MATHEMATICS D

Paper 4024/11
Paper 11

Key messages

In this paper it is important that candidates are familiar with the whole syllabus and remember necessary formulae. Some candidates need to do more work on topics such as scatter diagrams and relative frequency.

Candidates should read questions carefully and obey any specific instructions given e.g. **Question 14** which states “factorise completely” and **Question 24(b)** which instructs the candidates “to solve, by factorisation”.

All working should be shown and answers clearly written in the appropriate answer space.

This is a non-calculator paper and accuracy in basic number work is essential. Some candidates need to improve on their computational skills in order to gain more marks.

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

General comments

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

The questions that candidates found most difficult and which were commonly omitted were parts of **Question 12**, **Question 13**, **Question 20** and **Question 21(b)**. Many also found **Question 10** demanding.

Comments on specific questions

Question 1

(a) Most candidates obtained the correct answer. A few made arithmetic errors e.g. $\frac{1.4}{0.8}$ or gave the answer 0.2.

(b) Most realised that this was a question about the order of operations and obtained the correct answer. Some wrong answers such as $(9 + 6) \div (3 - 4) = -15$ and $(9 + 6) \div 3 - 4 = 15 \div 3 - 4 = 1$ were seen.

Answers: **(a)** 2 **(b)** 7

Question 2

(a) This part was very well done by most candidates. A few candidates realised that the calculation involved $\frac{15}{100} \times 80$ but were unable to work this out correctly.

(b) This part was also very well done by many candidates. A few incorrect answers of $\frac{1}{2}$ were seen.

Answers: **(a)** 12 **(b)** $\frac{11}{35}$

Question 3

Many completely correct answers were seen. It was helpful when ordering the numbers if the candidates realised that $\frac{9}{31} < \frac{9}{30}$ and if they could convert $\frac{15}{40}$ to a decimal.

Answer: $\frac{9}{31}$, 0.3, 0.32, $\frac{1}{3}$, $\frac{15}{40}$

Question 4

(a) While the majority of candidates were able to complete the shape correctly some spoiled their answer by misplacing one vertex. Candidates can improve on this topic by working with lines of symmetry which are not horizontal or vertical.

(b) Many candidates omitted this part and few completed the shape correctly. A common error was to complete the shape as if it had line symmetry or to change the centre of rotational symmetry. In order to improve, candidates need to work with a centre of rotation that is not a vertex of the given shape.

Answers: **(a)** Diagram completed correctly **(b)** Diagram completed correctly

Question 5

(a) Most candidates realised that they had to subtract 6 hours 50 mins and 3 hours from 17 20 but forgot that there are 60 minutes in an hour and not 100. These earned the method marks but did not get the correct answer.

(b) Usually correct but –26 was a common, incorrect answer.

(c) Approximately half the candidates answered this question correctly. Some forgot to divide 60 by 2 before multiplying by 300, others got the answer 900, while a few had problems working out 150 × 6.

Answer: **(a)** 07 30 **(b)** 60 **(c)** 9000

Question 6

(a) Most candidates found this challenging and many incorrect answers were given including $\frac{1}{2}$, $\frac{3}{8}$, $\frac{5}{8}$, $\frac{9}{16}$ and $\frac{11}{16}$.

(b) The majority of candidates answered this correctly. A few had trouble working out $\frac{60}{150} \times 100$ and a few incorrect calculations were seen e.g. $\frac{60}{100} \times 150$.

(c) Most candidates obtained the correct answer to this part. Candidates are advised to read ratio questions carefully so as to interpret the given information correctly and avoid errors. Some incorrect answers were 60 (from reversing the given ratio), 45 and $15 + \frac{15}{4} = 18.75$ (the latter both from misinterpreting the information).

Answers: **(a)** $\frac{7}{16}$ **(b)** 40 **(c)** 20

Question 7

Candidates need to ensure that they know how to find the mode and median from a grouped frequency table.

(a) Most candidates answered this question correctly, with 7 being a common, incorrect answer.

(b) About half the candidates gave the correct median. Some incorrect answers were 3.5 (the middle number of 1 2 3 4 5 6), 3 (the middle number from 0 2 3 3 5 7) and 10.5 (from $\frac{21}{2}$).

(c) About half the candidates gave the correct answer. A few left the answer as $\frac{77}{20}$. Candidates need to realise that they are considering 20 customers as given in the question. Incorrect answers included $\frac{21}{20}$, $\frac{77}{6}$ and $\frac{21}{6}$.

(d) Many candidates answered this correctly. Some had difficulty extracting the number of customers who bought 3 items from the table and calculated the angle for those buying 4 items instead, giving the incorrect answer of 54°.

Answers: **(a)** 5 **(b)** 4 **(c)** 3.85 oe **(d)** 90°

Question 8

(a) Most candidates gave the correct angle. Some thought that $B\hat{C}A$ was double $A\hat{B}C$ and gave the answer 76°.

(b) Half the candidates answered this correctly. Many realised that $A\hat{B}T$ was 52° but did not realise that $B\hat{A}T$ was also 52°. Common, incorrect answers were 52°, 38° and 128°.

Answers: **(a)** 52° **(b)** 76°

Question 9

Most candidates earned some marks from this question. The majority worked through to find that $x \geqslant -\frac{4}{3}$ and/or $x \leqslant 2$. Some did not give the integers satisfying the inequality and some did not give all of the four integers required. Candidates need to be confident of the meaning of words such as "integers".

Answer: –1, 0, 1, 2

Question 10

About a quarter of the candidates drew the correct loci i.e. a line parallel to *AB* 3 cm from *AB* (outside the barn) and two semicircles centred on *A* and *B* radius 3 cm (outside the barn) and shaded the enclosed area. Candidates need to understand that the dog is outside the barn and his movement is only restricted by the wire attached to the length of the outside wall. This did not seem to be fully understood. Many drew a line 3 cm from *AB* inside the barn.

Answer: Correct line and semicircles drawn with correct region shaded.

Question 11

Most candidates scored full marks on this part. Some showed the product of the two matrices but they were not able to transfer this information into a method for solving the problem.

Answers: $a = 5$, $b = 0$

Question 12

(a) This part was usually correct. A few seemed confused with the concept of the "next" car and gave the answer $\frac{10}{101}$.

(b) About half of the candidates gave the correct answer here. The question asks for the number of cars so candidates need to understand that we are not asking for a probability. Common incorrect responses were $\frac{12}{500}$, $\frac{1}{25}$, $\frac{3}{125}$ and $\frac{60}{500}$.

(c) Many omitted this part. The question asks for the number of cars and not a probability. Candidates need to understand that they are expected to use the given data to estimate the number of red cars when more cars than the number recorded pass the school gate. Many candidates gave a probability as their answer e.g. $\frac{30}{500}$, $\frac{3}{10}$, $\frac{3}{50}$, $\frac{1}{20}$, $\frac{150}{500}$.

(d) Many omitted this part. Candidates need to realise that the best estimate is based on the largest amount of data.

Answers: **(a)** $\frac{9}{100}$ **(b)** 60 **(c)** 75 **(d)** (c) because it is based on a larger sample

Question 13

Some candidates need to do more work on this topic in order to be able to tackle questions with confidence and understanding. A few omitted this question completely.

(a) A few candidates omitted this part. Most plotted the points accurately.

(b) Many omitted this part. About half the candidates were able to describe the correlation correctly. Some of the incorrect answers were "linear", "random distribution" and "proportional".

(c) Most candidates attempted this question but many drew lines which were outside the tolerance. The line of best fit lay between 3.2 and 3.7 when the mass of mother is 54 and between 5 and 5.4 when the mass of the mother is 105. Some candidates joined the points that they had plotted creating a zig-zag line.

(d) Many candidates were able to correctly answer this part or followed through from their line of best fit.

Answers: **(a)** 4 points correctly plotted **(b)** Positive **(c)** Acceptable line of best fit **(d)** 4.35 – 4.55

Question 14

(a) This question was very well done with most candidates giving the correct factors. A few were confused by the order of the terms but earned a mark for partial correct factorisation e.g. $a(2x - y)$ or $y(a + 3b)$.

(b) Partial factorisation was very common i.e. $3(9x^2 - y^2)$, $(9x - 3y)(3x + y)$ and $(9x + 3y)(3x - y)$. A few divided by 3 and worked with $(9x^2 - y^2)$.

Answers: **(a)** $(2x - y)(a + 3b)$ **(b)** $3\,(3x - y)(3x + y)$

Question 15

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

(b) Many gave the correct answer here. The main cause of error came from evaluating $(-2)^3$ as 8 resulting in the answer 31.

(c) Some candidates omitted this part. Often errors occurred in manipulating the algebraic expression obtained. After the correct expression, $3 - 2(4x^3 - 1)$, we saw $3 - 8x^3 - 2 = 1 - 8x^3$ or $1(4x^3 - 1) = 4x^3 - 1$. Occasionally candidates left their answer as $3 - 8x^3 + 2$.

Answers: **(a)** -7 **(b)** -33 **(c)** $5 - 8x^3$

Question 16

(a) Most candidates answered this question correctly. A few candidates thought that 3^3 was 9 and that 3^0 was 0.

(b) Most scored full marks here and many candidates earned one mark for a partially correct answer. Some candidates simplified the expression within the bracket but forgot to take the square root leaving their answer as $\sqrt{\frac{9b^2}{16a^2}}$. Some incorrect answers seen were $\frac{3b^2}{4a^2}$ and $\frac{3ab}{4}$.

Answers: **(a)** 26 **(b)** $\frac{3b}{4a}$

Question 17

Most candidates attempted this question and many gave the correct answer. Most found the correct area of the triangle *BCE* and used Pythagoras' Theorem correctly to find *BC*. Candidates needed to realise that the area of a square with side $\sqrt{85}$ is 85 in order to obtain the correct answer.

Answer: 106

Question 18

(a) Few candidates scored full marks. The word "fully" is in bold print and an example for line *AB* is given to emphasis the sort of description that is required. Most candidates realised that *BC* represented constant speed and that *CD* represented a deceleration. They needed to realise that more information about the speed/deceleration was required to achieve full marks. The most common errors arose from misreading the scale on both the speed and time axes.

(b) Most candidates attempted to find the distance either by finding the area of the trapezium or by finding the area of two triangles and the rectangle. The scale on the speed axis was often misread as 16 when it should be 18 and the time span taken as 84.5 rather than 85 which led to many incorrect answers.

Answers: **(a)** *BC*: constant speed 18 m/s for 50 secs and *CD*: deceleration 1.2 m/s² for 15 secs **(b)** 1215

Question 19

(a) The majority of candidates gave the correct answer. Incorrect answers included 288, 28 700 000 and 29.

(b) (i) The vast majority of candidates completed the row correctly.

(ii) Many candidates answered this part correctly. Some added 3.3 and 9.2 getting 12.5 and then gave the answer 1.25×10^7. Others tried to convert both numbers to a number $\times 10^5$ but made a mistake in doing so resulting in $(330 + 9.2) \times 10^5$ and the answer $3.39(2) \times 10^6$. A few used the population figures from the table instead of those for the land area.

(iii) Just over half the candidates answered this correctly. Candidates needed to realise that they were looking for a low population figure as most of the land areas were of similar magnitude.

Answers: **(a)** 28 800 000 **(b)** 1.3×10^8 correctly placed in the table **(c)** 4.22×10^6 **(d)** Greenland

Question 20

(a) This part was well answered. A few candidates used surface area instead of volume.

(b) Candidates found this part challenging. About a quarter gave the correct answer. Some left the answer in cm^3 while others attempted to convert this into m^3 but found the conversion difficult. Incorrect answers included 24 000 000, 24 000, 24 and 0.24.

(c) Candidates also found this part demanding. There were few correct answers and many omitted this part. Candidates can improve on this topic by remembering that the linear scale factor has to be cubed when finding the volume of a similar solid. The most common incorrect answer was 3600 from 2400 × 1.5.

Answers: **(a)** 3 **(b)** 2.4 **(c)** 8100

Question 21

(a) There were many correct answers. Candidates should remember that vectors do not have fraction lines in them.

(b) Many omitted this part. Candidates needed to realise that they were looking for a combination of $\begin{pmatrix} 3 \\ 4 \end{pmatrix}$ and $n\begin{pmatrix} -4 \\ 3 \end{pmatrix}$ to make $\begin{pmatrix} 11 \\ -2 \end{pmatrix}$.

Answers: **(a)** $\begin{pmatrix} 13 \\ 9 \end{pmatrix}$ **(b)** –2

Question 22

(a) Many correct answers were seen. Incorrect answers of ± 5 and $\frac{125}{3} = 41.2$ were seen.

(b) This part was well done by many. Most realised that you had to cube both sides of the formula and having done this proceeded to the correct rearrangement. A few made a sign error giving $s^3 + 4$ as their answer. Other incorrect answers included $s^3/4$, $4 - s^3$ and $\sqrt[3]{s-4}$.

Answers: **(a)** 5 **(b)** $s^3 - 4$

Question 23

Very few candidates achieved full marks for this question. Almost all attempted it.

(a) Most candidates had difficulty recognising this cubic curve. Figure C was often given as the answer as was Figure B.

(b) Candidates found this the most difficult graph to identify.

(c) Candidates found this part the most accessible with over half identifying the correct curve.

Answers: **(a)** F **(b)** A **(c)** E

Question 24

(a) There were some good responses to this question with candidates showing confidence in simplifying the given equation. A few forgot to multiply the right hand side by $(x+2)(x-1)$ and some made sign errors in their working.

(b) Some candidates found the equation difficult to factorise and resorted to using the formula. This will prevent them from earning full marks. Many correct solutions were seen. Some candidates earned a mark by finding factors which gave them three of the components of the equation but not all three e.g. $(7x+10)(x-3)$, $(7x-30)(x-1)$, $(7x-5)(x+6)$ etc.

Answers: **(a)** Given equation correctly simplified to $7x^2 - 37x - 30 = 0$ **(b)** $-\frac{5}{7}$ or 6

MATHEMATICS D

Paper 4024/12
Paper 12

Key messages

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

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

General comments

The majority of candidates were well prepared for this paper and showed good understanding of most of the topics covered. Most candidates attempted all the questions and many well-presented responses were seen.

In general, candidates performed well on number and standard algebra questions, although the problem-solving aspect of the sequences question was found to be a challenge. Some candidates were not prepared for questions on the new syllabus topics of relative frequency and nets. Other areas of weakness were matrices and transformations.

Good arithmetic skills were evident in many cases. Some candidates would benefit from checking their answers. It was common to see an incorrect answer resulting from a correct method involving arithmetic slips, particularly where negative numbers were involved. When a question asks for an answer in its simplest form, candidates should be aware that an unsimplified answer will not gain full credit.

Presentation was usually good with sufficient working shown. This should be shown in the answer space next to the question. Candidates should be reminded that when they replace work they should clearly cross it out. They should not overwrite their answers when they have made an error or if they have done working in pencil, as this leads to illegible answers. Candidates should take care to write digits carefully; in some cases it was difficult to distinguish between the digits 1, 2 and 7.

Comments on specific questions

Question 1

(a) Most candidates subtracted the fractions correctly, using 77 as the common denominator. Common errors were incorrect subtraction of the numerators or subtracting the numerators and denominators separately without the use of a common denominator.

(b) Most candidates reached a correct answer in this part, with some giving the answer as a fraction which was also acceptable. Some candidates multiplied the digits correctly but then made place value errors to reach answers such as 9.900 or 00.099.

Answers: **(a)** $\frac{6}{77}$ **(b)** 0.0099

Question 2

(a) Many candidates were able to calculate the percentage loss correctly. The most common error was to find 90 as a percentage of 120 rather than finding the percentage loss. A small proportion of candidates found the loss, 30, as a percentage of 90.

(b) Again, many correct answers were seen in this part, although some answers were given as the fraction $\frac{2}{5}$ rather than a percentage as required by the question.

(c) This question was found to be challenging for most candidates, with many unable to combine the two ratios. Answers such as 5:9:8 or $\frac{5}{11}:\frac{6}{11}:\frac{8}{11}$ were common. Candidates who understood that they needed to use equivalent ratios to find equal values of *b* often reached 15:18:48 which was an acceptable answer as simplest form was not required in this case.

Answers: **(a)** 25 **(b)** 40 **(c)** 5:6:16

Question 3

(a) Many candidates were able to arrange the numbers correctly. A common error was to order the negative numbers incorrectly and begin the list –0.3, –1.2.

(b) (i) Most candidates understood how to calculate the mean but the directed numbers in the list often led to arithmetic errors. Some candidates gave a final answer of $\frac{0.05}{5}$ which needed to be simplified to $\frac{1}{100}$ or evaluated as 0.01 to be given credit.

(ii) Many candidates did not know that to calculate the range they needed to subtract the lowest value from the highest value. Answers such as –1.2 to 1.3 or $-1.2 < x < 1.3$ were common.

Answers: **(a)** –1.2, –0.3, 0.05, 0.2, 1.3 **(b)(i)** 0.01 **(ii)** 2.5

Question 4

Most candidates used the correct relationship between the variables and found the constant of proportionality correctly. Some were unable to square $\frac{1}{2}$ and so their value of *y* was incorrect. Common incorrect answers were 180, from use of *x* rather than x^2, and 90, from $0.5^2 = 1$. Some candidates interpreted the question wrongly and used the relationship $y = kx^2$ or $y = \frac{k}{x}$.

Answer: 360

Question 5

(a) Candidates were able to identify this as the difference of two squares and most gave the correct answer. The common incorrect answers were $(5t - 4)(5t + 4)$, $(5t - 2)^2$ or $(25t - 4)(25t + 4)$.

(b) Most candidates answered this correctly. The most common error was a final answer of $(x - 6)(x + 3y)$ as a result of incorrectly factorising $-3xy + 18y$. If the final answer was not correct, a correct partial factorisation of $x(x - 6)$ was usually seen.

Answers: **(a)** $(5t - 2)(5t + 2)$ **(b)** $(x - 6)(x - 3y)$

Question 6

(a) Most candidates were able to state the lower bound correctly.

(b) Although many correct answers were given, this part was found to be challenging for many candidates. A common misconception was to start by finding the perimeter of the rectangle using 64 and 37, leading to 202, and then subtracting 0.5 to give the answer 201.5. Some candidates only added the lower bounds of the length and width leading to the answer 100.

Answers: **(a)** 63.5 **(b)** 200

Question 7

(a) The correct triangle was often drawn. Some candidates added three triangles to give a diagram with rotational symmetry of order 2 which was also acceptable. Errors included using the wrong centre of rotation (usually the midpoint of *OQ*) using line symmetry or producing a diagram with rotational symmetry of order 4.

(b) Candidates found it very difficult to visualise the symmetry in the diagram. Those candidates who drew a line of symmetry through the centre of the circle and the midpoint of one of the chords generally produced an acceptable diagram. It was common to see an additional chord that did not meet either of the given chords.

Answers: **(a)** Correct triangle drawn **(b)** Correct chord drawn

Question 8

This question was very well answered with most candidates reaching the correct answer. Candidates were able to eliminate the fractions correctly but, in some cases, they made errors in rearranging leading to answers of $x = 1$ or $x = -\frac{11}{13}$. Candidates who started by attempting to find a common denominator were usually unsuccessful.

Answer: $x = -1$

Question 9

(a) Many candidates added the fractions correctly and reached a correct answer. Some did not read the question carefully and did not simplify their answer so $\frac{19a^2}{6a}$ was a common, partially correct answer.

(b) In this part it was clear that candidates understood the method for dividing fractions with a first step of $\frac{5}{2b^2} \times \frac{4b^3}{15}$ frequently seen. Many went on to reach a correct answer, however answers that were not completely simplified and errors in cancelling were sometimes seen.

Answers: **(a)** $\frac{19}{6a}$ **(b)** $\frac{2b}{3}$

Question 10

Candidates who began by correctly rounding the given numbers to 600, 16 and 0.30 often reached the correct answer. Some had difficulty rounding to 2 significant figures and 590 or 60 were often used in place of 600 and sometimes 0.29 in place of 0.30. Division by 0.3 was found to be a challenge for some, leading to answers of 800 or 80 000. Some attempts at long division or long multiplication were seen; this is never required in a question of this type.

Answer: 8000

Question 11

(a) Most candidates were able to find f(–2) correctly.

(b) This part of the question was found to be more challenging, although most candidates were able to show a correct first step by replacing f(x) with y and rearranging to $x(3y + 2) = 1$. Some answers were left in terms of y and some included a fraction in the numerator which is not sufficiently simplified to gain full credit. Sign errors were sometimes seen in the rearrangement and some candidates found it difficult to manipulate the algebraic fraction.

Answers: **(a)** $-\frac{1}{4}$ **(b)** $\frac{1-2x}{3x}$

Question 12

(a) The term relative frequency was not well understood with the answer 80 being very common. Candidates who knew that a division was required often calculated 400 ÷ 80 leading to the answer 5. Some candidates incorrectly cancelled the correct fraction.

(b) The majority of candidates gave the correct answer here, having started again using a proportional calculation rather than following on from their answer in the previous part. Some candidates gave a fractional answer to this part.

Answers: **(a)** $\frac{80}{400}$ **(b)** 200

Question 13

(a) Some candidates were able to calculate the frequency densities correctly. Common misconceptions were to divide by 270 (the total number of children rather than the group widths), to multiply by the group widths, or to divide by the midpoint of the group. Some candidates did not notice that the group widths for the final two groups were different and divided by 100 each time.

(b) Some candidates used proportion to find the number of children in the $200 \leqslant d < 500$ group who could swim more than 400 metres and added this to the 50 children in the final group to reach the correct answer. Many candidates did not know how to calculate the estimate and answers of 60, 80 and 110 were common.

Answers: **(a)** 1.1, 0.5, 0.2, 0.1 **(b)** 70

Question 14

(a) Many candidates knew the formula for the sum of the angles in a polygon and applied it correctly to reach the correct answer. Some candidates divided the answer by 22 to find the size of the angle in a regular 22–sided polygon. Common errors were to find 22 × 180 or (22 – 1) × 180.

(b) Many candidates used the sum of the angles from the previous part correctly to find the size of the angle required. Common errors were to use a value other than their answer to part **(a)**, often 360°, in their equation or to include only one angle of 170°. Some candidates did not read the question carefully and found the size of the internal angle of a regular 20–sided polygon.

Answers: **(a)** 3600 **(b)** 163

Question 15

(a) This question was found to be a challenge for many candidates. Even those who understood the rules for matrix multiplication found it difficult to apply them to matrices of these orders. Candidates who found the correct answer often gave it as a number rather than including the matrix brackets. Arithmetic errors were common, particularly relating to the negative values in the second product, although one of the values 76 or 70 was often calculated correctly. A common error was to multiply elements incorrectly leading to the answer $\begin{pmatrix} 56 \\ 50 \end{pmatrix}$ or $\begin{pmatrix} 56 & 50 \end{pmatrix}$. In a small number of cases a 2 by 2 matrix was produced as the answer.

(b) Some candidates were able to interpret the matrix in part **(a)** as the difference between profits in the two weeks and good explanations included the key words "difference", "profit" or "money" and "weeks". A common misinterpretation was that the matrix represented the total profit, but most did identify that it related to weeks rather than types of tea.

Answers: **(a)** (6) **(b)** Correct explanation

Question 16

(a) The cumulative frequency curve was usually completed correctly with very few points plotted incorrectly.

(b) (i) Most candidates were able to read the median correctly from the cumulative frequency curve, although some misread the horizontal scale.

(ii) Most candidates were able to read the lower quartile correctly from the cumulative frequency curve, although similar misreading of the scale occurred.

(iii) This part was also well answered by many candidates. Some read the value 125 correctly from the graph but did not then subtract this from 200 to reach the correct answer. In a few cases, candidates subtracted from 150 rather than 200. Again, some candidates misread the scale and values such as 115 and 120 were common errors.

Answers: **(a)** Correct curve **(b)(i)** 1.7 **(ii)** 1.3 **(iii)** 75

Question 17

(a) Most candidates realised that two further triangles were needed to complete the net, but the sizes of these triangles were often incorrect. Common errors were to reflect the two correct triangles, to draw a triangle of height 5 cm on the top of the net and one of height 4 cm on the right of the net, to draw two triangles with height 4 cm or to include an isosceles triangle on the right. These errors demonstrated that candidates had not considered how the edges of the net would join when folded to make the pyramid.

(b) This part was well answered by the minority of candidates. Those who attempted to sum the areas of the faces often did not include all four triangles or omitted the area of the base. Many candidates showed working, so they gained credit for finding a correct area of one of the triangles. A common error was to give an answer of 33, which is the sum of the area of the square and four triangles of base 3 cm and height 4 cm. Some attempted to find the volume rather than the surface area.

Answers: **(a)** Correct net **(b)** 36

Question 18

In this question, candidates who drew all five lines correctly often shaded the correct region. In some cases, they identified the wrong side of the line $x + y = 10$ and shaded the small triangle. Some candidates mixed up the x and y values when drawing the horizontal and vertical lines. Others could not understand the double inequalities and drew the line $x = 5$, the midpoint of the inequality $2 \leqslant x \leqslant 8$, for example, rather than the lines $x = 2$ and $x = 8$. Candidates should ensure that they draw their lines as accurately as possible; some clear attempts at $x + y = 10$ were seen that crossed the axis several millimetres from the correct point.

Answers: Correct region shaded

Question 19

(a) Most candidates used ruler and a pair of compasses to produce an accurate perpendicular bisector. A small proportion drew a line that was too short; it is good practice in a question of this type to ensure that the bisector reaches the whole way across the triangle.

(b) (i) In most cases, a correct arc was drawn that met sides *AC* and *BC* of the triangle.

(ii) Many candidates identified that an angle bisector was required in this part and used ruler and a pair of compasses to construct an accurate bisector. Some bisectors were drawn from vertex *B* or *C* rather than from *A*. Again, it is good practice to ensure that the bisector reaches the whole way across the triangle.

(c) Many candidates had difficulty understanding what was required in this part. Those who realised that they had to show the points where the perpendicular bisector intersected the arc and the angle bisector often did not identify the points clearly enough. A label alone does not always make the point sufficiently clear, especially when the intersections of construction arcs are close to the required points; adding a dot or a cross at the correct point is recommended. Some candidates identified regions rather than points and often vertex *A* was used as one of the points.

Answers: **(a)** Correct perpendicular bisector **(b)(i)** Correct arc **(ii)** Correct angle bisector **(c)** P_1 and P_2 marked correctly

Question 20

(a) (i) This part was well answered by many candidates. The most common error was to give the answer as 14×10^{10}, which had not been converted to standard form as required.

(ii) This part was found to be very challenging for many. Although candidates generally started by writing $\frac{1}{2\times10^{8}}$, very few were able to convert this to standard form. Some candidates wrote this as 0.5×10^{-8}, but then left the answer in this form or converted it incorrectly to 0.5×10^{-7}, for example. Other common incorrect answers were 2×10^{-8}, 0.5×10^{8} and 5×10^{8}.

(b) This problem-solving question was a challenge to most candidates. Many realised that the product *MN* needed to have a power of 3, but the most common answer was 4 because the 10^8 term was not considered. A few candidates identified that the next cube number would be 1×10^{9} so gave the correct answer of 5. It was common to see the answer 40 which resulted from considering the two terms separately to reach the cube number 8×10^{9}.

Answers: **(a)(i)** 1.4×10^{11} **(ii)** 5×10^{-9} **(b)** 5

Question 21

(a) Most candidates recognised the pattern in the sequence and evaluated the fifth term correctly.

(b) Many candidates were able to compare the expression given with the four terms of the sequence shown and write down the values of *p* and *q*. Some candidates reversed the two values and others did a lot of unnecessary working which did not always lead to a correct answer. In some cases, algebraic answers in terms of *p* and *q* were given.

(c) In this part, candidates were expected to substitute their values of *p* and *q* from the previous part into the expression for u_n, then expand and simplify this. They could then compare the coefficients and write down the values of *A*, *B* and *C*. Those candidates who used this approach were usually successful, although, in some cases, errors in expansion or simplification were seen. Many candidates, however, started from the numerical sequence 7, 17, 31, 49 and attempted to find an expression for the *n*th term of this sequence. This approach was complex and rarely successful.

Answers: **(a)** 71 **(b)** $p = 2$, $q = 1$ **(c)** $A = 2$, $B = 4$, $C = 1$

Question 22

(a) Most candidates identified that they needed to use the fact that the angle at the centre is twice the angle at the circumference and reached the correct answer.

(b) Candidates who recognised the cyclic quadrilateral and used the fact that angles in opposite segments are supplementary usually gave the correct answer. Some subtracted 106°, the angle at the centre, from 180° and others thought that angle *x* was equal to angle *y* so gave the answer 106°.

(c) This part relied on knowing that tangents from an external point are equal and hence the triangle is isosceles. Candidates who used this fact usually gave the correct answer. Common errors were giving the answer 53°, from the assumption that angle *z* was an alternate angle with angle *DAB* or the answer 62°, from the assumption that angle *z* was equal to angle *ATB*.

(d) Many candidates used the fact that a tangent is perpendicular to the radius to reach the correct answer in this part. Those who had an incorrect answer in the previous part often used their answer correctly in this part and were given credit.

Answers: **(a)** 106 **(b)** 127 **(c)** 59 **(d)** 31

Question 23

(a) The majority of candidates attempted the correct process in this question, but arithmetic errors were common due to the number of negative values involved. A common error was to calculate $2\mathbf{A}-\mathbf{B}$ rather than $\mathbf{B}-2\mathbf{A}$. A small number of candidates multiplied the two matrices or thought that they needed to find the inverse of matrix **A**.

(b) This question was found to be challenging by many candidates. Many realised that the inverse matrix was needed and started the process of finding it correctly. There were often arithmetic errors in finding the determinant, with –2 or 6 commonly seen. Having found the correct inverse matrix some candidates did not realise that this was the correct answer. They then did further work, such as multiplying by the identity matrix, which did not always lead to the correct answer, or adding or subtracting the identity matrix. Some candidates attempted to divide each element in the identity matrix by the corresponding element in matrix **A**.

Answers: **(a)** $\begin{pmatrix} -2 & -1 \\ -4 & -2 \end{pmatrix}$ **(b)** $\frac{1}{2}\begin{pmatrix} 0 & 1 \\ -2 & 4 \end{pmatrix}$

Question 24

(a) Most candidates correctly identified the scale factor as 2.

(b) This was not a straightforward enlargement question which made it challenging for candidates. Although many identified the centre of enlargement (10, –4) on the diagram, they did not always know how to use this to find the correct position for *C*. Candidates who answered correctly usually drew rays from (10, –4) to the vertices of triangle *B* which could be used to identify the correct position for triangle *C*. It was common to see a correctly sized triangle *C* positioned incorrectly, often with a vertex at (10, –4) or positioned within triangle *B*.

(c) When the correct triangle had been drawn in part **(b)**, the vector in this part was generally correct. Some candidates did not realise that a vector was required for a translation and gave a 2 by 2 matrix as their answer.

Answers: **(a)** 2 **(b)** Correct triangle **(c)** $\begin{pmatrix} 5 \\ -1 \end{pmatrix}$

Question 25

(a) Most candidates knew that they needed to find the gradient of the last part of the graph for the deceleration and many correct answers were seen. Some gave the answer $-\frac{u}{10}$ and some did not simplify the answer as the question required, leaving their answer as $\frac{u-0}{10}$ or $\frac{0-u}{10}$.

(b) Candidates who recognised that $t = 55$ was halfway between $t = 50$ and $t = 60$ and so the speed would be halfway between u and 0 reached the correct answer directly. It was common to see answers such as $\frac{55u}{10}$, $\frac{55u}{50}$ or $\frac{u}{55}$ which resulted from attempts to use 55 in the working.

(c) Many candidates answered this part correctly. Correct methods were often seen, usually summing the area of the rectangle and the triangle and some using the area of a trapezium. Part marks could usually be awarded if simplification errors led to an incorrect answer. Some candidates felt that a numerical answer was required and so they tried to substitute a value for u.

Answers: **(a)** $\frac{u}{10}$ **(b)** $\frac{u}{2}$ **(c)** $55u$

MATHEMATICS D

Paper 4024/21
Paper 21

Key messages

Candidates who performed well demonstrated a good understanding of a question's requirements. In particular, where numerical accuracy was required, they worked with sufficient figures throughout the calculation so that their final answer could be given accurately to 3 significant figures. Candidates are advised to read the question at least twice, to ensure that they are answering the question being asked of them. This was particularly crucial in the question on direct proportion, where some candidates did not answer the question asked of them.

General comments

The method for solving a linear equation in one variable was well understood, as was the method of solving two simultaneous linear equations in two unknowns. Candidates' work involving the use of a ruler and a pair of compasses to construct a triangle was very good and many accurate results were seen. Also, the plotting of points and the drawing of a smooth curve through them was of a high standard. It was commendable that so many candidates recognised the need to employ the cosine rule in the question involving bearings. Particular areas where candidates can improve upon their responses include work on sequences, upper and lower bounds, congruency and equations of lines and perpendicular lines.

Comments on specific questions

Section A

Question 1

(a) This part was answered well by most candidates with many correct answers seen.

(b) (i) This part was answered well by few candidates. Many failed to include the values, 5, 7 and 11 anywhere in their Venn diagram. Others used some elements in more than one sub-set.

(ii) This part was answered well by some candidates. The common error seen here was the failure to count '4' as being in the required sub-set. So the answer of 3 was often seen as the number of elements. Some candidates listed the elements instead of giving the number of elements.

(iii) Many incorrect answers were seen here. Again, some candidates confused finding the number of elements in a sub-set with the numerical value of the element in that sub-set. It was common to see 3 as the answer and not 1, which was required.

(iv) Some candidates confused 'no elements' with the null set and gave this as their answer. An acceptable, follow through answer from a candidate's previous response was occasionally seen.

(c) (i) This part was answered very well by the majority of candidates. If not gaining full marks, candidates generally showed enough understanding of either the 'factor tree' or of the 'ladder' approach to be rewarded for the method.

(ii) Candidates need to understand that the indices of a square number have to be all even powers. The connection between this part question and the previous part was not recognised by a large proportion of candidates.

Answers: **(a)** (P ∪ Q)′ or P′∩ Q′ **(b)(ii)** 4 **(iii)** 1 **(iv)** A′ ∩ B ∩ C **(c)(i)** $2^2 \times 3^3 \times 5$ **(ii)** $2 \times 3^2 \times 5$

Question 2

(a) Candidates are advised to make sure that they are using the correct method for compound interest and not use the method for simple interest. Unfortunately, there were a number of candidates who chose to use the latter method here. Some candidates who did use the correct formula to calculate the amount were only partly successful because they did not then subtract the original $2000 to arrive at the total interest paid.

(b) Those candidates who realised that the amount paid back represented 108% of the original loan usually went on to obtain the correct answer of $600. Nearly all candidates did obtain the $648, but some then found 8% of this amount and subtracted this answer from $648 to give $596.16.

Answers: **(a)** 109.95 or 109.96 **(b)** 600

Question 3

(a) Many candidates earned full marks for this question. Candidates who made errors did so by either failing to expand the brackets correctly (eg 4p – 3) or they did not correctly collect the terms together.

(b) Candidates showed a good understanding of the methods for solving simultaneous equations and many were successful in answering this part question. The majority chose to equate the coefficients as the method, whilst a small number chose an alternate method of rearranging one equation to make x or y the subject and then substituting into the other equation. Candidates who successfully used the first method were aware, when either adding or subtracting the terms, of the signs involved. This was where some candidates made errors.

(c) Many candidates gained full credit for this part question. Candidates largely knew how to factorise the numerator, but some could not find the correct two factors of the denominator. Instead, it was often seen as $(2m + 3)(m - 1)$.

(d) Candidates need to read this kind of question at least twice, in order to be certain that they are answering the question being asked of them. Many candidates used indirectly proportional to a^3 or used directly proportional to $\sqrt[3]{a}$ or $\sqrt{a}$. Of those candidates who did answer the question correctly, there was a high percentage of fully correct answers seen. Others did obtain the correct equation of proportionality $b = ka^3$ and even reached $4 = k.2^3$ only to then become confused in further working e.g. $b = 2(5)^3 = 250$

Answers: **(a)** 9.5 oe **(b)** $x = 1$, $y = -3$ **(c)** $m/(2m - 1)$ **(d)** 62.5 oe

Question 4

(a) This question was answered well by the vast majority of candidates. Only a small percentage of candidates failed to give the answer in its lowest terms and left it as $\frac{2}{12}$.

(b) Candidates who were not completely successful here usually made the error of adding the 3 correct probabilities instead of multiplying them. Alternatively, some misunderstood the question and thought that the tiles were being replaced each time, so $\frac{1}{12} \times \frac{1}{12} \times \frac{2}{12}$ was often seen.

(c) (i) The majority of candidates successfully completed the probability tree. Other candidates should remember that the probabilities on a pair of branches must total to 1. Also, if a candidate gives the probabilities as decimals, then they must be given correct to 3 significant figures.

(ii) Again, many candidates were successful and multiplied the correct probabilities together. A small percentage however, incorrectly chose to add them instead.

(iii) The two routes that led to the correct answer were identified by the majority of candidates. However, there were some candidates who only gave the one route, usually $\frac{4}{12} \times \frac{8}{11}$, or they confused the operations, giving $\left(\frac{4}{12} + \frac{8}{11}\right) \times \left(\frac{8}{12} + \frac{4}{11}\right)$.

Answers: **(a)** $\frac{1}{6}$ **(b)** $\frac{1}{660}$ **(c)(i)** $\frac{8}{12}$, $\frac{8}{11}$, $\frac{4}{11}$, $\frac{7}{11}$ **(ii)** $\frac{1}{11}$ **(iii)** $\frac{16}{33}$

Question 5

(a) (i) This question was answered well by many candidates. If not completely successful, then most candidates did realise that the difference between each term was a constant (+6) and that the sequence was based on the 6 times table, with 6*n* often seen.

(ii) Candidates generally need to give fuller explanations when answering this type of question. For example, it is not sufficient to say that '251 is not a multiple of 6', or, that '256 is not divisible by 6'. In the last example, it would be correct to say that '256 is not exactly divisible by 6'. It would also be correct to state that *n* is not an integer as well as showing that this is the case by solving the relevant equation.

(b) (i) Candidates needed to recognise that, because they had to work out a second set of differences between terms before the difference became constant, the formula was based on p^2. This did not seem to be fully understood by many candidates.

(ii) Similarly in this part, the second difference would be a constant (+2) and the sequence would be based on p^2 + … . This again was not fully understood by the majority of candidates.

(c) (i) There were many correct drawings seen.

(ii) This part was answered well by the majority of candidates.

(iii) As with the previous parts that required the second difference between terms to be calculated, this was shown to be not fully understood by many candidates.

Answers: **(a)(i)** $6n - 5$ (ii) Correct explanation given **(b)(i)** $p^2 - 3$ **(ii)** $p^2 + 2p + 4$ **(c)(i)** Correct drawing **(ii)** 28, 40 **(iii)** $t^2 + 3t$

Question 6

(a) (i) Many correct, accurate constructions were seen. Only a few candidates did not show any arcs, which was a requirement of the construction.

(ii) The majority of candidates measured the correct, acute angle, angle *BAC*. However, a small number incorrectly measured the obtuse angle at point *A*.

(b) Candidates can improve on their understanding of stating dimensions to the relevant degree of accuracy. Some of the incorrect answers seen were 220 × 350, 224 × 354, 215 × 345 and 220.5 × 350.5.

(c) (i) This question was well answered by the majority of candidates, with both the correct angle and the correct reason being given. Also, there was only a small number of candidates who incorrectly gave 'Z angles' for the reason and not alternate angles, as was required.

(ii) There were many correct answers seen.

(iii) Candidates were nearly always successful in identifying the pairs of equal angles in two triangles. However, they need to better understand the difference between triangles being similar and triangles being congruent. Many candidates thought that proving the triangles had 3 pairs of equal angles was sufficient for proving them congruent. Only a small percentage of candidates identified that there was a common side as well and went on to correctly give the reason of congruency, AAS as required.

Answers: **(a)(i)** Correct construction **(ii)** 77° to 81° **(b)** 79 875 **(c)(i)** 66°, alternate angles **(ii)** 79° (iii) *RQT, RTQ, QT* is common, AAS

Question 7

(a) Candidates needed to show, in more detail, how the areas of the individual rectangles were obtained. A good response showed that the total was made up from $15+2(3x)+2\left(3\left(\frac{15}{x}\right)\right)$.

(b) Some candidates knew that they had to equate $65=15+6x+\frac{90}{x}$ and then perform the necessary algebraic manipulation to arrive at the required quadratic equation. From there, many went on to successfully solve the equation and gave the answer correct to the required 2 decimal places. Only a few gave 2.6 and 5.7 as their answers, perhaps confusing significant figures and decimal places.

(c) (i) Most candidates arrived at the correct answer here.

(ii) The accurate plotting of points, and then joining them with a smooth curve, was generally of a high standard.

(iii) Candidates were asked to obtain their answers from their graph and most did so. However, some candidates did correctly read from the graph one of the required values, more often the lower value (2.3 to 2.4). They then went on to perform the calculation 68 ÷ 2.3 = 29.56 and gave this as the other value.

Answers: **(b)** 5.70 or 2.63 **(c)(i)** 74.25 **(ii)** Correct curve given **(iii)** 2.3 to 2.4 and 6.5 to 6.6

Question 8

(a) Candidates are advised generally to improve upon their recognition of matrix transformations. In this case, the matrix needed to produce a rotation of 90°, anticlockwise about the origin.

(b) Many candidates drew the required triangle.

(c) A good percentage of candidates gave a full, correct description, of reflection in the line *y* = *x*. Some were only partly successful, mentioning that it was a reflection, but then giving the wrong line of symmetry *y* = – *x*, or saying that the rotation was centred about the origin. Others incorrectly thought that it was a rotation.

(d) Candidates should be reminded that in a vector translation, the figure retains its original orientation in relation to both the *x* and *y* axes but that it is not rotated. Completely correct translations were only rarely seen.

Answers: **(a)** $\begin{pmatrix} 0 & -1 \\ 1 & 0 \end{pmatrix}$ **(b)** Vertices at (2, –3), (4, –3), (2, –4) **(c)** Reflection in *y* = *x* **(d)** Rectangle at (–1, 5), (–1, 6), (2, 6), (2, 5)

Question 9

(a) Those candidates who worked through the method with sufficient figures were generally successful in giving the required answer correct to 3 significant figures. However, there were a substantial number of candidates who truncated or approximated values too soon in their working, so lost the accuracy when it came to the final answer. Candidates need to ensure that they use the correct formulae; for example $2\pi r$ was incorrectly used quite often, instead of πr^2, when finding the area of the sector.

(b) (i) Only a very small number of candidates realised that the solution lay in showing that the height of the prism was less than 1.5 cm and that this was achieved from the calculation h = 8 – 8 cos 35. The vast majority of candidates attempted to show that the volume of the prism was less than the volume of the box, so that the prism would fit inside the box.

(ii) Many candidates achieved the correct answer.

Answers: **(a)** 9.025 to 9.03 **(b)(i)** 1.45 or 1.446 to 1.447 so Yes **(ii)** 192

Question 10

(a) This question was answered well by many candidates but some incorrectly used $t = s/d$ to evaluate the time taken as being 1.25 hours, thus leading to an incorrect answer.

(b) The cosine rule proved to be well understood by the majority of candidates and there were many correct answers seen. Some candidates attempted to use Pythagoras' Theorem, even though triangle *ABC* was not a right-angled triangle.

(c) Many candidates correctly identified that they needed to use the (inverse) tan ratio to obtain the the angle of elevation. However, there were candidates who did not convert 105m and 2 km to a common unit before proceeding with the calculation. Some calculated the angle of elevation correctly but then subtracted this from 90° to give their final answer showing that they misunderstood what the angle of elevation meant.

Answers: **(a)** 11 13 **(b)** 13.7[0] **(c)** 3.0[0] to 3.01

Question 11

(a) Few candidates answered this question correctly. Whilst there were many who correctly drew the line $x = 1$ this was all that some attempted. If candidates did attempt to draw the other line needed, then the lines $y = 5$ and $x = 5$ were quite often drawn in error. There were some candidates who were completely successful and indicated correctly, with appropriate shading, the required region.

(b) (i) Many candidates recognised the need to use Pythagoras' Theorem here. They knew that the height of the triangle was represented by the difference in the *y* values of the points *A* and *B*, whilst the base of the triangle was represented by the difference in the *x* values of the two points. A small number of candidates then made the error of subtracting the squares of the two adjacent sides, rather than adding them, when it came to using Pythagoras' Theorem to obtain the length of *AB*.

(ii) There were many candidates who found the midpoint of *AB* correctly. Some candidates knew how to calculate the gradient of the line *AB* as $\frac{1}{3}$, but then they used this value in trying to find the equation of the perpendicular line passing through (2, 4).

Answers: **(a)** Correct region indicated **(b)(i)** 6.32 **(ii)** $y = -3x + 10$

MATHEMATICS D

Paper 4024/22
Paper 22

Key messages

On calculator papers, candidates should be encouraged to use their calculators efficiently to obtain accurate answers and be discouraged from rounding answers to 3 significant figures and then using these values in further working. A considerable amount of overwriting in ink of pencil work was seen; this makes some of the answers unclear.

General comments

Overall, candidates had enough time to answer the questions on the paper, with the majority of candidates making some attempt at all questions. The only question where there were a considerable number of blank answer spaces was **Question 8**. **Questions 1d, 4c, 5(b)(ii), 6(e)(ii), 8, 9, 10(c)(d)(e)** proved challenging for many candidates.

Comments on specific questions

Question 1

(a) Some candidates were able to correctly calculate the hourly rate. However, there were a number of aspects that candidates found difficult. Some were not able to accurately calculate the number of hours worked each day, with common wrong lengths of time worked being $7\frac{1}{2}$ hours or 8 hours. Some only calculated either the morning or afternoon hours, while others calculated it correctly but used 7.45 hours for the length of time. A number of candidates based their calculation on working 24 hours each day.

(b) Many candidates correctly interpreted this question as a reverse percentage calculation and appreciated that \$231 was 84% of the original amount. The most common wrong answer was \$267.96, obtained by increasing \$231 by 16%. Answers of \$194.04 were also seen when candidates calculated 84% of \$231.

(c) The correct method was applied by a large majority of candidates, most converting from one currency to another competently. This resulted in values such as \$259.09 or \$259.1 or \$260 being seen regularly. Many failed to round their answer to the nearest dollar as required. Often those who obtained an answer of \$260 did not show the method used of dividing 114 by 0.44. A significant number obtained the value 114 and then misread this value and calculated 144 divided by 0.44, the outcome being an answer of \$327.

(d) This was a challenging question for many candidates and was rarely fully correct. More candidates found the correct value for Account B than for Account A. Those who used the correct method for Account A often rounded too much at each stage of the calculation resulting in an incorrect total for the account at the end of three years. A much larger number calculated with \$3000 throughout, despite the question saying that the interest was added to the previous end of year total. Some added the interest rates and calculated 3.7% of \$3000, while others multiplied each year's interest by 3 or by the year number. Many used the correct compound interest formula to work out Account B. Some chose to work out the interest in stages but usually reached a correct value. The most common error with this account was to calculate simple interest. Some candidates who correctly worked out the values in the accounts went on to find the difference rather than the amount in the account that gives her more money.

Answer: **(a)** 17.60 **(b)** 275 **(c)** 259 **(d)** Account B and \$3118.53

Question 2

(a) The majority of candidates knew how to draw a frequency polygon. Errors included not plotting the points to the required degree of accuracy, using freehand lines and drawing a bar chart instead of, or as well as, the frequency polygon.

(b) This was a testing problem for many of the candidates which led to the finding of q before p using the mean. Some who were able to find q then wrote $p = 0$ as they did not use the total frequency to find p. Other candidates were able to work out the total number of movies watched but were unable to use this correctly in relation to the given mean. A common error for those attempting to find the total number of movies was to think $p \times 0 = p$. There were many candidates who made no progress with this question while others made no attempt.

(c) (i) This question was generally answered accurately with the angles correctly calculated and the pie chart drawn accurately. A few candidates did not label the sectors while others drew freehand lines for the sectors.

(ii) This was answered well by many candidates with the fractions being correctly added. Occasionally the probability of horror or the probability of drama was given. A common misunderstanding was to multiply the fractions resulting in an answer of $\frac{3}{100}$.

(iii) Many candidates obtained the correct probability. However, mistakes included adding the correct probabilities, thinking the two probabilities were $\frac{15}{60}$ and $\frac{14}{60}$ or $\frac{15}{60}$ and $\frac{15}{59}$ and either multiplying or adding these.

Answer: **(a)** Correct frequency polygon **(b)** $p = 8$ $q = 9$ **(c)(i)** Correct, labelled pie chart **(ii)** $\frac{7}{20}$ **(iii)** $\frac{7}{118}$

Question 3

(a) The majority of candidates were able to answer this correctly. Mistakes included errors when multiplying out the brackets and loss of the negative sign either when collecting the constant term or when dividing. Some candidates arrived at the answer –1.8 in the working and then wrote 1.8 on the answer line, making it unclear as to their intended answer.

(b) Generally, this part of the question was attempted by most candidates who demonstrated an understanding of the method for solving simultaneous equations. Some candidates had arithmetic slips in their working when multiplying an equation by a constant, when adding or subtracting the equations or when rearranging them. The candidates who chose to use the substitution method usually had more success when they rearranged the second equation.

(c) Candidates found this part of the question the most challenging. Understanding of the need to factorise was seen in many answers but some were only able to factorise either the numerator or the denominator. There were candidates who factorised both correctly but forgot that 'simplifying' should entail cancelling following factorisation. Common errors included factorising the numerator as $(v - 8)(v + 8)$ or the denominator as $(v - 8)(v + 1.5)$. Weaker candidates did not attempt any factorisation but simply cancelled v^2 and v throughout.

Answer: **(a)** –1.8 **(b)** $x = 2.5$, $y = -6$ **(c)** $\frac{v}{2v+3}$

Question 4

(a) (i) Fully correct solutions were in the minority with the most common error being the omission of the elements outside of A and B. Some candidates repeated numbers, usually including 1 as a prime number.

(ii) There appeared to be some confusion over factors and multiples with factors of 18 often being given as the answer. Those who appreciated the meaning of factor gave the answer 36, or a multiple of it (for example 72, 216 or 279936).

(iii) Most candidates appeared familiar with the notation, giving the correct answer from their Venn diagram. Common incorrect responses included listing the elements in sets *A* and *B* or giving 2 or 3 as their answer.

(iv) Identifying correctly the six elements in the required set was frequently seen. Errors included the omission of 1 or the inclusion of 2 and 3.

(b) The vast majority of candidates understood the need to use prime factors, with almost all using the ladder method. Some used a double ladder but this tended to produce more errors than separate ladders. Some correctly obtained the elements 2, 2, 5, 7, 11 but did not use these to give the correct value for the lowest common multiple. The most common error was to state the highest common factor of 70 as the answer.

(c) Sighting of the correct answer in this part was rare. Most candidates did not see the connection with the previous part and, as a consequence, prime factors were rarely used. Many attempted to find the area of the field and square root the answer, some carried out random calculations on the dimensions and others attempted to draw a rectangle and subdivide it. Some candidates found a possible side length for the squares but not the largest possible length.

Answer: **(a)(i)** Correct Venn diagram **(ii)** 36 **(iii)** 13 **(iv)** 1,4,6,9,12,18 **(b)** 1540 **(c)** 18

Question 5

(a) (i) Many candidates correctly worked out the arc length. Some candidates did not follow the instructions on the front of the paper directing them to use π as the calculator value or 3.142. Some candidates attempted to work with a sector but used the wrong formula and calculated πr, while others calculated πr^2. There were also those who did not understand the word ‘arc’ and calculated the length of the chord *AB*.

(ii) The most direct method for finding the shortest distance was used by the majority of candidates, however some truncated their calculator answer rather than rounding, it resulting in an inaccurate value of length. Those who chose to use a less direct route (such as trigonometry, Pythagoras’ Theorem or involving the area of a triangle) sometimes lost the accuracy of the final answer due to premature approximation. Some candidates had difficulty identifying the line they were required to find.

(b) (i) Candidates were normally able to substitute the given values into the correct formula to try and find the value of *r*. Many candidates did not appreciate that if attempting to show a value correct to 1 decimal place then it is necessary to calculate the value to more than 1 decimal place and show that it rounds to the given value. Some candidates used the wrong approach and substituted the values of *r* and *h* and showed that the volume was 115, correct to the nearest whole number.

(ii) This question was challenging to many as they did not realise the need to calculate the slant height. Many used the perpendicular height. Some who realised the need to use Pythagoras’ Theorem did so incorrectly. Of those who used the correct method for calculating the curved surface area, not all reached an accurate value as premature approximation was used for the slant height often resulting in answers of 107.88 or 107.9. Occasionally candidates calculated the total surface area of the cone.

Answer: **(a)(i)** 25.7 **(ii)** 4.30 **(b)(i)** Correctly shown **(ii)** 108

Question 6

(a) Very many candidates did not get the first value correct, by using their calculator wrongly, entering -1^2 instead of $(-1)^2$, which gave an answer of 4.5. The symmetry of the curve did not alert them to their error.

(b) The plotting and drawing of the curve using their values was usually good but, with errors seen in the previous part, not all of these were correct curves. The most common error was the misreading of the scale on the *y*-axis resulting in incorrectly plotting $y = -0.5$ and $y = -2.5$. Candidates usually drew smooth curves with very few choosing to join their points with straight lines.

(c) Sight of reasonable attempts to draw a tangent were frequently seen, however many were not always able to calculate the gradient often giving a positive value.

(d) Some candidates used their graphs and were able to complete the inequalities correctly. Others completed the inequalities to describe the range of values where $y \le 0$. It was very common for candidates to use the values –1 and 7 which are the values for the whole range of *x*.

(e) (i) There were a considerable number of incorrect lines, inaccurate lines and occasionally lines that were too short. When asked to draw a line, candidates should draw it to be complete for the whole grid, if plotting points then they should not just use two points that are close to each other as inaccuracies normally result.

(ii) Many candidates attempted this part by finding the intersections and then used simultaneous equations to find the required values. Much time was spent on this and often resulted in very inaccurate answers. Those who equated the two functions were normally able to give the accurate answers, however sometimes there were mistakes seen in their algebra.

Answer: **(a)** 5.5, 5.5 **(b)** Correct curve **(c)** –1.7 to -1.3 **(d)** $x \leqslant 0.6$ to 0.9, $x \geqslant 5.1$ to 5.4 **(e)(i)** Correct line **(ii)** $A = -9$, $B = -4$

Question 7

(a) The majority of candidates understood the need to use the sine rule. This was often set out correctly but a significant number of candidates would evaluate parts of the sine rule and write the values to 2 or 3 significant figures. This often led to inaccuracies in later working as a more accurate value was not used. The question asked candidates to show that an angle was 62.2° correct to one decimal place, but many did not appreciate that they needed to find the angle to a minimum of two decimal places in order to show that it rounds correctly to the required number.

(b) A correct bearing was frequently seen. Mistakes included finding the bearing of *C* from *A* or calculating 90 – 75.8. Occasionally candidates used 62 instead of 62.2 in their calculation.

(c) Correct methods were often seen to calculate *AB*, with the majority choosing to use the sine rule, rather than the cosine rule. Common errors involved using an incorrect angle, often rounded to the nearest degree, or rounding values prematurely leading to a final answer out of range. Some candidates attempted to use Pythagoras' Theorem or simple trigonometry.

Answer: **(a)** Correctly shown **(b)** 017.2° **(c)** 10.6

Question 8

(a) Candidates found it difficult to reason why these triangles were similar with only a minority knowing that equiangular triangles are similar. Some were able to identify one or two pairs of equal angles but not always able to give the correct reason. Alternate angles were often stated as corresponding angles. Some candidates confused properties of parallel lines with circle theorems, identifying *B* and *C* as the same stating they were angles in the same segment. Some candidates introduced incorrect statements about the lengths of lines stating that the parallel ones were equal.

(b) (i) Many wrong answers were seen, usually involving both the vectors **a** and **c**. A common wrong answer involving just **c** was 6**c**.

(ii) Candidates had difficulty obtaining the correct vector, however many partial answers were seen with either 9**a** or 6**c** involved. It was not uncommon to see answers involving constants added or subtracted or not involving just **a** and **c**.

(c) (i) Very few correct answers were seen, with many answers of 2:1 given.

(ii) Some candidates knew that the ratio for the area would involve squaring their previous answer, however their previous answer was not always numeric.

(iii) Correct answers here were rare, with many candidates omitting this part.

Answer: **(a)** Correct proof **(b)(i)** 4**c** **(ii)** 9**a**–6**c** **(c)(i)** 3:2 **(ii)** 9:4 **(iii)** 4:5

Question 9

(a) (i) Many candidates were able to derive a correct expression for the time in minutes. Some gave the time in hours while others thought that they needed to divide by 60 rather than multiply by 60 to convert from hours to minutes.

(ii) Candidates had similar issues with units in this part and again many gave the answer in hours rather than minutes. Further confusion was caused by the speed being 1.5 km/h slower and $1.5 - x$ or $x + 1.5$ was sometimes used.

(iii) Candidates who found correct times in the previous parts were normally able to add these and equate to 110. These candidates were usually able to correctly derive the equation, however some made algebraic slips in their working. Some candidates who found the time in hours previously were able to complete a correct equation by converting 110 minutes to hours. Candidates who used incorrect expressions for time were normally able to obtain the method marks for setting up an equation and attempting to rearrange correctly.

(iv) The majority of the candidates showed their working to obtain the solutions as stated in the question. Several of the candidates did not follow the second requirement which was to give their answers correct to 2 decimal places, with answers of 11.5, 11.6, 0.849 and 0.84 being very common. Errors seen in the working included writing $-b$ as –273, writing b^2 as -273^2 and including only the discriminant as part of the fraction.

(b) Candidates did not appreciate what was required and fully correct answers were in the minority. A wide variety of calculations were seen, some using the distance of 8 km rather than 20 km and others working with the two parts of the run separately with different speeds. Even when the correct calculation was seen, some failed to convert the time in hours to hours and minutes correctly and some did not give their answer correct to the nearest minute.

Answer: **(a)(i)** $\frac{720}{x}$ **(ii)** $\frac{480}{x-1.5}$ **(iii)** Correctly shown **(iv)** 11.56, 0.85 **(b)** 1 hour 59 minutes

Question 10

(a) This part was well answered by many candidates. In a few scripts there were sign errors and occasionally the coordinates were reversed. Other errors included subtraction rather than addition of the coordinates before division by 2.

(b) The gradient was correctly found by almost all candidates, with the occasional candidate inverting the vertical and horizontal changes. There were a few cancellation errors, usually $\frac{3}{6} = \frac{1}{3}$.

(c) Many candidates did not know the relationship between perpendicular lines and their gradients, with some just drawing a diagram and stating that they are perpendicular. The most common route taken by candidates who knew that the product of the two gradients had to be –1 was to find the gradient of *BC* first. They then justified their result by utilising their known gradient of *AB*. Most found the gradient of *BC* using the column vector, but some found the point *C* first which occasionally led to errors. There were those who stopped, having found the gradient of *BC* as –2. Similarly, using the approach of assuming the perpendicular property first, some who showed that the gradient of *BC* needs to be –2 did not go on to show that the gradient of *BC* is $-\frac{8}{4}$ which is –2.

(d) A minority of candidates managed to find the correct coordinates for *D* and the range of incorrect answers was vast. Many candidates clearly did not know what approach to use and the working reflected confused thinking with no real direction. Very few saw that the column vector

$\begin{pmatrix}-4\\-1\end{pmatrix}+\begin{pmatrix}4\\-8\end{pmatrix}$ provided the route from *A* to *D* and resulted in *D* being (0, –9). Some who had found *C* to be (6, –6) successfully applied the vector $\begin{pmatrix}-6\\-3\end{pmatrix}$ to it. A small number found the midpoint of *AC* and used this to find the coordinates of *D*. Some approached the question by finding the equations of intersecting lines, but often they were equations that did not intersect at *D* or their equations contained errors.

(e) Many candidates did not attempt this question, but those who did were often successful in finding the length of *AB* or *BC*. There were occasionally mistakes seen in the calculations or an incorrect use of Pythagoras' Theorem. Despite being told that *ABCD* was a rectangle some candidates still attempted to find four separate lengths, and often these had errors. Premature approximation often resulted in candidates who knew how to calculate the perimeter losing accuracy marks, usually having an answer of 31.2.

Answer: **(a)** (–1, 0.5) **(b)** 0.5 **(c)** Correctly shown **(d)** (0, –9) **(e)** 31.3