MATHEMATICS

Paper 4024/11
Paper 11

Key Message

To succeed in this paper candidates need to have completed full syllabus coverage, remember necessary formulae, show all necessary working clearly and use a suitable level of accuracy.

General Comments

The paper differentiated well between the candidates. Most of the scripts were well presented and legible. Candidates should be aware that the examiner needs to be able to distinguish between the figures 1, 4 and 7, which was difficult in some instances. There were also cases where 5, 6, and 8 looked very similar. The first few questions exposed some weaknesses in basic arithmetic. Transcription errors still cause candidates to lose unnecessary marks.

There was little evidence that candidates did not have sufficient time to complete the paper. The last question on graphs was attempted by nearly all candidates.

Comments on Specific Questions

Question 1

(a) This was very well answered and a good start to the paper for many. A few candidates tried to use long multiplication which was unnecessary and often lead to errors.

(b) This part was less successful. Many candidates inserted brackets that were not needed and wrong answers of 5, 15 etc. were common.

Answer: **(a)** 147 **(b)** 17

Question 2

(a) This was accurately answered by the majority of candidates.

(b) This question was not understood by a wide ability range of candidates, who appeared to be unfamiliar with the term 'irrational'. A common response was a number such as 3.5.

Answer: **(a)** $\frac{9}{50}$ **(b)** π or $\sqrt{10}$ …etc.

Question 3

(a) and **(b)** These two fraction questions were very well answered.

Answers: **(a)** $\frac{29}{30}$ **(b)** $\frac{8}{15}$

Question 4

(a) Many candidates wrote the expected answer of 25, although 1 was also an acceptable answer.

(b) Candidates were more uncertain in this part. The common wrong answer was 8.

Answers: **(a)** 1 or 25 **(b)** 216 etc.

Question 5

(a) Mostly correct answers were seen although some candidates missed out the minus sign

(b) This again was mostly correct. The most common wrong answer seen was 6.

Answers: **(a)** -24 **(b)** 102

Question 6

(a) and **(b)** This was generally well answered but many candidates struggled with both parts of this question, not seeming to understand the fractional or negative indices.

Answers: **(a)** 4 **(b)** 36

Question 7

(a) This was generally well answered, although weaker candidates struggled with the concept. They appeared to know the symbols but could not connect the sets.

(b) Again, only the more able candidates were successful in this part.

Answers: **(a)** $A \cup (B \cap C)$

Question 8

(a) and **(b)** There were varied responses to this straightforward ratio question. This did highlight a weakness in basic arithmetic for some candidates.

Answers: **(a)** 63 **(b)** 60

Question 9

(a) This was very well answered with good responses seen from candidates across the ability range.

(b) This was also well answered with mostly correct answers seen. Some candidates equated the expression to zero and then solved. If the correct factors had been seen then marks were awarded. However using the "formula" without seeing factors meant no credit could be given.

Answers: **(a)** $4ab(3b-2a)$ **(b)** $(2x-5)(x+4)$

Question 10

(a) This was well answered with even the weakest candidates using distance divided by speed to gain at least the method mark.

(b) This part proved to be the most challenging question in the paper and not many correct responses were seen.

Answers: **(a)** 14 05 **(b)** $\frac{100T}{110}$

Question 11

(a) and **(b)** This was not an easy question for many candidates. However confident responses were seen by the more able candidates.

Answers: **(a)** $\frac{-3}{2}$ **(b)** x≥1 y≥2 2y≥9-3x

Question 12

(a) Many correct explanations were seen in this part.

(b) Only the more able candidates were successful here. Many did not know nor could work out the angle of a regular hexagon.

Answers: **(b)** 96

Question 13

(a) Although many correct answers were seen, some candidates multiplied the number of text messages by the frequency and then added to reach a common incorrect answer of 173.

(b) 5 or 5.5 were common wrong answers.

(c) The majority of candidates understood how to find the modal number and read correctly from the graph.

Answers: **(a)** 31 **(b)** 6 **(c)** 5

Question 14

(a) Some correct answers were seen. However, quite a few candidates attempted to calculate using unsimplified numbers.

(b) Only a minority of candidates understood what was required here.

Answers: **(a)** 12000 **(b)** 9.575

Question 15

This was well answered. Some candidates however attempted to use Pythagoras to find *a* and *b*.

Answers: $a = 8.75$ $b = 6$

Question 16

(a) This was generally well answered. Although 0.25 appeared in many answers, it was often without an inequality sign or with a wrong inequality sign.

(b) Most candidates understood they needed to combine the algebraic fractions. Errors were made in multiplying and simplifying but some candidates, with great care and perseverance, completed the question successfully.

Answers: **(a)** x≥0.25 **(b)** $\frac{2}{3}$ or -3

Question 17

Most candidates managed to score some marks in this question, but some appeared not to be confident with this topic.

Answers: **(a)** 38 **(b)** 104 **(c)** 122 **(d)** 84

Question 18

(a) Some very good responses were seen in this part.

(b) and **(c)** Many candidates achieved the correct expression in part **(b)** but then did not know how to proceed for part **(c)**. Some of the more able candidates expanded the brackets in part **(b)** making part **(c)** straightforward for them. Many other candidates did not attempt part **(c)**.

Answers: **(a)** 79 **(b)** $n(n+1) + (n+2)^2$ **(c)** $A = 2$ $B = 5$ $C = 4$

Question 19

(a) Candidates generally showed some understanding but the presence of units of length and units of time was too complicated for some. Changing the units between parts **(i)** and **(ii)** was often not handled well.

(b) There were some good solutions seen to this difficult question. The best strategy was to divide by 2×10^3 initially. Writing the terms out in full sometimes led to errors.

Answers: **(a)(i)** 3.6×10^{-6} **(ii)** 3.6×10^{-3} **(b)** 3700

Question 20

(a) This was well answered.

(b) Often the method of finding the inverse was understood, but errors in the algebra were often seen.

(c) A fair proportion of candidates did not attempt this part, but those that did were reasonably successful.

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

Question 21

(a) Most candidates managed the first part of the tree diagram correctly. However, some made errors in the second part with inconsistent answers.

(b) This did not necessarily rely on the tree diagram and was quite well answered.

(c) This was a challenging question for many.

Answers: **(a)** Correct tree diagram **(b)** $\frac{4}{15}$ **(c)** $\frac{1}{15}$

Question 22

(a) Finding the area proved challenging for many candidates. Credit was given for being able to use the correct formula for the area of a circle. Keeping π in the results also caused problems. Some weaker candidates did not attempt this part.

(b) Some candidates managed to use the correct formula but some omitted the straight sides of the perimeter in question. Again, many weaker candidates did not attempt this part.

Answers: **(a)** $1200 + 450\pi$ **(b)** $40 + 10\pi$

Question 23

(a) and **(b)** Candidates generally seemed confident in constructing loci and there were many neat, well drawn solutions.

(b) Where the required loci were in place, the correct region was usually carefully shaded.

Question 24

This question gave many candidates a good finish to the paper. The aspects of graphical work being tested were generally well understood.

Answers: **(a)** 4, -5 **(c)** 0, 2.4 to 2.5 **(d)** follow through from graph

MATHEMATICS

Paper 4024/12

Paper 12

Key Messages

To succeed in this paper candidates need to have completed full syllabus coverage, remember necessary formulae, show all necessary working clearly and use a suitable level of accuracy.

General comments

There were opportunities for all candidates to demonstrate what they knew and generally the paper allowed positive achievement across the whole ability range.

There were many well presented scripts of a good standard, clearly written and easy to read. Occasionally, clarity in presentation was impaired by candidates initially working in pencil, and then inking over the final result. Also, in some cases, it was not always possible to read exactly what figure or letter the candidate intended. Indeed, it was clear that some candidates were themselves confused by their own script.

Candidates were able to complete the paper comfortably in the time available. Inevitably, there were gaps where some candidates were not able to make responses to particular questions.

Comments on specific questions

Question 1

(a) This was well answered although some candidates calculated (12 + 6) ÷ (2 – 8) or (12 + 6) ÷ 2 – 8.

(b) Again, this was well answered. Although it was expected that candidates would work in decimals, some candidates gave a final answer of $\frac{13}{25}$ which was accepted.

Answer: **(a)** 7 **(b)** 0.52

Question 2

(a) Candidates struggled more with this question. The response $0.2 < n < 0.25$ was a common answer. However, a value of n such as 0.21 was expected.

(b) This was one of the best answered questions in the paper.

Answer: **(a)** Any decimal value of n such that $0.2 < n < 0.25$ **(b)** 80

Question 3

(a) This was very successfully answered. A few candidates worked with decimals and if a decimal answer was given, credit was given for 3 significant figure accuracy, or better, only.

(b) This was one of the best answered questions in the paper. Here, the question asked for a fraction in its lowest terms, so other answers were not accepted.

Answer: **(a)** $\frac{7}{24}$ **(b)** $\frac{7}{18}$

Question 4

(a) The general ideas of manipulating inequalities seemed to be well understood. Some candidates omitted to write the appropriate inequality sign, >, in the answer space.

(b) Approximately half the candidates earned the mark. Credit was given only if all four integers were stated. The answer $-2 \le x < 2$ was sometimes seen.

Answer: **(a)** $y > 7.5$ **(b)** $-2, -1, 0, 1$

Question 5

(a) This was mostly accurate. There was a tendency for stray minus signs to appear.

(b) Candidates struggled more with this part. The modulus sign was not always understood. For example, the answer 8 + 6 was sometimes given. Since $|\mathrm{d}|$ represents a distance, negative or ± answers were not accepted.

Answer: **(a)** $\begin{pmatrix} -2 \\ 10 \end{pmatrix}$ **(b)** 10

Question 6

Although well answered by some candidates, others seemed to be unfamiliar with the format of this question. Usually, the working space contained calculations of the required areas for which credit could be given. Full credit was not given for numerical answers, or expressions that contained *a*'s and *b*'s. Some arithmetic errors were made, e.g. 0.5 x 6 x 9 was seen evaluated as 18.

Answer: $\frac{9\pi}{2} + 27$

Question 7

(a) This was well answered generally. Common incorrect answers were $\frac{4}{5}$ and $\frac{5}{9}$.

(b) Candidates were less successful in this part. Some obviously misread the information given in the question and assumed that there were 120 girls in the school.

Answer: **(a)** $\frac{4}{9}$ **(b)** 840

Question 8

This was generally well answered. Many candidates gave the equation $y = kx^2$ in the working space, but this did not always lead to a correct value of k. Sometimes the correct work leading to $2 = 16k$ was seen followed by $k = 8$.

Answer: 12.5

Question 9

Candidates found this question quite challenging with only the more able achieving full marks.

Answer: $y \le 3$, $y \ge -2x$

Question 10

Again, a challenging question for many candidates. The most successful strategy to adopt in this non-calculator paper was first of all to find the cube root of the ratio of the given volumes. Some, who used the ratio of the (unknown height)^3 to 12^3 were successful, but most adopting this strategy got into difficulties with the ensuing arithmetic.

Answer: 18

Question 11

The most common errors seen were from those trying, correctly, to use cos θ, and equating the given value, $\frac{7}{25}$ with $\frac{35}{AD}$ or simply to give the answer as 25. Before any credit could be given, it was essential to see $\frac{35-21}{AD}$. Attempts using sin, tan, the cosine rule for a general triangle, the sine rule and Pythagoras' theorem were seen. Some candidates thought the area of the trapezium could be found.

Answer: 50

Question 12

(a) It was expected that the shading would be clear and unambiguous. Any additional, unexplained shading scored 0.

(b) (i) There was some confusion between $n(P \cap Q)$ and $P \cap Q$. Candidates were given credit if it was clear that the answer was 2, however presented.

(ii) This was the least well answered part in the paper. When extra elements were included, no credit could be given.

Answer: **(b)(i)** 2 **(ii)** 2, 3, 4, 5, 7

Question 13

(a) Standard form was well understood and most candidates achieved the mark.

(b) (i) Again, most candidates achieved success here.

(ii) This was less well answered than the previous two parts. The difference -1.34×10^7 was also accepted.

Answer: **(a)** 2×10^{-5} **(b)(i)** 7.6×10^6, 2.1×10^7, 8.0×10^7, 1.2×10^8 **(ii)** 1.34×10^7

Question 14

(a) This was very well answered.

(b) This was a more challenging question which required clear thinking. When not fully correct, some credit was given if two of p, q and r were correct. Answers in the form 2^3 etc. were accepted, but to gain credit for $r = 1$, it was essential to see 7^1 and not just 7 alone.

Answer: **(a)** $2^2 \times 3^3$ **(b)** $p = 3$, $q = 2$, $r = 1$

Question 15

(a) This straightforward factorisation question was very well answered.

(b) Again, this was very well answered. Even when not fully correct, a mark was usually obtained for a partial factorisation. In a minority of scripts, candidates went on to solve an imagined equation.

Answer: **(a)** $3q(3p - 4q)$ **(b)** $(4p - 3)(2x + y)$

Question 16

(a) The bearing was generally accurately measured.

(b) Since the roles of *A* and *C* were reversed in this part, candidates were expected to find the bearing required without making any additional measurements. Credit was given for clearly adding 180° to the answer given in part **(a)**.

(c) The measurement and use of scale was generally well done.

Answer: **(a)** 057° **(b)** 237° **(c)** 237.5

Question 17

(a) The conversion of units was generally accurate.

(b) Again, this was usually accurate. The most common incorrect answer was 6919 (from calculating 6959 – 40.)

(c) Again, this was usually accurate. In this difference question, because of the wording, the answer – 381 was not accepted.

Answer: **(a)** 5.963 **(b)** 6999 **(c)** 381

Question 18

(a) (i) This construction of the bisector of the angle was well done. Some candidates incorrectly drew the diagonal, *PR*.

(ii) This construction was again well done. Some candidates drew the line from the midpoint of QR and parallel to *PQ*.

(b) The correct region was found by the majority of candidates.

Question 19

(a) In this part and throughout this question, the terms 'decimal places' and 'significant figures' were not always understood. A common incorrect response was 0.048.

(b) Although most candidates seemed to understand the meaning of $\sqrt{200}$, they did not all manage to reach 14. Some candidates made attempts to add 2 decimal places to 14.

(c) It was essential to see relevant working in this question. A more careful reading of the wording might have saved some candidates from attempting this calculation with the original numbers. It seemed difficult for many candidates to write all three numbers correct to one significant figure.

Answer: **(a)** 0.05 **(b)** 14 **(c)** 1000

Question 20

(a) Generally well answered, with the required interval described properly.

(b) Generally well answered. A few candidates used the interval width in their numerator, and some divided by 4.

Answer: **(a)** $20 < n \le 40$ **(b)** 37.5

Question 21

(a) Generally well answered although some candidates left their final answer as $\frac{16}{1}$.

(b) Generally well answered although some candidates left their final answer as 4^2.

(c) Candidates struggled more with this part. The strategy pursued by most candidates was to find the square root of each term first, accepting at this stage terms such as $4^{\frac{1}{2}}$. However many made errors, a common one being $\sqrt{y^9} = y^2$.

Answer: **(a)** 16 **(b)** 16 **(c)** $\frac{2y^4}{x}$

Question 22

(a) Most candidates recognised triangle *BOC* as isosceles and correctly found the required angle.

(b) The connection between angle at the centre and angle at the circumference was often seen.

(c) Candidates struggled more with this part. Many candidates were able to find the facts needed for congruency without actually establishing it. A lot of attempts at showing that the stated triangles were congruent used the angles at the circumference, at *A* and *D*, together with the vertically opposite angles at *E* and the equal sides, *AB* and *CD*. Unfortunately, this is not a case of congruency, so full credit could not be given. Likewise, merely listing all the possible equal angles (and often stating sides that could not be shown to be equal, such as *DE* and *AE*) was not a demonstration of congruency, and so could be given limited credit only. In constructing geometrical arguments of this nature, attention should be given to the use of appropriate notation. It was not always clear, for example, what letters such as *EAB* were referring to. Was it the triangle *EAB* or the angle *EAB*?

Answer: **(a)** 140° **(b)** 70°

Question 23

(a) (i) The relevant multiplication was usually calculated correctly.

(ii) This part was less successful and the calculation often went astray. Credit was given for a relevant calculation of a 20% increase. A common error was to apply this increase to the answer to part **(i)**.

(b) This was generally well answered. The common error was to use multiplication.

Answer: **(a)(i)** 560 **(ii)** 76.80 **(b)** 150

Question 24

(a) This was mostly accurate.

(b) Again, this was accurately answered by most candidates.

(c) (i) Most candidates substituted the correct values of x and y into the given equation. However some candidates then had problems solving it.

(ii) Less success was seen here, and a fair proportion of candidates omitted this part.

Answer: **(a)** (0.5,4) **(b)** 1.2 **(c)(i)** 4 **(ii)** **-** 1.5

Question 25

(a) Generally well answered, although after the brackets had been removed, there was some difficulty in grouping the terms appropriately in order to solve the equation. The actual removal of the brackets was not always successful. For a few candidates their first step was 7(2x – 1), or 10 – 6x – 1.

(b) Generally, sensible multiples of the given equations were found from which one variable could be eliminated. Since the value of y was negative, care was needed to achieve this. A common error was to do basically correct arithmetic, but to find that y was positive.

Answer: **(a)** $1\frac{1}{3}$ **(b)** $x = 5$, $y = -3$

Question 26

(a) Since the answer was given in the question, it was essential to see that the area of the rectangle was the product of its length and width and how this led to the equation given. So it was expected to see $(2x + 3)(x – 1) =12$ in order to gain the method mark, and at least $2x^2 +3x – 2x – 3 =12$ in the working leading to the given conclusion.

(b) Both approaches, factorisation, which was expected, and the quadratic formula, needed care in order to achieve full marks.

(c) It was expected that candidates would use their positive value from part **(b)** to calculate the perimeter of the rectangle. With only one mark available, no credit could be given for an answer left as an algebraic expression.

Answer: **(b)** 2.5, - 3 **(c)** 19

MATHEMATICS

Paper 4024/21
Paper 21

Key Messages

To succeed in this paper candidates need to have completed full syllabus coverage, remember necessary formulae, show all necessary working clearly and use a suitable level of accuracy.

General comments

There was a wide spread of ability evident on this paper. There were some excellent scripts presented in which candidates demonstrated a firm grasp of the concepts and an ability to express their knowledge and understanding clearly and accurately. However some candidates struggled to understand the concepts and did not demonstrate connected thoughts.

The new format of the papers was welcomed, and did not appear to cause any difficulties for the candidates. Almost all used the available space sensibly, and it encouraged them to set out their answers in a manner that was easy to follow. Solutions were not cramped, as was often the case in the past, and meant that answers did not appear in two, or more, columns.

Comments on specific questions

Question 1

There was a good response to this arithmetic question. However some answers were spoiled by not dealing with the precise demands of the question.

(a) This part was usually well answered, although a few candidates felt the need to quote this exact answer correct to three significant figures, and others multiplied their answer by 4. Some took 5¼ hours to be 325 minutes.

(b) Very many candidates knew that division was expected here, but the cost was often given as $20 per sheet rather than the correct $0.05. Perhaps candidates should have realised that $20 per sheet was not a reasonable value. For the next part it was expected that the other cost per page ($0.0485) would be calculated and that a conclusion would be drawn, although other methods were available. A few obtained $0.0485, rounded it to $0.05, and then deduced the costs were the same.

(c) There were many excellent answers to this reverse percentage question. The best approach was to find the full price of the system ($1335) and then subtract $445. However some added 15% of the discounted price and some thought 100% - 15% = 75%, but they could still earn method marks.

Answers: **(a)** 37.35 and A **(b)(i)** 0.05 **(ii)** Large **(c)** 890

Question 2

There were some very good solutions to this coordinate geometry question.

(a) The majority of candidates correctly found the midpoint.

(b) Most candidates found the gradient of the line, but many did not succeed in finding the constant term of the equation. It was expected that the coordinates (-2, -9) would be tested in the calculated equation, but many correctly considered the gradient of the line from (-2, -9) to *C* or *D* instead. A conclusion was required.

(c) Candidates struggled more with this part. Some confused the axes, reaching (0, 3¾). Only a minority knew how to find where $y = p$ cuts the given line. Few candidates were able to draw the line $3x + 2y = 30$ on the grid, but a few gained some credit for finding the intersection by solving the simultaneous equations using algebra.

Answers: **(a)** (7, 9) **(b)(i)** $y = 2x - 5$ **(ii)** Yes **(c)(i)(a)** (-5, 0) **(b)** $(\frac{4p-15}{3}, p)$ **(ii)** (5, 7½)

Question 3

There was a good response to this question on the whole.

(a) Although the sine rule was often used, many realised that this was most simply solved by using the tangent ratio in the right angled triangle. When finding the volume of the similar pyramid, some incorrectly used a factor of 4, a few used 4^2 but many used the correct 4^3 to obtain 192 cm³. A few became muddled and cubed the volume of 3 cm³.

(b) A few candidates converted \$110 into pounds, but most did convert £46.62 into dollars, usually correctly but a few did multiply by 0.45. Some rounded \$103.60 and lost accuracy in their answer.

(c) There were very many correct answers to this problem, but a few treated it as direct proportion and reached an answer of 50 hours.

Answers: **(a)(i)** 10.6 **(ii)** 192 **(b)** 6.40 **(c)** 18

Question 4

(a) Some candidates realised that they were expected to show how these two equations are produced from the information given in the physical situation. However many solved the equations here and then repeated the work in the next part.

(b) The solution of the simultaneous equations was well done generally, with very many correct solutions seen.

(c) Only a small number of candidates attempted to find areas. Since each garden is surrounded by the same number of slabs, the difference between the areas of the gardens is the same as the difference between the areas of the two plots, so it did not matter that some were confused about which areas were to be considered. The final answer was more likely to be correct when lengths were first corrected to metres before finding areas. In other cases 5600 cm² often became 56 m².

Answers: **(b)** $x = 40$, $y = 70$ **(c)** 0.56

Question 5

(a) The product of two matrices and finding the inverse were very well done by the majority of candidates.

(a) This part on vectors was also very well answered.

(c) Candidates struggled more with this part. The printed grid was not always used efficiently. Although most found the vector $\overrightarrow{TU}$, V was not always plotted correctly, so the coordinates were wrong. Finding the area of triangle *TUW* was a problem for many candidates. Only a few found the areas of a surrounding rectangle and subtracted the areas of triangles to be removed from that area, or some similar method. Correct answers were also obtained after finding the lengths of the three sides and either solving the triangle to find an angle followed by the use of ½*ab* sin*C* or by using Hero's formula. Those candidates who obtained the correct answer were to be commended for their perseverance.

Answers: **(a)(i)** $\begin{pmatrix} -10 & -4 \\ 15 & 7 \end{pmatrix}$ **(ii)** $\begin{pmatrix} -0.5 & -1 \\ 1.5 & 2 \end{pmatrix}$ **(b)(i)** 13 **(ii)** $\begin{pmatrix} 8 \\ 6 \end{pmatrix}$ **(c)(i)** $\begin{pmatrix} -5 \\ 2 \end{pmatrix}$ **(ii)** (18, 9) **(iii)** 22

Question 6

Once again the transformation question was not well done. This is an area of the syllabus that needs more attention.

(a) (i) Full descriptions of the transformations were required without reference to any other transformations. The scale factor of the enlargement was often wrongly stated to be -3.

(ii) The coordinates of the points onto which *A* was mapped were rarely correct. Candidates would probably have found it easier if they had used the given grid to find the points.

(b) Very many were able to name the kite, but the grid was rarely used to help find the point (*p*, *q*). Although it is not on the printed grid, the answer (4, -1) was also seen and accepted.

Answers: **(a)(i)(a)** Translation $\begin{pmatrix} 1 \\ -5 \end{pmatrix}$ **(i)(b)** Enlargement, centre (6, 4), scale factor 3 **(ii)(a)** (-1, -2) **(ii)(b)** (–1, 0) **(b)(i)** Kite **(ii)** (1, 3) and (4, 2)

Question 7

This was a popular question with some good scores. Although a lead was given suggesting how to set about the solution, candidates showed that there are many different orders in which the last four answers can be found. However they must be aware of circular arguments that assume a value which is later claimed to have been proved. This was particularly true in part **(b)**.

(a) The cosine rule was well known and very often used to obtain a correct answer.

(b) It was expected that the distance would be quoted as 16 cos25 or 16 sin65 to obtain the given value, but some validly found angle *ACB* and then used the length of *AC*.

(c) (i) There were good answers seen here, although a few candidates thought 16 to be the distance between the parallel sides.

(ii) Several correct methods were seen here, although Examiners were expecting to see ½ ×14.5 × 28.

(iii) Some used the area of triangle *ACD* or the sine rule in triangle *ACB* or the fact that sin *CAD* is 14.5 divided by *AC* to obtain the required angle. A few mistakenly thought that angle *ADC* is 65°.

Answers: **(a)** 30.4 **(c)(i)** 28 **(iii)** 28.4° to 28.5°

Question 8

This was a less popular question, although there were several good solutions.

(a) Many were able to use Pythagoras' theorem to produce the quadratic equation, which was often correctly solved. Both answers were required correct to 1 decimal place. For the length of the side a numerical value was expected from the positive root, and not just *y* + 9.

(b) The majority of candidates were able to show the first result convincingly, but were less successful when finding angle *OQS*. It was anticipated that the two results would be used to form the given equation, but many thought that they were being asked to solve the equation at once. Many of those who obtained x = 18 in that part went on to find some other value for angle *QTO* in the last part of the question.

Answers: **(a)(ii)** 12.5 or – 4.5 **(iii)** 21.5 **(b)(i)(b)** ½ (90 + x) **(ii)(b)** 18°

Question 9

Although this was one of the less popular choices, many of those candidates who did select this question demonstrated a good knowledge of the statistics required.

(a) There were good histograms drawn by those who chose to mark frequency density on the vertical axis. Most had outside columns twice the width of the central three. Most gave a sensible estimate in part **(ii)** and the correct interval in part **(iii)**. Some had errors in the probability, since they thought there were only 28 potatoes with a mass of less than 150 grams.

(b) Very many correct solutions for p were seen. Where solutions went wrong it was usually due to the use of the interval widths of 50 in place of the mid-interval values. A very small number of candidates used mid-intervals at 124.5, 174.5 and 224.5, when method marks were still allowed.

(c) The first probability was usually given in the expected form. There was a very good response to the second probability with very many candidates using their value of p and their answer to part **(a)(iv)**.

Answers: **(a)(ii)** 14 to 16 **(iii)** $200 \leq m < 250$ **(iv)** $\frac{7}{20}$ **(b)** 35 **(c)(i)** 1 **(ii)** $\frac{49}{750}$

Question 10

This test of mensuration was probably the least popular question in ***Section B***. It required some careful thought and was a searching test for candidates, although several excellent solutions were presented. Candidates needed to consider the meaning of their answers, and when it was necessary to round them down to integer values.

(a) Candidates needed to divide the total length of wick by the length in each candle, and then to round down to an integer. Several had difficulty adding 12 mm to 5 cm however, although a method mark was still available.

(b) (i) The length of wick inside the candle is 5 cm, not the 6.2 cm assumed by many candidates in spite of the emphasised wording of the question. Again the conversion from centimetres to millimetres caused some difficulties.

(ii) (a) The majority of candidates were able to find the total volume of each candle but many of these did not subtract the volume of the wick. It was easier to use the given 0.2 cm³ than to work it out using the answer to the last part.

(ii) (b) Candidates were expected to divide 3000 by their previous answer, rounding down to the next integer. Working was followed through strictly, so if the answer to the previous part was wrongly left as 56.7 cm, then the answer to this part should be 52.

(ii)(c) The length required is 1 cm more that the circumference of the base of the candle, but many did try to use the area of the base.

Answers: **(a)** 32 **(b)(i)** 1.13 **(ii)(a)** 56.5 **(b)** 53 **(c)** 12.9

Question 11

This was another popular question which was reasonably well attempted in most cases, although more attention to details could have led to better scores for some.

(a) The majority of candidates clearly understood what was needed to interpret the speed-time graph. The total time taken for the journey presented few problems. The need to use hours in the next two parts caused some problems. The simplest method to find the acceleration is to use the fact that the speed has increased by 60 km/h in $1/6$ h. At maximum speed he travels for $1/12$ h at 84 km/h.

(b) The main problem with the distance-time graph arose from candidates not reading the scale of the vertical axis correctly. The point (8.23, 22) was very often plotted at (8.23, 21). Many candidates expected to have a graph similar to that in part **(a)**, finishing on the time axis. The results of the two calculations, following through where possible, were often correct.

(c) Credit was often lost in the first part due to candidates not quoting the answer to the expected two decimal places. It should be emphasised that a solution by drawing is not acceptable when a calculation is demanded, and is unlikely to give the demanded accuracy anyway. Measurement on the given diagram was expected for the final two parts however, and many accurate answers were seen.

Answers: **(a) (i)** 35 **(ii)** 360 **(iii)** 7 **(b)(i)** 10 **(iii)** 20 **(c)(i)** 12.29 **(ii)(a)** 247° **(b)** 10.2 to 10.7

MATHEMATICS

Paper 4024/22
Paper 22

Key Messages

To succeed in this paper candidates need to have completed full syllabus coverage, remember necessary formulae, show all necessary working clearly and use a suitable level of accuracy.

General comments

The new format did not appear to cause any difficulties for the candidates with the available working space generally being used sensibly and the work being set out in a way that was easy to follow.

The paper appeared to be of an appropriate length with most candidates completing the required four Section 'B' questions. There was a slight concern that a small number of candidates who did not complete the last question had not noticed the instruction to turn over at the foot of page 23.

The presentation was generally good, although a small number of candidates did all their working in pencil and then either inked over it or left the working in rather indistinct pencil and inked in just the answer, or, on some occasions, erased all their working - inevitably losing any chance of gaining method marks.

Although in one or two of the one mark questions the answer could be written down without working e.g. **Question 3(a)** and **Question 4(a)(i)**, it was slightly worrying that other answers, which clearly needed a number of steps, were written down without any evidence of working. Candidates were clearly ignoring the instruction "If working is needed for any question it must be shown in the spaces below that question". Candidates should be aware that they will lose marks if they do not show the relevant working.

In both graph questions, **Question 9** and **Question 12**, a small number of candidates ignored the instruction to 'draw a smooth curve' and used a ruler to join the points. Quite a large number of candidates lost marks by not reading the question carefully. For example in **Question 3** they ignored the instruction to give the answers as fractions in their simplest form and in **Question 9(d)(ii)** to give each answer correct to 2 decimal places.

Candidates should be made aware of the statement on the cover page of the question paper, that "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" They should also take special care in transferring the final result in their working to their response in the answer space.

Candidates should also be reminded that when a method involving several stages is used, especially when Pythagoras is one of the stages, it is imperative that they keep intermediate answers to at least 4-figure accuracy, and make full use of the memory function on the calculator.

Comments on specific questions

Question 1

(a) (i) This was often answered correctly, although the final answer was sometimes given with the x appearing as a power of the 10, or in the numerator. Many took a common denominator of $10x^2$ and correctly evaluated the numerator as x, but then did not simplify.

(ii) The majority of candidates used the correct common denominator. Most arrived at $4(x – 3) + 7x$ as the numerator, but many were unable to reduce this to its simplest form, with many strange 'cancelling' methods used. A few started off with a denominator of $x^2 – 3$ or $x + x – 3$.

(b) (i) This part was almost always correct.

(ii) Many candidates knew how to find the inverse expression, but a significant number were unable to progress from $\frac{1}{2}(4x + 3)$ to $c = 2$ and $d = 1.5$, not realising that c was the coefficient of x and d the numerical term.

(iii) Most of those who started by correctly equating $\frac{1}{4}$ $(2g - 3)$ and $-g$ were able to reach 0.5 although a number went from $6g = 3$ to $g = 2$ or ⅓.

A significant number of candidates solved $g = \frac{2(-g)-3}{4}$ and a few tried to solve equations with mixed variables such as $-g = \frac{1}{4}$ $(2x - 3)$.

Answers: **1(a)(i)** $\frac{1}{10x}$ **(ii)** $\frac{11x-12}{x(x-3)}$ **(b)(i)** 0.25 **(ii)** $c = 2$, $d = 1.5$ **(iii)** 0.5

Question 2

(a) (i) Most candidates made a good attempt at this part. The usual difficulty was in the handling of the $\frac{1}{2}$ h. Occasionally $\frac{2A}{h}$ $- d$ in the last line of working became $\frac{2A-d}{h}$ in the answer space. A number of less able candidates substituted values from part **(ii)**.

(ii) This part was usually answered correctly. Less able candidates made errors in multiplying out brackets and a few interpreted 22 cm^2 as 22^2.

(b) This proved to be one of the more challenging parts of the paper with many candidates not having a full understanding of the work on upper and lower bounds, not appreciating what was meant by a measurement being given to the nearest centimetre.

(i) A large proportion of candidates found the perimeter using 32 and 20 (reaching 104) and then subtracting 0.5, giving 103.5 as their answer.

(ii) Similarly in this part many calculated (32 × 20) – (26 × 14) and gave their final answer as 276.5. Most candidates realised that they should subtract the inner area from the outer to find the area of the frame but a large proportion of these used the upper bound dimension values in calculating both areas and obtained the very common wrong result of 282. Only a very small number realised that they should use the lower bounds in finding the inner area.

Answers: **(a) (i)** $\frac{2A}{h} - d$ **(ii)** 3 **(b) (i)** 102 **(ii)** 322

Question 3

(a) Apart from a small number of candidates who left their answer as $\frac{2}{6}$, almost all candidates were successful.

(b) (i) Many assumed replacement and evaluated $\frac{1}{6} \times \frac{3}{6} \times \frac{2}{6}$. A few added the fractions instead of multiplying.

(ii) Again, a large number of candidates assumed replacement and arrived at an answer of $\frac{5}{36}$. Some correctly arrived at values of $\frac{1}{20}$ for ANN and $\frac{1}{10}$ for ANA but then either did not add them, added them incorrectly ($\frac{1}{20}+\frac{1}{10}=\frac{2}{30}$ was seen several times) or multiplied them.

Answers: **(a)** $\frac{1}{3}$ **(b) (i)** $\frac{1}{20}$ **(ii)** $\frac{3}{20}$

Question 4

Some candidates were unfamiliar with the suffix notation and used, for example u_n for n. Some used the expression $a + (n–1)d$, often without simplification.

(a) This was generally well answered, the sequence in part **(ii)** usually following on from their answer to part **(i)**. $u_n = n + 3$ was the most common incorrect answer.

(b) (i) Answers involving n and/or –2 were common, but it was relatively rare to see $–2n$.

(ii) Most candidates attempted this part by multiplying their earlier expressions, but relatively few were able to get to the correct answer. Many did a lot of work to no avail. Very few selected just the terms in n. A few used corresponding terms (usually the first) to obtain an expression such as $4 \times 15 = 17 + k\text{x}1 – 6 \times 1^2$, which was usually solved correctly.

Answers: **(a) (i)** $3n + 1$ **(ii)** 61 **(b) (i)** $17 – 2n$ **(ii)** 49

Question 5

A wide range of marks were gained on this question as even the least able candidates were able to gain some credit and yet the most able sometimes struggled with the last part. Most errors arose either from misreadings of the axes, particularly the ‘time of day’ axis, or from assuming that there were 100 minutes in an hour.

(a) This part was almost always correct.

(b) This was generally well answered, but there were many answers of 78, from candidates who gave each small division a value of 6 instead of 3. A second common incorrect answer of 79 arose when candidates tried to subtract the correct scale readings of 13 15 and 12 36 but assumed 100 minutes to the hour.

(c) A small number of candidates confused the location and gave the distance from home, but overall this part was well answered.

(d) The return journey was quite often taken to be $1\frac{1}{4}$ hours instead of $\frac{3}{4}$ hour, producing an answer of 14.4. A few candidates gave the answer as 0.4 i.e. in km/minute rather than km/hour.

(e) There seemed to be some misunderstanding of this part. Some calculated the speeds for the different sections and then named the two sections with the slowest speeds.

(f) The majority of candidates correctly found Salim’s time to the shopping centre, but many then took this time from 1 hour 36 minutes to give the common wrong answer of Salim arriving 24 minutes before his brother, ignoring the fact that Salim started his journey 15 minutes later than Ravi.

Answers: **(a)** 11 30 **(b)** 39 **(c)** 8 **(d)** 24 **(e)** park and shopping centre **(f)** Salim, 9

Question 6

Attempts at this question were usually very good, with some of the less able candidates gaining a good proportion of their marks here.

(a)(b)(c) The success rate in the first three parts was very high, candidates handling well the proportionality between the sector angles and the income of the five employees. Usually the required incomes and the angle were found directly from 270 × 5 in part **(a)**, $\frac{1}{6}$ of their answer to part **(a)** for part **(b)** and $\frac{405}{(a)} \times 360$ for part **(c)**. Occasionally candidates used areas with rather less success. A quite common error in part **(c)** was to assume that Carol and Brian made up half the circle thus producing an answer of 120°.

(d) This was usually answered correctly although occasionally candidates would get as far as 80° and give that as their answer, while others stopped at £450.

(e) Again, many correct answers were seen, with just a few taking off the 20% correctly, but then finding 6% of the £216. A small number found 26% correctly, but then left this (£70.20) as their answer.

(f) There were many good attempts at this part, using one of a number of methods, although at times it was difficult to follow the working shown. The usual errors were in simple arithmetic; in calculating x% of £324 instead of £450 or in assuming that the deductions were £287.55 instead of £450 – £287.22.

(g) There were many who made the predictable error of finding 92% of £270 and the answer £248.40 was very common. A smaller number realised that they should be working with 108 but then multiplied by $\frac{108}{100}$ instead of the reciprocal.

Answers: **(a)** 1350 **(b)** 225 **(c)** 108° **(d)** 300 **(e)** 199.80 **(f)** 9 **(g)** 250

Question 7

(a) (i) Almost all candidates gave the answer 2, although just a few wrote either 6 or 1.

(ii) Attempts at this part showed that many candidates had little, or no, understanding of vectors. Of those who did have some understanding, it was common for them to assume that $\overrightarrow{DC} = \mathbf{r}$, $\overrightarrow{BC} = \mathbf{q}$ or $\overrightarrow{YB} = \frac{2}{3}\mathbf{p}$.

(a) **r** – **q** was regularly seen although there were many correct answers to this part.

(b) There were relatively few correct answers to this part. After correctly adding –**q** to 2**p** for the first two stages of the journey from F to C, many then assumed that $\overrightarrow{DC}$ was +**q** and ended with an answer which simplified to 2**p**.

(c) Many thought that $\overrightarrow{AY}$ was $\frac{2}{3}$**p** and others, who correctly recognised the ratio 3:1, forgot the vector 2**p** and gave the answer as –**r** + 3.

(d) There were very few correct answers to this part, with many assuming $\overrightarrow{BC}$ to be **r** or/and $\overrightarrow{CX}$ to be $\frac{1}{2}$**q**.

(b) There were more successful attempts at this part of the question and many candidates gained all three marks. A few assumed that all the interior angles of the hexagon were equal, even though one was shown as 140° and others took *PS* to be parallel to *UT*.

Answers: **(a)(i)** 2 **(ii)(a)** $\mathbf{q} - \mathbf{r}$ **(b)** $2\mathbf{p} - \mathbf{q} - \mathbf{r}$ **(c)** $\frac{3}{2}\mathbf{p} - \mathbf{r}$ **(d)** $\frac{1}{2}\mathbf{p} - \mathbf{q} + \frac{1}{2}\mathbf{r}$
(b)(i) 45° **(ii)** 95° **(iii)** 80°

Question 8

(a) Errors were made in both parts, but these were almost always arithmetical.

(i) The most common error here was in calculating the fourth element, 2 – (–2), as 0 rather than 4. Others gave –2 – (–3) as –5.

(ii) Very many correct answers were seen with the most common errors appearing in the calculation of the determinant with –2, 22 or –22 all appearing fairly frequently. A few candidates simply gave the adjoint as their answer.

(b) (i) The most common error was to give x = 1 as the mirror line. Less able candidates had difficulty with the language and phrases such as 'mirror image', 'along the line' or 'parallel to the x axis' were often seen instead of the accepted expressions.

(ii) Many candidates correctly wrote 'enlargement' although a few described it as 'diminished', 'shrink' or 'magnification.' The usual errors were in giving the wrong coordinates for the centre of enlargement after drawing lines on the diagram or in giving the scale factor as 2, –2 or –½.

(iii) There were rather fewer correct answers to this part with reversed coordinates or answers of (–3, 2), (–5, 4) and (–7, 4) being fairly common.

(iv) Most candidates recognised this as a rotation but a significant number did not give both the centre and the angle of rotation.

Answers: **(a) (i)** $\begin{pmatrix} 3 & 2 \\ 1 & 4 \end{pmatrix}$ **(ii)** $\begin{pmatrix} -1 & -2 \\ 1.5 & 2.5 \end{pmatrix}$
(b) (i) Reflection in the line y = 1 **(ii)** Enlargement, scale factor ½, centre (–5, 0)
(iii) (–2, 3), (–4, 5), (–4, 7) **(iv)** Rotation, 90° anticlockwise about centre (0, 0)

Question 9

This was a very popular question and the majority of candidates gained good marks.

(a), (b) Very many excellent curves were drawn after candidates correctly calculated the two values required in part **(a)**. However some candidates did not check their answers to part **(a)** when their results gave a graph that was clearly not a quadratic.

(c) This proved to be the most difficult part of the question, particularly the first two parts.

(i) Many gave just one solution, some gave coordinates and a few tried to solve algebraically.

(ii) Candidates struggled with this part. The curves usually had y = –6 as the minimum value and this was the value given as their answer to this part. Few realised that the curve must go below this line for symmetry.

(iii) Most candidates attempted to draw the tangent, but some of these did not find an acceptable value for the gradient.

(d) (i) Many candidates showed a good understanding of what was required here and realised that they should equate the two expressions for *y*. Occasionally slips were made, and some candidates tried to 'fiddle' the given result, but most were successful.

(ii) Candidates were usually successful in gaining either 3 or 4 marks. The quadratic formula was applied efficiently and the most common error was not giving the answers correct to 2 decimal places. A small number made arithmetical errors, either using 3 instead of –3 or 8 for $\sqrt{65}$ or similar.

Answers: **(a)** –5, –6 **(c) (i)** –2.2 to –2.35 and 1.65 to 1.85 **(ii)** –6.4 ≤ ans < –6.0
(c)(iii) 8 to 10 **(d) (ii)** 1.27 and –2.77

Question 10

(a) (i) This part was almost always correct, with most candidates recognising that it was 90 minus the given angle of 15.

(ii) Those candidates who used the cosine rule were mainly successful, although the usual errors of adding instead of subtracting, or of using $A - B\cos C = (A - B)\cos C$ occurred quite regularly. Other candidates split the triangle *SCB* into two right-angled triangles and if they realised that the given length 300 referred to *BS*, and not from *S* to the point where the horizontal line from *C* met *BS*, they were largely successful.

(iii) There was some confusion as to which was the required angle. Some attempted to find the angle *CSB* and others *SCB*. Those who did appreciate which angle was required had a good choice of method to use and many were successful providing that they realised which length was *SB*.

(b) (i) There were few problems here, with many candidates having already found the required length in part **(a)**. A few applied the wrong ratio and found *CD*.

(ii) This was well answered by the majority of candidates, although a few worked out $\frac{1}{2} \times 200 \times 250$ sin30, producing the fairly common answer of 12500.

(iii) More able candidates recognised that *DN* was the diameter of the circle, but a few were confused and answers such as 450, 241.5 and 120.9 were seen.

Answers: **(a)(i)** 75° **(ii)** 337 **(iii)** 44.3° **(b)(i)** 241 **(ii)** 12100 **(iii)** 225

Question 11

This was the least popular question, with many candidates not coping well with the first part. Many candidates started this and then abandoned the whole question.

(a) Those candidates who realised that the heights were $\frac{1}{3}H$ and $\frac{2}{3}H$ were usually successful, although most worked with *h* and 2*h* and never introduced *H*. A few who started with the two expressions for the volume were unable to combine the two fractions.

(b) (i) Most used Pythagoras to show the result correctly. A few tried to solve using volumes or surface areas instead of lengths.

(ii) A very small number of candidates used the formula for area, but most of those who attempted this gained the 2 marks.

(iii) Candidates coped well with this quite difficult concept. The approach using arc length was slightly more popular than that using areas, but many of those who had the right idea were able to complete the proof correctly. A few equated an area to an arc length, and a few confused the radii 10 and 18.

(iv) A few attempts at volumes were seen, but generally $2\pi rh$ and πrl were used. Some candidates did not realise that $h = 30$, but the most common mistake was to add in two or three circular areas, because candidates remembered the formulae for the total surface areas of the cone and the cylinder.

Answers: **(a)** $\frac{7}{9}\pi r^2 H$ **(b)(ii)** 62.8 **(iv)** 2760

Question 12

(a) This part was almost always correct.

(b) (i) Candidates generally used the scales stated - just occasionally the horizontal scale was halved. A more common error was to have an almost correct horizontal scale except for the spacing between 100 and 120 minutes being halved. Occasionally the curve was drawn from (70, 24) to the intersection of their axes, which was not necessarily the point (60, 0). Nevertheless the quality of the graph work was generally good and an acceptable ogive was drawn despite the occasional plot being slightly out.

(ii) Most candidates knew how to find the median and the interquartile range and many gained all 3 available marks. Part **(c)** proved to be a little more challenging and many found the percentage of students who took 'less than 95 minutes' rather than 'at least 95 minutes'.

(iii) (a) Many candidates did not appear familiar with the term '20th percentile' and read off the value of 69, working from 20 on the vertical scale.

(b) This was often answered correctly although many gave their answer as 75% (not subtracting from 100) or 225 (by reading from 95 on the horizontal scale).

(c) Candidates were expected to use either the percentage of students taking at least 95 minutes or the medians to make their comparisons and then to make a statement about the two tests. Many simply wrote about the number of students or the time taken and even then did not make it clear which test they were referring to.

Answers: **(a)** 220, 288, 312, 320 **(b)(ii)(a)** 83 to 85 **(b)** 13.5 to 16.5 **(c)** 15 to 19%
(b)(iii) (a) 76 **(b)** 25%