responses

- Some candidates worked with the ratio 2:1 for squares and triangles, leading to the values of 40 and 20 in the total column
- A common error was to divide 60 into 5 parts, rather than 6 parts, leading to the values 48 and 12 in the total column.
- A few candidates tried to divide the 40 red cards into the ratio 5:1.

Question 5

(a) Comprehensive responses

- Many candidates constructed an accurate position for *C* using a pair of compasses, leaving visible arcs to show their method.
- Most candidates showed their understanding of scale by drawing lengths of 5 cm and 8 cm.

Limited responses

- Some candidates identified the correct position of *C* without showing construction arcs.
- Some candidates constructed a position of *C* north of *B* using correct lengths of 5 cm and 8 cm.
- Some candidates wrote down the correctly scaled lengths and did not draw the position of *C* on the diagram.
- A few candidates applied the scale incorrectly and used 4.5 cm rather than 5 cm to represent 2.5 km.

(b) Comprehensive responses

- Many candidates understood that bearings are measured clockwise from north.
- Many candidates used their protractor to measure the bearing accurately.

Limited responses

- Some candidates gave answers that suggested they had not measured the correct angle, for example, giving the bearing of *B* from *A*.
- A few candidates misread the scale on their protractor for example, reading 96° as 84° .

Question 6

Comprehensive responses

- Many candidates calculated the simple interest for 4 years and added it on to the initial investment to find the correct final value of the investment.
- Candidates often simplified the calculation first by dividing 2000 by 100, carrying out the multiplication 20×3.5 and then multiplying by 4.

Limited responses

- Some candidates gave \$280 as their answer, which is the total amount of interest rather than the final value of the investment.
- Some candidates made errors in place value when multiplying by 3.5. This led to incorrect values for the interest such as \$28 000, \$2800 or \$28.
- A few candidates multiplied by 3.5 instead of $\frac{3.5}{100}$ in the interest calculation.
- A small number of candidates attempted to calculate compound interest instead of simple interest.

Question 7

Comprehensive responses

- Most candidates used the formula for the area of the trapezium and formed the correct equation $\frac{1}{2}(7+x) \times 8 = 100$.
- Many candidates solved the equation and obtained the correct value of 18 for the base of the trapezium.
- Some candidates divided the trapezium into a rectangle and a triangle, calculated the base of the triangle as 11 and added 7 to obtain the correct value of x .

Limited responses

- Many candidates made errors in one term when expanding the bracket in their equation, for example, $\frac{1}{2}(7+x) \times 8 = (7+x)4 = 7 + 4x$.
- A small number of candidates did not recall the correct formula for the area of a trapezium, for example, $\frac{1}{2}(7 \times x) \times 8$.
- Some candidates made basic arithmetic errors such as $7 \times 8 = 54$ or $200 - 56 = 44$.
- Some candidates who divided the trapezium into a triangle and a rectangle used either x or $(7-x)$ as the base of the triangle instead of $(x-7)$.
- A few candidates did not equate the area of the trapezium to 100.
- A few candidates used the formula for the area of a triangle rather than a trapezium.

Question 8

(a) Comprehensive responses

- Some candidates identified that the relevant fact needed to show the fairness of the spinner was that the frequencies were all close to 100.

Limited responses

- Some candidates confused fairness with recognising that the given results were a complete set and stated that all the frequencies added up to 500.
- Some candidates confused fairness of the spinner with a fair test and stated that the spinner was spun many times.
- Some candidates described what is meant by a fair spinner rather than using the data in the table, referring to equal probabilities or an equal chance of landing on each number.

(b) Comprehensive responses

- Some candidates understood the term relative frequency and stated the correct relative frequency as a fraction or a decimal.

Limited responses

- Many candidates did not understand the term relative frequency and gave an integer answer such as 20, 100 or 500.
- Some candidates used the number on the spinner rather than the frequency in their relative frequency, for example, $\frac{5}{500}$ or $\frac{5}{100}$.

(c) Comprehensive responses

- Many candidates found the expected number of times the spinner would land on 5.
- Candidates who did not understand the term relative frequency were often able to find the expected value using the information given in the table.

Limited responses

- Some candidates gave the relative frequency of the spinner landing on 5.
- Some answers were greater than the number of times the spinner had been spun.

Question 9

Comprehensive responses

- Many candidates converted the mixed numbers to improper fractions and used the correct order of operations; some gave the answer as a mixed number in its simplest form as required.

Limited responses

- Many candidates gave a correct equivalent answer, such as 3.7 , $\frac{37}{10}$, $\frac{111}{30}$ or $3\frac{21}{30}$ and did not convert this to a mixed number in its simplest form.
- Candidates usually converted the given mixed numbers to improper fractions $\frac{5}{3}$ and $\frac{11}{5}$ before calculating.
- Most candidates used the correct order of operations and multiplied before adding. They usually reached the correct result of $\frac{45}{30}$.
- Many candidates showed correct use of a common denominator when adding fractions. Some attempted to add the numerators and the denominators separately.
- Some candidates attempted to multiply the fractions before adding.

Question 10

Comprehensive responses

- Some candidates correctly reflected triangle A in the line $y = x$.

Limited responses

- Some candidates drew the correct line $y = x$ on the grid. They reflected one vertex of triangle A correctly to (1, 1), then completed the triangle incorrectly. This usually resulted in a rotation of 180° about the origin.
- Many candidates reflected triangle A in the x-axis or in the y-axis.
- A few candidates reflected triangle A in the line $y = -x$.

Question 11

(a) Comprehensive responses

- Most candidates were able to express 400 as a product of prime factors.
- Many candidates wrote the product using indices, $2^4 \times 5^2$.
- Many candidates used a factor ladder to identify the prime factors.

Limited responses

- Some candidates wrote a list of factors, 2, 2, 2, 2, 5, 5, as the answer when a product was required.
- Some candidates included 1 in the product of prime factors.
- Some candidates made basic arithmetic errors in their factor ladder or factor tree.
- Some candidates included non-prime numbers such as 4 or 25 in their product.

(b) Comprehensive responses

- Many candidates correctly identified the highest common factor as $2^2 \times 5$.
- Many candidates gave the correct value of 20 for the highest common factor.

Limited responses

- Some candidates identified a common factor other than the highest common factor, for example, 4 or 10.
- Many candidates expressed 180 as a product of its prime factors, $2^2 \times 3^2 \times 5$.
- Some candidates found the lowest common multiple rather than the highest common factor.

Question 12

Comprehensive responses

- Most candidates rearranged the formula to make m the subject, demonstrating a good understanding of algebraic manipulation.

Limited responses

- Some candidates correctly rearranged the formula to $m = \frac{k+4p}{4}$ then cancelled incorrectly leading to the answer $m = k + p$.
- Some candidates showed a correct first step of $\frac{k}{4} = m - p$ then made a sign error when rearranging to isolate m .
- Some candidates expanded the bracket incorrectly to $k = 4m - p$.

Question 13

(a) Comprehensive responses

- Many candidates used the expression for the n th term to find the first 3 terms of the sequence.

Limited responses

- Some candidates made an arithmetic error after substituting $n = 1$, $n = 2$ and $n = 3$.
- Some candidates misinterpreted the expression $n + 8$ as $8n$, leading to the answer 8, 16, 24.
- Some candidates did not understand that the three terms should be numerical values and gave answers in terms of n , for example, $n + 1$, $n + 2$ and $n + 3$.

(b)(i) Comprehensive responses

- Some candidates understood the meaning of 'term-to-term rule' and stated the rule using the correct operation $+ 6$.

Limited responses

- Some candidates did not understand the meaning of 'term-to-term rule' and stated the n th term, $6n - 2$.
- Some candidates stated the common difference of 6 without identifying the operation required to find the next term.
- Some candidates included an unnecessary algebraic term in their rule, such as $n + 6$ or $T + 6$.
- Some candidates tried to describe the nature of the sequence rather than stating the rule, for example, arithmetic progression, linear sequence or increasing by 6.
- Some candidates gave the next term of 28.

(ii) Comprehensive responses

- Many candidates found a correct expression for the n th term of the sequence.
- Some candidates gave the unsimplified answer of $4 + (n - 1)6$.

Limited responses

- Some candidates identified that a difference of 6 gives an expression of the form $6n + k$ and gave an incorrect value for k .
- Some candidates substituted 4 and 6 incorrectly into the general formula for the n th term of a linear sequence, $a + (n - 1)d$. Some misquoted the formula, for example using $4 \times (n - 1) \times 6$.
- A few candidates used the difference of 6 incorrectly to give an n th term of $n + 6$.

(c) Comprehensive responses

- Some candidates successfully used $T_n = 6n - 2$ and $R_n = 5$ to form the correct equation, then solved it to reach the correct answer of 42.

Limited responses

- Some candidates formed an equation using their n th term expression from **Question 13(b)(ii)** and substituted $n = 5$ rather than equating their expression to 5.
- Some candidates did not understand the subscript notation, R_n , used for terms of a sequence.

- Some candidates substituted $R_n = 5$ then rearranged to find an expression for T_n .

Question 14

(a) Comprehensive responses

- Most candidates expressed 350 000 correctly in standard form.

Limited responses

- Some candidates used a power of -5 in place of $+5$.
- Some candidates gave an answer of 35×10^4 which is not in standard form.

(b) Comprehensive responses

- Many candidates expressed 2.7×10^{-4} correctly as an ordinary number.

Limited responses

- Some candidates misplaced or omitted the decimal point, for example, 0.0027 or 00027.
- Some candidates interpreted the negative power incorrectly, giving answers such as 27 000 or 270 000.

(c) Comprehensive responses

- Candidates who understood that a place value adjustment was required before adding the two numbers often reached the correct result.
- Some candidates identified that a result such as 46.3×10^{12} was not in standard form and adjusted it to give a correct answer in standard form.

Limited responses

- Some candidates adjusted one of the numbers correctly to give equal powers of 10, either 0.13×10^{13} or 45×10^{12} .
- Some candidates did not know whether to multiply or divide a number by 10 when manipulating to give equal powers of 10. A common error was 13×10^{13} in place of 0.13×10^{13} .
- Some candidates did not understand how to calculate with numbers in standard form. They added the values 1.3 and 4.5 and added the powers of 10 leading to the common incorrect answer of 5.8×10^{25} .
- Some candidates started by converting both numbers out of standard form before adding. As there were many zeros in the numbers, they often made place value errors when adding leading to answers such as 5.8×10^{13} .

Question 15

(a) (i) Comprehensive responses

- Many candidates correctly rearranged the equation to make y the subject.
- Some candidates could extract the gradient from an equation in the form $y = mx + c$.

Limited responses

- Many candidates correctly rearranged the equation to make $2y$ the subject. Some then selected 19 as the gradient.
- Some candidates made algebraic errors in rearranging the equation, such as sign errors or dividing only one term by 2.
- A common error was to give a gradient of $-\frac{x}{2}$ rather than $-\frac{1}{2}$.

(ii) Comprehensive responses

- Many candidates found the correct y -intercept of the line.

Limited responses

- Some candidates who rearranged to $2y = 19 - x$ gave 19 as the y -intercept.
- Some candidates made arithmetic errors in calculating $19 \div 2$.

(b) Comprehensive responses

- Some candidates used the relationship between the gradients of perpendicular lines with the gradient of line L as $-\frac{1}{2}$ to show a correct justification for the gradient of line M as 2.
- Many candidates substituted $(-1, -5)$ and the gradient of 2 for line M into $y = mx + c$ or $(y - b) = m(x - a)$. They rearranged this correctly to show $y = 2x - 3$.

Limited responses

- Some candidates stated the relationship between the gradients of perpendicular lines without applying this to the gradients of the lines in this question.
- Many candidates showed no justification or insufficient justification for the gradient of line M .
- A common error was to substitute $x = -1$ into the given equation to show $y = -5$ rather than using these values to show that the y -intercept is -3 .

(c) Comprehensive responses

- Some candidates found the correct point of intersection by solving the simultaneous equations using either elimination or substitution.

Limited responses

- Some candidates made arithmetic errors or sign errors when adding, subtracting or multiplying to eliminate a variable.
- Some candidates made a correct substitution to eliminate one variable, then made errors in rearrangement, which led to an incorrect solution.
- Some candidates did not know that the point of intersection of the lines is found by solving the simultaneous equations. They often substituted arbitrary values into the two equations, for example, $x = 0$, $y = 0$ or attempted to use midpoints.

Question 16

(a) Comprehensive responses

- Some candidates identified three pairs of equal angles with correct reasons.
- Some candidates used the correct vocabulary when stating the geometrical reasons: 'alternate angles are equal' and 'vertically opposite angles are equal'.

Limited responses

- Some candidates identified two correct pairs of angles with correct reasons and omitted the third pair.
- Some candidates did not use appropriate notation for the angles, for example, 'the angles at X ' rather than angle DXM and angle AXB .
- Some candidates used incorrect vocabulary, for example, 'common' for 'vertically opposite' and 'alternating', 'alt' or 'alternative' for 'alternate'.
- Some candidates stated that angles were similar or stated a pair without saying that they were equal, for example, 'angle BAX and angle DMX are alternate angles' with no mention of equal.
- Some candidates referred to ratios of sides rather than pairs of equal angles.
- Some candidates did not know what was required to show triangles are similar and made comments about the size and orientation of the two triangles.

(b)(i) Comprehensive responses

- Many candidates identified the correct scale factor, $\frac{8}{4}$ or $\frac{4}{8}$.
- Some candidates divided BD in the correct ratio, leading to $DX = 5$.
- Some candidates formed and solved the equation $\frac{8}{4} = \frac{15 - x}{DX}$.

Limited responses

- A common error was to use the equation $\frac{8}{4} = \frac{15}{DX}$, leading to the incorrect answer 7.5.
- A few candidates did not use similar triangles and attempted to apply Pythagoras' Theorem.

(ii) **Comprehensive responses**

- A few candidates recognised that for a linear scale factor of 2, the area scale factor is 4.

Limited responses

- Most candidates knew that the linear scale factor was 2 and used this to give the ratio of areas as 2:1.
- Some candidates added both parts of the ratio together to give the ratio of areas as 3:1.

Question 17

(a) **Comprehensive responses**

- Some candidates identified the side lengths of the triangle as x , $x - 7$ and $x + 2$.
- Some candidates applied Pythagoras' Theorem to form a correct equation. They showed expansion of the brackets and simplification, leading to the required equation.
- Good responses showed a sketch of the triangle with the sides labelled, an equation with brackets inserted correctly and each step of working written as an equation on a separate line.

Limited responses

- Some candidates did not retain an equation throughout their working, often omitting $= 0$ when they collected all terms on one side of the equation.
- Some candidates interpreted a height of 7 cm shorter than the base as $(7 - x)$ instead of $(x - 7)$.
- A few candidates omitted the brackets around $(x - 7)$ and $(x + 2)$ when forming an equation using Pythagoras' Theorem.
- Some candidates incorrectly expanded $(x + 2)^2$ to $x^2 + 4$ and $(x - 7)^2$ to $x^2 + 49$ or $x^2 - 49$.
- Some candidates attempted to use the formula for the area or perimeter of a triangle to form an equation.

(b) **Comprehensive responses**

- Many candidates showed a correctly factorised equation leading to the two correct solutions.

Limited responses

- Some candidates used the quadratic formula to solve the equation and did not follow the demand to solve by factorising.
- Many candidates made sign errors when factorising, for example, $(x + 3)(x + 15)$ or $(x - 3)(x + 15)$.
- Some candidates attempted partial factorisation using inconsistent signs, such as $x(x - 15) + 3(x + 15)$.

(c) **Comprehensive responses**

- Some candidates used $x = 15$ correctly to find the area of the triangle.
- Some candidates identified that the value of x must be greater than 7 and used their solutions from **Question 17(b)** in a correct formula for the area of the triangle.

Limited responses

- Some candidates did not recognise that substituting $x = 3$ into $x - 7$ gives a negative height, so this solution should be rejected.
- Some candidates used their solutions from **Question 17(b)** as the base and height of the triangle.
- Some candidates found an expression for the area of the triangle in terms of x . They did not recognise that the solutions to the quadratic equation from **Question 17(b)** could be used to find a value for the area.
- Candidates who had the incorrect expression of $7 - x$ for the height of the triangle often used $x = 3$ to find the area of the triangle.

Question 18

(a) **Comprehensive responses**

- Many candidates selected appropriate values from the table and found the correct percentage of apples with a mass greater than 110 grams.

Limited responses

- Many candidates used an incorrect frequency in their percentage calculation, with the most common values being 110, 80 and 40 in place of 120.
- A few candidates calculated the proportion using incorrect totals, for example, dividing $80 + 40$ by 110 or 100 instead of the total frequency of 200.

(b) **Comprehensive responses**

- Many candidates calculated the correct frequency densities and used these to draw an accurate histogram using ruled lines.

Limited responses

- Some candidates drew freehand lines, resulting in inaccurate bars.
- Some candidates drew the height of the first bar as 1.4 or 1.6 rather than 1.5.
- A common error was to divide each frequency by 10 rather than the appropriate group width. This led to only two correct bars.
- Another common error was to divide the midpoint of the class interval by the frequency, giving incorrect frequency densities.
- A few candidates drew frequency polygons or bar charts.

Question 19

Comprehensive responses

- Some candidates identified the required steps to solve the problem. They formed an equation relating the volumes of the two solids, rearranged to find the value of k , and substituted this value into a correct expression for the total surface area of the cylinder.
- Few candidates found the correct expression for the total surface area of the cylinder.

Limited responses

- Many candidates selected a correct formula for the volume of a cylinder, the volume of a hemisphere or the curved surface area of a cylinder. Some candidates also included the area of two circles to give the total surface area of the cylinder.
- Some candidates equated correct expressions for the volumes of the two solids, expanded brackets correctly and rearranged to find $k = \frac{9}{2}$.
- A common error was to omit the bracket around $2x$ or $3x$ when substituting for r , for example, using $3x^3$ in place of $27x^3$ or $2x^2$ in place of $4x^2$.
- Some candidates used k rather than kx in the formula for the curved surface area of the cylinder, leading to an expression with inconsistent powers of x .
- A few candidates used an incorrect formula for the volume of a hemisphere, for example, using r^2 in place of r^3 or using the volume of a sphere.
- Some candidates did not use the information about equal volumes. They formed an expression for the surface area of the cylinder and made no further progress.

Question 20

(a) **Comprehensive responses**

- Many candidates identified the route $\overrightarrow{PO} + \overrightarrow{OR}$ and found the correct vector $\overrightarrow{PR}$.

Limited responses

- Some candidates did not consider the direction of the vectors and gave answers of $2\mathbf{b} + 3\mathbf{a}$ or $-2\mathbf{b} + 3\mathbf{a}$.

(b) **Comprehensive responses**

- Some candidates recognised that $RQ = 2OR$ and found the correct vector $\overrightarrow{RQ}$.

Limited responses

- Many candidates applied the ratio $OQ = 3OR$ incorrectly, resulting in an answer of $6b$.

(c) Comprehensive responses

- Some candidates understood the term 'position vector of X ' as the vector $\overrightarrow{OX}$ and used a correct route on the diagram to find a correct expression in terms of a and b .
- Some candidates found a correct expression for $\overrightarrow{PQ}$ and used this to find $\overrightarrow{PX}$ and then $\overrightarrow{OX}$ with all vectors clearly labelled.

Limited responses

- Some candidates identified a correct route for $\overrightarrow{OX}$ along the lines of the diagram, for example, $\overrightarrow{OP} + \overrightarrow{PX}$.
- Some candidates found the correct expression for vector $\overrightarrow{PQ} = 6b - 3a$. Some used the fact that X is the midpoint of PQ to find a correct expression for $\overrightarrow{PX}$.
- Many candidates found vector $\overrightarrow{PX}$ instead of vector $\overrightarrow{OX}$ and referred to this incorrectly as vector X .
- Many candidates wrote expressions in terms of a and b without identifying the vectors represented by these expressions.
- Many candidates did not understand the term 'position vector'.

Question 21

Comprehensive responses

- Many candidates showed familiarity with the required processes and successfully combined the fractions using a common denominator.
- Candidates whose first step was to show a single fraction with appropriate brackets around the terms in the numerator often reached the correct final answer.
- Some candidates expanded the brackets and simplified the numerator correctly while leaving the denominator in its factorised form. Some candidates expanded the denominator correctly.

Limited responses

- Most candidates showed a single fraction with the correct common denominator in factorised or expanded form.
- Brackets were often omitted in the numerator, for example, $2x + 3(4 - x) - 5x(x - 1)$. Some candidates recovered from the missing brackets to give a correct expansion of the first part. Many candidates continued with the error and expanded to give $2x + 12 - 3x - 5x^2 + 5x$.
- Many candidates made errors when expanding $-5x(x - 1)$, for example, sign errors leading to $-5x^2 - 5x$ or incorrect expansion leading to $-5x^2 + 5$.
- Some candidates made arithmetic errors when collecting terms, often with terms involving negative values.
- After reaching a correct single fraction, some candidates attempted to factorise the numerator or expand the denominator and made errors in this unnecessary step. Some candidates attempted to cancel terms in the numerator and denominator inappropriately.

Question 22

(a) Comprehensive responses

- Some candidates correctly substituted the values for the coordinates of point P into the equation $y = a^x + b$ to find $b = 4$.
- Some candidates correctly substituted $b = 4$ with the values for the coordinates of point Q to find $a = 3$.

Limited responses

- A few candidates who had found an incorrect value of b showed a correct substitution with the coordinates of point Q into the equation $y = a^x + b$.

- Some candidates did not use the equation $y = a^x + b$ and attempted to find the gradient or the midpoint of the chord PQ .
- Some candidates found the equation of the chord PQ , $y = 4x + 5$, which led to $b = 5$.

(b) Comprehensive responses

- A few candidates were familiar with the properties of exponential graphs and correctly identified the asymptote as a horizontal line intersecting the y -axis at their b value.

Limited responses

- Many candidates were unfamiliar with the concept of an asymptote.
- A few candidates understood that the asymptote is a horizontal line and gave an equation of the form $y = n$, for example, $y = 0$ or $y = 5$.
- Some candidates gave an answer of the form $x = n$.
- Some candidates gave equations of sloping lines, curves or exponential graphs.

Question 23

Comprehensive responses

- Some candidates understood the laws of indices and could successfully manipulate the terms to give an equation with both sides using base 3, leading to $x = -2$.

Limited responses

- Many candidates were unable to reach the stage where both sides of the equation had the same base.
- Many candidates could simplify $27^{-\frac{4}{3}}$ to give a correct equivalent in the form 3^n . Some also gave a correct equivalent with base 9, such as 9^{-2} .
- A common error was to write $27^{-\frac{4}{3}}$ incorrectly as $27^{\frac{3}{4}}$ or $\frac{1}{27^{\frac{3}{4}}}$ or $(3^3)^{\frac{3}{4}}$.
- Some candidates applied index laws incorrectly, for example, $(3^3)^{-\frac{4}{3}} = 3^{3 \cdot \frac{4}{3}}$ or $9^x = 3^{3x}$.

Question 24

Comprehensive responses

- Some candidates were systematic in expanding the brackets and then simplifying the surds, leading to a correct answer in the required form of $a + b\sqrt{2}$.

Limited responses

- Many candidates used a correct method to expand the brackets with at least three of the four terms correct.
- Some candidates showed correct simplification of surds at some point in their working, for example, using $\sqrt{8} = 2\sqrt{2}$ or $\sqrt{2} \times \sqrt{8} = \sqrt{16} = 4$.
- Some candidates treated the coefficient and surd separately in their expansion, leading to an expression with more than four terms.
- Some candidates were unfamiliar with the manipulation and simplification of surds. Examples included writing $\sqrt{4} = \sqrt{2}$, $5\sqrt{2} = \sqrt{10}$ or $3 + 5\sqrt{2} = 8\sqrt{2}$.

MATHEMATICS SYLLABUS D

Paper 4024/13
Non-Calculator

Key messages

What candidates did well

- Questions on sequences were well done.
- The subtraction of fractions was carried out correctly by many candidates.
- Candidates had a good grasp of using and calculating percentages.
- Many candidates solved the simultaneous equations correctly and showed their working.

What candidates needed to improve

- It is important that candidates take note of the instructions given in the question, for example, in **Question 13(b)** it clearly states that candidates should solve by factorisation, and in **Question 8** candidates are asked to find reflex angle QRS.
- Many candidates were unable to use and interpret a three-figure bearing.
- Many candidates had difficulty in calculating unknown angles by using the geometric properties of a circle.
- Many candidates were unable to calculate with frequency density and draw and interpret a histogram.
- Some candidates had difficulty in rearranging a formula.

Comments on specific questions

Question 1

(a) Comprehensive responses

- Many candidates were able to write the correct figures for 2.3 million.

Limited responses

- Some candidates included too many or too few zeros.
- Some candidates gave the answer in standard form.

(b) Comprehensive responses

- Many candidates gave all six correct factors.

Limited responses

- Some candidates gave only four or less factors.
- A few candidates wrote calculations which gave the answer 45, for example, $3^2 \times 5$ or 3×15 , and did not write down factors of 45.

Question 2

(a) (i) Comprehensive responses

- Scalene was the correct word chosen to describe the triangle by some candidates.

Limited responses

- Many candidates had difficulty using the correct word to describe a triangle.
- Obtuse, acute and reflex were sometimes seen as answers.

(ii) Comprehensive responses

- Some candidates correctly stated that angle ABC was obtuse.

Limited responses

- Many candidates had difficulty using the correct word to describe an angle.

Question 3

(a) Comprehensive responses

- Many candidates gave the correct mode.

Limited responses

- A few candidates gave the mode as 40.

(b) Comprehensive responses

- Many correct answers were seen.

Limited responses

- Some candidates made errors in adding the data and then divided by 10.
- Some candidates added the data and then divided by a number other than 10.

(c) Comprehensive responses

- Many candidates were able to give the correct median.

Limited responses

- Some candidates started correctly by writing out the data in numerical order and then made an error, for example, giving the answer 6.5.
- A few candidates were not sure what was required and gave one of the other averages as their answer.

(d) Comprehensive responses

- A few candidates were able to give a good explanation recognising that 40 was an outlier or that 9 values are below the mean.

Limited responses

- The majority of candidates did not understand that the office with 40 meeting rooms had caused the mean to be higher than a number which was a good representation of the data.
- Some candidates stated that there was a large difference between 6 and 40 (implying that the range was high).

Question 4

Comprehensive responses

- Most candidates simplified the expression correctly.

Limited responses

- A few candidates made an error in simplifying either the x terms or the y terms.
- Occasionally, candidates made an equation from the expression, for example, $5x + 7y = x + 2y$, and went on to solve their equation.

Question 5

(a) Comprehensive responses

- Almost all candidates gave the next two terms correctly.

(b) Comprehensive responses

- Many candidates gave the next three terms correctly.

Limited responses

- A few candidates made arithmetic errors in their calculations and gave two of the three terms correctly.
- Some candidates used the first three terms from **(a)**, namely 2, 5 and 8, to calculate the first three terms in the sequence in **(b)**, which gave the incorrect terms 7, 28 and 67.

Question 6

Comprehensive responses

- Candidates who answered this question correctly realised that the difference between the red and yellow parts was 2 and so divided 60 by 2 to find one part and went on to get the correct answer.
- Some candidates took an algebraic approach and wrote $3x + x = 60$ which usually led them to the correct answer.

Limited responses

- Candidates needed to appreciate that the difference between the ratio connected to the red beads (1) and the ratio connected with the yellow beads (3) was 2 parts and that they needed to divide 60 by 2 in order to find one part.
- The most common error was to divide 60 by 3 which usually resulted in 20 red beads, 60 yellow beads and 120 blue beads giving a total of 200 beads.
- Candidates needed to check that their number of the different colour beads was in the ratio 1:3:6 so that the criteria in the question was satisfied.

Question 7

(a) Comprehensive responses

- Many candidates worked this out correctly.

Limited responses

- Some candidates calculated $30 - 0.5$ first and then multiplied that by -6 .
- Some candidates realised that they needed to work out 0.5×6 and then made an error in their calculation and got the wrong answer.
- Some examples of calculations seen include $30 - 3$, $30 - 0.3$, $30 + 0.3$ and $30 + 30$.

(b) Comprehensive responses

- Most candidates worked this out correctly.

Limited responses

- Some candidates got as far as $\frac{18}{40}$ and then stopped or made an error in cancelling, for example, $\frac{18}{40} = \frac{6}{20}$.
- Candidates needed to realise that they had to write both fractions over the same common denominator, and a few forgot this, for example, $\frac{9}{12} - \frac{3}{10} = \frac{6}{2} = 3$.

Question 8

Comprehensive responses

- Successful candidates here realised that they needed to find reflex angle QRS and gave the correct answer.

Limited responses

- Many candidates needed to appreciate that they were being asked to find reflex angle QRS , which must be greater than 180° , and that 107° is not a reflex angle and therefore cannot be the correct answer.
- A common incorrect answer was 73° .
- Some arithmetic errors were seen where candidates were calculating $360 - (65 + 42)$.

Question 9

(a) Comprehensive responses

- Most candidates applied the simple interest formula correctly and then added on the \$300.

Limited responses

- Some candidates correctly calculated the interest on the savings account and then forgot to add it to the \$300 to find the value of the investment at the end of the three years.

- A few candidates had the correct formula for the interest and then made arithmetic errors in their working out.
- A few candidates used the formula for compound interest rather than simple interest.

(b) Comprehensive responses

- Many correct answers were seen here.

Limited responses

- Some candidates needed to realise that the percentage reduction is $\frac{\text{reduction}}{\text{original price}} \times 100$.
- Some candidates gave answers of 0.2 or 80, both of which implied an incomplete correct method.

Question 10

Comprehensive responses

- Some candidates realised that they needed to use Pythagoras' theorem to find BD and then use that to find the area of triangle BCD and to use $\frac{1}{2}\sqrt{39} \times \sqrt{39}$ and hence find the correct area.

Limited responses

- Some candidates did not recognise that it was necessary to use Pythagoras' theorem to find BD as a first step towards finding the area of triangle BCD and tried other formulae for the area of a triangle.
- Some candidates made errors in their use of Pythagoras' theorem and a common error was $BD = \sqrt{89}$.
- Some candidates were unsure about evaluating $\sqrt{39} \times \sqrt{39}$ and used approximations for $\sqrt{39}$, for example 6.1, in evaluating the area of the triangle.
- A few candidates found the area of triangle ABC instead of BCD .

Question 11

(a) Comprehensive responses

- Some candidates were able to give the correct bearing of town B from town A .

Limited responses

- Most candidates would have benefited from drawing a sketch to show the positions of A and B from the data given in the question.
- The most common incorrect answers were 18 and $360 - 162 = 198$.

(b) Comprehensive responses

- Some candidates realised that a good starting point in this question was to state that 1 cm represents 10 km and then to change to 10 km into cm and hence work out the correct scale of the map.

Limited responses

- Many candidates tried to convert either cm into km or km into cm and made errors in their conversions, resulting in wrong answers such as 1:200 and 1:20 000.
- A few candidates correctly converted 20 km into cm and then forgot to divide by 10 for the final answer.

Question 12

(a) Comprehensive responses

- Many candidates gave the standard form correctly.

Limited responses

- A few candidates forgot to write a negative power and gave the answer as 6.3×10^4 .

(b)(i) Comprehensive responses

- Some candidates correctly squared 7, wrote 49 in standard form and multiplied it by 10^{2x} to obtain the correct answer in standard form.

Limited responses

- Some candidates correctly squared 7 but forgot to write it in standard form before combining it with 10^x , and gave the answer 49×10^{2x} .
- A few candidates forgot to square 7 or multiplied 7 by 2 instead of squaring.
- A few candidates made an error in converting 49×10^{2x} into standard form, for example $4.9 \times 10^{2x-1}$ or 49×10^x .

(ii) Comprehensive responses

- Some candidates correctly divided 7 by 5, and 10^x by 10^{3x} to obtain the correct answer.

Limited responses

- Some candidates correctly divided 10^x by 10^{3x} but forgot to divide 7 by 5 and left the answer as $\frac{7}{5} \times 10^{2x}$.
- A few candidates left their answer as $\frac{7 \times 10^x}{5 \times 10^{3x}}$ and did not simplify further.
- A few candidates made an error in the power of 10 and gave the answer 1.4×10^{2x} .
- A few candidates approximated 1.4 to 2 in their answer.

Question 13

(a) Comprehensive responses

- Many candidates solved the pair of simultaneous equations correctly using either elimination or substitution.

Limited responses

- Some candidates only multiplied some terms correctly before elimination rather than multiplying all terms.
- Some sign errors were made when adding or subtracting equations.
- A few candidates made errors in evaluating the second unknown after finding the first unknown correctly, for example, $x = 5$ was followed by $10 - 3y = 1$ and then $3y = -9$ and then $y = -3$.

(b) Comprehensive responses

- Many correct answers were seen here, with candidates stating the factors of $6x^2 - x - 5 = 0$ and giving the correct solutions to the equation.

Limited responses

- Some candidates used the formula to find the solutions to the equation ignoring the instruction given in the question to solve by factorisation.
- Candidates needed to clearly state the factors here and not just leave them worked out in a table.
- A few candidates, having found the correct factors, made sign errors in their answers for x .

Question 14

(a) Comprehensive responses

- Most candidates earned some marks here usually two marks and occasionally three.

Limited responses

- Candidates needed to realise that the single transformation required was a rotation.
- A few candidates described the angle of rotation as 90° anticlockwise, while others gave the wrong centre of rotation or gave it as a vector rather than as a pair of coordinates.

(b)(i) Comprehensive responses

- Some candidates gave the correct equation of the line of reflection.

Limited responses

- A few candidates gave $x = 4$ as the equation of the line of reflection.

- Candidates needed to realise that the equation of a line was needed here and that a pair of coordinates could not be the correct answer.

(ii) Comprehensive responses

- Many correct answers were seen here with candidates stating the correct coordinates of the other two vertices of shape *A* after the reflection.

Limited responses

- Some candidates translated shape *A* and obtained shape *C* with coordinates $(-3, 6)$, $(-1, 6)$, $(-2, 7)$ and $(-3, 7)$, and so gave $(-2, 7)$ and $(-3, 7)$ as their answers.

Question 15

(a) Comprehensive responses

- Some candidates recognised that angle $TBC = 30^\circ$ using the geometrical property of a circle that angles in the same segment are equal.

Limited responses

- Candidates needed to recognise the geometrical property of a circle that angles in the same segment are equal.

(b) Comprehensive responses

- Some candidates recognised that angle $PTC = 30^\circ$ because of the alternate segment theorem.

Limited responses

- Candidates needed to use the alternate segment theorem here in order to evaluate angle PTC .

(c) Comprehensive responses

- A few candidates realised that angle ATP was equal to 123° and then subtracted their value for angle PTC to evaluate angle ATC .
- A few candidates were able to evaluate angle ATC correctly using the angle PTC already found and then used the fact that angles in triangle ATP add up to 180° .
- A few candidates were able to evaluate angle ATC correctly by finding that angle $ACT = 57^\circ$ and then using the fact that angles in a triangle ATC add up to 180° .

Limited responses

- Many candidates assumed wrongly that angle ATC was 90° .
- Candidates needed to be familiar with and able to use the various geometric properties of a circle in order to answer this question.

(d) Comprehensive responses

- A few candidates were able to give the correct value for angle ABC .

Limited responses

- Candidates needed to be able to recognise that $ABCT$ was a cyclic quadrilateral and to know that the opposite angles of a cyclic quadrilateral sum to 180° in order to find angle ABC .

Question 16

Comprehensive responses

- Some candidates were able to complete all the statements correctly.

Limited responses

- Responses to this question were very varied with more candidates matching $y = x^2 + 1$ to the correct sketch than either of the other two.

Question 17

Comprehensive responses

- A few candidates realised that the block for $3 < m < 3.5$ needed to be 20 units high and labelled the frequency density scale and completed the histogram correctly.

Limited responses

- Many candidates would benefit by further study of this topic.
- Many candidates assumed that the height of the block for $3 < m < 3.5$ was 10 because the frequency for $3 < m < 3.5$ was 10.
- Some candidates attempted to calculate the frequency density for each block showing their calculations and $\frac{10}{0.5} = 5$ and $\frac{8}{0.5} = 4$ were frequently seen.
- A few candidates drew the first block from $0 < m < 2$ rather than $1 < m < 2$.

Question 18

Comprehensive responses

- Many candidates rearranged the formula correctly to make x the subject.

Limited responses

- Some candidates began by clearing the fraction and expanding the bracket correctly and then had problems in isolating the x terms.
- Some candidates got as far as $7a - ax = x + 4$ and then made sign errors.
- Some candidates were unable to make any progress with this question.

Question 19

Comprehensive responses

- Many candidates found the gradients of line L and line N correctly and went on to find the correct equation of line N .

Limited responses

- Some candidates obtained a correct fraction for the gradient of L and then evaluated it incorrectly, for example, $\frac{7 - (-)1}{1 - 3} = 4$.
- Some candidates correctly followed through from their gradient of L to find the equation of their line N .
- A few candidates found the equation of a line through the midpoint of PQ using the coordinates $(2,3)$ instead of $(1,7)$.

Question 20

Comprehensive responses

- Many candidates reached the correct answer by considering the major arc, setting up an equation and solving it to find the value of x .
- Some candidates reached the correct answer by considering the minor arc, setting up an equation to find the angle subtending the minor arc and then subtracting it from 360° to find x .

Limited responses

- Some candidates managed to set up a correct equation but had difficulty in solving their equation to find x .
- Some candidates did not realise that they needed to use the formula for the circumference of a circle and not the formula for the area of a circle.

Question 21

(a) Comprehensive responses

- Some candidates showed that they understood and could use indices and gave the correct answer.

Limited responses

- Most candidates needed to do more work on understanding and using indices.
- Many candidates made errors showing that they had difficulty using indices and some examples of incorrect answers and working are, for example, $\frac{25^{-3}}{x^2}$ $\frac{1}{125x^6}$ $\frac{5^{-3}}{x^{-6}}$ and $\frac{25}{x^4} \times \frac{2}{3}$.

(b) Comprehensive responses

- A few candidates showed that they understood and could use the rules of indices by writing both sides of the equation as powers of 2 giving $2^{3x} = 2^{2x+6}$ and hence found the correct value of x .
- A few candidates showed that they understood and could use the rules of indices by dividing both sides of the equation by 4^x giving $2^x = 4^3 = 2^6$ and hence found the correct value of x .

Limited responses

- Most candidates needed to do more work on understanding and using the rules of indices.
- Many candidates made errors showing that they had difficulty working with indices and answering the question, for example $2^{3+x} = 4^{x+3}$ and $8x = 4x + 3$.

Question 22

(a) Comprehensive responses

- Many candidates showed a good understanding of surds and were able to simplify the expression correctly.

Limited responses

- Some candidates were able to simplify the surds and got as far as $7\sqrt{2} - 3\sqrt{2}$ and stopped there.
- Some candidates needed to do more work on understanding surds and simplifying expressions containing them, as they made errors such as $2\sqrt{7}$ and $2\sqrt{3}$ and $\sqrt{80}$.

(b) Comprehensive responses

- Many correct answers were seen here with candidates showing that they could rationalise the denominator.

Limited responses

- Some candidates began correctly by multiplying by $\frac{3-\sqrt{7}}{3-\sqrt{7}}$ and then had difficulty simplifying $(3+\sqrt{7})(3-\sqrt{7})$ correctly.
- A few candidates knew they had to multiply by something involving 3 and $\sqrt{7}$, such as $3+\sqrt{7}$ or just $\sqrt{7}$.

Question 23

(a) Comprehensive responses

- Many candidates gave the correct expression for $\overline{AB}$.

Limited responses

- Some candidates made a sign error in their answer, for example $3a - b$ or $3a + b$.

(b) Comprehensive responses

- Some candidates demonstrated that they could solve a vector problem involving ratio and found the correct expression for $\overline{OX}$ in terms of **a** and **b** in its simplest form.

Limited responses

- Most candidates needed to do more work on solving vector problems involving ratio.

- A few candidates got as far as expressing $\overline{OX} = 3a + \frac{2}{5}(b - 3a) = 3a + \frac{2}{5}b - \frac{6}{5}a$ and then made an error in simplifying, for example $-\frac{9}{5}a + \frac{2}{5}b$, $3a - \frac{8}{5}b$ or $\frac{2}{5}b + 9a$.
- A few candidates wrote down a correct route for $\overline{OX}$ and went no further.
- A few candidates associated AX with $\frac{2}{5}$ and BX with $\frac{3}{5}$ and then could not go on to use them.

Question 24

Comprehensive responses

- Some candidates showed that they could manipulate algebraic fractions and wrote the expression as a single fraction in its simplest form.

Limited responses

- Some candidates were not able to make a start on this question and needed to do more work on manipulating algebraic fractions.
- Some candidates obtained a correct fraction and then cancelled the x^2 and x to obtain the final answer $\frac{-14}{4}$.
- A common error was to omit brackets in the numerator, for example $x - 4(x + 3)$ or $(x - 4)x + 3$, which led to errors, although sometimes candidates recovered in later working.
- Many candidates forgot that the minus sign outside $2(x + 1)$ applied to both terms in the bracket and expanded it as $-2x + 2$ instead of $-2x - 2$, leading to $\frac{x^2 - 3x - 10}{(x + 1)(x - 4)}$, which was a common wrong answer.

MATHEMATICS SYLLABUS D

Paper 4024/22 Calculator

Key messages

What candidates did well

- Many candidates demonstrated expertise with the content and presented their solutions well.
- Most candidates demonstrated competence in questions requiring the direct application of mathematical processes.
- Many candidates demonstrated expertise in basic algebraic manipulation and solving linear equations.

What candidates needed to improve

- Candidates must remember to use more than 3 figures in their intermediate calculations to ensure that the final answer is accurate.
- When asked to give an answer to a given degree of accuracy, candidates must show at least one more degree of accuracy in their working before reaching their conclusion.
- Candidates need to understand that they must not take measurements or make assumptions based on diagrams that are labelled 'NOT TO SCALE', for example, that two lines are parallel or that a given triangle is isosceles.
- Candidates should take extra care when calculating with negative values and use a calculator where appropriate, if only to check their working.
- Candidates should ensure that fractional answers are written unambiguously using a horizontal line rather than a diagonal line.

Comments on specific questions

Question 1

Comprehensive responses

- Most candidates listed the numbers in the correct order, usually after converting two of them into decimals.

Limited responses

- A few candidates listed the numbers in reverse order.
- A few candidates took the 2-digit decimal 0.38 to be bigger than the one-digit decimal 0.4.

Question 2

(a) Comprehensive responses

- Almost all candidates identified red as the least recorded colour.

Limited responses

- A few candidates identified the most recorded colour.
- A few candidates gave the lowest frequency instead of the colour.

(b) Comprehensive responses

- Almost all candidates found the correct total number of cars.

Limited responses

- A few candidates gave the total number of different colours.

- A few candidates made slips when adding the frequencies, with 21 being the most common error.

Question 3

Comprehensive responses

- A few candidates found the total length of the edges of the cuboid.
- Those who drew a sketch of a cuboid were more successful.

Limited responses

- Many candidates gave the perimeter of the net.
- Many candidates calculated the total length of all the lines in the net.

Question 4

Comprehensive responses

- Most candidates used their calculators correctly and gave an answer correct to 2 decimal places.

Limited responses

- Many candidates gave either a truncated answer of 5.41 or an answer rounded to 2 significant figures instead of an answer rounded to 2 decimal places.
- Many candidates gave an incorrect answer without showing a more accurate value first.
- A few candidates gave an incorrect decimal in working and were able to round it correctly to 2 decimal places.

Question 5

(a) Comprehensive responses

- Almost all candidates gave the correct pair of coordinates.

Limited responses

- Reversing the coordinates was the most common error.
- A few candidates used an incorrect convention for recording their coordinates, such as $(x = 2, y = -3)$.

(b) Comprehensive responses

- Most candidates were able to work out the gradient of AB correctly.

Limited responses

- Some candidates started with incorrect coordinates for A and B .
- Some candidates made errors when dealing with negative values in the calculation.
- Subtracting the coordinates in an inconsistent order also resulted in some errors.

(c) Comprehensive responses

- Most candidates found the correct midpoint, usually by calculation rather than interpreting the given diagram.

Limited responses

- A few candidates had the correct coordinates for A and B , then made errors in their calculation, usually involving signs.
- Instead of adding the two coordinates, some candidates subtracted them before dividing the total by 2.

Question 6

(a) Comprehensive responses

- Most candidates found the value of 1 part and multiplied this by 6 to correctly calculate Bill's share.

Limited responses

- The most common error involved sharing \$60 in the ratio 5 : 6, leading to \$32.72 or \$32.73.
- Some candidates used the ratio as 6 parts for Sara and 5 parts for Bill, which led to the answer of \$50.

(b) Comprehensive responses

- Most candidates calculated the correct number of books.

Limited responses

- Some candidates gave the answer as a decimal, such as 8.57.
- Some candidates rounded up and gave the answer 9, not realising they did not have enough money for 9 books.

Question 7

(a) Comprehensive responses

- Most candidates were able to give the correct column vector.

Limited responses

- Some candidates introduced an additional minus, multiplying **d** by -2 and then subtracting from **c** instead of adding this to **c**.
- Arithmetic slips, especially when dealing with negative numbers, led to some incorrect answers.
- A few candidates incorrectly included a fraction line between the two components of their answer.

(b) Comprehensive responses

- Many candidates applied the correct vector operation, $OP + PQ$, and found the correct coordinates of point Q.

Limited responses

- Some candidates applied the operation $PQ - OP$, leading to the common error $(-5, 5)$.
- Some candidates made errors in dealing with negative numbers. Some of these resulted in answers with one correct coordinate.

Question 8

(a) Comprehensive responses

- Many candidates correctly completed the tree diagram.
- Almost all candidates gave the correct pair of probabilities for the first tile.

Limited responses

- Many candidates gave an incorrect pair of probabilities for the second tile, treating the situation as 'without replacement', with $\frac{6}{12}$ or $\frac{6}{11}$ a common error for A on the second tile.
- A few candidates completed the tree diagram with integers, usually the number of tiles available for selection.

(b) Comprehensive responses

- Many candidates understood that they needed to multiply the probabilities of picking a tile labelled A. Most did this correctly.

Limited responses

- Some candidates made arithmetic slips when multiplying the probabilities.
- Some candidates added the probabilities instead of multiplying them.

Question 9

Comprehensive responses

- Many candidates gave a correct answer.
- Almost all candidates had an understanding of speed and distance and calculated the correct time for the journey, 1.6 hours.
- Many candidates converted the time into hours and minutes correctly.

Limited responses

- Some candidates converted 1.6 hours into hours and minutes incorrectly, and 1 h 6 min and 1 h 60 min were common incorrect conversions.
- A few candidates used the incorrect formula $\text{time} = \text{speed} \div \text{distance}$.

Question 10

(a) Comprehensive responses

- Some candidates completed the Venn diagram correctly. Of the successful candidates, many listed the elements of set F and set C before attempting to complete the Venn diagram.

Limited responses

- Not all candidates listed the sets correctly.
- Common errors included listing 1 as a factor of 6 and not as a cube number.
- The element 9 was sometimes placed as a cube number.
- Some candidates identified the factors and the cube numbers and included these on the Venn diagram, with the remaining integers omitted.

(b) Comprehensive responses

- Some candidates identified the subset $(F \cup C)'$ and listed the number of elements correctly from their Venn diagram.

Limited responses

- Some candidates listed the elements in the subset rather than the number of elements.
- A few used incorrect notation, such as $n(4)$ and $\{4\}$.

Question 11

Comprehensive responses

- Most candidates had a good understanding of percentages and were able to find the correct sale price.
- Some candidates gave the price reduction \$17.92 as their answer.

Limited responses

- Some candidates rounded the sale price to 2 or 3 significant figures without showing a more accurate value in their working.
- Candidates are advised not to round answers that are exact.

Question 12

(a) Comprehensive responses

- Almost all candidates gave a correct value of k , usually as a decimal.

Limited responses

- The common error involved incorrect rearrangement to $5k = 12 - 2$.

(b) Comprehensive responses

- Most candidates expanded the brackets and rearranged the equation to find the correct value of $y = -4.5$ or an alternative correct form.

Limited responses

- Some candidates made errors when expanding one or both brackets, forgetting to multiply the constant term, and $12y + 1$ and/or $10y - 1$ were often seen.
- Some candidates made errors when rearranging the equation, usually involving signs.
- The equation $10y - 5 = 12y + 4$ was sometimes rearranged with an incorrect sign, such as $10y - 12y = 4 - 5$.
- Some candidates correctly isolated the terms in y , reaching $-2y = 9$, and then lost the negative in the final division.

Question 13

(a) Comprehensive responses

- Almost all candidates evaluated $f(-4)$ correctly.

Limited responses

- A few candidates made errors with signs and simplified $-8 + 3$ as 5.
- A few candidates misinterpreted the question as an equation and attempted to solve $f(x) = -4$.

(b) Comprehensive responses

- Most candidates had a good understanding of composite functions and evaluated $gf(1)$ correctly.

Limited responses

- A few candidates gave the answer as a decimal, 0.33, with insufficient accuracy.
- Some candidates misinterpreted the composite function and evaluated $g(1) \times f(1)$.
- Some candidates evaluated $fg(1)$, and others just $g(1)$.
- A few candidates attempted to solve the equation $g(x) = f(1)$.

Question 14

Comprehensive responses

- Many candidates recognised that the question required exponential growth and repeated multiplication by the growth factor of 1.017.
- Some candidates applied the method correctly and obtained an accurate value for the increase in population.

Limited responses

- A small number of candidates obtained the correct increase before incorrectly going on to calculate the increase as a percentage of the original population.
- Some candidates applied the method correctly and gave the new population as the answer instead of the increase.
- Other candidates calculated an increase after prematurely rounding 1.017^3 to 1.051 and 1.0518, both of which led to an inaccurate final answer.
- Many candidates calculated the increase for the first year and simply multiplied this by 3.

Question 15

(a) Comprehensive responses

- Almost all candidates gave the correct answer.

Limited responses

- The most common error was an answer of a^{15} .

(b) Comprehensive responses

- Many candidates dealt with the powers correctly. b^{-5} or $\frac{1}{b^5}$.

Limited responses

- Common errors included b^5 , with a few candidates giving the power as 6 or -6 .

(c) **Comprehensive responses**

- Most candidates understood the rule for powers of a power and many gave a correct answer.

Limited responses

- The common errors involved either forgetting to cube the 4 or adding the powers of the variables.

Question 16

Comprehensive responses

- Most candidates used the appropriate midpoints to find the correct estimate of the mean.

Limited responses

- A few candidates used the class widths of the intervals instead of the midpoints.
- Some candidates made errors in identifying one or more of the midpoints.
- A few candidates summed the midpoints or the class widths.
- A few candidates divided by 4 instead of the total frequency of 60.

Question 17

(a) **Comprehensive responses**

- Many candidates successfully dealt with the idea of inverse proportionality, converting the given information into $f = \frac{k}{h^2}$.
- Some candidates with the correct relationship substituted the given values and found the correct value of f .

Limited responses

- Many candidates correctly calculated the constant of proportionality, $k = -3$, then used -5^2 , without essential brackets in the denominator, which led to sign errors and an incorrect answer of 0.12.
- Some candidates missed 'the square of h ' and worked with $f \propto \frac{1}{h}$ instead.
- Some candidates missed 'inversely' and treated the question as direct proportion.

(b) **Comprehensive responses**

- Some candidates used the direct proportion relationship between c and d^2 and gave a correct answer, usually 16 and occasionally 4^2 .

Limited responses

- Most candidates did not understand the link between c and d^2 and gave a wide variety of answers, with 2, 4 and 8 being the most common.

Question 18

(a) **Comprehensive responses**

- Some candidates gave the correct angle with the correct geometrical reason.
- In giving geometrical reasons, candidates are advised to use the correct terminology given in the syllabus for circle theorems.

Limited responses

- Many candidates gave the correct angle with either an insufficient reason or an incorrect reason. Common errors in the reasoning involved not using the correct terminology.
- Some candidates gave an answer of 40° using the incorrect reason 'angle at the centre is half the angle at the circumference'.

(b) **Comprehensive responses**

- Some candidates used the alternate segment theorem and obtained the correct value of 35° .

- A few candidates used the angle between the tangent and their drawn radius to find 35° .

Limited responses

- Some candidates attempted to label an angle at B as 45 without clearly identifying which of the angles was 45. With more than one angle at B , candidates should use the three-letter notation for the angle.
- Some candidates assumed that triangle ABC was isosceles.
- Many candidates assumed that BC and the tangent were parallel and applied alternate angles.

Question 19

(a) Comprehensive responses

- Most candidates used the graph correctly to find the median score.

Limited responses

- A few candidates gave the answer 50, the middle score on the horizontal axis.
- A few candidates gave the answer 35 from $70 \div 2$.

(b) Comprehensive responses

- Most candidates calculated the number of candidates passing the test by working out 60 percent of 40.
- Some candidates reaching 24 realised they needed to work with the 16 that failed and went on to give a correct pass mark.

Limited responses

- Many candidates did not subtract of 24 from 40 to take the appropriate reading for the pass mark of the test and 55 was a common answer.
- A few candidates read off the cumulative frequency for a score of 60.

Question 20

Comprehensive responses

- Most candidates knew that bounds needed to be found before $\text{length} = \frac{\text{Area}}{\text{width}}$ was calculated.
- Some candidates were able to identify the upper bound of the area and the lower bound of the width needed to find the upper bound of the length.

Limited responses

- Many candidates used the upper bound for area and then mistakenly used the upper bound for the width.
- Some candidates calculated the length using the given figures for area and width and then attempted to give the upper bound for their answer.

Question 21

(a) Comprehensive responses

- Most candidates simplified the expression correctly.

Limited responses

- Some candidates gave the answer as $\frac{1}{4}x$.

(b) Comprehensive responses

- Some candidates factorised the numerator and denominator and cancelled to simplify the expression correctly.

Limited responses

- Some candidates factorised the numerator correctly but the denominator incorrectly, with $(f - 4)^2$ being the most common error.

- Some candidates made no attempt to factorise and instead cancelled individual terms, such as f^2 , in the numerator and the denominator.
- A few candidates gave an ambiguous answer of $2f/f + 4$ using a diagonal fraction line instead of a horizontal line.

Question 22

(a) Comprehensive responses

- Some candidates applied both the sine rule and right-angled trigonometry methods correctly to obtain the area of the triangle.
- Most candidates started by calculating the length of AC as their first step.
- Some candidates showed clear working that was easy to follow.
- A small number of candidates used a correct approach, different from the standard methods shown in the main mark scheme. One such method involved the use of the tangent ratio.

Limited responses

- Some candidates made no attempt to find either of the two angles of $CAD = 16^\circ$ or $ACD = 146^\circ$ as a starting point.
- Some candidates assumed that the triangle ACD was isosceles, using AC as 8 cm.
- Other candidates assumed that BC was 8 cm.
- Many candidates did not consistently work to a sufficient degree of accuracy within this multi-step question.
- Some candidates did not rearrange formulae to an explicit form before writing their answer.
- A few candidates did not identify which lengths they were working out and then went on to put their answer in the incorrect place on the diagram.
- A few candidates used right-angled trigonometry in a non-right-angled triangle.

(b) Comprehensive responses

- Some candidates understood the context of the question, divided the area by 5, rounded this up to the nearest integer and then multiplied by 6.

Limited responses

- Many candidates divided their area by 5 without rounding up before multiplying by 6.

Question 23

(a) Comprehensive responses

- Many candidates obtained a correct expression for the arc length and equated this to 44 before giving a correct answer.
- Premature approximation of some values in an otherwise correct solution often led to answers that were outside the acceptable range.

Limited responses

- Some candidates found the angle of the minor sector.
- Having found the correct angle, some candidates spoiled their answer by working out the area of the sector.
- Some candidates equated an expression for the area of the sector to 44.

(b)(i) Comprehensive responses

- Few candidates gave a fully correct answer.
- Some candidates realised that the circumference of the base of the cone was 44 cm and went on to solve $2\pi r = 44$.
- Some candidates used the sector angle to find the area of the sector and equated this to πrl , the curved surface area of the cone.

Limited responses

- Many candidates who used a correct method did not reach a correct solution because they did not give their answer to a sufficient degree of accuracy, often giving it as 7 or 7.0.

- Some incorrectly used Pythagoras or trigonometric methods often using the given value.

(ii) Comprehensive responses

- Many candidates used Pythagoras correctly to find the height of the cone and substituted this into the formula for the volume of a cone.
- Many candidates used a premature approximation of the height of the cone in an otherwise correct solution, leading to answers that were outside the acceptable range.

Limited responses

- When attempting to find the height of the cone, a few candidates used 7 and 9.1 in an incorrect Pythagoras calculation.
- A few candidates used an incorrect formula for the volume of a cone.

(iii) Comprehensive responses

- Some candidates linked the volumes with the corresponding radii correctly in an equation.

Limited responses

- A few candidates used squares and square roots in their working instead of cubes and cube roots.
- Some candidates linked the ratio of volumes directly with the ratio of the radii.
- Some candidates equated the volume of 2387 with $\frac{1}{3}\pi r^2 h$, often incorrectly using 9.1 as h .

Question 24

(a) Comprehensive responses

- Many candidates linked either 720 or 120 to a correct expression for the volume.
- Many candidates showed well-presented step by step working.

Limited responses

- Some candidates did not have a correct expression linked to 720 or 120.
- Many candidates did not use brackets appropriately, for example, $(3x - 10)(6)(x + 2)$ expanded as $3x(6) - 10(6)(x + 2)$.
- Some candidates made slips such as omitting x from one of the terms, writing a wrong sign or not setting an equation to zero when all terms are brought to the same side.
- A few candidates attempted to equate the total surface area to 720.

(b) Comprehensive responses

- Many candidates used a correct quadratic formula and showed clear correct substitutions.
- Some candidates gave final values which were correct to at least 2 decimal places.
- It was common to see fully correct working with one of the answers given incorrectly as -6.19 .

Limited responses

- Some candidates made errors with their substitutions into the formula, such as -4 instead of $-(-4)$ and -4^2 instead of $(-4)^2$. Not all candidates recovered in their working from these slips.
- Other candidates substituted 140 instead of -140 .
- Some candidates had a short division line in the formula, for example,

$$4 \pm \frac{\sqrt{(-4)^2 - 4 \times 3 \times -140}}{6} \text{ or a short square root sign on occasions.}$$

(c) Comprehensive responses

- Some candidates correctly evaluated the area using 7.53 from **part (b)**.
- Many candidates identified the area of the top face as $6(3x - 10)$ or its expanded equivalent.
- Many candidates made an attempt to substitute their positive solution into a formula for the top area.

Limited responses

- Some candidates gave the area as $6(3x - 10)$ and made no substitution.

- Some candidates attempted to calculate the total surface area of the cuboid.
- Some candidates omitted brackets, writing the area as $3x - 10 \times 6$.

Question 25

(a) Comprehensive responses

- Some candidates were able to write the given expression in the required form.

Limited responses

- Some candidates obtained $2(x - 2)^2$ followed by an incorrect constant term.
- A few candidates who expanded $a(x - b)^2 + c$ made little progress when trying to compare coefficients.
- Writing the square term as $(x - 4)^2$ was a common error.
- A few candidates gave incorrect forms such as $2x(x - 4)$ or $2x(x - 2)^2 + 7$.

(b) Comprehensive responses

- Some of those candidates with an answer in completed square form, even when incorrect, were able to give the appropriate turning point for their expression.

Limited responses

- A few of those candidates with an answer in completed square form, even when incorrect, gave an incorrect turning point, usually ignoring the signs of the number terms.
- Many candidates did not appreciate that the completed square form could be used to find the turning point and so gave random values.

(c) Comprehensive responses

- A few candidates were successful in this part, either giving the correct inequality or giving an answer based on their turning point.

Limited responses

- Some candidates gave an algebraic expression rather than a numerical value, quite often linked to the original expression in the question.
- Many candidates made no attempt at a response.

MATHEMATICS SYLLABUS D

Paper 4024/23 Calculator

Key messages

What candidates did well

- Many candidates were able to demonstrate good basic arithmetic and algebraic skills.
- Candidates were able to show clear methods leading to their answers.
- Candidates had learned how to apply the formulae provided.

What candidates needed to improve

- Candidates need to ensure they are familiar with all the syllabus content.
- Candidates need to answer the question asked rather than answering their own assumed question.
- Candidates need to work to a sufficient degree of accuracy to be able to give non-exact numerical answers to at least 3 significant figures or 1 decimal place for angles.
- Candidates should review their work carefully to minimise avoidable mistakes with basic arithmetic, sign errors and slips when transcribing their work.

Comments on specific questions

Question 1

(a) Comprehensive responses

- Most candidates were able to round the given number correctly to the nearest 100.

Limited responses

- Some candidates gave their answer as 400, 412 000 or 412 300.

(b) Comprehensive responses

- Most candidates were able to give their answer correct to 2 decimal places.

Limited responses

- Some candidates gave their answer as 313.49, 3.1 or 3.1300.

Question 2

Comprehensive responses

- Most candidates calculated the total cost of the eight drinks and subtracted their answer from \$30 to work out the amount of change.

Limited responses

- A few candidates assumed that \$2.50 was the cost of all 5 cups of tea and that \$3.40 was the cost of all 3 cups of coffee.
- A few candidates made basic computational errors or miscopied their own answers.

Question 3

Comprehensive responses

- Some candidates recognised the need to calculate the sum of the interior angles of the hexagon and then find the sum of the remaining 3 angles before dividing it in the given ratio to find the size of the largest angle.

Limited responses

- Many candidates realised that the sum of the interior angles of the hexagon needed to be found but recalled the formula incorrectly. Incorrect values seen for the total interior angles were 1080° and 900° .
- Many candidates, after having found the sum of the 3 given angles, incorrectly proceeded to divide this total in the given ratio.
- Some candidates did not know the correct number of sides of a hexagon.

Question 4

(a) Comprehensive responses

- Some candidates were able to represent the inequality on the diagram using the correct circles on either end of a single line.

Limited responses

- Some candidates drew a line from -4 to 1 and got the open and closed circles the wrong way round or gave both as closed circles.
- Some candidates showed $x > 4$ and $x \leq 1$ separately with arrows and the two lines going beyond the relevant boundaries.
- Other incorrect responses included only showing $x > 4$ or $x \leq 1$ on the number line.

(b) Comprehensive responses

- Most candidates were able to solve the inequality correctly.

Limited responses

- Some candidates omitted the inequality sign from their answer or replaced it with an equal sign.
- Some candidates changed the direction of the inequality sign.
- Some candidates subtracted 3 rather than divided by 3.

Question 5

(a) Comprehensive responses

- Many candidates recognised that the horizontal portion of the graph represented the time the bus was not moving and were able to read the scale of the graph correctly to give a time of 36 minutes.

Limited responses

- Some candidates misread the graph, giving an incorrect answer of 40 minutes.

(b) Comprehensive responses

- Some candidates were able to calculate average speed correctly by converting the time taken for the whole journey from hours and minutes to hours and then dividing the total distance travelled by the time.

Limited responses

- Some candidates recognised the need to calculate $12 \div$ time taken, found the correct time taken for the journey and did not convert it correctly into hours. Values of 1.54 and 114 were common.
- Other errors included losing an hour in their calculations after converting 54 minutes to 0.9 hr or using 11:54 as their time.
- Many candidates attempted to find the area under the graph to calculate the distance or calculated the speed for the 3 stages of the journey and then took the average.

(c) (i) Comprehensive responses

- Some candidates drew a single line that started and ended at the correct points.

Limited responses

- Many candidates drew a single line that started at the correct point and ended at the distance where the bus was at 11:30.
- Some candidates drew a single line starting at (10:30, 6) and ending at (11:30, 9.6).

- Some candidates drew a journey with more than one stage, mirroring the journey of the bus. Vertical lines were often visible, resulting in a graph that seemed to show the cyclist returning.
- Some candidates drew a line which ran parallel to the horizontal axis, perhaps thinking this implied a constant speed.

(ii) Comprehensive responses

- Most candidates who drew a single line with a positive gradient recognised that the intersection of the two lines was required.
- Most of those candidates accurately interpreted the scale of the vertical axis.

Limited responses

- Some candidates misread the scale of the vertical axis, thinking that 1 square represented 2 km rather than 4 km.
- Some candidates were unable to read off the intersection due to their single line not crossing the graph of the bus or their line having two points of intersection.

Question 6

(a) Comprehensive responses

- Most candidates were able to factorise the expression correctly.

Limited responses

- Some candidates tried to solve it as an equation, giving an answer of $a = 0.5$.
- Other common wrong answers seen were $2a$, $2a - 1$ and $2(2a)$.

(b) Comprehensive responses

- Most candidates were able to fully factorise the quadratic expression into a single bracket.

Limited responses

- Some candidates tried to solve it as an equation.
- Some candidates only partially factorised the expression, taking out a common factor of only x or 3 rather than $3x$.

Question 7

(a) Comprehensive responses

- Most candidates were able to give the coordinates of point A.

Limited responses

- Common incorrect answers seen were $(3, -4)$, $(x : -4, y : 3)$ and $(-4, 0, 0, 3)$.

(b) Comprehensive responses

- Many candidates were able to calculate the gradient of the line using the coordinates of A and B or by choosing two other points on the line.

Limited responses

- Some candidates worked out the difference in the x coordinates and the y coordinates but then calculated $\frac{\text{change in } x}{\text{change in } y}$.
- Some candidates calculated the gradient as $-\frac{4}{8}$ and then gave their final answer as -2 .
- Some candidates made sign errors or arithmetic errors when calculating the differences.

Question 8

(a) Comprehensive responses

- Most candidates were able to reach the stage of $12x = 4$ and then go on to give the correct exact fraction as their answer or a decimal with 3 or more significant figures.

Limited responses

- Some candidates reached the point $12x = 4$ and then gave their final answer as 3.
- Some candidates reached the point $12x = 4$ and then gave their final answer as 0.3 or 0.33.
- A few candidates made basic computational or sign errors when rearranging the equation.

(b) Comprehensive responses

- Most candidates recognised the need to remove the denominator by multiplying both sides of the equation by 3 and then went on to rearrange it correctly to reach the answer.

Limited responses

- Some candidates reached the stage $-y = 7$ and then gave the answer 7.
- After reaching the stage of $8 - y = 15$, some candidates gave the next step as $y = 15 - 8$.
- Another common incorrect answer was 23 after a correct first step.

Question 9

(a) Comprehensive responses

- Few candidates set up a correct vector expression, for example $\overrightarrow{DE} = \overrightarrow{DO} + \overrightarrow{OE}$, using the correct numerical vectors from the given coordinates to find $\overrightarrow{DE}$.

Limited responses

- Many candidates did not appreciate that the direction of the vectors needed to be considered when converting the coordinates into vector form.
- Common wrong answers seen were $\begin{pmatrix} 2 \\ 6 \end{pmatrix}$, $\begin{pmatrix} 4 \\ -10 \end{pmatrix}$ and $\begin{pmatrix} 10 \\ -4 \end{pmatrix}$.

(b) Comprehensive responses

- Few candidates set up a correct vector expression to find $\overrightarrow{OF}$, for example $\overrightarrow{OF} = \overrightarrow{OE} + \overrightarrow{EF}$, and then changed it to coordinate form.

Limited responses

- Some candidates set up $\overrightarrow{FE} = \overrightarrow{FO} + \overrightarrow{OE}$, calculated $\overrightarrow{FO}$ but did not appreciate the direction of the vector and gave the coordinates of the point F as (3, -12).
- Another common wrong answer seen was (1, 4).

Question 10

(a) Comprehensive responses

- Many candidates were able to complete the tree diagram with the correct probabilities on both sets of branches for both red and yellow counters.

Limited responses

- Most candidates were able to give the probability of a yellow counter as 0.7 on the first set of branches of the tree diagram.
- Many candidates assumed that the counter was not replaced before the second draw.
- Common wrong probabilities for a yellow counter seen on the second set of branches were 0.6 or $\frac{6}{9}$.
- Some candidates did not appreciate that the probabilities on each set of branches needed to add up to 1 and, for the second counter, gave the probability for red as 0.2 and yellow as 0.7 on the first set of branches and the probability for red as 0.3 and yellow as 0.6 on the second set.

(b) Comprehensive responses

- Some candidates understood the need to multiply the probability of the first counter being yellow by the probability of the second counter being yellow and used their probabilities from their tree diagram.

Limited responses

- The most common error made by many candidates was the addition of the two probabilities.

Question 11

(a) Comprehensive responses

- Many candidates were able to complete the Venn diagram correctly.

Limited responses

- Some candidates repeated 2 and 10, putting them in both set A and set B rather than in the intersection.
- Other common errors were placing 1 in $(A \cup B)'$ rather than in set A or leaving $(A \cup B)'$ empty.

(b) Comprehensive responses

- Many candidates were able to list the correct elements in $(A \cup B)'$.

Limited responses

- The most common error was to list the elements in $A \cap B$.
- Another error was to list the elements in $A \cup B'$.

(c) Comprehensive responses

- Very few candidates were able to identify the correct region required and give the number of elements in it.

Limited responses

- Many candidates listed the elements in the required region, rather than the number of elements as requested.
- A common error was not to include the elements in $A \cap B$ in the total.

Question 12

(a) Comprehensive responses

- Most candidates realised that side PR corresponded to side AC .
- Many candidates applied proportionality correctly by finding the scale factor and then using it with 3.4 to find the length of PR .

Limited responses

- Some candidates calculated the value of 15.3 but attributed it to side QR and then went on to use it to try to find PR using a variety of methods.
- Some candidates did not appreciate that the properties of similarity needed to be used and attempted to solve the problem using trigonometry or Pythagoras inappropriately.
- Some candidates found the difference between sides PQ and AB and then added it to 3.4 to get an incorrect answer of 17.4.

(b) Comprehensive responses

- Few candidates used the most efficient method of applying the area scale factor to solve the problem correctly.
- Alternative approaches using $\frac{1}{2} \times \text{base} \times \text{height}$ to calculate the perpendicular height of triangle PQR or $\frac{1}{2}ab \sin C$ to calculate $\angle P$ were quite common, with some candidates applying them correctly and completing the necessary rearrangements to solve the problem.

Limited responses

- Candidates who calculated $\angle P$ would often introduce inaccuracy. The multi-stage approach meant that rounded values were often used, leading to an answer that was not exact.
- Many candidates did not consider the area of PQR and reached an answer of 6.8, usually from the calculation $\frac{1}{2} \times 3.4 \times 4$.
- Many candidates produced an answer of 12.6 by using a linear scale factor.

- Some candidates thought the question required a Pythagoras calculation using 3.4 and 4.
- A few candidates recognised that a scale factor needed to be squared for an area calculation but applied it to the wrong part of their calculation.

Question 13

(a) (i) Comprehensive responses

- Many candidates used the cumulative frequency curve correctly to identify an estimate for the median time.

Limited responses

- The most common error was to give an answer of 40, which was the midpoint of the values on the x-axis.

(ii) Comprehensive responses

- Few candidates were able to correctly calculate the interquartile range.

Limited responses

- Some candidates were able to identify either the upper quartile or the lower quartile but made computational errors.
- A common error seen was responses that found $\frac{1}{4}$ of 100 and $\frac{3}{4}$ of 100 and then gave the interquartile range as $75 - 25 = 50$.
- Another common error was to calculate the range of times, with an answer of 40 given.

(b) Comprehensive responses

- Few candidates were able to accurately read off the values from the curve to find the frequencies.

Limited responses

- Some candidates managed to get one or two correct values but made errors either with their subtraction or their readings of the required values.
- The most common wrong answers were 36, 75 and 100, giving the cumulative frequencies rather than the frequencies.

Question 14

Comprehensive responses

- Some candidates recognised that \$303.40 was 82 per cent of the original price and went on to divide by 0.82 to calculate the original price.

Limited responses

- Some candidates recognised that it was a reverse percentage problem and divided by 0.18 rather than 0.82.
- Other incorrect answers seen were calculating 18 per cent, 118 per cent or 82 per cent of the sale price.

Question 15

(a) Comprehensive responses

- Most candidates were able to substitute -1 into $f(x)$ and evaluate it correctly.

Limited responses

- A common error made by some candidates was to evaluate $6 \times (-1)$ as 5 and give an answer of 13.
- Some candidates missed the negative sign and gave an answer of 14.

(b) Comprehensive responses

- Many candidates were able to give the inverse of $g(x)$.

Limited responses

- Some candidates gave a correct first step for finding the inverse of the function.

- After $3y = x - 1$ was given as the first step, some common wrong answers were $3x - 1$ and $3y + 1$.
- After $x = \frac{y-1}{3}$ was given as the first step, a common error was to deal with the -1 before removing the denominator.
- Some candidates tried to evaluate the function.

(c) Comprehensive responses

- Few candidates set up a correct equation using the two functions and went on to solve it.

Limited responses

- Some candidates set up a correct initial equation and made errors when trying to remove the brackets and/or denominator, or made sign errors when rearranging.
- Some candidates substituted 14 into one of the functions, evaluated it and substituted their answer into the other function.
- Some candidates attempted to multiply the two functions or started with $\frac{6x+8-1}{3} = 14$.

Question 16

(a) Comprehensive responses

- Many candidates recognised the modal class as $30 < t \leq 50$.

Limited responses

- There were a variety of incorrect answers, with the most common one being $10 < t \leq 90$.

(b) Comprehensive responses

- Some candidates were able to calculate an estimate for the mean using the midpoints of the intervals.

Limited responses

- Of those who used the correct method, occasionally one of the midpoints was incorrect or there was an error in the multiplication of the numerator.
- Some candidates divided the correct total by 4 rather than 50.
- Other errors included using either the upper bounds or the lower bounds of the intervals to calculate the total time.
- The most common error was to use the class widths instead of the midpoints.

(c) Comprehensive responses

- Most candidates were able to choose the correct value from the table to give the probability, either as a fraction, decimal or percentage.

Limited responses

- A common wrong answer was $\frac{12+18}{50}$.
- Some candidates had the correct numerator with the wrong denominator.

Question 17

Comprehensive responses

- Some candidates set up a correct initial equation and went on to solve it correctly, either by taking the sixth root of 1.306 or by using trial and error.

Limited responses

- Some candidates set up a correct initial equation as the first step and then subtracted 3000 from 3918 rather than calculating $3918 \div 3000$.
- Another common error was not giving an answer to 3 or more significant figures after taking the sixth root of 1.306.
- Another common error was to treat it as a simple interest problem.

Question 18

(a) **Comprehensive responses**

- Few candidates were able to give both the correct lower and upper bounds of the width.

Limited responses

- Some candidates only gave one correct bound.
- Some common incorrect answers were $6.5 \leq w < 7$, $6.5 \leq w < 7.4$, $6.4 \leq w < 7.5$, $6 \leq w < 8$ or $6.95 \leq w < 7.05$.
- Another common error was to give the correct bounds the wrong way round.

(b) **Comprehensive responses**

- Very few candidates recognised that they needed to divide the upper bound of the area by the lower bound of the width.

Limited responses

- Many candidates gave the upper and lower bounds of the area and did not attempt to calculate the upper bound of the length.
- Some candidates used the upper bound of the area and divided it by 7 rather than the lower bound.
- Another common error was to calculate the length using the given values and then attempt to give the upper bound.

Question 19

(a) **Comprehensive responses**

- Some candidates identified that $\angle ACD$ needed to be calculated and applied the sine rule correctly to calculate AD and gave their answer to at least 3 significant figures.

Limited responses

- Many candidates showed the correct rearrangement of the sine rule using 40° and used prematurely rounded values or only gave their answer to 2 significant figures.
- Some candidates set up the correct implicit sine rule expression and then made errors in the rearrangement to the explicit form.
- A common wrong answer was 7.45 because candidates used $\angle CAD$ and calculated CD .
- Some candidates used right-angled trigonometry and/or Pythagoras.

(b) **Comprehensive responses**

- Few candidates were able to show that the value of AB was 7.9 correct to 1 decimal place by showing $\frac{1}{2} \times 14 \times AB \times \sin 67 = 50.9$ and then solving it to give a value for AB to at least 2 decimal places.

Limited responses

- Many candidates wrote $\frac{1}{2} \times 14 \times AB \times \sin 67 = 50.9$ and solved it to give AB to 1 decimal place only.
- Some candidates used 7.9 to show the area was equal to 50.9.
- Some candidates tried to use $\frac{1}{2} \times \text{base} \times \text{height}$.

(c) **Comprehensive responses**

- Some candidates identified that the cosine rule was required to calculate BC and were able to substitute the correct values and evaluate it correctly.
- A few candidates used an alternative approach using the area of the triangle to calculate the perpendicular height of the triangle and then used right-angled trigonometry and/or Pythagoras to calculate the split of AC or AB and then calculate BC .

Limited responses

- Some candidates stated the correct explicit cosine expression and made errors in the evaluation of it.
- Many candidates made incorrect assumptions about the angles and sides of triangle ABC before attempting to use the sine rule.
- Some candidates assumed $\angle ABC$ was 110° , $\angle ACB$ was 43° , or that BC and AD were parallel and so $\angle ABC$ was 83° .
- Some candidates assumed ABC was an isosceles triangle and applied right-angled trigonometry and/or Pythagoras.

Question 20

Comprehensive responses

- Few candidates set up a correct inverse proportion equation in terms of a , c^3 and k and used the given values to find the value of k before going on to calculate the value of a when $c = 2$.

Limited responses

- Some candidates set up the correct equation with the given values of a and c^3 substituted and then made errors in trying to find the value of k .
- A common error that many candidates made was not to cube c in either the initial equation or the second one when trying to calculate the value of a .
- Some candidates used $\propto c$ or set up a direct proportion equation.

Question 21

Comprehensive responses

- Very few candidates were able to identify the angle between EC and the face $ABFE$ or calculate any of the relevant lengths needed.
- Most candidates who calculated the angle correctly approached it using trigonometry, with a small number choosing to use the cosine rule instead.

Limited responses

- Many candidates assumed $\angle CEG$ was the angle required and calculated EG rather than EC .
- Some candidates did calculate EC to use for calculating $\angle CEG$.
- Some candidates thought the surface area needed to be calculated.

Question 22

(a) Comprehensive responses

- Most candidates were able to expand the single bracket.

Limited responses

- There were very few incorrect responses, so no common errors could be identified.

(b) Comprehensive responses

- Many candidates expanded the 3 brackets correctly and simplified the result to give a correct 4-term expression.

Limited responses

- Many candidates were able to get at least 3 terms correct from expanding 2 of the 3 brackets.
- Some candidates made errors when simplifying the middle terms after correctly expanding 2 of the brackets, which then resulted in them getting more than one term incorrect in their final answer.
- After correctly expanding two of the brackets, some candidates did not go on to multiply all of those terms by the terms in the third bracket due to the omission of necessary brackets.
- Some candidates correctly expanded the first and second brackets, expanded the second and third brackets and then combined all the terms.

Question 23

Comprehensive responses

- Some candidates were able to factorise both the numerator and denominator correctly and cancel common factors to give the simplified algebraic fraction.

Limited responses

- Factorisation of the numerator to $(3x + 1)(x - 4)$ was often correct, although some candidates did get the signs the wrong way round.
- Some candidates took out a common factor of 2 from the denominator and recognised the remaining factor to be a difference of two squares and went on to factorise it correctly.
- A common error seen when attempting to factorise the denominator was to put both signs as negative in the brackets.
- Another common error seen when attempting to factorise the denominator was $2x(x - 16)$.
- Some candidates cancelled both terms of $2x^2 - 32$ by 2 to leave $x^2 - 16$ as the denominator.
- Many candidates did not recognise the need to factorise both parts of the algebraic fraction in order to simplify it and made errors when attempting to simplify due to cancelling individual terms rather than common factors.
- Some candidates equated the fraction to 0 and attempted to solve it.

Question 24

Comprehensive responses

- Very few candidates were able to calculate the total surface area of the frustum.
- Of the candidates who did calculate the surface area correctly, most opted to calculate the curved surface area of the small cone by calculating the height using a length scale factor and then calculating the slant height and curved surface area, rather than applying the area scale factor to the curved surface area of the large cone.

Limited responses

- Some candidates calculated the curved surface area of the frustum and omitted the areas of the two circles.
- A few candidates calculated (total surface area of the large cone – total surface area of the small cone) rather than (curved surface area of the large cone – curved surface area of the small cone) + the areas of the two circles.
- Some candidates recognised the need to calculate the slant height of the large cone and went on to calculate the surface area of the large cone but were unable to progress further because they did not calculate the slant height of the small cone.
- Many candidates made no attempt to calculate the slant height of the large cone and assumed it was 75, and made no attempt to calculate the height of the small cone, assuming it was 50.
- Some candidates tried to calculate the volume of the cone rather than the surface area.