MATHEMATICS

Paper 0980/12
Paper 12 (Core)

Key messages

When reasons and explanations are required in questions more details, rather than vague statements, are needed.
The four rules, when applied to directed numbers, need strong emphasis in preparing candidates for the examination.

General comments

This paper gave all candidates an opportunity to demonstrate their knowledge and application of mathematics. Most candidates completed the paper, making an attempt at most questions. The presentation of work was generally good and most candidates showed clear working where required. Premature rounding in calculations was sometimes seen.

Comments on specific questions

Question 1

Most candidates were able to find the correct order and combination of digits but there were a number of common errors. The digits 0 and 7 reversed and 0 omitted were the most common. A small number gave the answer as three separate numbers, 600,7 000,532.

Question 2

Parts (a), **(b)** and **(c)** of this question were well answered. In **part (a)** 65 was occasionally seen for a square number while incorrect choices for multiples of 13 and factors of 186 were most often from mixing up 62 and 65. **Part (d)** was not so well answered with many candidates just giving one prime number and a small number quoting three or more numbers as primes or even all the odd numbers.

Question 3

The drawing of a congruent triangle was well done with only a small proportion of candidates drawing an enlarged triangle. Good, clear ruled triangles were generally seen with few making errors on accuracy. Rotations and reflections, although not needed, were usually still well drawn. Only a few candidates did not use the grid lines.

Question 4

(a) Stem-and-leaf diagrams were understood by many candidates. The answer 2 was seen at times from those who just considered the 30 line.

(b) Generally those who gained credit in **part (a)** also found the mode correctly. Some attempts at both mean and median were seen. A common incorrect answer was 9, which showed recognition of the most common but lacked interpreting the diagram correctly.

Question 5

Candidates who followed the instructions of the question to repeat the example with the new values usually gained full credit. Missing out a step or not doubling both numbers was seen. Some did not follow the defined method and simply finding the result of the calculation did not earn credit.

Question 6

There were many responses that focused on the two required reasons and gave enough description to earn credit. It was the width, or an equivalent word, of the bars that was required and not 'coffee was larger'. Specifying the actual widths, 2 and 3 also made that reason clear. Simply stating that the scale was wrong was not enough; it needed some detail about the scale not having equal intervals. Some chose to specify missing items such as a title or not enough candidates or drinks surveyed.

Question 7

(a) The placing of the brackets in this part was correct for the vast majority of candidates.

(b) This part was far more challenging, but a significant number of candidates did work out correctly that it was just a single number to be bracketed. A few included the index in the bracket. Otherwise, there were many attempts at different positions of the brackets.

Question 8

This question was answered correctly by very nearly all candidates. The most common incorrect answers were 5 or −5 although occasionally 12 was seen.

Question 9

(a) While there was a good response to the sector angle, a significant number followed the fraction by nothing or multiplying by 100 which led to a percentage rather than an angle. Some tried to calculate the area of a circle. A small number, realising an angle was required, multiplied the fraction by 180 instead of 360.

(b) It was rare for an answer of 'yes' followed by an explanation, however simple, not to gain credit. Very occasionally, an explanation seemed to contradict that the sector angle for red had changed. Some felt that no cars leaving the car park meant the angles for them did not change, even though there were more cars present. Just a calculation of the new angle for red cars without a worded reason did not gain credit.

Question 10

(a) The vast majority of candidates understood the method for subtracting vectors and usually this part was correctly answered. The main error seen was not on vector operation, but in working out $2 - (-1)$ which was often given as 1.

(b) More correct responses were seen than in **part (a)** since negative numbers were not involved and the multiplications were basic. A few added fraction lines in the answer and some regarded the answer as if it was a fraction and so reduced to its simplest form.

Question 11

Although many candidates understood how to find the surface area, with considerable success, many confused volume and surface area, resulting in the often seen $8 \times 6 \times 3$. A number of responses had the addition of the three distinct areas but without doubling the result. Drawing a sketch was a help for many correct solutions. Common errors were to find four of one area with two of another or a square cross-sectional area.

Question 12

(a) While there were quite a number of correct expressions for the cost of one bag, many could not take the step from a numerical question to the same process with letters. Multiplication of the letters and division the wrong way round was often seen. The difference between an expression and an equation caused a lot of candidates to not gain credit.

(b) Most candidates realised that the expressions rx and ay were part of the solution, and usually they added them. Most errors then occurred in the expression for the change from \$20. Subtracting \$20 instead of subtracting from \$20 was seen at times but the major error was from no brackets around the whole expression for the cost, or without brackets adding, rather than subtracting, ya. Some had expressions which did not include all the letters, often $20 - x - y$ which showed weakness in translating a numerical question to an algebraic expression. Again, an equation was often seen, usually $20 = rx + ay$.

Question 13

(a) This question was well answered with most performing a single calculator operation leading directly to the whole number. The errors came when answers were found, and usually written down, for the square roots separately. Rounding then produced an inaccurate answer.

(b) This question testing understanding of using the calculator to find cube roots generally resulted in partial credit. However, a significant number of candidates thought the index meant division by 3. Others just ignored the index and tried to apply 2 decimal places to the figures 6789. Many candidates didn't round to 2 decimal places or gave an incorrect rounding, often truncating to 18.93.

Question 14

The first stage in this ratio question was to change the numbers in standard form to ordinary numbers and most candidates did this correctly. Once past this stage there were many correct ratios but most were not in the simplest form.

Question 15

(a) The terms of the sequence were found correctly by most candidates, and a partially correct answer was rarely seen. Some assumed the first term was for $n = 0$ instead of $n = 1$. More usually errors came from incorrectly working out the expression or simply writing algebraic expressions for the terms such as n, $n + 1$, $n + 2$.

(b) Showing 5196 was a term in the sequence was quite well done. Most candidates either worked through the equation to find $n = 72$ or showed that $72^2 + 12$ did equal 5196. Worded descriptions were common but did not always gain full credit. Incorrect methods seen were square rooting or squaring 5196 as well as adding 12 or dividing by 12. Some stated the number was too big to be in the sequence.

Question 16

The question stated that there were two irrational numbers and so both were required to gain credit. While some did correctly identify the two numbers, it was clear that many did not understand irrational numbers. Most found one correctly, either π or $\sqrt{3}$.

Question 17

The rules of indices were well understood and credit was gained by the majority of candidates. A small number of candidates thought the indices had to multiply to give 12, rather than add. Only a few candidates made the error of giving the answer as 9^{10}.

Question 18

Most candidates understood what was required in this question but many responses included trailing zeros. For example, 2.0 instead of just 2 and 0.050 instead of 0.05 were common. Otherwise, the rounding error of 850 instead of 800 was particularly common. Quite a number simply worked out a calculator answer for the sum as it stood.

Question 19

This limits question was not well answered. The error of adjusting by 0.5 rather than 0.05, leading to 30.2 and 31.2 was very common. Some candidates reversed otherwise correct limits. Further misunderstanding of the inequality signs saw quite a number of upper limits of 30.74.

Question 20

(a) Most candidates gained at least partial credit simplifying the algebraic expression. Most could expand the brackets correctly but some worked out $-3b - b$ as $-2b$. Other incorrect combinations of letters and numbers occurred in simplifying.

(b) Apart from those with no understanding of factorising, this was answered very well. With only one factor, an algebraic one, most were successful in finding a correct expression in the brackets.

Question 21

There were many fully correct answers but a few candidates were unsure of the difference between lowest common multiple and highest common factor. Working with tables or factor trees was generally good although some did not realise the factors had to be primes. Lists of multiples were often successful but errors did occur. Some gained credit by giving a multiple of the LCM.

Question 22

Candidates found this reverse bearings question challenging. Very few knew that they had to add 180 and the diagram did not seem to help. 180 – 59 was a common incorrect calculation which indicated no realisation of the angle (clearly reflex) that was required. The other main error was to subtract 59 from 360, sometimes by incorrectly writing 59 for the obtuse angle at *B*.

Question 23

By far the majority of candidates understood a method for subtraction of mixed numbers. Most converted them to improper fractions and then to a common denominator. Some of those who dealt with the whole numbers and fractions separately did get rather mixed up and could not reach the final answer correctly. Working was seen quite clearly in most cases but occasionally decimals were seen in the working or answer. Many left the answer as an improper fraction rather than a mixed number.

Question 24

The majority of candidates realised that the required side could only be found after the vertical common side of the two triangles was calculated. The main challenge was in finding this length but provided some value was indicated for it, a method mark for correct Pythagoras' theorem in the second part could be gained. Some used incorrect ratios for the trigonometry. With 4 marks for the question, candidates needed to realise that length *BC* could not be found from a single calculation.

MATHEMATICS

Paper 0980/22
Paper 22 (Extended)

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 many high scoring scripts with a significant number of candidates demonstrating an expertise with the content and showing adept mathematical skills. Premature, excessive or inaccurate rounding did cost candidates marks. This was particularly evident in **Questions 7**, **12b**, **14**, **17b** and **23**. Some candidates do not draw certain digits clearly leaving doubt as to which number they are trying to write: 1, 4 and 9 in particular cause problems. There were quite a few cases where candidates appear to have misread their own handwriting, changing values between consecutive steps. Candidates were strong in the basic skills assessed in the earlier questions on the paper. Where candidates scored highly but did not get full marks, it was frequently **Questions 7**, **18b** and **23** that were the cause. There was no evidence that candidates were short of time, as almost all attempted the last few questions omissions were due to lack of familiarity with the topic or difficulty with the question rather than lack of time. Few candidates were unable to cope with the demand of this paper.

Comments on specific questions

Question 1

The majority of candidates were able to answer this question correctly. Most gave 13 but –13 was also a common correct answer. Many needed no working but others wrote 4–(–9). Some showed an incorrect calculation e.g. 4 – 9 = –5 or 9 – 4 = 5. Using a number line may have helped understanding. +/– 14 was also seen, sometimes accompanied by the sequence 4,3,2,…,–8,–9. This suggests that candidates included both ends of the number line that they drew. Others gave the answer +/– 12.

Question 2

Most candidates understood how to find the angle for a sector of a pie chart and gained both marks. A common method was to find the fraction $\frac{3}{20}$ and then multiply this by 360, although some candidates stopped at $\frac{3}{20}$ or multiplied by 100 giving the percentage 15 per cent rather than the angle. Some of these candidates thought it was 15°. Some candidates confused the question with the area of a sector and involved π, with $\frac{3}{20}\pi$, $\frac{3}{20}\pi r^2$ or $\frac{\theta}{360}\pi r^2$ often quoted. Many candidates could not score as they were using the incorrect colour of car and so more care should be advised when reading values from a table. Weaker responses often divided either 20 or 360 by 3. $\frac{3}{360}$ was also occasionally seen.

Question 3

This question had a strong response with many candidates gaining full marks. The vast majority of candidates knew how to start and hence scored at least 1 mark. The most common strategy was to use division with either 500 ÷ 43 or 5 ÷ 0.43 but some chose to use repeated subtraction or addition to reach an answer. Use of trial and improvement was also seen. A common incorrect answer came from those who thought that the answer to the division was dollars and cents and 11.63 frequently became 11 figs. and 63 cents change. There were also quite a few who were unsure how to deal with the units and who gave the answer 11 figs. and 0.27 cents. Occasionally candidates rounded 11.6 up to 12 rather than down to 11. A small number of candidates scored 0, sometimes using 43 ÷ 5 or by not knowing the conversion from cents to dollars, with $5 being seen as variously 50, 5000 or 250 cents.

Question 4

Most candidates correctly found the exact value of 102. A small number of candidates lost accuracy by rounding each of the roots before multiplying them and giving an inexact answer that rounded to 102.

Question 5

This was reasonably successful for many candidates with the majority scoring at least 1 mark. The most common successful method seen was doubling each face area then summing. Only a small number gained 2 marks by finding all three face areas but forgetting to double the sum. A very common error was thinking there were four of one face area and two of another. Most common among those not scoring was multiplying all three sides to find volume (sometimes then doubling their answer). A small number of candidates found the sum of all the edge lengths.

Question 6

Most candidates answered this question correctly scoring 2 marks realising that all three probabilities added to one. It was very rare to see any working such as $1-(0.2+0.32)$ resulting in incorrect answers scoring 0 marks. One error was adding 0.2 to 0.32 to reach 0.34 but this was very rare as most candidates are likely to have used their calculators. The most common error was to forget to subtract from 1, leading to 0.52.

Question 7

This question was very well answered. Many candidates were able to calculate the reduced price correctly, usually by finding 82 per cent of $126, although some found 18 per cent of $126 and then subtracted the discount from the original price. The answer of $132.32 is exact so should not be rounded, however it was very common to see the correct answer rounded to either $103.3 or $103 which was not accepted for 2 marks. A small number of candidates gave the answer $22.68, the discount rather than the reduced price. Some candidates interpreted the question wrongly and used incorrect methods including 126 × 1.18, 126 ÷ 1.18, 126 ÷ 0.82 and 126 – 0.18.

Question 8

A high proportion of the candidates answered this question correctly. Common errors were to give algebraic expressions as answers such as $n^2 + 1$, $n^2 + 2$ and $n^2 + 3$, or not evaluating and giving answers such as $1^2 + 12$ and so on or using n = 0 or n = 2 to find the first term. It was also common to see the first three terms of the sequence n × 2 + 12 rather than $n^2 + 12$.

Question 9

This proved to be a difficult question for many. The best answers used a diagram with the North line drawn in at B. Of those who gave the correct answer, many used the diagram and the method 180 + 59 = 239 with the diagram split up to show the North line, 180 and 59 or found 121 using co-interior angles between the parallel North lines then 360 – 121. Some tackled this without using the diagram and only wrote 180 + 59 to get the correct answer. The required angle on the diagram was not usually drawn in this case. Weaker responses did not show understanding of the concept of bearings, and split the diagram up incorrectly, often using 90°. Many found the wrong angle on the diagram. 360 – 59 = 301 or 180 – 59 = 121 were common wrong methods and answers.

Question 10

The vast majority of candidates understood the notation involved in **part (a)** and correctly found both vectors. There were very few using fraction lines in this session. The most common error in **part (a)(i)** was to make an arithmetic error with the negative, resulting in the answer $\begin{pmatrix} 1 \\ 4 \end{pmatrix}$. In **part (a)(ii)** some candidates correctly found $\begin{pmatrix} 12 \\ 48 \end{pmatrix}$ but then 'cancelled' this to give an answer of $\begin{pmatrix} 1 \\ 4 \end{pmatrix}$.

It was apparent that the notation in **part (b)** was not widely understood with a very high rate of non-response and many giving the answer $\begin{pmatrix} 3 \\ 4 \end{pmatrix}$ again. Of those who did recognise the need to use Pythagoras, there was a large proportion using the vectors incorrectly, often dealing with the modulus of **p** and **q** separately. There were many combinations of adding and subtracting the values from the vectors involving squaring and square rooting. Among the correct answers, were those who used $\sqrt{(2 - -1)^2 + (8-4)^2}$ rather than using their answer to **(a)(i)**.

Question 11

This question was generally done well. The most common incorrect answer was 7 from the misconception that the indices should be multiplied instead of added and most candidates who gave this answer also showed the calculation 28 ÷ 4. A few instances were seen with an answer of 6^{24}. This gained no marks as the question asked for the value of p.

Question 12

In **part (a)** those who understood that the gradient of each line segment on the distance-time graph represented the speed of each part of the journey usually scored some marks here. A common error for the first part of the journey was to draw a line segment from the origin to the point (1.5, 20) instead of (1.5, 30). In many cases, candidates correctly drew a horizontal line on their graph representing the 30-minute stop following on from their initial diagonal line. Many drew the first two parts of the journey correctly but had trouble with the third part. The most difficult part of the question was to draw an appropriate line with a gradient of 16 for the final part of the journey. Some candidates drew a line with the correct gradient but did not realise that the graph needed to end at a distance of 70. It was quite common to see lines extended all the way to 5 hours.

Those making no progress tended to draw horizontal or vertical lines at various points and in some cases more than three parts to their journeys or simply left this part of the question blank.

Many candidates demonstrated some knowledge of $\text{speed} = \frac{\text{distance}}{\text{time}}$ in **part (b)**. The most common errors with the time included using 4 hours (neglecting to include the 30-minute stop) or using 5 hours (usually following through the final time shown on their graph, which was sometimes a 30-minute horizontal line at the end of a correct graph). Weaker responses assumed that the average speed could be found by averaging the speed of each part of the journey, giving the common incorrect response of $\frac{16+20}{2} = 18$. Some incorrectly found the area under the distance-time graph. Despite being told in the question that the total distance for the journey was 70 km, there were a number of candidates who did not use 70 km in their calculation of average speed. Quite often the answer was truncated from $15.\dot{5}$ to 15.5 instead of accurately rounded to 3 significant figures.

Question 13

Most candidates were able to score well on this question with little evidence of reliance on calculators. Most attempted the route of changing to improper fractions, usually with success, but many then missed the simpler common denominator of 24, instead choosing to use 48. Cancelling the result was usually successful although a noticeable number missed the demand to give their answer as a mixed number in its simplest form, instead commonly giving the answer $\frac{31}{24}$ or less frequently $1\frac{14}{48}$. Those scoring only 1 mark typically had an arithmetic error when changing to improper fractions. In the minority of candidates who chose to work with mixed numbers, an error sometimes seen was in the subtraction of a larger fraction from a smaller to leave a positive answer, resulting in an answer of either $1\frac{17}{24}$ or $2\frac{17}{24}$. Although directed not to use a calculator, those with an incorrect answer may have realised they had made a mistake and possibly located their error had they checked their answer with a calculator.

Question 14

This question proved a challenge for most candidates. The most common error was to take the interest $1328.54 to be the final amount rather than the interest earned. Those who started correctly and got as far as $\left(1+\frac{r}{100}\right)^{10} = \frac{5868.54}{4540}$ sometimes proceeded to spoil their answer by incorrectly writing $1+\left(\frac{r}{100}\right)^{10} = \frac{5868.54}{4540}$ instead of $1+\frac{r}{100} = \sqrt[10]{\frac{5868.54}{4540}}$. Another common error was to round their result too soon, writing $\left(\frac{5868.54}{4540}\right)^{0.1}$ as 1.03 rather than 1.026, giving an inaccurate final answer of 3 per cent rather than 2.6 per cent. A small number of candidates worked with simple interest rather than compound interest. A small number of candidates used a trial and improvement method with less success.

Question 15

This proved quite challenging with quite a few offering no response. Many candidates were able to find the correct highest common factor. Some unsimplified answers were seen such as 2^2a^2b or $2ab \times 2a$. Candidates who understood HCF usually gave an answer involving 4. They did not always appear to know how to deal with the algebraic parts of the expressions, so answers of 4, $4ab$ and $4a^2b^2$ were common. Some responses showed a confusion between highest common factor and lowest common multiple so the answer $60a^3b^2$ was also often seen. Some also picked out 2 as a common numerical factor and used that in place of the 4. Others identified correct factors but then wrote them with addition or subtraction instead of a product. Some candidates attempted to use factor trees or factor ladders but were not always able to deal with the algebraic terms. A method that often led to the correct answer was to write each expression as a product of individual terms, for example, and then identify the common terms in the two products to give the HCF. A common incorrect answer was $4a^2\,b(3a + 5b)$.

Question 16

Approximately a third of candidates answered **part (a)** correctly. Successful answers realised the need for brackets to establish priority. In weaker responses P' often appeared with no union or intersection sign. Incorrect responses most commonly seen were $(M \cup G)P'$, $M \cup G \cap P'$, $(M \cup G) \cup P'$, $n((M \cup G) \cap P')$ and $(M \cap G) \cup P'$. Quite a few candidates gave a numerical response to this question with 22 often being seen.

Only the strongest scripts reached the correct answer of 22 in **part (b)**; this was one of the most difficult questions on the paper for the candidates. In future, candidates need to make sure they are familiar with set notation. The most common incorrect response seen was 3, followed by 13. A few listed the values in the correct region but did not give the total.

Part (c) was answered correctly by about half of the candidates. Of those not gaining 2 marks it was common to award a mark for the correct numerator, usually $\frac{8}{40}$ or $\frac{8}{14}$, or the correct denominator, usually $\frac{14}{23}$. Many others also scored a mark for the working $\frac{3}{n} + \frac{5}{n}$. The most common incorrect working and answer was $\frac{3}{23} \times \frac{5}{23} = \frac{15}{529}$.

Question 17

A significant number of candidates drew perfectly symmetrical graphs in **part (a)** with the angles marked on the x-axis, passing through the necessary points and with correct amplitude, although many of the diagrams contained straight lines while others lacked rotational symmetry. Not starting at zero was quite common, often starting at (0,1) and drawing a cosine curve, or starting at (0,–1) instead. Weaker responses used the wrong wavelength e.g. drew graphs of $y = \sin 2x$ or $y = \sin \frac{x}{2}$. There were quite a few non-responses or straight lines drawn.

A few candidates got both answers correct in **part (b)** to gain 3 marks, but accuracy was sometimes a problem. The majority of candidates scoring marks gave one correct angle to gain 2 marks. This was often given with –19.5 as the other answer. Accuracy with the angles was a problem with truncation to –19.4 often seen. If candidates struggled with the angles, they often managed to gain 1 mark usually for $\sin x = -\frac{1}{3}$ or for two angles adding to 180. Some candidates did not proceed beyond the answer their calculator gave of –19.5. Some could be seen using their answer to **part (a)** to help them find other angles but this was not very common, perhaps because –19.5 did not fit on their graph and they did not know how to extend their graphs to include it. 160.5 was often seen as an answer linked to 19.5 from using $\sin x = \frac{1}{3}$. Some candidates did not rearrange the equation to find sin x. Candidates are advised that if answer space provides for two solutions, then giving a third solution or only giving one solution should indicate that a mistake has been made.

Question 18

Successful candidates in **part (a)** set up the correct relationship as $y = k \times \sqrt[3]{x+1}$ and found the multiplier which was then substituted correctly and there was a good proportion of fully correct answers. There were some errors rearranging the equation $1 = k \times \sqrt[3]{7+1}$ to find the constant of proportionality. Some candidates set up the correct equation to find the constant but then did not use the same relationship when substituting the values to find y. Those who did not score marks were generally setting up incorrect relationships which mostly stemmed from not reading the question carefully or misinterpreting the information given. Many omitted the cube root, used the cube, square or square root or used inverse proportion. A common incorrect answer from weaker responses was 5, from simply evaluating $\sqrt[3]{124+1}$.

Hardly any candidates correctly answered **part (b)**, with this being the most challenging question on the paper. The most common answer by far was that F will double. Many said that F increases but did not give a factor. Many demonstrated a lack of understanding of inverse proportionality by saying that it would also halve or that it would stay the same. Some candidates set up a correct relationship and substituted values, often leading to a correct answer. A few did not gain the mark because they said ‘it increases by 4’ which suggests an addition.

Question 19

In **part (a)** the most successful candidates began with their first step as interchanging the variables i.e. changing $y = 7x - 8$ to $x = 7y - 8$. Those who began with this as their first step always scored the first mark regardless as to whether or not there were sign errors in the rearranging, which was very common. Many were then able to rearrange successfully to make x the subject and gain full marks. Some lost a mark as they did not swap the variables leaving a final answer of $\frac{y+8}{7}$. The most frequent error was a sign error in the working and with $\frac{x-8}{7}$ being the most common incorrect answer. Some candidates were unsuccessful as they seemed to confuse the f^{-1} notation with that of a reciprocal and hence gave the answer $\frac{1}{7x-8}$. Some of the weaker responses gave numerical answers.

Many candidates were able to attempt **part (b)** with most able to substitute the $\frac{1}{3}$ into the expression correctly gaining at least 1 mark. Some converted $\frac{1}{3}$ to rounded decimals such as 0.3 and 0.33 and lost accuracy due to this. Some who correctly evaluated $g\left(\frac{1}{3}\right) = 17$ were then unable to solve the equation $2^x + 1 = 17$ successfully as they added the 1 to the 17 instead of subtracting it, or were unable to solve $2^x = 16$. Candidates should be able to spot that the power is 4, or were expected to try various powers if they could not. Some candidates over complicated the work by attempting to use logarithms, not always correctly. A further incorrect answer that was sometimes seen was 131073 arising from $2^{17} + 1$.

Question 20

There was a generally good attempt made in **part (a)** with about two thirds of candidates successfully factorising the given expression. Of those making a correct first step, such as $2m(1-4k)+3p(1-4k)$, some went on to cancel the $(1-4k)$ leaving them with an incorrect answer of $2m+3p$. A few made sign errors when factorising and $(1+4k)$ was sometimes seen in the final answer. Some lost the 1 from $(1-4k)$, leading to an answer of $(-4k)(2m+3p)$. Candidates are advised to ensure both parts contain the same signs, it was not uncommon to see the expression $2m+3p-4k(2m-3p)$.

Part (b) was found to be more challenging than **part (a)**, although about a third of the candidates had fully correct solutions. The most common answer seen was the incomplete factorisation of $5(x^2-4y^2)$. Some candidates appeared to recognise that they were dealing with the difference of two squares but gave incorrect final answers such as $5(x+4y)(x-4y)$. Some candidates divided throughout by 5 at the start and gave a final answer of $(x+2y)(x-2y)$.

Question 21

About a third of candidates worked through to a correct solution, often with rather disorganised working. A sizeable minority of candidates were attempting, with mixed success, to use standard results for a quadratic sequence, i.e. 1^{st} term $a+b+c$ and 1^{st} difference $3a+b$. Greater care needs to be exercised in reading and understanding the question, a very common error was with candidates not substituting 1 and 2 for *n*, but rather substituting for *n* the *values* of the first and second terms (–3 and 2). Some candidates substituted into the given expression but equated to zero. A further error for some was to see for example $a \times 1^2$ simplified to a^2 in their equations (sometimes going on to make use of the quadratic formula). Many candidates were able to go on to gain credit for a correct attempt to solve their simultaneous equations, although some made processing errors, being inconsistent with their addition/subtraction at this step. A large number only obtained one equation, often 3a + b = 5 using the first difference and not knowing how to substitute 1 and 2 into the nth term to obtain a second equation.

Question 22

There was a very large variety of answers for this question. A large proportion of scripts gave no response at all, others wrote down just the correct answer and others just an incorrect answer, with no working shown. The most common incorrect answer given was 3:4. Those who attempted to show some working generally found the vectors $\overrightarrow{AD}$ and $\overrightarrow{DB}$ but sign slips meant that they frequently did not arrive at the correct values of $\frac{4}{7}(-x+y)$ and $\frac{3}{7}(-x+y)$ respectively. It was not uncommon to see $\overrightarrow{AD}$ left unsimplified as $-x+\frac{3}{7}x+\frac{4}{7}y$.

Question 23

Candidates work for this question was generally well presented with the relevant steps well set out and the correct answer 18.4 was seen quite often. The majority of candidates scored at least 1 mark by substituting numbers into the given formulae. A common error was not halving the hemisphere. Premature rounding was common, leading to a loss of accuracy in subsequent calculations, which in turn lead to a final answer that fell outside the required accuracy. Another common error was including the area of the circle from the hemisphere, many went straight to a hemisphere formula of $3\pi r^2$ rather than adapting the given sphere formula to the situation. Some candidates started with a correct equation $2 \times \pi \times 6.2^2 + \pi \times 6.2 \times l = 600$ but then struggled to manipulate the algebra and rearrange the equation correctly to find l. It was common to see $l = 600 \div \left(2 \times \pi \times 6.2^2 + \pi \times 6.2\right)$ or $l = 600 - \left(2 \times \pi \times 6.2^2 + \pi \times 6.2\right)$ evaluated. Also common was the radius to be used as 6.2 for the sphere but 6.5 for the cone or vice versa.

MATHEMATICS

Paper 0980/32
Paper 32 (Core)

Key messages

To succeed in this paper candidates need to have completed full syllabus coverage, remember necessary formulae, show all working clearly and use a suitable level of accuracy. Particular attention to mathematical terms and definitions would help a candidate to answer questions from the required perspective.

General comments

This paper gave all candidates an opportunity to demonstrate their knowledge and application of mathematics. Most candidates completed the paper making an attempt at most questions. The standard of presentation and amount of working shown was generally good. Candidates should realise that in a multi-step problem-solving question the working needs to be clearly and comprehensively set out particularly when done in stages. Centres should also continue to encourage candidates to show formulae used, substitutions made and calculations performed. Attention should be made to the degree of accuracy required. Candidates should be encouraged to avoid premature rounding in workings as this often leads to an inaccurate answer. Candidates should also be encouraged to read questions again to ensure the answers they give are in the required format and answer the question set. Candidates should also be reminded to write digits clearly and distinctly. Candidates should be prepared to use an algebraic approach for a problem-solving question. Candidates should use correct time notation for answers involving time or a time interval.

Comments on specific questions

Question 1

(a) (i) The majority of candidates answered this question correctly. Common errors included miscounting the number of ‘gates’ giving an answer of 43 or 53, ignoring the incomplete gate and stating 45, or only considering the vertical tallies in each ‘gate’ so giving 39 from 4 × 9 + 3.

(ii) The majority of candidates answered this question correctly. Common errors included the unsimplified $\frac{15}{48}$ or calculating 48 ÷ 15.

(iii) This part on using a given ratio was generally reasonably well answered. The common error was to incorrectly use the value of 28 as the total number of tubs of ice cream, leading to the incorrect method of $\frac{28}{18}\times 7$.

(b) (i) This part on working out the range was generally very well answered. Common errors included answers of 45 – 165, 165 – 45, and using 156 as the largest value. A small yet significant number of candidates confused range, median and mean throughout **part (b)**.

(ii) This part on working out the median was generally very well answered. The common error was to give the middle value of 45 from the unordered list, with occasional miscounting of the number of values in the list and using a middle pair.

(iii) The majority of candidates answered this question correctly. Common errors included the incorrect answers of 636 and 628.6, due to incorrect use of the calculator (lack of brackets), arithmetic errors in the addition, and leaving the answer as 770.

(c) (i) Whilst a good number of candidates answered this question correctly it was evident that many did not appreciate the full method to be used. Common errors of this type included 4.20 – 2.50 = 1.70, $\frac{1.7}{2.5} = 0.68$ as an answer and $\frac{4.2}{2.5} \times 100 = 168$. Common errors using incorrect methods included $\frac{1.7}{4.2}$ leading to 40.5, and $\frac{2.5}{4.2}$ leading to 59.5.

(ii) This part on calculating a volume using a given formula was generally very well answered, with the correct units also given. Common errors included incorrect substitution and the use of 15^2, with the units sometimes given as cm or cm^2 or omitted.

(d) This was very well answered by the large majority. The most common and successful methods were to compare ml per \$ or \$ per ml, with working clearly shown with numbers rounded to enough accuracy to make comparisons. It was however quite common for candidates to make an error in comparing the correct figures, often leading to an answer of *C*. Candidates not gaining credit either looked at what needed to be added to each bottle, in terms of \$ or ml, to get the next bottle, or simply multiplied \$ by ml for each bottle.

Question 2

(a) (i) The table was generally completed very well with the majority of candidates giving 4 correct values. The occasional sign or arithmetic error was made.

(ii) Many reciprocal curves were really well drawn with very little feathering, double lines or straight lines seen. A few but noticeable number of candidates with correctly plotted points did not attempt to join them in a curve.

(iii) This part on rotational symmetry was generally very well answered. Common incorrect answers seen were 4, 1, clockwise, reflection and positive.

(iv) This question was found challenging by many candidates and few correct equations for the two lines of symmetry were seen. A lot of numerical answers were offered as well as various coordinates and inequalities.

(v) This part was generally very well answered, although common errors included inaccuracies in plotting and drawing $y = -2.5$ or $x = 2.5$.

(vi) This part on using the graph to solve the given equation was well answered with candidates reading the values off accurately from their curve. A small yet significant number of candidates tried to solve the equation algebraically which was not the required method and was rarely successful.

(b) This question testing understanding of perpendicular was found challenging by some candidates. Some lines passing through *P* crossed at a wide variety of angles, were parallel, vertical or horizontal, or outside the allowed tolerance.

(c) Candidates found this part challenging. Some gave a numeric answer, most commonly 8 from substituting a value of $x = 1$. Some who attempted the correct form interpreted the requirement of the question incorrectly using the given values leading to equations $y = 1x + 7$. Those that recognised that a parallel line had the same gradient gave an equation that started with $y = 3x$ but finding the intercept was the most challenging.

Question 3

(a) (i) Many candidates gave the correct answer. A range of different spellings were given, some of which were ambiguous. The most common incorrect answer was acute. Other incorrect answers came from not reading the question carefully and naming the shape as 'triangle' or giving the name of the triangle such as scalene, isosceles or equilateral.

(ii) The majority of candidates measured the angle correctly. Some candidates misread the protractor scale, giving 67° as their answer.

(b) (i) Many candidates were able to sketch a rhombus. Although not required, some candidates carefully showed the lines of symmetry and equal length signs on their shapes. Although most made a good attempt at sketching the shape, some were ambiguous, with the shape having more resemblance to a square. Common incorrect answers included sketches of a parallelogram, kite, rectangle or a square.

(ii) Many candidates gave the correct name of the shape. Incorrect answers included square, parallelogram, kite, rectangle, trapezium, diamond, polygon and triangle. Frequently the word chosen did not match the sketch in the previous part.

(iii) Few candidates gained full credit in this part. Some candidates achieved partial credit for finding 110° but did not go on to give the correct answer. Common errors included: giving all angles as 70°, giving 70°, 20°, 20° from using sum of angles in a quadrilateral is 180° or giving 96.7°, 96.7°, 96.7°, from $\frac{(360-70)}{3}$.

(c) (i) A good proportion of candidates gave a clear geometrical statement that 'the angles in a triangle add to 180°'. Candidates needed to be precise in their response, with inaccurate statements, such as, 'a triangle is 180°' not gaining credit. Some candidates gave descriptions about the properties of an isosceles triangle.

(ii) Most candidates gave the correct equation. Common errors included omitting the = 180 or writing the equation $x + 6y = 360$ or $2x + 6y = 180$. A few added the two equations to give $3x + 8y = 360$.

(iii) The majority of candidates had the mathematical knowledge and skills to gain some credit in this question on simultaneous equations with many successfully gaining full credit. The most common and most successful method was to equate one set of coefficients and then use the elimination method, and the majority of candidates showed full and clear working for this. It was less common to see a rearrangement and substitution method which is where more algebraic errors occured. Common errors included a range of numerical errors, incorrect addition/subtraction when eliminating, lack of working, and the use of a trial and improvement method which was largely ineffective. A small number of candidates were unable to attempt this part.

Question 4

(a) (i) Most candidates answered this part correctly. A few gained partial credit for correctly labelling the sides of rectangle *A*. Other errors included finding the perimeter of rectangle *A* or assuming that the length and width of rectangle *A* were either both 5 or both 7.8. Some confused it with the area of a triangle and calculated half of the area.

(ii) A minority of candidates were able to find the dimensions of the cuboid correctly. A common incorrect answer came from adding the two given dimensions to create the third dimension 5 + 7.8 = 12.8. A significant number did not always use the two given dimensions and restarted. Common incorrect answers included finding $\sqrt[3]{468} = 7.76$ and hence the dimensions of a cube, calculating $\frac{468}{3} = 156$ for all three measurements, or a random set of three dimensions with a product of 468.

(b) Whilst many candidates were able to correctly use the formula for the volume of the cylinder, only a minority of these went on to give their answer in terms of π, with the majority giving a decimal answer. A variety of incorrect formulae for the volume of a cylinder were used; $2\pi r$, $\pi \times 8 \times 12$, $2\pi r^2 h$, $2\pi rh$ or finding combinations of surfaces and volumes. A few omitted π from the working, just stating $8^2 \times 12$ and some wrote the correct working but missed π out of the answer, leaving it as 768.

(c) This question was found challenging by many candidates and proved to be a good discriminator, although few correct and complete answers were seen. Candidates should realise that in a multi-step problem-solving question such as this the working needs to be clearly and comprehensively set out. Partial credit was often gained for finding the correct area for either the circle or the parallelogram. Many candidates used 12 × 12 as the area of the parallelogram (not recognising the height of the parallelogram was the same as the diameter of the circle). Many used the diameter 7 for the radius of the circle. Others used an incorrect formula for the area of a circle such as $2\pi r$, and sometimes $\frac{1}{2} \times 12 \times 7$ for the parallelogram.

Question 5

(a) The scatter diagram was generally completed very well with the majority of candidates correctly plotting the 4 values. The occasional scale or accuracy error was made.

(b) The majority of candidates answered this question correctly. Common errors included negative, ascending, flight and variable.

(c) This question was found challenging by many candidates and few correct points were identified. Common errors included (500, 380), (600, 340) and (70, 60).

(d) The line of best fit was generally completed very well with the majority of candidates correctly drawing an acceptable line. Very few non-ruled straight lines were seen.

(e) This question was found challenging by many candidates although a number of fully correct answers were seen. This multi-stage problem involved an accurate measurement, a correct conversion and correct use of the candidate's line of best fit. There were many well written and comprehensive answers showing these three values, although few candidates indicated with straight lines drawn on their scatter diagram to show how the line of best fit was being used.

Question 6

(a) (i) The majority of candidates answered this question correctly. Common errors included 0.9 and 8.

(ii) The majority of candidates answered this question correctly, with a variety of acceptable equivalences to 'stationary' seen. Common errors included constant speed, constant time, and no acceleration.

(iii) The majority of candidates answered the first part of this question correctly but found the second part more challenging to explain using mathematical language. A variety of acceptable equivalences to 'gradient is steepest' were seen. Common errors included 'it is faster', 'he is accelerating', together with a variety of non-mathematical reasons.

(iv) This part on working out the average speed was generally very well answered with most candidates able to identify the correct formula to be used. Common errors included incorrect distances read off from the graph, using 0724 as the time taken, and incorrect evaluation or conversion of minutes to hours.

(b) This part on working out the total amount was generally very well answered, although not all candidates appreciated that as the answer was an exact amount of money the only acceptable answer was \$32.72. Common errors included miscalculations for the 1 dollar coin, converting 1 cent and 5 cents to \$0.1 and \$0.5, simply finding the number of coins, and dividing their total amount by 92 (the number of coins) possibly trying to find the mean rather than the total.

(c) The majority of candidates answered this question correctly. Common errors included 774.34 and giving a rounded answer of 633.

(d) This part was generally very well answered, although not all candidates appreciated that simple interest was to be used and that the total interest only was required. Common errors included 9092.91 (from using compound interest), 9078 (from finding the total amount), 57800 (from using 8500 × 1.7 × 4), and a variety of incorrect formulas using the values of 8500, 4 and 1.7 or $\frac{1.7}{100}$.

Question 7

(a) The majority of candidates answered this question correctly. Common errors included 4, 9, 12, 16 and 18 squares shaded.

(b) (i) The majority of candidates answered this question correctly. The most common errors were not shading the triangle or shading both shapes but generally the shapes were correct.

(ii) This question was found challenging by many candidates. Only the more able candidates focused on the position number as stated in the question, with many answers referring to position, shape or size. The most common errors were factors of 4, 4th position, 4 sides, or just 4, it's before the circle, and it's shaded.

(iii) This question was found challenging by many candidates and proved to be a good discriminator. Most candidates related the 99th term to being 3 × 33 or 9 ×11 and so it must be the same shape. Many just referred to the pattern of shapes with the required shape always being the 3rd in the sequence and therefore in position 99 without further explanation. Only a minority used *n*th term or mentioned the 100th term.

(c) (i)(a) This part on completing the Venn diagram was generally very well answered The more able candidates answered well but many others added extra shapes, put them in the wrong place or even repeated shapes. Common errors included the black circles being entered in $B \cap C'$ and the white circles placed outside $B \cup C$.

(b) This part was generally answered well. However the union was often interpreted as the intersection, and many did not realise that a number was required and a list of drawn shapes was often seen.

(ii) This question was found challenging by many candidates and proved to be a good discriminator. The majority of candidates had the mathematical knowledge and skills to gain some credit in this question on Venn diagrams with many successfully gaining full credit. A number of candidates did not appreciate that the required labels were *L* and *B*. Common errors included labelling the circles *W* and *B*, or *LW* and *SB*, incorrectly positioning one or more of the shapes, in particular the small white circle and rectangle, and omitting one or more of the shapes.

Question 8

(a) (i) Many candidates answered this question well using $\frac{360}{8}$ as their method. Some attempted to find the total of the interior angles leading to one interior angle and finally to the exterior angle. Some drew a portion of an octagon and labelled the angles without showing any calculations. A relatively high number of candidates made no attempt at a response.

(ii) A good proportion of candidates were able to gain credit although most started from scratch and did not use the angle from the first part of the question.

(b) (i) Many did not pick up on work already done in the previous parts. Most candidates opted to measure the bearing and answers of 140, or a value close to it were common errors. Occasionally a candidate would give the bearing of *A* from *B*.

(ii) This part proved challenging and some correct answers of *H* from *G* were seen. Some identified the parallel direction but then gave the opposite direction of *G* from *H*. Only a few candidates opted for *B* from *E* or for *A* from *F*. Most incorrect answers involved *F* from *E*.

(iii)(a) Candidates were often successful in this part and isosceles was often seen. Common incorrect answers included scalene, equilateral, right-angled along with generic names such as triangle and quadrilateral.

(b) This part proved challenging and correct solutions were in the minority. Those that recognised the connection with the work done in **part (a)(ii)** were usually successful in finding the correct angle or were able to demonstrate a correct method following on from a previous incorrect answer. A significant proportion of candidates made no attempt at a response.

(c) More able candidates calculated the correct time, showing all appropriate working. Others were able to gain partial credit for using distance/time. Often their method was spoilt by doing additional incorrect work, while others seemed to be unaware of the correct relationship between time, distance and speed.

(d) Only a few candidates were able to gain full credit in this question with 'No it's too small/big' being the most common answer. Few candidates wrote units in their working and so could not compare relative sizes.

Question 9

(a) (i) This part was generally answered well with the majority of candidates able to identify the given transformation as a translation, although not all were able to correctly state the required translation vector to complete the full description. Common errors here included using coordinates, fractions, and sign or arithmetic errors within the vector.

(ii) The majority of candidates were able to identify the given transformation as an enlargement but not all were able to correctly state the three required components. The identification of the centre of enlargement proved the more challenging with a significant number omitting this part, and (0, 0), (2, 2) and (0, –1) being common errors. The scale factor also proved challenging with 3, $\frac{1}{2}$, and –2 being the common errors. A significant number gave a double transformation, usually enlargement and translation, which results in no credit. Less able candidates often attempted to use non-mathematical descriptions.

(b) This part was generally answered well with the majority of candidates able to draw the given rotation. Common errors included 90° anticlockwise, 180°, incorrect centres of (0, 0), (2, 2), and (6, –2). A variety of reflections were also seen.

MATHEMATICS

Paper 0980/42
Paper 42 (Extended)

Key messages

To do well in this paper, candidates need to be familiar with all aspects of the syllabus. The recall and application of formulae in varying situations is required as well as the ability to interpret situations mathematically and problem solve with unstructured questions.

Work should be clearly and concisely expressed. Intermediate values should be written to at least four significant figures, and only the final answer rounded to the appropriate degree of accuracy.

Candidates should show full working with their answers to ensure that method marks are considered where answers are incorrect.

General comments

Many candidates were well prepared for the paper and their solutions were often well presented. All candidates appeared to have sufficient time to answer the questions.

Most candidates were unable to give clear geometrical justifications in **Questions 2(a)** and **9(a)**. In some cases, insufficient method was shown to gain credit when answers were incorrect. Candidates should avoid rounding or truncating values prematurely in their working, as this leads to inaccurate final answers and the loss of method marks. This was particularly common in questions where trigonometric ratios were used.

The topics that were answered well were:

- sharing a given amount into a ratio
- conversion of a recurring decimal to a fraction
- percentage reduction to find the original value
- working with linear equations
- rearranging a formula when the subject occurred twice
- mean from grouped data
- cosine rule/sine rule
- transformations

The weaker areas were:

- using geometrical facts and properties with shape and angle
- using geometrical reasons with the correct terminology
- problems involving upper and lower bounds
- problem solving with volume of cones
- sketching a cubic with known turning points

Comments on specific questions

Question 1

(a) Many were successful in this first part. The most common incorrect answers were 3, 5 or 15 coming from trying to find the lowest common factor. Many gave factor trees or factor ladders of 30 and 75 to gain a method mark even when the final answer was incorrect.

(b) This part involving ratio was very well done and almost all scored full marks.

(c) There were a mixture of responses. Some gave fractional rather than decimal answers and were unable to convert to standard form. Some gave the correct decimal but then were unable to convert to standard form. The most common error was to give 2.6×10^{-2} as the answer rather than an answer to 3 significant figures (or better).

(d) This was answered very well with most showing their working. A few did not understand the significance of the recurring decimal notation and gave answer of $\frac{27}{100}$.

(e) This calculation involving density and mass proved to be straightforward for most. Common errors were in the units, for example cm^3/g or g/cm^2. Some overcomplicated the problem by converting for example to kg and m^3 which was unnecessary and often led to errors.

Question 2

(a) This question involving geometric reasoning was found to be very challenging.

Candidates are expected in this type of question to explain clearly which angle they are finding in the method, and to give a correct geometric reason for this using the correct terminology as given in the syllabus.

The best approach that a few adopted was using the 3 lines of the working space, one line for each angle with a reason.

Most candidates who attempted to give a reason for angle *PQR* = 90 failed to use the correct terminology. Angle is a semicircle = 90° was expected. Examples of incorrect language/reasons 'because *PR* is a diameter', 'two chords from the end of a diameter.........' etc.

For the second mark, many stated 180 – 90 – 29 for PRQ = 61, rather than give the correct geometric reason "Angles in a triangle sum to 180°".

For the final mark same segment or same arc was acceptable. Many gave same chord which is not an acceptable reason.

(b) More responses were successful in this part where written geometric reasons were not required. Many sensibly annotated their diagram with angles which earned method marks for each correct angle step to the answer.

Weaker responses did not identify that angle *ABT* = angle *ATS* = 98° (alternate segment theorem) and some also assumed that *AT* was a diameter, this often led to the answer 53.

Most candidates often gained a partial mark for angle *ATC* = 82°.

Some showed calculations of angles in working but these were not always identified unambiguously by their letters or marked correctly on the diagram and method marks cannot be awarded in these cases.

Question 3

(a) Many were successful and recognised the use of Pythagoras' to calculate the distance between the two coordinates.

A number were unable to deal with the directed numbers when subtracting to find the vertical and horizontal components.

Some answers attempted to find the gradient of the line and misunderstood the question. Of those using the correct method, the most common error was in the accuracy of the answer with 8.2 or 8.24 given on occasions.

(b) This question involved a number of steps. Most started well by finding the gradient of the line *FG*. Many then completed the second step of finding the gradient of a line perpendicular to *FG*. Many candidates did not consider the midpoint of *FG* for the perpendicular bisector, and those that did usually went on to give the correct equation. The majority of candidates having done the first two steps well then substituted point *F* or point *G* into the equation to find the '*c*' value.

(c) This question challenged many candidates and was the most difficult part of the question. A number were able to recognise that if *H* lies on the *y* – axis, then the *x* – coordinate of the point must equal zero. These candidates gained credit for two answers of the form (0, *j*) and (0, *k*).

A few candidates drew a diagram where it became clear that the distance from point *H*, horizontally to the axis was 5 units and a 5, 12, 13 right-angled triangle was formed.

Having established the distance for the third side of the triangle, candidates needed to add or subtract 12 vertically from the point (0, 4) to give answers (0, 16) and (0, –8). This was completed well by some more able candidates but for many this proved very challenging.

Question 4

(a) This part involved using the cosine rule and was generally done well, but a number of candidates lost marks by giving the answer as 7.05, i.e. truncating, or rounding to 7.1. The majority did use and apply the cosine rule correctly, although a few candidates thought that the opposite angles of a trapezium add to 180° and used sine rule with angle *C* =135°. A small number of other candidates used angle *B* = 38° treating triangle *BCD* as isosceles.

(b) (i) This was generally done well with candidates recognising the use of angles in a triangle. A few gave an answer of 90°, although there was no information in the question to suggest this. An error in this part had an impact on the next part.

(ii) This sine rule question was very well answered, and answers were rounded more successfully than **part (a)** because of the figures involved 15.300. Most candidates used their answer to **part (b)(i)** successfully but angles of 90°, 38° and 45° were not allowed method marks as these assumed triangle *ABD* to be right angled or isosceles.

(c) Candidates who tried to find the area of two triangles did much better than those who tried to find the area of the trapezium where the height was needed to be found.

When finding the area of the 2 triangles, most candidates used $\frac{1}{2}ab\sin C$ correctly, with 38° being the included angle in each triangle.

Candidates using the formula for the area of a trapezium found the height to be a real challenge, with many using their answer to **part (a)** as a perpendicular height. The stronger candidates were able to use the diagram efficiently and use $10.9\sin 38°$, and then proceed to use the formula for the area correctly. A few introduced 6.7 for the height with no evidence of method or a more accurate value, thereby not scoring. A correct method is not implied by values given to 2 significant figures without the method leading to that value being shown.

Question 5

(a) This question was generally correctly answered. A surprising number of candidates included the diagonals.

(b) (i) (a) This part was very well done, most using the correct term 'translation' together with the correct column vector. It is pleasing to report that very few used 'transformation' or 'translocation' or 'transition'. The vector was usually correct although a few candidates had the components reversed or made an error with the vertical component. A small number of candidates used incorrect notation for the vector.

(b) This part was also done well with most candidates giving 'rotation' and '90° anticlockwise', so earning two of the three marks. The centre of rotation was less well answered but still there were many correct answers. A small number of candidates gave two transformations, and no marks can be awarded in such cases when a single transformation is asked for.

(ii)(a) The drawing of the reflection in the line $y = 2$ was answered correctly by almost all candidates.

(b) The drawing of an enlargement with a negative scale factor was a more challenging question. This part was frequently not attempted and enlargements with factor 2 or $\frac{1}{2}$ were quite often seen as well as those that used the correct scale factor but the incorrect centre.

Question 6

(a) This proportion question was generally well answered with candidates correctly using the given data to carry out the calculation. A small number of candidates were perhaps unsure about using this method of proportion because of the word 'estimate' being in the demand of the question.

(b) This was a challenging probability question, unusually involving three different products of two fractions. The stronger scripts were able to cope with the three different combinations of transport and that each could occur in two ways, as well as it being a 'without replacement' situation. A few other stronger responses found the probability of the three same combinations and subtracted this from 1. Many earned partial credit for three correct products but without multiplying each by 2. A few gained one mark by showing one product of two fractions with denominators 12 and 11. A small number of answers treated the question as a 'with replacement' situation.

(c) This reverse percentage question was very well answered with only a small number of responses treating the given amount as 100 per cent.

(d) (i) This lower bound question proved to be quite challenging. As it involved a division, it required the lowest numerator over the highest denominator, each worked out from the 'to the nearest' information given. Many candidates divided the lowest possible numerator by the lowest possible denominator. Most candidates earned one mark by showing one of the four correct bounds. A small number of candidates carried out the calculation using the given values without bounds and then attempted to look at the possible range of answers.

(ii) This part, involving the subtraction of a lower bound from an upper bound, was found to be more successful, although a number of candidates found the difference of the two upper bounds. As in **part (d)(i)** almost all candidates with incorrect answers did earn one mark by showing one correct bound.

Question 7

(a) Candidates usually scored full marks, confidently working with midpoints and frequencies. The main error when working with midpoints was using an incorrect value for the midpoint in the 25 to 40 group. A small proportion of responses worked with the incorrect approach of using group widths multiplied by frequencies.

(b) There were many completely correct solutions. The majority of candidates knew that the bars of the histogram would have to be the correct interval width and most showed an understanding that the heights of the bars are calculated using frequency densities. A significant number of answers did not take sufficient care with drawing the correct bar heights, particularly the 25 to 40 intervals. A common error was to not use the intervals from the frequency table and have five equal bar widths in their diagram.

(c) (i) This part was usually correctly answered. A relatively common error was to state the frequencies.

(ii) Almost all candidates correctly answered this question part, including some who had incorrectly completed their cumulative frequency table in the previous question part, but were able to go back to the frequency table and make a fresh start.

Question 8

(a) This question part was well answered. Most rearranged the given equation and correctly solved $7 = 14p$. The main errors were that a number of responses went on from $7 = 14p$ to give the answer 2, along with a few others who made errors in the first step of rearranging the equation.

(b) Many candidates were comfortable with the methodology involved and the strongest responses adopted the following steps:

Rearrange the given equation to have both terms containing m on one side of the equation.

Remove m as a common factor from the terms in m.

Divide both sides of the equation by the bracket to isolate the term in m.

This produced many clear and concise solutions.

The majority of errors resulted in not isolating the terms in m in the first step leading to some answers that contained several terms in m.

(c) The majority of candidates adopted a correct approach to combine the two fractions under a common denominator. Following this first step, fewer candidates could process the algebra to remove the fractions. Some candidates had difficulty with solving the correct 2 term equation, they seem to be more confident with the methods required to solve three term quadratics. The best solutions were concise with obvious care taken to ensure that their working contained no sign errors.

(d) The most common method which yielded full marks for candidates was to make x the subject of $x + 2y = 12$ and substitute this into the second equation. This provided an equation in one variable y that could be simplified into a 3– term quadratic equation to solve. A similar method making y the subject of the first equation tended to produce more complex algebra, with candidates having to work with a fraction and a more difficult expansion. Another common approach was for candidates to multiply the first equation by 5, and then eliminate x to work towards a 3 – term equation in y. This often resulted in sign errors. The best solutions were able to solve a 3 – term equation by either factorisation or by using the formula. It is important that when using the quadratic equation formula candidates show the full substitution and each step of working. Some candidates showed two correct solutions but did not show full working including the method to solve the quadratic equation and did not score full marks as a consequence.

(e) This part was well answered, with many candidates familiar with the standard techniques for the expansion of brackets. Other answers made a promising start with two of the brackets but then made sign errors and errors with indices when multiplying. A small number of responses achieved the correct expansion but then attempted some form of factorisation.

Question 9

(a) This proved to be a challenge for almost all respondents. The strongest solutions made a very clear specific link between the named pair of equal angles in each triangle and gave a reason. These solutions had a logical style of presentation line by line for each pair.

A feature of the strongest solutions was the clarity of knowing that similar triangles would have 3 pairs of equal angles and in conclusion they stated this fact.

Weaker solutions were not specific in the statements made, e.g. ‘they both have a right angle’, ‘they both share an angle’ without saying which pairs of angles they were referring to.

Many responses made assumptions about 45° angles and listed equal sides which were incorrect.

(b) (i) This was a very well answered part with clear working shown. The only common error was for candidates to lose accuracy by working with a two significant figure value as a scale factor. This error also impacted on their accuracy in **part (b)(ii)**.

(ii) The most common method used was to find the scale factor, then square to find an area scale factor, taking care to not prematurely round any numerical values. This is an area of the syllabus where candidates appear to lack confidence. Most realise it has something to do with a scale factor, many used length scale factors, others sometimes seem to be confused on whether to divide or multiply. The area of triangle method was used by a relatively small number of candidates some of whom lost accuracy due to the premature approximation of numerical values.

Question 10

(a) Most candidates rearranged the inequality as far as $2n < 7$ or $n < 3.5$. Some solved it as an equation and others reversed the inequality to give $n > 3.5$. Many candidates gave the inequality as the answer rather than the positive integers that satisfied the inequality as required by the question. Those that did list integers often included 0 as well as 1, 2 and 3. A small number of candidates did not understand the term integer and included some decimal values in their list.

(b) (i) Most responses understood that the three given equations should be used to set up the inequalities to define the region. Those who inserted inequality symbols into the three given equations answered this part more successfully than those who attempted to rearrange them first to give explicit equations for y, such as $y = 80 – 0.8x$. When equations were rearranged, some made sign or arithmetic errors or omitted an x. Some responses did not appreciate the difference between the dashed and solid lines defining the region and gave all the inequalities as strict inequalities, using < and >, rather than ⩽ for the solid boundary. A small number of answers used ⩾ in place of > as well as ⩽ in place of <. Some reversed all the inequalities and others just restated the given equations. A small number gave three sets of coordinates as the answer.

(ii) This part proved challenging. Some responses found a point in the region and used its coordinates to evaluate the expression $3x + y$. Some used trial and error with a number of points in an attempt to get the largest result. Those that understood the term integer usually reached the correct result, although many used decimal values in an attempt to find the largest possible result. A minority of responses identified the point (7, 2) and gave that as the answer.

Question 11

(a) (i) The majority of candidates used the correct formula to set up the equation $2\pi r = 28$. It was often shown rearranged to $r = \dfrac{28}{2\pi}$ or $r = \dfrac{14}{\pi}$. Many answers did not show the result evaluated to more figures than the value 4.46 given in the question. This was required to demonstrate that they had performed the correct calculation. Some equated the area of the rectangle and the curved surface area of the cylinder leading to the same result. A small number worked from the volume found in **part (a)(ii)** to show the value for the radius, which was not acceptable as they had used 4.46 to calculate the volume. Others started by using $r = 4.46$ to show *AD* was approximately 28 which was also unacceptable. A minority of responses used incorrect formulas such as the area of a circle or the surface area of a solid cylinder.

(ii) Most respondents knew the formula for the volume of a cylinder and calculated the answer correctly. Some quoted the formula incorrectly, for example $2\pi r^2 h$, πr^2 or πrh.

(iii) Many candidates identified the correct angle in the cylinder and calculated its value correctly. It was common to see a triangle drawn on the diagram of the cylinder, annotated with its dimensions and the required angle indicated which often led to the correct answer. The most efficient method was to use tangent to find the angle, although some candidates used Pythagoras' to work out the distance *NA* and then used either sine or cosine. Some responses truncated their answer to 65.9, which was outside the acceptable range, so did not gain full credit. Common errors were to use 28 as the height of the cylinder, to calculate angle *NAB*, to use the radius rather than the diameter, or to start from a triangle on the rectangle rather than the cylinder.

(b) Many candidates were able to start this question using the given formula and replacing h with $2r$. Many found it difficult to rearrange the formula $\dfrac{1}{3}\pi r^2 \times 2r = 310$ correctly to find the value of r. Common errors in the rearrangement were to take a square root rather than a cube root or to divide by 3 rather than multiplying by 3. Those who found a value for r usually doubled this value to find h, but this was often given as the answer rather than using their values of r and h to find the slant height. Those who distinguished between the height and the slant height usually showed correct Pythagoras using their values of *r* and *h*, although in some cases $\sqrt{r^2 + 2r^2}$ was used in place of $\sqrt{r^2 + (2r)^2}$. Some answers were out of the accepted range because the radius was prematurely rounded to 5.3. A small number of scripts linked this part to **part (a)** and used the radius 4.46 to find the height.

Question 12

(a) There were some fully correct answers to this part with candidates differentiating the function correctly, equating the derivative to 6, substituting $x = 2$ and rearranging to show that $k = 1.5$. In a few cases the derivative was incorrect, for example $3x^2 - 2kx + 1$ and others equated to 0 rather than 6.

It was clear, however, that many did not know that the derivative of the function gave the gradient, and these started by substituting $x = 2$ and $y = 6$ into the given cubic function. Others attempted to use the method for the gradient of a straight line. Some of these substituted $k = 1.5$ and attempted to show the result from that point.

(b) More answers were aware that they needed to use the derivative to find the stationary points than had used it for the gradient in **part (a)**. Many showed a correct derivative here and equated to 0, however not all were able to solve the equation $3x^2 - 3x = 0$ with errors in factorising common. Some answers gave the two correct stationary points without showing any evidence of differentiation, often from using a table of values. Some quoted the coordinates of any two points on the curve, often including (0, 1).

(c) The most common response in this part was a positive cubic curve but the curve often did not have stationary points positioned correctly, even if they had been found correctly in **part (b)**. In some cases, the curvature was poor with shapes that suggested that, if continued, there would be a further maximum or minimum. Some negative cubic curves were seen and also quadratic curves, reciprocal curves, or straight lines were seen. A small number of answers did not show an understanding of what is required of a sketch, and made a table of values, added scales to the axes and attempted to plot points, rather than using the general shape of a positive cubic, and the stationary points found in **part (b)** to identify the correct shape and position of the curve.