MATHEMATICS

Paper 4024/11
Paper 11 (Syllabus D)

Key messages

Questions should be read carefully. Any specific instructions in a question e.g. writing each number correct to 1 significant figure in **Question 7**, should be followed or marks are likely to be withheld.

In this paper it is important that candidates are familiar with the whole syllabus and remember necessary formulae.

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.

General comments

There were many well presented scripts of a good standard. Scripts were seen covering the whole range of marks. Although some candidates did not attempt some of the questions towards the end of the paper most candidates appeared to have sufficient time to complete the paper.

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

Candidates should be encouraged to consider whether or not their answer is sensible e.g. whether or not an angle that appears acute in a diagram is likely to be 140.

Comments on specific questions

Question 1

(a) Having realised that this was a question about the order of operations many candidates went on to make basic arithmetic errors in this part. A common incorrect answer was 6 after $12 - 2 + 4$ was seen.

(b) This was usually well done although a few candidates struggled with the multiplication. Some candidates gave incorrect answers of 45 and 4.5.

Answers: **(a)** 14 **(b)** (0).45

Question 2

(a) This part was well done. Almost all candidates gave the correct answer.

(b) This part was also well done. A few candidates inverted the first fraction rather than the second and some forgot to cancel $\frac{9}{21}$ to $\frac{3}{7}$.

Answers: **(a)** $\frac{1}{24}$ **(b)** $\frac{3}{7}$

Question 3

(a) Many correct answers were seen. A few candidates need to have more practice at tackling questions of this type involving the 24 hour clock. Incorrect answers included 26:25, 14:25 and 0125.

(b) Candidates need to realise the importance of the accuracy given, in this case ‘correct to the nearest 100 km’. Many candidates did appreciate this and gave the correct answer. But others did not and gave answers such as 3195 or 3199.5. A few candidates had little idea of the concept of lower bound.

Answers: **(a)** 02 25 **(b)** 3150

Question 4

Many correct answers were seen. The most common incorrect answer was 370 from 1270 – 900 which is the mass of half the liquid. Also seen was the answer 265 which is the mass of half the bottle. Both these answers achieved partial credit. A few candidates had difficulty converting 1.27 kg into grams**.**

Answer: 530

Question 5

Many candidates found this question demanding. They need to understand that Stella is walking for 5 minutes and that they need to calculate her total number of steps. Many candidates simply added 120 and 80 and divided this by 2 or 5. Some candidates correctly obtained the total number of steps as 4 x 80 + 120 x 1 and then made an error in the arithmetic or divided 440 by 200. They should remember to consider whether or not they have obtained a sensible answer**.**

Answer: 88

Question 6

(a) This was answered well by the majority of candidates. A few did not seem to understand the instruction to put the number into standard form and gave their answer as a number in its normal form. Answers such as 34×10^{-6} and 0.000034 were seen.

(b) The majority of candidates wrote the given numbers in standard form and then gave the given numbers in the correct order.

Answers: **(a)** 3.4×10^{-5} **(b)** 0.42×10^{-5} 33.7×10^{-6} 0.034×10^{-3}

Question 7

Many candidates answered this question correctly taking notice of the instruction within the question. Some need more practice in dividing by decimals e.g. 240 ÷ 0.4. However some candidates ignored the instruction and attempted to work out the given multiplication and division with the complete numbers. A common error was to use 29 rather than 30 in the calculation and $\frac{30 \times 10}{0.4}$ and $\frac{3 \times 8}{0.4}$ were also seen.

Answer: 600

Question 8

(a) Most candidates attempted this part but many incorrect responses were seen. Some attempted to draw a quadrilateral resembling a kite but their attempt was very inaccurate. Many drew either a parallelogram or a trapezium.

(b) This part was slightly better done with many acceptable parallelograms seen. Incorrect responses of a kite or a trapezium were common.

Answers: **(a)** acceptable kite **(b)** acceptable parallelogram

Question 9

This was answered well with many candidates giving both correct inequalities. A few gave $x \le 3$, confusing the x and y axes and some had difficulty finding the equation of the other line and hence gave the wrong inequality.

Answers: $y \le 3$ $y + x \ge 0$

Question 10

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. $5(x - 4)$ or $3y\,(x - 4)$.

Answer: $(x - 4)(3y + 5)$

Question 11

(a) The majority of candidates knew the process involved in finding $f\left(-\frac{3}{4}\right)$ but some need more practice at the arithmetic involved in the calculation. Whilst many obtained the correct answer many made arithmetic errors e.g. $2 \times -\frac{3}{4} - 9 \Rightarrow -\frac{6}{8} - 9 \Rightarrow -9\frac{3}{4}$ or adding 2 and $-\frac{3}{4}$ rather than multiplying them.

(b) This part proved more difficult for most candidates but many good candidates obtained the correct answer. $y = 2x - 9$ was sometimes followed by $x = \frac{y-9}{2}$ while a common incorrect method was to calculate $f(3) = -3$.

Answers: **(a)** $-10\frac{1}{2}$ **(b)** 6

Question 12

(a) This part was accessible to most candidates who obtained a correct answer. A few multiplied 9 by 5 and gave the answer as 45. Some cancelled incorrectly after obtaining $\frac{18}{5}$.

(b) This part proved more challenging as candidates need to understand what happens to the linear scale when area is involved. Some correct answers were seen but common incorrect answers were 10 (from $\frac{4}{2} \times 5$) and 100 (from 10^2).

(c) This part also proved challenging as candidates needed to be confident in changing units. Again some correct answers were seen but the most common incorrect answers were 1: 2.5 (ignoring the different units) and e.g. 1 : 250 000 000 (an error in changing the units).

Answers: **(a)** 3.6 **(b)** 25 **(c)** 1: 250 000

Question 13

This question was answered well by many candidates with correct solutions. Both elimination and substitution methods were seen. In the former the coefficients of x or y were equated correctly but errors occurred when subtracting to eliminate x or y. Thus $15x = 20y$ and $3 + 15x = 18y$ was followed by $3 = 2y$ (a sign error) resulting in $y = \frac{3}{2}$. This was often followed by a correct follow through giving $x = 2$. With the substitution method e.g. $x = \frac{4y}{3}$ was substituted correctly but some candidates forgot to multiply all elements of the resulting equation by 3. A few candidates would benefit from more practice in getting from $2y = -3$ to $y = \frac{-3}{2}$ as we still see $2y = -3$ leading to $y = \frac{-2}{3}$

Answers: $x = -2$, $y = -1.5$

Question 14

Many candidates successfully solved this problem. They needed to realise that the formula given was for a sphere and this question involved a hemi-sphere. Some forgot this but found the volume of the cone correctly obtaining the answer $k = 30$. A few candidates complicated the question by substituting in $\pi = \frac{22}{7}$. A small number of candidates found the area of wood removed rather than the area of wood remaining.

Answer: 12

Question 15

(a) This part was generally well done. Some candidates found $8 = k4^2$ but did not manage to get to the answer 4.5, either because they then made $k = 2$ or because they multiplied 3 by $\frac{1}{2}$ rather than 9 by $\frac{1}{2}$. A few used the wrong relationship and thought that y was proportional to x or inversely proportional to x^2.

(b) About half of the candidates realised that if q is doubled then p is halved. Many doubled p as well obtaining the wrong answer of 30.

Answers: **(a)** 4.5 **(b)** 7.5

Question 16

(a) This part was usually correct although a few arithmetic errors were seen e.g. 180 – 160 = 40.

(b) This part was usually correct too.

(c) This part proved more challenging with less than half the candidates finding $D\hat{Q}R$ correctly. Candidates needed to remember that $C\hat{D}E$ is an interior angle of the polygon and equal to 160° which meant that $P\hat{D}Q$ = 20° and hence $D\hat{Q}R$ = 60°. Some thought that $A\hat{D}E$ = 160° and hence got $D\hat{Q}R$ = 50°. A few candidates omitted this part.

Answers: **(a)** 10° **(b)** 20° **(c)** 60 °

Question 17

(a) Almost always correct.

(b) Many correct answers. Incorrect answers included $n + 2$ and $n - 2$. Some candidates tried to use the formula $a + (n - 1)d$ but they need more practice at this as they had trouble applying it to the given sequence.

(c) Again well done and many correct answers after the correct expression seen in **(b)**. Some arithmetic errors were seen e.g. $2n + 2 = 200$ followed by $2n = 180$. A few candidates found the number of counters in Diagram 200 rather than the Diagram with 200 counters.

Answers: **(a)** 10, 12 **(b)** $2n + 2$ **(c)** 99

Question 18

(a) Some candidates knew that this question was about frequency density but many thought that the diagram was incorrect because the bars were of different width or because the bars did not start at 0. A few were confusing cumulative frequency with frequency density.

(b) Those candidates who gave a correct explanation in **(a)** went on to gain marks in **(b)** – often 3 marks. Of those, some forgot to label the vertical axis as frequency density. Candidates can improve their performance in this topic by additional work in this area which is one with which they have some difficulty. Most candidates had an attempt at **(b)** and repeated the diagram as in **(a)** or drew it and changed the width of the first bar so that it met the vertical axis or made the bars of equal width

Answers: **(a)** Vertical axis should be labelled “frequency density” or heights of bars should be 3, 8, 10, 2 **(b)** Rectangles drawn with the same bases as in **(a)** with heights 3, 8, 10 and 2 and vertical axis labelled frequency density with a suitable scale.

Question 19

Throughout this question candidates should remember to write their answers in the answer space even if they have marked the size of the angle on the diagram.

(a) (b) (c) (d) All parts of this question were well done by the majority of candidates with many achieving full marks

Answers: **(a)** 40° **(b)** 140° **(c)** 50° **(d)** 40°

Question 20

(a) This part was well answered. Occasionally the answer was given as 16.

(b) This part was well answered. Occasionally the answer was given incorrectly as 3 or 7 these being the two pieces of data in the middle column.

(c) This part was more demanding but many correct answers were seen. A few otherwise correct solutions were marred by candidates having difficulty in evaluating 80 ÷ 50. Some candidates omitted to multiply the number of goals scored by the frequency and worked out ∑frequency ÷ 7 or (0 + 1 + 2 + 3 + 4 + 5 + 6) ÷ 7 as their answer.

Answers: **(a)** 0 **(b)** 1 **(c)** 1.6

Question 21

(a) Almost always correct.

(b) (i) This was the more accessible of the three parts to **(b)**. Some candidates would benefit from more work on the laws of indices as those who were confident in these laws were able to do well at this part and **(ii)** and **(iii)**. Quite a lot of candidates worked out the value of M (18) and N (144) and then worked out $M \times N$ (2592) and then proceeded to put this back into index form. This was a lot of hard work and not the best method but several managed to get to the correct answer.

(ii) The division made this part more difficult for some. The method of evaluating M and N was more difficult with the division and few got to the correct answer. Those using the laws of indices sometimes gave the answer $p = 3$ and $q = 1$.

(iii) Many who had correct answers in **(i)** and **(ii)** also had correct answers here showing that they could apply the law of indices.

Answers: **(a)** $2^2 \times 5^3$ **(b)(i)** $p = 5$ and $q = 4$ **(b)(ii)** $p = -3$ and $q = 0$ **(b)(iii)** $p = 8$ and $q = 4$

Question 22

(a) Usually correct. Some candidates gave an angle just out of range or the supplement of the correct angle. There were a few candidates who did not attempt this question so candidates need to be aware that geometrical instruments may be needed when taking this paper.

(b) (i) Usually correct. Candidates should be aware that the question states " construct the locus inside the triangle". A few drew an incomplete arc within the triangle.

(ii) This part proved more challenging. Many candidates drew in the bisector of $A\hat{C}B$ or $C\hat{A}B$ and several did not attempt this part.

(c) Many candidates were able to find point *P*, even when they had not drawn the correct locus in **(b)(ii)**, and gave a correct value for *AP*. Some marked *P* on the arc but it was not 2 cm from *AC* leading to a value of *AP* which was out of range.

Answers: **(a)** 101° to 103° **(b)(i)** Circular arc, centre *B***,** radius 4 cm **(b)(ii)** Line parallel to *AC*, 2 cm away **(b)(iii)** 6.2 to 6.6

Question 23

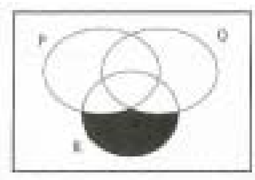
(a) Many candidates shaded the correct area of the Venn diagram. Incorrect answers included the areas for $P \cup Q \cup R$, $P \cap Q \cap R$ or $(Q \cup R) \cap P'$ being shaded.

(b) (i) This part was usually well done. A few candidates confused multiples with factors. Some candidates gave incorrect values e.g. 28, 32 along with the correct value of 24 or forgot the limits on the value of *x.*

(ii) Many candidates were correct in this part. A common incorrect answer was 7 when they had omitted 22 or 33 from $E \cup T$. A few candidates listed all the elements of $E \cup T$ rather than giving n($E \cup T$).

(iii) This part was usually correct.

Answers: **(a)**



(b)(i) 24 **(b)(ii)** 8 **(b)(iii)** 22 or 26 or 30

Question 24

(a) (i) This part was generally well done. A small number of candidates left the expression unprocessed e.g. $\frac{0-20}{0-T}$.

(ii) Few candidates gave the correct answer here. Most gave the incorrect answer 15 which is the speed at $t = \frac{1}{4}T$.

(b) (i) Some good candidates gave the correct answer here. Many forgot that they were using the area of a triangle and used $20T = 150$ obtaining the answer 7.5.

(ii) A few candidates were able to draw the correct distance –time graph. Most had an attempt and Incorrect graphs seen included straight lines drawn from (0,0) or lines or curves starting at (0,150).

Answers: **(a)(i)** $\frac{20}{T}$ **(a)(ii)** 5 **(b)(i)** 15 **(b)(ii)** Curve, concave down, from (0,0) to (*T*,150)

Question 25

Many candidates were not able to make attempts at this question and need to do more work to improve on their understanding and ability to answer questions on this topic.

(a) (i) The majority of candidates who attempted this part answered it correctly. A few gave answers such as **q** – **p** or **p** + **q**.

(ii) Few candidates were able to give the correct vector here. They seemed to be thinking that $\overrightarrow{AB}$ was ***q*** and so thought that $\overrightarrow{AX}$ was $\frac{1}{4}\boldsymbol{q}$. Some candidates would benefit from writing down the route from *B* to *C* and working from that starting point.

(iii) Some correct answers were seen. Often successful answers followed the writing down of a route from *X to Z* and working from that starting point.

(b) A challenging question which was successfully answered by a few candidates who had scored well in **(a)**.

Answers: **(a)(i) p** − **q (a)(ii)** 3**p** − 4**q (a)(iii)** 9**p** − 9**q (b)** 1 : 8

Question 26

Again many candidates felt unable to attempt various parts of this question and would benefit from more in-depth study of probability in order to tackle problems with greater confidence.

(a) (i) Many correct answers were seen.

(ii) This was a challenging part and few correct answers were seen. A white ball was bound to be chosen from Box 1 and candidates needed to realise that the answer depended on the probability of a black ball being chosen from the second box. A typical incorrect answer was $\frac{6}{7}$ from $\frac{1}{2} \times \frac{3}{7}$. Many made no attempt at this part

(b) This part proved more accessible than **(a)(ii)**, although many were still unable to make an attempt. Successful candidates realised that in this part they only needed to consider the second box and several correct answers were seen. Candidates need to read the question thoroughly and realise that in this part they do not need to consider the first box.

(c) Strong candidates were able to correctly answer this part. Some candidates isolated $\frac{1}{2}$ and $\frac{4}{7}$ from the data in the question but had problems using them to work towards the correct answer. Thus $\frac{1}{2} \times \frac{4}{7} = \frac{4}{14}$ was a typical incorrect response.

Answers: **(a)(i)** 0 **(a)(ii)** $\frac{3}{7}$ **(b)** $\frac{2}{7}$ **(c)** $\frac{11}{14}$

MATHEMATICS

Paper 4024/12
Paper 12 (Syllabus D)

Key messages

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

- be familiar with the entire syllabus and remember necessary formulae
- show all of their working out and write their answers clearly on the answer line
- perform basic arithmetic accurately
- give answers in the form required by the question.

General comments

Many candidates demonstrated good understanding of many of the topics covered in the paper. Candidates had time to complete the whole paper and the paper discriminated well between candidates of different abilities. Some questions were accessible to all candidates and others offered challenge to the most able candidates.

Many well-presented scripts were seen with clear, logically set out solutions. Graphs and diagrams were usually neatly drawn using the correct equipment. Candidates should be reminded to state their final answer clearly on the answer line and to ensure that they transcribe the figures correctly. All writing should be done in pen, rather than in pencil which is then overwritten. If an answer needs to be replaced, it is more legible if it is crossed out and replaced rather than overwritten. All figures should be formed clearly: in some cases it was hard to distinguish between 4 and 9 or 8, 5 and 3.

Candidates need to take care with basic arithmetic. A number of marks were lost due to simple errors such as $7 \times 8 = 54$ or writing 18 in place of –18. Candidates should understand that when a fraction is required, it must consist of integer values and that an expression such as $\frac{62.5}{100}$ is not acceptable.

Candidates should read the question carefully and ensure that they give their answer in the required form, for example in terms of π, in standard form, as a fraction, in its simplest form. If a particular form is requested, full credit will not be given for an equivalent answer in a different form.

Many candidates demonstrated good skills in algebraic manipulation. Questions involving probability and statistics were found more challenging and candidates would benefit from more practice in these topics.

Comments on specific questions

Question 1

(a) Many candidates applied the correct order of operations and reached an answer with the digits 69. Some candidates placed the decimal point incorrectly after the multiplication by 0.2 and answers such as 6.9 or 690 were given. Candidates should take care to use the correct place value when adding decimals: in some cases candidates added 2.05 and 1.04 rather than 2.05 and 1.4.

(b) Most candidates subtracted the fractions correctly in this part. When a question involves fractions, the answer is expected as a fraction. Some candidates converted their correct fraction to a decimal, but in many cases this was incorrect or insufficiently accurate. Some poor arithmetic was seen with 20 – 12 leading to 18 rather than 8.

Answer: **(a)** 0.69 **(b)** $\frac{8}{15}$

Question 2

(a) Candidates who sketched a rectangle to assist with their answer were more successful than those who did not draw a sketch. Even with a diagram, many candidates thought that a rectangle had 4 lines of symmetry. It was also common to see rotational symmetry of order 4.

(b) In this part it was clear that some candidates could not distinguish between rotational and line symmetry. In many cases, candidates shaded the four blank squares in the middle columns.

Answer: **(a)** 2, 2

Question 3

(a) Many candidates correctly plotted the point (100, 56). Many then went on to rule a line from this point to the origin to create the correct conversion graph. Common errors were to draw the correct line stopping short of the origin or to draw horizontal and vertical lines from (100, 56) to meet the axes. When plotting a conversion graph, it is only necessary to plot two points and join them with a ruled line. Some candidates did not realise this and calculated a series of values of dollars and pounds and plotted these points: in some cases this led to a correct graph but in many it led to an inaccurate line due to arithmetic errors.

(b) In this part, candidates were expected to use their graph to find the answer. Some correctly read the value at \$64, but some misinterpreted the scale and £38, rather than £36, was a common incorrect answer. Some candidates used the given values to calculate the value as £35.84. A common error was to read the graph at £64 and give an answer of 114 or 115.

Answer: **(b)** 36

Question 4

Many candidates could complete at least two correct values, usually 0.15 and 15%. Many identified the decimal as 0.625 in the bottom row, but could not convert this to a correct fraction: common incorrect fractions were $\frac{25}{4}, \frac{2.5}{4}, \frac{62.5}{100}, \frac{625}{100}$. A fraction is only acceptable if it contains integers rather than decimals. Other common errors were 0.105 for 0.15 and 62.5, 0.62 or 0.63 for 0.625.

Answer: 0.15, 15%, $\frac{5}{8}$ or $\frac{625}{1000}$, 0.625

Question 5

(a) Almost all candidates answered this part correctly.

(b) This part was also well answered. Common incorrect answers were 18 (which may have resulted from miscopying their working), –8, –19 and –23. Drawing a number line to assist with the calculation may have helped candidates to reach the correct answer.

Answer: **(a)** 9 **(b)** –18

Question 6

(a) This was well answered with candidates either using index notation in their answer or writing the product out in full. Some candidates mixed their notation and answers such as $2^3 \times 2^2 \times 3$ were not uncommon. Common errors included an answer of $2^3 \times 3 \times 4$ or miscounting the number of 2s leading to answers such as $2^4 \times 3$. Only a small number of candidates listed factors rather than giving a product.

(b) Many candidates identified that a multiple of 24 was required as the answer, but an answer of 48 was far more common than the correct answer of 72. Some candidates did not understand what was required and gave a factor of 24 as their answer.

Answer: **(a)** $2^5 \times 3$ **(b)** 72

Question 7

(a) In this part, candidates needed to do two stages of calculation which was not appreciated by many. Many calculated the difference in time between Dubai and Mumbai as 4 hours 40 minutes, and in many cases this was given as the answer. It was then necessary to find the difference between this time and the flight duration to find the time difference of 1.5 hours. Many correct answers were given using poor notation, for example 0130 rather than 1 hour 30 minutes.

(b) Candidates who had found the correct time difference in part **(a)** usually found the correct answer in this part. Many candidates added the departure time to the duration without considering the time difference and gave an answer of 1905. Some candidates had difficulty with an addition when the result had more than 60 minutes and 1805 or 2005 were common.

Answer: **(a)** 1.5 hours **(b)** 20 35

Question 8

Many candidates recognised that $y = kx^2$ and reached the correct answer, usually given as either 7.2 or $\frac{36}{5}$. Some stated $20 = 100k$ but then found $k = 5$ rather than $\frac{1}{5}$. Others found the correct value of k, but then did not square 6 when calculating their final answer. Some candidates did not read the question carefully and used $y = kx$, $y = \frac{k}{x}$ or $y = \frac{k}{x^2}$.

Answer: 7.2

Question 9

Candidates who started by identifying that 26 – 15 candidates liked Comedy only were more often successful in this question. If a Venn diagram was then drawn with 11 correctly positioned, the answer was usually correct. Following a correct Venn diagram, the answer was sometimes given as 31 which is the total number who like Action rather than those who like Action only. Some candidates placed 26 in the Comedy only section of the diagram which led to the answer 1. Algebraic methods were usually incorrect, usually equations such as $26 + 15 + 8 + x = 50$ or $26 - 15 + x - 15 + 15 + 8 = 50$.

Answer: 16

Question 10

Many candidates identified that the most straightforward way to solve these equations was to add them to give $10x = 5$ and they then usually reached the correct solutions. Those who tried to first eliminate x were less successful. Many candidates did manage to produce a pair of values that fitted one of the equations, but few of them checked their answers in both equations.

Answer: $x = 0.5$, $y = -2$

Question 11

(a) This part was generally well answered with answers given in a variety of acceptable forms. Common incorrect answers included $\frac{3x^4}{y^3}$ and $\frac{x^4y^3}{3}$.

(b) This part was less well answered. Many candidates could deal with either the fractional index or the negative index, but found the two together too much of a challenge. A common incorrect answer was $\frac{v^2}{4t}$, where candidates had dealt correctly with the powers but had omitted to take the square root of 4. Some candidates squared rather than taking the square root and others took the square root but did not invert the result.

Answer: **(a)** $\frac{x^4}{3y^3}$ **(b)** $\frac{v^2}{2t}$

Question 12

(a) (i) Most candidates constructed a correct arc that reached from *AB* to *AC*.

(ii) Many candidates drew a correct bisector of angle *ACB*, but some of them were too short and did not meet side *AB*. A common error was to draw the bisector of angle *BAC* and a small number of candidates constructed a perpendicular bisector of one or more of the sides.

(b) Candidates who had drawn a correct arc and bisector usually shaded the correct region in their diagram. Many candidates who had drawn a short arc in part **(a)(ii)** shaded the correct region in this part. A small number of candidates who had used arcs in their construction of the angle bisector forgot to shade the small part between *C* and their construction arc.

Question 13

(a) Most candidates ordered the values correctly.

(b) (i) Candidates who squared the terms in the inequality to reach $4 < x < 9$ usually then gave a correct value in this range. Common correct answers were 5 and 6.25 and some candidates listed all four integer values in the range. Stating the inequality alone was not acceptable. Common incorrect answers were 2.5, $\sqrt{5}$, 4 and 9.

(ii) Some candidates identified that the cube of any number in the range $-1 < x < 0$ would be in the required range and –0.5 was a common correct answer. Common incorrect answers were 0, –1, values less than –1 and positive decimal values. Some gave answers such as -0.5^3 which were not accepted. A few candidates confused squaring and cubing and said that there were no possible values of x.

Answer: **(a)** 27^0, $\sqrt[3]{1000}$, 5^2, 2^5 **(b)** value in range $4 < x < 9$ **(c)** value in range $-1 < x < 0$

Question 14

Candidates found this question very challenging. If they had sketched the situation, they would have found it easier to access the problem.

(a) A number of candidates recognised that the *y*-coordinate for each point should be 2. Some candidates also identified that as the line was 10 units long, 5 should be added and subtracted from 1 to give the *x*-coordinates of the two points. Many candidates did not understand the significance of the statement that the gradient of the line was 0. Using this information and sketching a horizontal line with (1, 2) marked in the Centre would have helped candidates to start their solution.

(b) In this part of the question, using the given gradient to sketch the situation simplified the problem. A sketch showing the point (1, 2) with a movement of 4 in the *x*-direction and 3 in the *y*-direction gives a gradient of $\frac{3}{4}$. This sketch then leads directly to the coordinates of *A* and *B*. Many candidates attempted to find the equation of the line, but even if this was found correctly, it seldom led to the correct coordinates. It was also common to see many complex calculations involving Pythagoras' theorem which were also unsuccessful.

Answer: **(a)** (–4, 2), (6, 2) **(b)** (–3, –1), (5, 5)

Question 15

(a) The equations of two of the required lines were given in the question, and those candidates who recognised this usually gave the correct inequalities for these lines. Some candidates gave $y \geq 0$ for the third inequality rather than $x \geq 0$. It should be noted that a dashed line is used to represent a strict inequality, > or <, so in this case, as the lines were solid, ≥ and ≤ were expected. Some candidates rearranged the inequalities to make *y* the subject, which was unnecessary and often led to errors. In some cases the inequality symbols were reversed or replaced by =. Some candidates did not use the given equations and tried to work out the equations of the lines from the graph.

(b) Candidates found this part of the question difficult and there was little evidence that they had used the graph to help with their solution. A common incorrect answer was 2, where candidates had not included the points on the line $y = a$. Other common incorrect answers were 0 and 4.

Answer: **(a)** $x + y \leq 8$, $2y \geq x + 4$, $x \geq 0$ **(b)** 3

Question 16

(a) Many candidates knew that rounding to the nearest 10 meant that they had to subtract 5 from 600 and gave the correct answer. Common incorrect answers were 590, from subtracting 10, and 599.5, from subtracting 0.5.

(b) The key to success in this part was to recognise that, to find the least amount remaining, the maximum mass of the portions of sweets had to be subtracted from the minimum mass of sweets. Those candidates who started by calculating 25.5 × 10 often reached the correct answer, however some subtracted this from 600 rather than 595. The most common answers resulted from subtracting 24.5 × 10 from either 600 or 595. Some candidates only used the bounds at the end of their calculation and incorrect solutions such as 600 – 250 – 0.5 = 349.5 were also common.

Answer: (**a**) 595 **(b)** 340

Question 17

Many candidates started this question by marking some known angles on the diagram which often proved to be a successful strategy. When $\angle CAB$ was identified as 70°, the isosceles triangle of 70°, 55° and 55° was often found which led to 295° as one of the correct values of x. Many candidates did not realise that there were two other possible isosceles triangles with angles 70°, 70° and 40°, leading to the other two values of x. Some candidates through that isosceles triangle meant that all of the angles were 60°. When candidates had not marked angles on the diagram, there were often many calculations in the working space that were difficult to follow.

Answer: 280, 295, 310

Question 18

(a) Many candidates answered this question correctly. A common incorrect answer was –16, although some candidates corrected this to 16 as reference to the diagram showed that v was positive. Other common errors were 48 from 4×12, 32 from 8×4, 2 from $8 \div 4$, and 1 from $4 \div 4$.

(b) Many candidates calculated the distance correctly using their value of v from part **(a)**. Most candidates calculated the area as the sum of a rectangle and a triangle rather than using the formula for the area of a trapezium. Some candidates showed a correct area calculation but made arithmetic errors, often in calculations such as 8×16, or as a result of incorrect cancelling. A common error was to multiply their value of v by 12.

Answer: **(a)** 16 **(b)** 160

Question 19

Some very good answers were produced with two correct pairs of angles stated with clear reasons and the correct pair of sides stated with clear reasons. Some candidates paired up the required sides and angles but did not give reasons for all of their stated pairs. The reason that was most commonly correct was that AO and OB were equal radii. Some candidates confused vertically opposite with alternate angles. Some candidates gave PA and QB as a pair of equal sides with the reason that they were both tangents. It was not uncommon for candidates to be confused between congruence and similarity and to show that three pairs of angles were equal.

Question 20

(a) Many completely correct tree diagrams were seen. The most common error was to repeat $\frac{7}{9}$ rather than write $\frac{8}{9}$ on the second blue branch. Other common errors were denominators of 10 or 8 instead of 9 in the second set of branches.

(b)(i) Many candidates selected the fractions required from the tree diagram and multiplied them correctly to reach their result. Some candidates made errors in simplifying their answer or basic arithmetic errors in their multiplication. A very small proportion of candidates added, rather than multiplied, the fractions.

(ii) In this part, candidates also often selected the required routes through the tree diagram and reached an answer that followed through correctly from their fractions. Again some candidates made arithmetic or cancelling errors. Some candidates only found one of the routes, BW, and did not add the probabilities of BW and WB. A small proportion of candidates confused when they should use the product of probabilities and when they should use the sum.

Answer: **(b)(i)** $\frac{56}{90}$ **(b)(ii)** $\frac{32}{90}$

Question 21

(a) Many candidates identified that the values in the table went up in 2s but were unable to turn this into a correct expression for f(x). If they had related the question to finding the nth term of a sequence, they may have had more success. A common incorrect answer was $x + 2$.

(b) (i) This part was very well answered.

(ii) Most candidates understood how to approach finding the inverse function and many acceptable answers were seen. Others gained 1 mark for rearranging to $2y = 8 - 3x$, but failed to reach the correct answer due to sign errors when dealing with $-3x$. Candidates need to remember to give a final answer in terms of x rather than y for full marks: a final answer of $\frac{8-2y}{3}$ was not uncommon.

Answer: **(a)** $2x + 3$ **(b)(i)** 7 **(b)(ii)** $\frac{8-2x}{3}$

Question 22

(a) Many candidates knew what was meant by standard form and those who read the question carefully then gave the answer to 2 significant figures and gained full credit. An answer of 1.77×10^8 was common, when candidates had not rounded to the required accuracy. Some candidates had the correct figures 18 in their answer but an incorrect index, often 7.

(b) This part was found to be more challenging with fewer correct answers. Common incorrect answers were 0.2, 2, or 20, resulting from attempting to divide the numbers incorrectly.

(c) The most straightforward approach to this problem is to round 1.86×10^6 to 2×10^6 and 3.6×10^7 to 4×10^7 and then to divide which leads directly to the answer 20. Although many candidates realised that an estimate was required, they seldom rounded the values before attempting the division leading to some very difficult arithmetic, which was not the intention of the question. These candidates often did not round their final answer to 1 significant figure as required by the question.

Answer: **(a)** 1.8×10^8 **(b)** 5 **(c)** 20

Question 23

(a) Candidates often knew that they had to divide the frequency by the class width to calculate the frequency density in order to draw the missing bars. Some candidates drew the bar for $30 < t \leqslant 60$ correctly, but did not attempt a bar for $0 < t \leqslant 10$. Having found that the first class width was 10, some used this width in the other calculation and had a height of 1.8 rather than 0.6 for the second bar. Most candidates used the scale correctly.

(b) Candidates who understood the meaning of frequency density usually found the correct answer. Common incorrect answers were 2, from 0.2×10, 0.2 or 6.

(c) Many candidates used their value of m to find the correct fraction in this part. A common error was to use the value of m to reach a correct numerator but to use a denominator of 120 rather than the sum of 138 and their value of m. Some candidates gave the number of candidates who took more than half an hour rather than the fraction of the candidates as required.

Answer: **(b)** 12 **(c)** $\frac{30}{150}$

Question 24

(a) Many candidates correctly quoted the formula for the area of a sector. Some however did not square $3r$ correctly and reached $3r^2$ rather than $9r^2$. Those who squared correctly and equated this area to $8\pi r^2$ usually reached the correct answer. It was common to see candidates equating to 8, rather than $8\pi r^2$, or to multiply the sector area by 8.

(b) The correct formula for arc length was often quoted in this part. Many candidates did not substitute their value of *a* into the formula or used a radius of *r* rather than $3r$. Some candidates reached a correct expression for the arc length but did not add the two radii to reach the required perimeter.

Answer: **(a)** 320 **(b)** $6r + \dfrac{16\pi r}{3}$

Question 25

(a) (i) This part was well answered. Some candidates did not know that they had to substitute $n = 2$ into the given expression to find the 2nd term.

(ii) In this part, candidates often reached the correct answer using a trial and improvement approach. Many candidates formed the equation $p^2 - 5p = 150$ and some rearranged this to $p^2 - 5p - 150 = 0$ and solved it correctly using either factorisation or the quadratic formula. Some did not reject the negative solution and gave both solutions or rejected the positive solution. It was very common for candidates to attempt to solve $p^2 - 5p = 150$ without rearrangement and $p(p - 5) = 150$ followed by $p = 150$ and $p - 5 = 150$ or $p = 0$ and $p = 5$.

(b) Many candidates correctly formed the equation $3 \times 5^2 - 5k = 55$ in this part and often went on to reach the correct solution. Some arithmetic errors were seen, for example incorrect subtraction of 75 and 55 or incorrect division by 5. Common incorrect methods involved substituting 55 for *n* or equating to 0 rather than 55.

Answer: **(a)(i)** –6 **(a)(ii)** 15 **(b)** 4

Question 26

(a) Many candidates recognised that the first step in the rearrangement was to eliminate the fraction and this was often done correctly. Candidates then often attempted to isolate the *p* terms in the formula and reached $pt - p = 4t + 3$, but sign errors were sometimes seen in this step. The more able candidates then went on to complete the correct rearrangement to make *p* the subject. Some candidates did not know how to deal with two terms involving *p* and many errors involving incorrect division or cancelling of terms were seen.

(b) Candidates who factorised both numerator and denominator correctly usually cancelled correctly to reach the correct answer. Incorrect factorisations of the numerator included $(2x - 1)^2$ and $(4x + 1)(4x - 1)$. Incorrect factorisations of the denominator included $(2x + 1)(x + 5)$ and $(2x - 1)(x + 5)$. Some candidates factorised only one of the numerator or denominator and could then progress no further. A small proportion of candidates attempted to cancel individual terms, such as $4x^2$ and $2x^2$ and made no attempt to factorise.

Answer: **(a)** $\dfrac{3 + 4t}{t - 1}$ **(b)** $\dfrac{2x - 1}{x - 5}$

MATHEMATICS

Paper 4024/21
Paper 21 (Syllabus D)

Key messages

Common to a number of candidates, of all abilities, was a tendency to round too early. When working to give a final answer which is correct to 3 significant figures, it is necessary to work with 4 or more figures, throughout any method calculations. Some candidates who were guilty of early approximation, either through rounding or truncating, lost marks as a result. Candidates would do well to heed this advice in future.

General comments

This paper proved to be suitable and accessible to candidates of all abilities. This was evidenced by the wide range of marks that the candidates achieved. These ranged from candidates who achieved the maximum mark possible, to those candidates who only achieved scores in single figures.

Comments on specific questions

Section A

Question 1

(a) By far the most common error seen here, was made by those candidates who found 60% of $12, thus giving answers of $7.20 or $4.80. The correct answer was in short supply here.

(b) There were more correct answers here. Some candidates having correctly found the profit, $5.40, then divided this by $17.40 and not the cost price of $12.

(c) This part proved to be the most successful for most candidates, with many correct answers seen. However, a number of candidates reached 65% and either from a misunderstanding or from forgetfulness, gave this as their final answer rather than 35%.

(d) This part proved most difficult for the vast majority of candidates and fully correct answers were rarely seen . Weaker candidates floundered with the complexity of the working needed. It was a shame that those candidates who successfully reached 24.4 plates, did not then realise that it was necessary to round up to 25 plates and thus earn the full marks.

Answers: **(a)** $7.50 **(b)** 45% **(c)** 35% **(d)** 25

Question 2

On the whole candidates tended to score well on this question.

(a) Very well answered, with many fully correct answers seen.

(b) Not so well answered. Many candidates knew the square root of 9 was 3, but became confused when handling the powers, remembering to halve some but not others and/or not subtracting them for the division.

(c) Another part where many fully correct answers were seen, or candidates showed some evidence of correct factorization, usually for correctly factorizing the denominator.

(d) (i) Again, many candidates factorized the expression correctly. However quite a number mistakenly thought that they should use the quadratic formula here and treated it as an equation. Candidates need to read the question carefully before answering.

(ii) Those who correctly factorized in the previous part, usually were successful here. As this was a part where a follow through mark was available, then some candidates earned this mark.

Answers: **(a)** 6 **(b)** $\frac{3b^2}{a}$ **(c)** $\frac{q^2}{3}$ **(d)(i)** $(4t - 1)(t + 9)$ **(ii)** $\frac{1}{4}$ -9

Question 3

(a) Many good, correct curves were seen and there were only a few instances where candidates used the wrong scale on the x-axis. Candidates must remember that when they draw a quadratic curve that it should not be flat at the bottom, but rounded.

(b) (i) Candidates' readings were usually accurate.

(ii) Again, candidates mostly knew that they had to take readings where $y = 2$ meets the curve and these were usually accurate.

(c) Most candidates knew how to draw the tangent correctly and their estimates of the gradient were nearly always within the acceptable range.

(d) (i) This was a poor question for many candidates and many did not make an attempt at all. Only a relatively few number of candidates realised that $y = 2x - 2$ and $y = x^2 + x - 3$ had to be equated in order to reach the given equation that had to be solved.

(ii) Because the vast majority of candidates could not answer the previous part, instead of drawing a straight line to find the solutions here, they more often than not, used the quadratic formula to arrive at the two solutions. Since candidates were specifically asked to solve the equation by drawing a straight line, they could not gain full marks here for failing to do so.

Answers: **(b)(i)** – 2.3 and 1.3 **(ii)** – 2.8 and 1.8 **(c)** 2.4 to 3.6 **(d)(i)** $y = 2x - 2$ **(ii)** –0.6 and 1.6

Question 4

(a) Many candidates confused similar triangles with congruent triangles and thought that if they could try and prove that they were congruent, which they could not, then that would prove that they were similar triangles too. A good number of candidates did successfully identify two pairs of equal angles in the triangles, usually angle *ANM* and angle *NBL* and did give the correct reason of corresponding angles. Also angle *NAM* and angle *BNL*, again correctly identifying corresponding angles. Those who used angles *AMN* and *NLB* as being equal, often failed to give a full reason as to why they were equal.

(b) (i) There were many incorrect answers of 2 : 3 given here with candidates failing to realise that *BC* was equal to 5 parts.

(ii) There were many more successful answers given here. Showing that candidates know that the ratio of the areas is found by squaring the ratio of their sides.

(iii) This proved to be the least successful part for the majority of candidates, with many not attempting an answer at all. Only a very small percentage of candidates were completely successful. Some were partly successful and did reach $\frac{4}{25}$, but then failed to obtain the other required ratio of 9 : 25, from where they could have gone on to reach a successful conclusion.

Answers: **(b)(i)** 2 : 5 **(ii)** 4 : 9 **(iii)** 1 : 3

Question 5

(a) There were many fully correct answers to this part seen, largely because the angle of depression is equal to the angle of elevation and a good many candidates used the latter to obtain their answer. There was a large number of candidates who correctly reached 74.9° for angle *CAB*, but then gave this as the answer, rather than subtracting it from 90°, to obtain the correct answer.

(b)(i) This part also was well answered by many candidates. The majority chose the simple way to calculate the angle by using sin *LJK*, but a few chose a longer route by using Pythagoras's Theorem to find side *LJ* first of all. Only a handful were unsuccessful through incorrectly using cos *LJK* = 354/1100.

(ii) Again there were many correct answers given here. However, some candidates lost the mark for giving the bearing incorrectly as N 251 SW or similar. Candidates should remember that the bearing is simply the number of degrees measured in a clockwise direction from North.

Answers: **(a)** 15.1 or 15.08(.. **(b)(i)** 18.8 or 18.77… **(ii)** 251 or 251.2(…

Question 6

(a) Very well answered with many fully correct answers seen.

(b) Not quite so well answered as the previous part, but still there were many correct matrices seen. A common error made by some candidates however, was simply to square the four elements, instead of performing the correct matrix multiplication.

(c) Another quite successful part for many candidates, even if not completely correct. Many correctly evaluated the determinant as –10, but then became confused when swapping over the elements and using the minus sign, in the elements of B.

(d) Not many correct answers seen here and a good many candidates did not even make an attempt.

(e) A fairly good response to this part compared with the previous part. Still, there was a large number of candidates who did not know the identity 2 × 2 matrix, or wrote it down incorrectly as (0 1)
(1 0)

Answers: **(a)** $\begin{pmatrix} -6 & 2 \\ -5 & 11 \end{pmatrix}$ **(b)** $\begin{pmatrix} -15 & -7 \\ 7 & 8 \end{pmatrix}$ **(c)** $-\frac{1}{10}\begin{pmatrix} -5 & 0 \\ -7 & 2 \end{pmatrix}$ **(d)** $\begin{pmatrix} 0 & 0 \\ 0 & 0 \end{pmatrix}$ **(e)** $\begin{pmatrix} 0 & 0 \\ 7 & -7 \end{pmatrix}$

Question 7

(a) This was not a good question for the vast majority of candidates. Only the most able realised that they had to work with angle *BOC* in order to calculate the length of the minor arc *BC*. It was very common to see *BC* = 10 sin 26° being used, or a combination of trigonometry and Pythagoras, to arrive at an answer for *BC*. Most candidates did earn at least the mark for identifying angle *BAC* = 26° or for angle *ABC* being 90°.

(b)(i) A fairly well answered part on the whole, with a good number of fully correct answers seen. Candidates understood that the method involved subtracting the inner area from the outer area.

(ii) The common error that a good many candidates made here was, that they used the remaining area 650 cm², and not the area of the tray used up by cutting the holes out of it, when proceeding with their calculations. Thus it was common to see $650 = 44\pi r^2$. Some candidates who did use the correct area, unfortunately sometimes made slips such as not dividing by 44 first of all, before taking the square root to find the value of *r*.

(iii) Again, it was the most able candidates who had complete success here. A good number did the method correctly and reached *d* = 0.662…., but then either gave this as their answer or 6.62 mm. It was pleasing to see some correctly round to 7 mm.

Answers: **(a)** 4.53 cm to 4.54 cm **(b)(i)** 101, or 100 to 100.6 cm² or 32π **(ii)** 0.87 cm to 0.871 cm **(iii)** 7 mm

Question 8

(a) (i) Usually answered correctly. A few lost the mark here for omitting the minus sign or not giving the answer correct to 3 significant figures.

(ii) Again, there was a large proportion of completely correct answers seen. Of those which were not, the method mark was usually earned for correctly showing the cross multiplication stage and reaching $pq = 8 – 5q$.

(b) (i) Candidates here were often guilty of not using brackets when multiplying two expressions together. For example, $H/2\ (x – 2 + x)$ became $H/2\ x – 2 + x$, which made following the working through quite difficult. Candidates would be well advised to heed this advice in the future.

(ii) This part was generally very well done with many correct answers seen. It was pleasing to see so many candidates expanding $– 30(x – 1)$ without making an error.

(iii)(a) Also another part which many candidates did correctly. Again, it was pleasing to see many candidates showing good skill at expanding the brackets and collecting terms, without making a slip.

(b) Another part which candidates did well on. Some lost a mark however, for giving both solutions to the equation, rather than just the positive value, which was needed here since it was a physical quantity. Others did not give their answer to 2 decimal places, as asked for, but only gave it as 4.9

Answers: **(a)(i)** – 1.92 **(ii)** $\dfrac{8}{(p+5)}$ **(b)(iii)(b)** 4.90

Question 9

(a) (i) Very well answered with most candidates gaining full marks here, showing that Pythagoras' Theorem is well understood.

(ii) Another part which was well answered by the majority of candidates, with the sine ratio correctly employed. Only in a few instances did candidates choose incorrectly to use the cosine. Some candidates lost a mark here for not giving their answer correct to 3 significant figures.

(iii) This part confused many candidates, beginning with them making the wrong assumption that *AE* = *AC*. Also many worked in the plane containing *ADC* and not in the correct plane that contained triangle *AFE*. Candidates should read the question more carefully.

(b) (i) This was a much better part for most candidates, with many showing a good understanding of the cosine rule and they applied it correctly to reach a correct answer.

(ii) Only the more able candidates realised that because angle *KGH* was obtuse, then the square of the opposite side would be bigger than the sum of the squares on the two adjacent sides. The answers were varied.

Answers: **(a)(i)** 5.38 to 5.39 or $\sqrt{29}$ **(ii)** 0.517 to 0.518 **(iii)** 68.8 to 68.9 **(b)(i)** 80.94… or 81 **(ii)** >

Question 10

(a) The vast majority of candidates completed the table of values correctly.

(b) On the whole the plotting of points was accurate and candidates generally made good attempts at drawing smooth curves.

(c) (i) The median value was well known by most candidates.

(ii) The interquartile range was less well answered. Some candidates knew that they had to read at the 25th and 75th percentile, but then did 75 –25 = 50, giving this as their answer. Candidates need to remember that readings need to be read off the horizontal axis from where their curve is met by the 25th and 75th horizontals, in order to get the interquartile range.

(d) A fair proportion of candidates did not plot this curve at all, whilst others only plotted some correct points. So in general, this was less successfully answered compared with part **(b)**.

(e) Many candidates were successful here. A small number unfortunately gave for their answer, the number that lasted more than 275 hours. There were a few who also were unsuccessful, because they misread the question and used the curve for Brand B instead of Brand A.

(f) Poorly answered overall. Many candidates seemed to think that because curve A was higher at 275 than curve B, then this meant that there were more Brand A bulbs that lasted longer than Brand B bulbs.

Answers: **(a)** 14, 54, 84, 98 **(c)(i)** 195 ft 190 $\leq$ and 200 **(ii)** 50 to 75 **(e)** 92 ft **(f)** B 15ft A

Question 11

(a) Many correct answers seen here.

(b) (i) Again, most candidates knew what to do here and were successful.

(ii) Surprisingly this part was not so well answered, with many not attempting it.

(iii) The more able candidates who understood what to do in the previous part were generally successful here, correctly employing Pythagoras's Theorem. One or two made the error of subtracting the squares of the sides, instead of adding them.

(c) (i) Of those attempting this part, the majority drew the correct triangle.

(ii) Similarly with this part, most were successful.

(iii) There were a good many candidates who were completely correct here. Unfortunately, a small number lost all marks by mentioning a second transformation.

Answers: **(a)** $\begin{pmatrix} -6 \\ 2 \end{pmatrix}$ **(b)(i)** $\begin{pmatrix} 8 \\ 4 \end{pmatrix}$ **(ii)** $\begin{pmatrix} -8 \\ -4 \end{pmatrix}$ **(iii)** 8.94 **(c)(iii)** Rotation, 180°, centre (5, 4)

MATHEMATICS

Paper 4024/22
Paper 22 (Syllabus D)

Key messages

Although this has been a major concern and mentioned in these reports several times before, premature approximation is still a constant source of lost marks.

The general instruction on the front of the paper is "If the degree of accuracy is not specified in the question, and if the answer is not exact, give the answer to three significant figures. Give answers in degrees to one decimal place.

For π, use either your calculator value or 3.142, unless the question requires the answer in terms of π". These instructions are regularly ignored, and marks are almost inevitably lost.

Trigonometric ratios are regularly written to two decimal places, $\frac{22}{7}$ is used for π, $\frac{1}{3}$ is approximated to 0.33 and even 0.3.

Even when a question specifies a degree of accuracy, this is routinely ignored. This was particularly noticeable in **Question 5 (d)(ii)** when answers of 3.9 and 0.6 or 0.649 were regularly seen when two decimal places were stated in the question

General comments

There were many excellent scripts on what proved to be a more difficult paper than those in recent years.

The Trigonometry questions **(Question 9)** in particular was more difficult than usual with the understanding of the term "angle of elevation" and the subsequent calculation of the angles required to get started on the sine rule causing real problems for many candidates. This perhaps deterred candidates from attempting the rest of the question, particularly if the term "angle of depression" was not fully understood.

Question 11 was another question on a fairly "standard" topic which was a little harder than similar questions in the past, with the first part in particular defeating a considerable number of quite able candidates.

Most candidates seemed to have sufficient time to complete as many of the questions as they were able to attempt.

Presentation was perhaps poorer than in previous years with those candidates who write over earlier or deleted work producing scripts that are very difficult to read after the scanning process. This can, of course, lead to loss of marks in extreme cases.

Comments on specific questions

Section A

Question 1

(a) This was answered very well.

Some found 2.4% to be 972 but, instead of adding it to 40 500, they left this as their answer.

A few calculated $40\,500 + (2.4 \times 100)$ and gave an answer of 40 740.

(b) Candidates continue to have difficulty with the reverse percentage question.

The most common error was to simply calculate 5% of \$68.25 and then subtract their answer from \$68.25 to arrive at the most common response of \$64.84.

A significant number reached \$71.66 by adding 5% of \$68.25 to \$68.25.

Candidates who did appreciate that \$68.25 was equivalent to 105% usually went on to use an appropriate method to arrive at \$65.

(c) Most candidates scored some, if not all, of the marks available in this part.

The product of ticket numbers and costs per ticket were regularly computed using the correct or follow through values from **(a)** and **(b)**.

Sometimes the wrong pairings of $40\,500 \times 68.25$ and their $41\,472 \times$ their 65 were seen.

Occasionally, the incorrect denominator of 2 830 464 instead of 2 632 500 was used.

Direct use of the separate percentage increases in attendance figures and ticket sales given in **(a)** and **(b)** were rarely seen.

Answers: **(a)** 41 472 **(b)** \$65 **(c)** 7.5

Question 2

(a) (i) This was not answered as well as one would have expected.

Common errors were $\begin{pmatrix} 1 \\ 8 \end{pmatrix}$ and $\begin{pmatrix} -2 \\ 15 \end{pmatrix}$ which were found by adding or multiplying the vectors for *JK* and *LM*.

It was interesting that several candidates wrote that they believed this part not to be possible because information was missing.

(ii) The majority of candidates scored by correctly calculating the magnitude knowing the method for doing so. However, by no means did all candidates appreciate the meaning of the modulus symbol.

The main error noted was $\sqrt{(4^2 - 2^2)}$ leading to responses of 3.46.

On occasions the correct method using $\sqrt{(4^2 + (-2)^2)}$ was adopted but this still led to $\sqrt{12}$ and 3.46.

Some actually used $\sqrt{(4^2 - (-2)^2)}$, clearly thinking that they had to subtract the squares of the components.

The answer of 4.47 was common but $\sqrt{20}$ and $2\sqrt{5}$ were also seen.

(b) (i) Questions involving vector routes are not well understood. Responses were quite often seen in terms of vectors *OA* and *OB*, not vectors **a** and **b.** The main failings resulted from candidates not taking into account direction, and sign errors occurred frequently.

In part **(a)**, $\mathbf{a} - \frac{1}{2}\mathbf{b}$ was common.

Success in the first part was often followed by a correct approach in part **(b).** Unfortunately many candidates did not simplify their answers or did so incorrectly. It was not unusual to see a response left as $\frac{b}{2} - 3\mathbf{a} + \mathbf{b}$.

(ii) Candidates who got the vector expressions correct generally went on to score the ratio mark.

Sometimes the ratio was reversed and 9:1 was also seen fairly frequently.

Generally, answers were numerical but some candidates simply wrote their answers to **(a)** and **(b)** as a ratio.

Answers: **(a)(i)** $\begin{pmatrix}5\\6\end{pmatrix}$ **(a)(ii)** 4.47 **(b)(i)(a)** $\frac{1}{2}\mathbf{b} - \mathbf{a}$ **(b)(i)(b)** $\frac{3}{2}\mathbf{b} - 3\mathbf{a}$ **(b)(ii)** 3 : 1

Question 3

(a) (i) Candidates were clearly familiar with this type of question requiring them to find the mean from a frequency table and the success rate was high.

Incorrect answers were obtained when the candidates only added the frequencies without multiplying each one by the number of children or when the correct product was divided by 5 or 10 instead of 25.

The predictable error of $7 \times 0 = 7$ leading to 1.92 was made by a significant number.

(ii) **Most candidates** linked the median to the middle value.

A few showed working to arrive at the 13th value and in some cases the 25 numbers were listed prior to the required one being extracted.

Others answered 5 from ordering the frequencies as 3, 4, 5, 6, 7 and selecting 5 as the middle value.

12.5 or 13 were common wrong answers and 6, the middle value in the frequency column, was chosen by a few candidates.

(iii) Most candidates correctly identified the mode as the most common value.

The main error noted was 7 from listing the largest frequency and not the number of children from the given table.

(b) Most candidates were unable to give any reasons relating to the mode being an extreme value and as a consequence gave no indication of a central or middle value.

The majority of them simply defined mode and/or mean or gave information from the data such as "7 women have no children".

Many did not recognise the mode as an average and suggested that the only average was the mean.

(c) More able candidates succeeded on this but most were unprepared for an 'AND' probability question.

A significant number added the probabilities, $\frac{5}{25} + \frac{4}{24}$, giving $\frac{11}{30}$.

Some did not completely take into account the reduction in the number of outcomes and computed $\frac{5}{25} \times \frac{5}{25}$ giving $\frac{1}{25}$, or $\frac{5}{25} \times \frac{5}{24}$ giving $\frac{1}{24}$.

Others had the correct method but then multiplied by 2 to spoil the method: $2(\frac{5}{25} \times \frac{4}{24})$. The weaker candidates simply stated $\frac{5}{25}$ and went on to simplify to $\frac{1}{5}$.

On occasions attempts at tree diagrams were made but often these were abandoned and incorrect solutions replaced them.

(d) A significant number of candidates were unable to draw a basic bar chart.

In many scripts the horizontal labelling was not central to the bars. Generally the heights were all correct although a not insignificant number missed out the first bar – presumably because it was for no children.

(e) Most candidates could make the connection with the frequency table and/or bar chart.

Usually 0, 0, 1, 3, 4 were identified as the missing values but occasionally 2 was included and/or more than one of 1, 3 or 4.

Sometimes either no reference to the table was made or it was incorrectly interpreted, this being implied by 5, 6 or 7 being quoted as missing values.

Answers: **(a)(i)** 1.64 **(a)(ii)** 2 **(a)(iii)** 0 **(c)** $\frac{1}{30}$ **(e)** 0 0 1 3 4

Question 4

(a) (i) It was really encouraging to see that constructions this year were very accurate. Candidates almost always included their construction lines so that Examiners could clearly see their arcs.

Occasionally, *AC* was drawn as 8 cm but partial credit was usually given because *BC* was drawn of the correct length and there were clear arcs.

(ii) The majority of the candidates measured the angle accurately. In some cases however the candidates obtained an angle of 72° to 76° as they read the degrees from the incorrect side of the protractor. Some candidates did not understand the notation $B\hat{A}C$ and provided the perimeter of 27 cm as a final answer.

(b) This part was answered well and most candidates displayed a pleasing understanding of the formulae relating to the angles of polygons and how to apply them.

The vast majority of candidates used the method $\frac{((12-2)\times 180)}{12}$. The most common error was to fail to divide by 12 leading to the common answer of 1800°. A few candidates, having reached the right answer of 150°, then subtracted this from 180° to get 30°.

Some used the exterior angle route and correctly reached 30° but then did not take this from 180° to obtain the interior angle.

(c) (i) The good candidates generally had no difficulty here but the weaker ones struggled.

The temptation to see *p* as 90 was too great for many.

The other common wrong answer was 55 with many candidates not realising that it was $\frac{1}{2}p$ and 125 that were allied angles.

(ii) Those who were successful with the first part generally got this part right.

Candidates seemingly arrived at 165 by applying the symmetry of the shape, the knowledge of interior angles and of angles at a point.

Most of those getting 90 for **(i)** arrived at 145 here because they wrongly concluded that the angle opposite *p* was 90 and then used sum of interior angles to get $\frac{(720-90-90-125-125)}{2}$ = 145.

There were many other approaches but most were based on wrong assumptions such as that which took the polygon to be regular and resulted in *q* being evaluated as 120.

(d) Candidates found this question challenging but there were some very good attempts at it…….a good discriminator.

Many labelled the sides with the sizes in relation to other sides, rather than in terms of *x*. A good proportion knew how to work out the area of a trapezium but because they were using sides (*PQ*, etc.) rather than *x*'s; their efforts were not rewarded.

Others used the multiples of *x* (e.g. 2, 3, 6, $\frac{3}{2}$, etc.) but the *x*'s did not appear.

Partial marks for *PQ* = 3x or area = $3x^2$ were earned quite often but further credit was more commonly earned from a correct formula for the area of *PQRS* than for using the correct similar figures area scale factor.

A few left their answer in the form 13.5 $\frac{x^2}{4}$.

Many reached the correct answer of 27 $\frac{x^2}{4}$ in the working and wrote 27 × $\frac{x}{4}$ in the answer space.

Candidates perhaps interpreted our instruction to give their answer in terms of *x* as meaning there should only be *x* in the answer.

Answers: **(a)(ii)** 106 **(b)** 150° **(c)(i)** 110° **(c)(ii)** 165° **(d)** $\frac{27}{4}x^2$

Question 5

(a) This was done fairly well. Errors in factorising were either with dealing with the numeric values within the bracket such as $4x^2(2y-6x^3)$, incorrectly taking out a factor of 2 instead of 4 to give $2x^2(4y-6x^3)$, or taking out just *x* leaving $4x(2xy-3x^4)$.

(b) Most errors came from incorrectly multiplying out the brackets. Common errors were $4x-2x-5=3$ and $4x-2x+10=3$. Some multiplied out to give a quadratic as they multiplied $4x$ by $(x+5)$. Some got to the expression $2x-7$ but as they had no equation could not proceed. A few arrived at an answer of 7.5 from $2x=13$.

(c) Not as well answered as in previous years. I think the $-5y$ caused a great problem for many so although most candidates got to the value of 2.6 or –2.6 very few got the correct sign and inequality. $x<-2.6$ was a very common error, also $y>2.6$. Some would just leave the inequality sign out and offer answers of $y=2.6$ or just the value written on the answer line. Another less common error was $-5y<20+7$. Many had problems correctly manipulating the inequality sign when dividing by a negative value.

(d) (i) Many candidates did not attempt this part.. Both width methods were generally as common as each other, and the alternative method of $\frac{(18-4x)}{2} = \frac{10}{2x}$ was sometimes seen. If candidates could get to $\frac{5}{x}$ or 9 – 2*x*, generally both marks were awarded. Some tried to bracket the given expression but then did not know how to proceed further. Some incorrectly simplify the width from $\frac{10}{2x}$ to 5*x*. Some let the width be *x* then ran into problems.

(ii) 3.85 and 0.649 were very common answers scoring two marks. Sometimes candidates had too short a division line even though they had the correct values of 9, 4 and 41. Some candidates attempted to factorise to (x – 5)(2x + 1) or (x – 5)(2x – 1). Some made the error of adding b^2 and 4*ac* to give √121.

(iii) This was not well answered. Some just gave the difference between their 2 answers in the previous part. Others calculated 2x – x for their value of x so 3.85 was commonly seen. An incorrect answer of 5 was also seen.

Answers: **(a)** $4x^2(2y - 3x^3)$ **(b)** $x = 6.5$ **(c)** $y > -2.6$ **(d)(ii)** 3.85 and 0.65 **(d)(iii)** 6.40 or -6.40

Question 6

(a) (i) (a) This was well answered; common errors seen were 5 or 5, 10.

(b) This was more difficult – the complement sign sometimes ignored giving long list. The empty set or 0 were sometimes given.

(c) This was not as well done. Common alternatives were 3, 5, 7 or an extra value e.g. 2, 3, 5, 7, 11.

(a) (ii) Most of those candidates who had the correct answer in the previous part were also successful here and many others gained a 'follow through' mark from their error in the previous part. The main error was to give $\frac{1}{n}$ as the answer after *n* numbers given in part **(a)(i)(c)**.

(b) (i) This was very well answered even by quite weak candidates. Some scored 1 mark for getting 3 elements correct.

(ii) This was also usually correct. Some scored just B1 for a correct matrix but incorrect multiplier such as $\frac{1}{2}$, others gave $\frac{1}{4}$ but an incorrect matrix, commonly $\begin{pmatrix} 2 & 2 \\ -1 & 1 \end{pmatrix}$. Occasionally a correct matrix came with a fraction of $\frac{1}{0}$.

Answers: **(a)(i)** 10 **(b)** 9 **(c)** 3, 5, 7, 11 **(a)(ii)** $\frac{4}{11}$ **(b)(i)** $\begin{pmatrix} 8 & 0 \\ 3 & 1 \end{pmatrix}$ **(b)(ii)** $\frac{1}{4}\begin{pmatrix} 1 & -2 \\ 1 & 2 \end{pmatrix}$

Question 7

(a) This was usually correct with the rare odd slip such as 80 instead of 88, 112 instead of 113. Also on occasion some added pairs of values, 13 + 36, 36 + 30, 30 + 16,…

(b) This was mostly accurately plotted, sometimes the 1st plot was (10, 8). Most candidates were able to produce good smooth curves. A small number of candidates plotted against the midpoint of the interval.

(c) (i) Quite a few gave the value of 30 from a correct curve although they had already plotted the point (30, 58). Otherwise this was very well answered. A small number gained an FT mark from their incorrect curve.

(ii) Many read from 90 and, as for part **(c)(i)** some scored an FT mark. A few gave 108 as their answer.

(d) Many more found this curve difficult to draw correctly. Some gave the correct curve apart from plotting the last point at (80, 120). Others only got the first and last points correct.

(e) Many did not attempt this part and some offered a solution with no working shown. It was rare to see evidence of reading from the graph. Nearly all candidates that attempted the alternative method of working, with those who did not receive a gift, incorrectly concluded that garage B offered more customers a gift.

Answers: **(a)** 58, 88, 104, 113, 118 **(c)(i)** 30 < their answer $\leqslant$ 31 **(c)(ii)** 53 $\leqslant$ their answer $\leqslant$ 55

Question 8

(a) This was very well answered. Occasionally an incorrect answer of 0.25 or $\frac{1}{4}$ was seen.

(b) On rare occasions straight lines were used to join the points but there were very many well drawn smooth curves. Most errors were in plotting (0, $\frac{1}{4}$), often plotted slightly outside tolerance, or at (0, 0) and, more rarely, (1, $\frac{1}{2}$) plotted inaccurately or at (1, 1).

(c) A number of candidates drew a horizontal and vertical line from the point (4, 4) rather than drawing the tangent. Many scored the mark for a tangent drawn but often their answer was outside the given range. Some left their answer as a fraction with numerator and denominator. Some tangents were too short to be clear.

(d) (i) Some had an idea of how to begin but did not eliminate y from the linear expression, e.g. $2x + y - 6 = y = \frac{1}{4} x\ 2^x$. If candidates successfully equated the 2 expressions, which was more common than substitution, generally they went on to attain the mark. A few left their final expression without stating = 0. Some used $y = 2x - 6$ and there was some confusion between $2x$ and 2^x.

(ii) It was very common for the line not to be drawn so no marks could be awarded. Most drawing the correct line scored both marks.

(e) (i) This was very well answered with most common errors being 0.5, 0.3 and 0.34.

(ii) A number omitted this part or simply drew the line *PQ*, sometimes labelled as *l*. It was quite common for the parallel lines offered to cut the curve, such as a line passing through (2, 2) and (5, 3).

(iii) In most cases an equation was given and B1 was scored for $y = \frac{1}{3}x + k$ but their k was very rarely within an acceptable range, generally having a value greater than 1.

Answers: **(a)** 0.5 **(e)(i)** $\frac{1}{3}$ **(e)(iii)** $y = \frac{1}{3}x + k \quad 0 < k < 0.25$

Question 9

This question proved to be unpopular with very many candidates, with the majority choosing to either omit it entirely or abandoning it after attempting one or more parts. In many cases, the only work done was to mark a couple of angles, often incorrectly, on the first diagram. Where the question was seriously attempted, there were some excellent solutions, showing a clear understanding of the techniques required and applying these logically. A common problem throughout this question was for candidates to round values prematurely and then use their rounded values in subsequent steps of their calculation. For example, trigonometric ratios given to only 2 d.p. were seen on a large number of scripts. This inevitably resulted in a loss of accuracy in the final answer and a corresponding loss of marks.

(a) Many failed to identify the required angles. The value 9° was seen more frequently than 115°. Some treated this question as if *ABC* was a right angled triangle; a few candidates attempted longer methods involving correctly identified right angled triangles, but these rarely led to an answer that was within the required range. Candidates who identified the angles 9° and 115° usually went on to score full marks, apart from those who lost the accuracy mark because of premature rounding of numbers in the calculation.

(b) Whilst most candidates realised the need to use the cosine rule, many were unable to use this to find the correct angle. It was very common to see the cosine rule used to find angle *FED*, with candidates seemingly under the impression that they had calculated *DFE*. Those candidates who did find angle *DFE* correctly usually went on to find the angle of depression, but a significant number were unable to do so, either offering their value for angle *DFE* as a final answer, or continuing using an incorrect method.

(c) This part caused real difficulties, with a significant number of candidates abandoning the question at this point. In many cases it was difficult to give any credit for the method used because candidates did not show all of their calculations, with values appearing, presumably from their calculators. A number of candidates showed working that involved setting out numbers in an array, often with diagonal lines, but did not show their calculations.

(i) Many seemed unclear what was required, with attempts involving simple division or trigonometry being seen quite frequently. Many gave 90 as the answer – sometimes clearly from 3 × 30.

(ii) A common error was to divide their answer to **(c)(i)** by 15. The conversion of units also caused difficulties for many candidates although a good number earned the method mark.

(iii) This proved to be particularly difficult. Unsurprisingly, those who were unable to complete part **(c)(i)** were also unable to make any progress with part **(c)(iii)**, many of these simply calculated 90 ÷ 30 or left the answer space blank. The candidates who realised that the circumference of the circle had been given and who showed full working usually gained full marks. A significant number of candidates chose to use proportion and $\frac{90}{(\text{c})(\text{i})} \times 30$ was used to find the radius of *Q*. Even the few candidates who got the method mark often forgot to subtract their answer from 30.

Answers: **(a)** 174 **(b)** 51.5° **(c)(i)** 188 **(c)(ii)** 170 **(c)(iii)** 15.7

Question 10

This was a popular question which was attempted by the majority of candidates.

(a) This was left blank by a surprising number of candidates. Those who realised the need to use Pythagoras' theorem usually scored full marks in this part. A common incorrect answer was *a* = 1, *b* = 2.

(b) The majority showed some understanding, with a large number giving completely correct answers. The most common errors involved reversing the components, or incorrect use of negative signs.

(c) Most were able to identify the reflection and give a correct equation for the line of reflection symmetry. A significant number felt that a centre was also required; this was usually stated to be the origin. Some lost the marks when they included a second transformation which was usually a rotation.

(d) There were many excellent answers, the most common error being to state that the scale factor was 2 rather than −2. Shear was used on several occasions.

(e) Relatively few candidates were able to identify the correct matrix in part **(e)**, with many suggesting a matrix that implied a scale factor of 2 or −2. A number of candidates offered a generalised answer using algebraic terms rather than one that was specific to this particular case.

(f) (i) This was rarely correct, with only a handful of the strongest candidates even attempting to use h and g in their answers. The vast majority either left this blank or gave numerical values.

(ii) Most were able to identify a reflection, the most common error was to give the line of reflection symmetry as $y = x$. Again it was quite common for candidates to include a second transformation, usually a rotation.

Answers: **(a)** $a = 3$ $b = 5$ **(b)** $\begin{pmatrix} -6 \\ 2 \end{pmatrix}$ **(c)** reflection $y = x$ **(d)** Enlargement, Scale factor – 2, centre (– 4, 2)

(e) $\begin{pmatrix} -\frac{1}{2} & 0 \\ 0 & -\frac{1}{2} \end{pmatrix}$ **(f)(i)** $(-h, -g)$ **(f)(ii)** reflection $y = - x$

Question 11

This was attempted by the majority of candidates. Most showed clear working, with the steps set out in a logical order.

(a) (i) The most common error in this part of the question was to use the formula for a cone rather than a cylinder, presumably because that formula was given at the start of the question, immediately before this part.

The most common marks gained were for showing $r + 3.5$, or for showing a complete correct expression for volume, equated to 3000. A number of the weaker candidates failed to realise the need to use $r + 3.5$, calculations involving cylinders of radius r and/or radius 3.5, sometimes with a subtraction as a final step were quite common. There was a tendency to miss the middle term of $2 \times 3.5 \times r$ in the attempts to square $(r + 3.5)$. Some candidates attempted to add their calculations rather than subtract them. A significant minority of candidates showed completely correct calculations, but gave the answer 5.1 rather than working to 3 s.f.

(ii) Most were able to write an expression for the volume of the cone, although weaker candidates often failed to use $2r$ for the height, either leaving it as h, or substituting a numerical value. Rearranging the expression caused real problems in a large number of cases, the most common difficulty being in dealing with the power of r. Rearrangements that led to expressions for r^3 and then using square root rather than cube root were seen on a significant number of scripts. The majority of candidates who found a correct value for r went on to score full marks.

(b) Whilst there were many excellent solutions, finding the area of the triangle caused difficulties for a large number of candidates. Most attempted to use $\frac{1}{2} \times$ base $\times$ height rather than $\frac{1}{2}ab \sin C$, however many simply used one of the given dimensions, usually 8, as the height. Most attempted surface area, but there were many cases were the candidates did not include the correct number of triangles and/or rectangles in their final calculations. Some calculated the volume.

Answers: **(a)(i)** 5.07 **(a)(ii)** Solid II by 2.5 – 2.6 **(b)** 631