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MATHEMATICS

Paper 0580/12
Paper 12 (Core)

Key messages

Look carefully at what is asked in questions and check that the answer found is sensible for the question. Ensure that all topics in the syllabus are studied.

General comments

Most candidates showed a good performance on this paper. Some candidates did not answer what was asked for in the question, even when candidates clearly understood the topic. This was particularly seen in the simple interest question in which interest was often given as the answer but the question asked for the value of the investment.

Presentation was generally good with most showing working where needed. However, clear figures that cannot be misread and showing working needs encouraging.

Comments on specific questions

Question 1

This question was well answered but some candidates treated sixteen thousand and thirty seven as separate parts producing the response of 16 000 037. Other errors produced responses of 6307, 1637, 17 017 and 1636.

Question 2

Most candidates easily identified the correct six factors. However, multiples rather than factors were seen, or even a mixture of both. The numbers 8, 9 and 12 were seen at times as factors while some omitted the number 1 from their list.

Question 3

This question was accurately answered by most candidates although some had problems writing the correct number of zeros; 1000 was often seen. Truncation to 9000 was seen at times as was the nearest hundred, 9900.

Question 4

While the question was correctly answered by most candidates, there were many different incorrect answers seen. Clearly interpreting a pictogram was not well understood by some candidates. Some just counted the number of small squares with no reference to the key while it was clear that a subtraction of two numbers was not always performed. Answers greater than the correct answer were often seen.

Question 5

Finding a reciprocal is well understood although some thought they just had to change the fraction to a decimal. Other fractions, $\frac{1}{3}, \frac{2}{3}$ and $\frac{25}{35}$ were also seen occasionally.

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Question 6

Quite a number of candidates felt they had to simply show a long multiplication to answer the question. Others confused the example given with the set question or did not include the middle line. Some made a final subtraction error. However, a large majority followed the example fully and correctly.

Question 7

(a) While the main error was to add pm to an otherwise correct answer, this question was very well answered. Writing 15 for the hours was a common error. 29 was sometimes given for the hours, presumably from adding 24 to 5.

(b) Finding the length of time when it goes from one day to the next was found challenging by many candidates. The response 7 h 48 min was common from adding 15 and 33, having worked out the number of hours correctly. Another common error was 16 h 42 min from a subtraction of the two times. Many other attempts gave a variety of incorrect answers.

(c) Changing seconds to hours was challenging for many candidates. Dividing by 60 to give an answer of 171, the number of minutes, was the most common error. Quite common was finding the correct answer but then changing it to 3 hours 25 minutes for the final answer. Lack of understanding of time was evident in some answers from multiplying the number of seconds by 60 or 3600.

Question 8

(a) Nearly all candidates were able to measure the angle correctly. Reading the wrong scale on the protractor produced the most common error of 140° while some were inaccurate or guessed incorrectly as they presumably didn't have a protractor. A few did not answer the question and simply gave the type of angle, namely acute.

(b) While the construction was mostly correctly done, presumably a number of candidates did not have a pair of compasses, resulting in no arcs seen or clearly arcs just marked on by hand. A few had just one line correct, although just arcs without lines was extremely rare. Some felt the two constructed sides had to be the same length.

Question 9

This question, requiring putting in one pair of brackets, was not well attempted and it is felt that had more checking of their resulting expression been shown, correction would have taken place. Those close to a correct answer included the power 2 or the minus sign inside their brackets. Two pairs of brackets were sometimes shown.

Question 10

This straightforward calculator computation was not well answered by many candidates. Some included the 6 or the 6^2 under the square root sign. Rounding $\sqrt{5}$ before multiplying was common. Many gained partial credit but showed poor rounding skills leading to common answers of 80.49 or 80.5 while some gave answers to more than 2 decimal places.

Question 11

This question was answered correctly by the vast majority of candidates. The squaring of n was sometimes ignored, usually resulting in an answer of 49 which gained partial credit. Some incorrectly subtracted 24 from 25 instead of adding it.

Question 12

While this straightforward ratio question was quite well answered, asking for a percentage, rather than an actual amount, did cause confusion for some candidates. 7 divided by 9 (instead of 7 + 9) was often seen as well as denominators of 10 or 100. For those completing a correct method, some did not realise that an exact answer should not be rounded.

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Question 13

(a) Most candidates recognised that the gradient was the coefficient of x, but some gave $5x$. Others gave a mixture of responses; 2 from 7 – 5, and 12 from 7 + 5. Fractions using 5 and 7 or just 7 were the most common incorrect responses.

(b)(i) Candidates found this challenging, being given the equation of a line and finding coordinates of points where axes are crossed. Many of the incorrect responses did not have 0 as one of the coordinates and it was sometimes given as the y-value. There was a variety of answers for the coordinates using the values 5 and 7 from the equation.

(b)(ii) Even fewer candidates gave a correct answer for this part, somewhat due to the answer being negative and a fraction. Only a few formed an equation and then it was usually not equated to zero. Those gaining the first mark often did not get the sign correct for the answer.

Question 14

(a) Some candidates reflected in the wrong axis. Otherwise many did not look at their result since quite often their images were not a reflection of the original.

(b) The translation was not well drawn, sometimes due to candidates translating their image from **part (a)**. However, the major error was to move 4 to the left and 3 down.

Question 15

The question asked for the value to be written as a power of 10 but many candidates gave an answer in standard form (1×10^{-4}). Apart from other incorrect attempts at writing the value in standard form, many miscounted the places resulting in for example, 10^{-5} or 10^{-3}. This was one of the questions found most challenging by candidates on the paper.

Question 16

A high percentage of candidates gave the correct word and any qualifying words were condoned. Some candidates did not know the words to describe the type of correlation. Few gave the incorrect 'negative' and more common were words such as decreases, increases, perfect and direct with many other descriptions of the relationship rather than type of correlation.

Question 17

Candidates need to distinguish between the two types of interests and apply the one in the question. For those correctly choosing and applying simple interest for their calculation, many stopped at just the interest and didn't give the value of the investment. Quite a number of candidates did not divide by 100, leading to a rather generous result of $10 500 for the interest.

Question 18

(a) Very nearly all answers were correct with only a few arithmetic slips. A few gave an incorrect first value but did then add 22 to gain partial credit.

(b) The nth term was quite often fully correct, helped by the emphasis on the difference between terms found in **part (a)**. Many applied the formula $a + (n – 1)d$ with correct values but some made errors in simplifying. Others did not recall that formula correctly, missing out the + sign or substituting incorrect values for the letters. A significant number of answers were just values of terms, such as 177 and 199, while 22 was often seen as the added part rather than the coefficient of n.

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Question 19

(a) Many candidates answered this algebra question correctly but some changed the order of the terms to put like terms together but left the signs as they were. So often seen was $5f + 8f – 7g + 2g$ leading to $13f – 5g$. Other errors with the signs led to a wide variety of incorrect answers. A few, having found the correct answer, then combined the two parts to give a term containing fg.

(b) The rule for adding indices when multiplying was well known and nearly all candidates gave the correct answer. The error of multiplying powers was not very common but a few other errors were made such as subtracting the indices.

(c) The combination of skills needed in this part resulted in very few fully correct answers. With the first term it was often just 16 or x^2 which was square rooted rather than both, while the second term was often just 1(presumably from y^0) rather than 5 × 1. Others combined the 5 with 16 resulting in 80 or an attempt at the square root of 80. Those who showed working for each part usually made better progress. A few candidates, having reached the stage of $4x \times 5$, did not then take the final step to the answer.

Question 20

Most candidates had the right idea that $\frac{n}{5}$ and $\frac{n}{2}$ had to be subtracted from n but some equated n to the sum of these two fractions. Following on from that stage proved challenging for most candidates but some did add these fractions correctly and gained credit for $\frac{7n}{10}$.

Question 21

(a) This question was quite well answered although answers of $A \cup B$ or simply words, for example intersection, were seen.

(b) The notation n(C) was not quite so well known and few candidates understood that they had to just give the number in that set. Some did give the answer 3 but didn't include the intersection. Many simply gave a list of the letters in the set, either 3 or 5 of them.

Question 22

The fraction question was quite well answered but many candidates did not fully answer the question. Having reached the improper fraction correctly, many did not then convert it to a mixed number, as instructed. Most knew that they had to start by changing the mixed number to an improper fraction but some did that incorrectly. While most either cancelled terms or multiplied numerators and denominators, a significant number adopted an addition approach by finding a common denominator of 42. Following that step it was usual to see just 42, rather than 42^2 as the denominator, as in an addition question. Writing answers as decimals was also quite common and just a few gave the final fraction part of the answer as $\frac{6}{5}$.

Question 23

(a) Many candidates gave a correct answer to this expanding and simplifying an algebraic 2-bracket expression. Some did not seem to understand that it produced four terms. Some of those who did the expansion in the correct way did not correctly apply the rules of multiplying directed numbers. Others equated the expression to zero and treated it as an equation to solve.

(b) Many found explaining the reason of incompleteness challenging to express even though they knew what the full answer should have been. Quite a few said that the answer was completely wrong which was not what the question stated. Many gained credit for the correct answer even if they could not explain clearly the reason for Renuka not scoring full marks.

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Question 24

This question was found challenging by candidates although many did gain partial credit, very often for finding the prime factors of 90. Others found two numbers that had either an LCM of 90 or an HCF of 6. Some gave one of the numbers as 6 but the question clearly stated that both numbers were greater than 6.

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MATHEMATICS

Paper 0580/22
Paper 22 (Extended)

Key messages

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

General comments

There were many high scoring scripts which demonstrated expertise and showed good mathematical skills. Scripts which scored highly but did not get full marks frequently contained errors in **Questions 13(b)**, **20** and **22**. There was little evidence that candidates were short of time, as almost all attempted the last few questions. Although a significant number of candidates omitted the last question, many of those who did attempt it did not answer it correctly. Omissions may have been due to lack of confidence with vectors rather than to lack of time. Candidates showed particular success in the skills assessed in **Questions 1**, **6**, **10(a)** and **13(a)**. Candidates were very good at showing their working. Occasionally stages in the working were omitted, which was particularly significant in **Questions 20** and **21(a)**, where full working was required. The standard of presentation was usually good, and responses were generally contained within the allocated answer space.

Comments on specific questions

Question 1

Most responses gave the angle within tolerance. The most common incorrect answer was from reading the wrong scale, giving 140. Few answers were outside the tolerance.

Question 2

Responses were strong for this question. The most common reasons for not achieving full credit were for giving the answer 80.5 when two decimal places were asked for, or for truncating to 80.49. Some responses appeared to round or truncate $\sqrt{5}$ before multiplying by 6^2.

Question 3

This question was frequently well answered. Common incorrect answers included; 5 h 18 min (doing 9 – 4 and 33 – 15); 6 or 8 h with 18 min (correct method but an arithmetic slip); 19 h 18 min (converting the 7 to 24 hour clock); 25 h 48 minutes (adding the two times); 6 or 7 h with 48 minutes (adding the minutes); 16 h 82 min (from the subtraction 2115 – 0433) and 16 hrs 42 mins (the difference between 0433 and 2115 on the same day rather than 2115 one day and 0433 the next day).

Question 4

This was generally well answered with most responses reaching the correct answer of 166. Some candidates found only half of the area, giving 83. The most common error was to find the volume. Another common misunderstanding was to count four of the faces as being the same size and give a calculation such as $2(4 \times 5) + 4(7 \times 4)$ or $2(4 \times 5) + 4(7 \times 5)$. A small number of responses only gave the area of one face. In a few cases arithmetic slips led to incorrect answers, for example $2(7 \times 5 + 7 \times 4 + 5 \times 4)$ being calculated as $2 \times (7 \times 5) + 7 \times 4 + 5 \times 4$, leading to 118 as the answer.

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Question 5

(a) A very small number of responses gave an answer of $5x$ rather than 5 in **part (a)**, but the vast majority gave the gradient of the line correctly.

(b) The overall response to **part (b)** was weaker than to **part (a)**. The most common error was finding the point of intersection with the x-axis rather than the y-axis.

Question 6

Almost all responses scored at least 1 mark. There was some variation in accuracy across scripts, but most fell within the tolerance of $\pm$ 2 mm. Those who used a pair of compasses carefully generally scored 2 marks. A few had the lines interchanged from the original diagram, and a few missed or ignored the given 12 cm line. The question asked candidates to leave in their construction arcs but a few tried to erase them or had arcs that were too small to see.

Question 7

This question was a challenge for a large proportion of candidates. The two most common incorrect answers were $n < -1$ and $-1 < n < 1$. Also seen, but less frequently, were incorrect answers such as $-1 < 1$ and $-1 < n < 1$.

Question 8

(a) (i) Answers demonstrated a good knowledge of transformations in both parts of the question. A majority of responses drew both of the correct images in **part (a)**. The two most common errors for the reflection in **part (i)** were to either reflect in the x-axis or for the image to be 1 grid square to the left, i.e. reflecting in $x = -0.5$.

(ii) In **part (ii)** some responses gained 1 mark for translating in either the x or y axis correctly. Some had the x and y directions the wrong way round in the vector. Candidates should be encouraged to check that their image is congruent to the original in reflections, rotations and translations.

(b) **Part (b)** was also well answered, with a good proportion of candidates understanding the properties needed to describe an enlargement. The greatest difficulty appeared to be with the scale factor, and values of 2, –2 and $-\frac{1}{2}$ were commonly seen. Some thought that it was a negative enlargement because the image was smaller. Weaker responses gave a combined transformation of enlargement and translation and so could not gain any marks.

Question 9

This was well answered. Some candidates did give the correct answer but then spoilt this with attempts at further factorisation, for example $3\boldsymbol{a}\left(2\boldsymbol{a}-\sqrt{7}\right)\left(2\boldsymbol{a}+\sqrt{7}\right)$ because they thought it was the difference of two squares. Other common errors included leaving in an extra '$\boldsymbol{a}$' in the bracket to give $3\boldsymbol{a}\left(4\boldsymbol{a}^2-7\boldsymbol{a}\right)$ or leaving out an '$\boldsymbol{a}$' in the first term to give $3\boldsymbol{a}\left(4\boldsymbol{a}-7\right)$. Many gave $3\boldsymbol{a}\left((2\boldsymbol{a})^2-7\right)$. It was less common to see 1 mark awarded for partial factorisation. Where this was awarded, it was an even split between those who had $3\left(4\boldsymbol{a}^3-7\boldsymbol{a}\right)$ and those who had $\boldsymbol{a}\left(12\boldsymbol{a}^2-21\right)$.

Question 10

(a) Nearly all responses gained both marks in **part (a)**. The exception was those making arithmetic errors in one or more of the evaluations.

(b) **Part (b)** was less well answered, although most recognised the pattern of reducing by 8. A few responses gave incorrect answers of $n - 8$ or $+ 8n$. It was fairly common to see $a + (n - 1)d$ as a starting point, although some were unclear what to do next. It was also common to see $15 + (n - 1) - 8$ rather than $15 + (n - 1)(-8)$. This was often, but not always, recovered to reach $15 + 8n + 8$. If

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candidates are going to rely on a formula it may be better to use $a + d(n - 1)$ which would help with this issue as then it would not matter if there were no brackets around the –8.

Question 11

This was often correct. The most common incorrect answers were '*direct proportion*' or just '*direct*'. Occasionally a few explained the relationship by copying parts of the question as their answer. It was extremely rare to see an answer of 'negative'.

Question 12

(a) **Part (a)** was well answered, with most responses scoring the full 3 marks. The principal amount was sometimes not added back on. Occasionally the correct method was shown but arithmetic errors led to an incorrect answer. Another common error was using compound interest instead of simple interest.

(b) **Part (b)** had a weaker response than **part (a)**. Most set up the initial equation correctly, although initial set-up errors such as $1030.35 = 700 + \left(1 + \frac{r}{100}\right)^{17}$ or $1030.35 = 700\left(1 - \frac{r}{100}\right)^{17}$ were seen. The former was unlikely to go any further but the second slip could still earn a second mark by correct re-arrangement leading to $\sqrt[17]{\frac{1030.35}{700}}$. Some answers were inaccurate due to premature rounding.

Question 13

(a) Nearly all responses used the laws of indices correctly in **part (a)**. The most common incorrect answer was h^{10}.

(b) **Part (b)** was one of the most challenging questions on the paper. Some answers got as far as $\frac{1}{\left(\frac{343}{x^3}\right)}$, $\left(\frac{x}{7}\right)^3$ or $\frac{x^3}{7^3}$ but did not complete the simplification. Others dealt correctly with the 7 but not the x, giving an answer of $\frac{x}{343}$.

(c) Many candidates were successful with **part (c)**. The most common incorrect answers were 10, 4 and a^6.

Question 14

The majority of answers scored full marks. The most common errors were using πr^2 or πr or using πd but with 4.7 used as the diameter. Candidates should use the π key or 3.142 in their calculations. Answers that used 3.14 or $\frac{22}{7}$ to approximate π got the results which were outside the acceptable range and did not gain the accuracy mark.

Question 15

This question was well answered. Almost all responses correctly gave the improper fraction $\frac{7}{3}$ for 1 mark. The most common error was giving $\frac{11}{6}$ as the final answer. Other common unsimplified answers included $\frac{77}{42}$ and $1\frac{35}{42}$. A small number of answers cross multiplied giving $\frac{7}{3} \times \frac{11}{14} = \frac{7 \times 14 + 3 \times 11}{3 \times 14}$, confusing addition and multiplication of fractions. Also very commonly seen was $\frac{11}{14}$ misread as $\frac{11}{4}$.

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Question 16

Many scripts gave correct answers to both parts of this question.

(a) In **part (a)** the majority of answers found the gradient and then substituted one of the points to find the intercept. The negative values often led to mistakes in both of these steps. A gradient of positive 2 was seen, along with several who found a gradient of 1 from the calculation $\frac{-3-5}{-2-6}$ instead of $\frac{-3-5}{-2--6}$. Candidates could have spotted these were errors by looking at the diagram more carefully. A check of the diagram shows that the gradient is negative and that a positive intercept is impossible. Candidates could have made the work easier by joining points *A* and *B* on the diagram.

(b) The majority of responses displayed understanding of how to find the gradient of a perpendicular line in **part (b)**. Some weaker responses omitted either the change of sign or reciprocal. A significant number of responses missed the fact that the line passes through the origin. This led to the use of either point *A* or *B* or the midpoint between them and many used the intercept of –7 again. One mark was commonly awarded for either a correct perpendicular gradient, which could follow through from their **part (a)**, or an equation of a line with a zero intercept. Close to 10 per cent of scripts gave no response to this question.

Question 17

This question was one of the more challenging in the paper. However many scripts were able to score at least partial marks and quite a few scored full marks for an answer of 77.8 or an answer in the range 77.77 to 77.80. The vast majority of answers showed their method to gain the method marks when supported by an answer out of the acceptable range such as 77.7. The main problem was finding the angle at the centre of the sector, angle *POX*, which many assumed was 45° or they measured or guessed it, resulting in an angle in the range 60° to 65°. If all subsequent work following this incorrect angle was correct, and the angle was acute, responses could still earn 3 of the method marks with full working shown and often did. Answers that calculated the angle *POX* correctly usually used the method $\tan(POX) = \frac{11}{4}$, with a few using the less efficient method of Pythagoras and $\sin(POX) = \frac{11}{11.7}$. Many responses correctly calculated the area of a sector. Other common errors included calculating the arc length instead of sector area. Some used a radius for the sector of 5.85 which assumes *X* is the midpoint of *OQ*. A small number used the radius of the sector as 5.5 from 11 ÷ 2 though this was less common. The vast majority of answers calculated $\frac{\textit{their area}}{44}$ correctly as a percentage. The most efficient method was to use their area of the sector of the circle and subtract it from 4×11 and then to find this as a percentage of 4×11. Some candidates used the two triangles with areas 22. Although this was longer method, it often led to the correct answer. It was quite common to see inaccurate calculations including premature rounding of figures part way through the calculations. This led to a final answer outside the acceptable range. Some responses found the percentage of the shape that was unshaded. A small number confused perimeter and area for some or all parts of the question. Candidates are advised that, to reach an answer correct to 3 significant figures, any rounding of interim figures cannot be to 3 significant figures. Candidates should use calculator memories or write down interim values to a higher degree of accuracy.

Question 18

This was a challenging question. Most scripts attempted an equation as instructed. The most common error was including just one shirt leading to $x = \frac{140}{3}$. Other common errors were including $x - 48$ rather than $2(x - 24)$ or including the hat as $x - 16 - 24$. Candidates must read the wording of the question carefully. Often responses with these common slips were able to gain a mark for correctly simplifying their partially correct equation. Another common error was to use $24 - x$ and $16 - x$ for the cost of the shirt and the hat instead of $x - 24$ and $x - 16$.

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Question 19

Most responses were able to score at least 2 marks in this question. Working was generally clearly presented. A significant number of responses did not gain the final accuracy mark by giving their answer as a decimal which did not have enough accuracy, often 0.67 or 0.666. Candidates should remember that they must give answers correct to 3 significant figures or exact, so 0.667, $\frac{2}{3}$ and $0.\dot{6}$ were all acceptable answers.

Some responses did not seem to have read the question carefully and used the square of (x + 4) or used x + 4. Others used direct proportion instead of inverse proportion. Some found the constant of proportionality incorrectly, due to arithmetic or rearranging errors, but were able to gain the second method mark. Conversely, others found the constant of proportionality correctly and then forgot about the inverse or the square root when substituting in to find *y*.

Question 20

This was one of the more challenging questions on the paper. However, many responses gained full marks. Full working was usually shown, with only a small number missing out a step of the working- usually the solution of the quadratic. Of those who did not reach the final answer, the most common cause was an error in manipulating the linear equation to set up the quadratic equation. Those who used elimination frequently did not add or subtract consistently. Those who chose, for example, to make y the subject of each equation and then equate the expressions, arithmetic slips were often the problem, with the incorrect equations $x^2 + 6x - 4 = 0$ or $x^2 - 6x - 4 = 0$ each seen quite often. Marks were still available for solution of this incorrect equation and SC1 could be awarded for substitution of two incorrect values into one of the original equations, thus making 3 marks available following the early error. The most efficient method which usually gained the marks was to substitute the first equation into the second resulting in $x^2 - 2(11 - 3x) = 18$. Those who attempted to eliminate the *x*-variable by the substitution $\frac{(11-y)^2}{3^2} - 2y = 18$ often followed this by an incorrect simplification of $\frac{(11-y)^2}{3^2}$. Almost all responses made progress and gained marks on this question.

Question 21

(a) Most responses showed good understanding of three-dimensional trigonometry and could identify the required angle for **part (a)**. A good proportion of responses gained full marks in this part of the question, along with a large number who gained 3 marks for a fully correct method. Weaker responses produced inaccurate answers from rounding within working. It was common to see $\tan^{-1}\frac{14.5}{20.7}$ leading to an answer of 35, 35.0 or 35.01. Many answers showed the starting point of using Pythagoras to find *AC* or *AG*, even if they did not show further understanding of which angle to find or how to proceed. Some responses used triangle *GAB* and weaker responses used a variety of trigonometric functions with combinations of the given dimensions, most commonly finding $\tan^{-1}\frac{14.5}{18.6}$. Some had the correct method but then added on angle *CAB* to the otherwise correct angle.

(b) In **part (b)** candidates were required to show their working. Many did so correctly, giving a more accurate value for the given length, *GM*, before rounding it correctly to one decimal place. Candidates could either use their angle from **part (a)** to find the length *AG* or they could use Pythagoras's theorem. Those that made use of insufficiently accurate values from **part (a)** did not obtain the given value and did not gain the accuracy mark. It was common to see $18.6^2 + 9^2$ as 20.7^2, which led to a value for *AG* of 25.27, and a value for *GM* of 4.7. Many candidates did not go back to correct this even though they were supposed to be showing that the value was 4.8. Many weaker candidates found the length of *AG* by using the given length of *GM*.

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Question 22

(a) Most scripts answered this question even though only the strongest were successful. The best responses began by stating the route first, usually *PO* + *OR* + *RQ* which was sufficient for the first method mark. Answers that did not score often had not clearly planned a route. Instead, many wrote down a combination of ***a***'s and ***b***'s making it difficult to credit their method.. The $\overrightarrow{RQ} = \frac{3}{5}\left|\overrightarrow{OP}\right|$ notation seemed to cause confusion on generally weaker scripts which were did not translate that into $\frac{3}{5}\boldsymbol{b}$ and then could not proceed. Some responses did reach $-\boldsymbol{b} + \boldsymbol{a} + \frac{3}{5}\boldsymbol{b}$ but then did not correctly simplify this.

(b) Roughly 80 per cent of scripts attempted **part (b)** but only the strongest scripts gained 2 marks. Strong responses could see that the answer needed to be a multiple of ***a***. Weaker ones simply assumed $\overrightarrow{OR}$ and $\overrightarrow{RW}$ were the same magnitude, with 2***a*** being a common incorrect answer. Those that tried to find a route to *W* using the vectors they already had invariably ended up with a combination of ***a***'s and ***b***'s missing that this could not be a correct answer.

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MATHEMATICS

Paper 0580/32
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. The majority of candidates completed the paper and made an attempt at most questions. Although a number of questions have a common theme, candidates should realise that a number of different mathematical concepts and topics may be tested within the question. The standard of presentation and amount of working shown was generally good. Centres should encourage candidates to show formulae used, substitutions made and calculations performed. Attention should be paid to the degree of accuracy required in particular questions. Candidates should be encouraged to avoid premature rounding in workings as this often leads to an inaccurate answer. Centres should remind candidates that the rubric states that 'For π, use either your calculator value or 3.142'. In 'show that' questions, candidates must show all their working to justify their calculations to arrive at the given answer. In 'explain' questions candidates must answer fully and use the correct mathematical terminology. 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.

Comments on specific questions

Question 1

(a) (i) This part on reading and completing the given frequency table was answered correctly by the majority of candidates.

(ii) The majority of candidates were able to work out the required percentage correctly.

(b) (i) A good number of fully correct answers were seen, demonstrating a logical method of using the given information. The common error was in the misuse or incorrect calculation of the fraction $\frac{4}{9}$.

(ii) The majority of candidates were able to work out the required probability correctly. The common error was the answer of $\frac{3}{10}$ or $\frac{36}{120}$.

(c) (i) The majority of candidates were able to work out the required pie chart sector angles correctly. A small minority attempted to use percentages which lead to the incorrect answers of 42, 25 and 33.

(ii) The majority of candidates were able to draw the required pie chart correctly and many accurate and precise diagrams were seen.

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Question 2

(a) This part on finding the interior angle of a regular pentagon was answered reasonably well with the two valid methods equally used. Common errors included $360 \div 5 = 72$, $(5 - 2) \times 180 = 540$ and $180 \div 5 = 36$.

(b) (i) This part was again answered reasonably well, particularly with partial credit allowed for a follow through. The geometrical reason given was usually correctly stated although straight lines were often assumed leading to an incorrect reason.

(ii) This part was again answered reasonably well, particularly with partial credit allowed for a valid follow through, although a number of candidates did not appreciate that the triangle to be used was isosceles. The correct geometrical reason was less successfully stated, and candidates should note that the full reason should be stated and not partial reasons such as 'a triangle is 180' and 'two angles are equal'.

(iii) This part was generally answered well.

Question 3

(a) (i)(a) Many candidates were able to identify the given quadrilateral although a variety of other mathematical names were seen, with the most common incorrect answer being rhombus.

(i)(b) This part was answered reasonably well with the most common method being the use of the formula for the area of a trapezium. Some candidates treated the shape as a composite area, and only a small number used the 'counting squares' method. Common errors included the use of incorrect formulas, and the use of one of the lengths of the trapezium as 6 and 4. The units stated for their answer was generally correct although a small minority omitted this part.

(ii) The majority of candidates were able to measure the required angle correctly, although common errors included 63 and 27 possibly due to misuse of the protractor.

(iii)(a) This part was generally answered reasonably well with a good number of candidates able to identify the given transformation as an enlargement and 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 (2, 0) being common incorrect answers.

(iii)(b) This part was generally answered well with the majority of candidates able to identify the given transformation as a rotation and able to correctly state the three required components. The identification of the centre of rotation proved the more challenging with a significant number omitting this part, and (0, 0) and (2, 4) being common errors. The angle of rotation was sometimes omitted or incomplete, with 90°, 90° anticlockwise and 180° being the common errors. A small yet significant number gave a double transformation of a rotation and a translation which doesn't gain any credit.

(b) Candidates found this part quite challenging and it proved to be a good discriminator. Common errors included triangles with a height of 3 cm (from the use of the incorrect $6 \times h = 18$), triangles with BC and $AC = 6$ cm, a second parallelogram drawn and an incorrect calculation of the area of the parallelogram.

Question 4

(a) (i)(a) Many candidates were able to identify the given line as a radius although a variety of other mathematical names were seen, with the most common incorrect answer being diameter.

(i)(b) Many candidates were able to identify the given line as a chord although a variety of other mathematical names were seen, with the most common incorrect answer being tangent.

(ii) The vast majority of candidates were able to measure the required line accurately.

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(b) Most candidates were able to apply the correct formula accurately to gain full credit. A very small number used 3.14 or $\frac{22}{7}$ for π and gave an inaccurate answer.

(c)(i) The majority of candidates were able to use their geometric knowledge and correctly complete both of the given equations with 90. Common errors included 180, 45, and 12*xy* with 16*xy*.

(ii) A good number of candidates were able to show clear and correct working and gain full credit on this part of solving simultaneous equations. The majority attempted to use the elimination method to solve their equations, with equal attempts to equate the coefficients of *x* and *y*. However, some numeric and algebraic errors were seen in the setting up of the equations. The most common error in the method was to add rather than subtract the equations when attempting to eliminate *x*, possibly caused by a sign error when using the term –4*y*. Candidates who did not gain the method mark were able to earn the SC mark, for finding 2 values that satisfied one of their equations, provided the evaluation of the second value was given to enough accuracy.

Question 5

(a) (i) This part, on drawing the net of a given cuboid, was generally very well answered with a variety of correct nets seen which were drawn accurately and precisely. Common errors included nets consisting of 5 rectangles, 2 opposite faces incorrectly orientated, and occasionally a 3-D sketch of a cuboid.

(ii) Candidates found this part quite challenging and it proved to be a good discriminator. The most common method used was $(100 \times 100 \times 100) \div (2 \times 4 \times 5)$. Common errors included $100 \div 40$, $1000 \div 40$, $1 \div 40$, resulting from incorrect conversion of units, and $100 \div 11$, $40 \div 1\,000\,000$ or 10 000 or 100 resulting from use of incorrect formulas, or simply finding the volume of the box or the container.

(b) (i) This part was generally answered well with the majority of candidates using one of the valid ratio or method of unity methods.

(ii) This part was not answered as well with many candidates not appreciating one of the required stages in this multi-stage calculation. Common errors included just converting the cost to 224 rupees, inverted ratio calculations and incorrect use of the given values.

(c) This part was not answered well with very few fully correct answers seen. Common errors included the answer of 421 875 from 75^3, 0.075, and a number of different errors in the conversion from cm^3 to litres.

Question 6

(a) (i)(a) This part was generally answered well, although the common errors of $\frac{8}{9}$ and $\frac{1}{8}$ were seen.

(i)(b) This part was generally answered well, although the common errors of $\frac{6}{9}$ and $\frac{6}{7}$ were seen.

(ii) This part was generally answered well, although the common errors of $\frac{2}{135}$ and 15 were seen.

(b) Candidates found the whole of **part (b)** quite challenging and it proved to be a good discriminator, with many candidates not appreciating or understanding the given frequency table.

(b) (i) Common errors included 15 and 16.

(ii) The common error was 16 – 9 = 7.

(iii) Common errors included 14.5 or 3.5 by just considering either set of 6 numbers given. Few candidates appreciated that the 40th/41st values were needed or how to use the table to find these.

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(iv) This part was better answered with a number of candidates able to gain full credit. Common errors included 80 ÷ 6, 80 ÷ 21, 21 ÷ 6, 268 ÷ 21 and 268 ÷ 6.

Question 7

(a) This part was generally answered well with the majority able to apply the correct method for this two-step calculation. Common errors included incorrect conversion from metres to kilometres, and incorrectly or forgetting to give the answer correct to the nearest metre.

(b) (i) This part was generally not answered well with the majority unable to work out the reverse bearing required. The very common error was the answer of 38.

(ii) The majority of candidates were able to use the correct Speed, Distance, Time formula to find the required first step journey time of 2.4 hours, but only a small number were able to go on and score full credit. Common errors included the incorrect conversion to 2 hours 40 minutes or 2 hours 4 minutes; giving 2.4 hours or their equivalent as the final answer; and giving the incomplete 4.54 as the final answer.

(c)(i) This part on the measurement of a bearing was not generally answered well with common errors of 73°, 253°, 287° and 9 cm frequently seen.

(ii) Candidates found this part quite challenging and it proved to be a good discriminator. Many candidates did not appear to appreciate that the bearing would remain the same and that the distance would change with the different scale used. Consequently, many scale drawings were inaccurate in either the bearing or the distance or both. There was little evidence of the calculations needed to find the distance required.

Question 8

(a) (i) The table was generally completed very well with the majority of candidates giving 3 correct values.

(ii) This part was well answered by a good number of candidates who were able to gain full credit for accurate, smoothly drawn curves. Most others only gained partial credit, mainly due to one or more points being plotted out of tolerance, or for just plotting the points without drawing the curve through them.

(iii)(a) This part on identifying the equation of the line of symmetry was not well answered. Common errors included $x = -0.3$, $x = 3$, $y = -3$, 3, $y = mx + c$ and $y = x^2 + 6x - 160$. Although not required it may have helped candidates to draw the line of symmetry first.

(iii)(b) This part on finding the coordinates of the lowest point on the graph was also not well answered. Common errors included (0, –160), (–5, –165), and inaccurate answers such as (–2.5, –165) or (–0.3, –165).

(iv) This part on solving the given equation was generally answered reasonably well particularly with the follow through allowed. Common errors included using the intersection of the graph with the *y*-axis, or misreading one or both of the scales.

(b) This part on rearranging the given formula was generally answered well. Common errors included the incorrect first line of $mx = c - y$, attempting to use the graph from **part (a)**, and attempting to find numerical values for m and c.

Question 9

(a) (i) Candidates found this part very challenging and it proved to be a good discriminator. Very few candidates appreciated that Pythagoras' theorem was to be used. Common errors included invalid use of trigonometrical ratios, or more often simple statements like 'it is a right angle', 'they are alternate angles'.

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(ii) Candidates again found this part very challenging and it proved to be a good discriminator. Many did not appreciate that the length *PS* had to be found by using the tangent ratio. However, a good number were able to gain partial credit by finding correctly the area of triangle *PQR*. Common errors included assuming the given shape was two equal triangles of a parallelogram, and the incorrect use of area formulas and/or trigonometrical ratios.

(b) (i) This part was generally answered well, although the common errors of 3.8 and 4.8, 4.2 and 4.4, 4.29 and 4.31 were seen.

(ii) This part was generally answered well, with a good number showing all the required working needed in this 'show that' question.

(iii) This part was generally answered reasonably well, with the majority of candidates working out the solution in separate stages. Common errors included the final answer of 2.4, interim answers of 0.48 and 0.576 used, and premature rounding in the calculations.

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MATHEMATICS

Paper 0580/42
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, with intermediate values written to at least 4 significant figures and only the final answer rounded to the appropriate level of accuracy where the value is not exact. Candidates should show full working with their answers to ensure method marks are considered when final answers are incorrect.

General comments

The strongest scripts demonstrated expertise with the content and proficient mathematical skills. There were some weaker scripts that showed a lack of familiarity with some topics and contained no responses for some questions. There was no evidence that candidates were short of time, as most candidates attempted nearly all of the later questions. Weaker responses made assumptions about geometrical diagrams. For example, two common errors were in **Questions 4(a)** and **4(b)** in assuming that one or more of the triangles were right-angled, and in **Question 6(b)** assuming angle *AOB* was a right angle. In **Question 7(b)** an exact value was needed for the upper bound and not a rounded value. Some responses rounded intermediate values within their working which led to inaccuracies in final answers, for example in **Question 4** and **Questions 9(a)** and **9(b)**.

The areas that proved to be most accessible were:

- Standard calculations with fractions
- Ratio and percentages
- Standard problems involving functions
- Application of the sine rule to a standard problem
- Calculating an estimate of the mean, and constructing and interpreting a cumulative frequency graph
- Angle calculations in cyclic quadrilaterals
- Tree diagrams
- Simple probability

The most challenging areas were:

- Repeated percentage change
- Interpreting inverse functions
- Dealing with frequency density and scaling in histograms
- Giving geometric reasoning for similarity
- Calculations with bounds
- Flow problem with a cylindrical pipe
- Combining conditional probabilities
- Sketching a cubic function
- Problem solving with stationary points

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Comments on specific questions

Question 1

(a) Most responses to this part were correct. The most common errors were expressing either 300 or the increase of 552 as a percentage of 852. Another common error involved finding 852 as a percentage of 300 rather than the percentage increase from 300 to 852. Some responses showed correct working leading to 184 per cent, but then incorrectly subtracted 100 per cent to give an answer of 84 per cent.

(b) Almost all answers were correct. The most common error was to give the answer 355, the number of part-time workers. A less commonly-seen error was giving 71, the value of one part of the ratio.

(c) (i) Almost all responses wrote the number in words correctly.

(ii) Answers were mostly correct. Common errors usually involved writing an equivalent value but not in standard form, usually either 40.6×10^3 or 406×10^2. A small number of responses contained a negative power, usually 4.06×10^{-4}.

(d) Many answers were correct. Misinterpretation of the question led to the most common error, which was calculating 48 per cent of 3000 correctly to give 1440, but then subtracting this from 3000 before finding $\frac{3}{8}$ of the remaining 1560 rather than finding $\frac{3}{8}$ of 3000.

(e) The most efficient method of using the multipliers $1.15 \times 1.18 = 1.357$ giving a 35.7 per cent increase was not often seen. Some candidates used a starting amount, most often 3000, increased this by 15 per cent then increased the result by 18 per cent before calculating the overall percentage increase in the amount to get the correct answer. In some cases, responses gave the answer 1.357 or 135.7 per cent, rather than finding the percentage increase. The most common error was to add the two percentages together, giving an answer of 33 per cent. Other weaker responses subtracted the percentages to give 3 per cent, sometimes continuing to find 3 per cent as a percentage of 15 per cent, giving the overall answer of 20 per cent. Another common method was to find 18 per cent of 115, giving the answer 20.7 per cent, which could have led to the correct answer if the 115 per cent had been added on.

Question 2

(a) Most candidates correctly completed the table. Common errors involved incorrect rounding of the results or incorrect use of a calculator. For example, when $x = -0.5$ the value of y was often seen as 0.4. This is the result of the calculation $-(0.5)^2 - 1 \div (3 \times -0.5) = 0.416...$, i.e. dealing with the square term incorrectly.

(b) Plotting the points on the grid proved challenging and fully correct curves were in the minority. Most issues concerned the plotting of (–0.1, 3.3) which was often plotted at (–0.05, 3.3). When the points were plotted correctly, the quality of curves was generally very good although a few had their points joined by ruled line segments.

(c) There were comparatively few strong responses to this question. A small number of answers drew the required line but then misinterpreted the horizontal scale when reading off the solution. Some were able to identify the required line and gave the correct solution but without drawing the required line. A high proportion of scripts contained no attempt at a response.

Question 3

(a) (i) Many correct answers were seen. Most errors involved misinterpretation of the composite function gf(x) as $1 + 4x^2$ or as $1 + 4x$ or as $x^2(1 + 4x)$.

(ii) Many correct answers were seen here too. As in the previous part, most errors usually involved the misinterpretation of the composite function fg(x) as $(1 + 4x)^2$ or as $x^2(1 + 4x)$. A small number of responses attempted substitution and gave a numerical answer.

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(iii) This question proved more challenging, and correct answers of x were in the minority. Many candidates seemed unfamiliar with the knowledge that $f^{-1}f(x)$ returned the original value of x. Several attempts to find the inverse function were seen followed by attempts to find the composite function. Some were able to reach the correct answer, some obtained a correct composite function but did not simplify their answer and others made slips in the working.

(b) Most answers demonstrated a good understanding of solving the equation $f(x) = 15$ and many correct solutions were seen. The most common error involved substitution of $x = 15$ leading to an answer of 61.

Question 4

(a) (i) Most solutions used the sine rule and applied it correctly. Incorrect answers usually resulted from premature approximation, giving the value of sin ABC as 0.65 or 0.655, both of which led to 3 significant figure answers that were out of range. Those opting to use the cosine rule usually did so correctly, although premature approximation also affected some of their answers. Weaker responses often made incorrect assumptions, such as that the triangle was right-angled or isosceles.

(ii) Almost all answers correctly identified that the area could be found using $\frac{1}{2}ab\sin C$ and usually obtained the correct answer. Most of the candidates opted to use the given angle of 51.6°, a sensible method to use as it does not involve any calculated values. In some cases, the angle chosen was not the included angle for the two sides being used. A few candidates opted to use Hero's formula but not all were successful. A smaller number incorrectly assumed that the triangle is right angled and so used the method $\frac{1}{2} \times \text{base} \times \text{height}$.

(b) (i) A good majority of responses calculated SQ and used their value to find SR. A variety of methods to find SQ was seen, most commonly the sine rule and the cosine rule with some using the properties of isosceles triangles to find $\frac{1}{2}SQ$. With SQ found, most continued correctly to find SR. Incorrect answers resulted from slips in the use of the calculator, premature approximation, errors in the rearrangement from the implicit form of the cosine rule to the explicit form and errors in the collection of terms in the cosine rule. Weaker answers wrongly assumed either that triangle SQR was a right-angled triangle or assigned incorrect values to the angles in the triangle. As a result their attempts did not include finding the length of SQ.

(ii) Many responses identified that the shortest distance is the length of the perpendicular from P to SQ and this line was often indicated on the diagram. However not all clearly marked the right angle at the base or showed working to indicate this was the case. Using trigonometry was a more popular method than Pythagoras'. As in previous parts, premature approximation often led to inaccuracies in the final answers.

Question 5

(a) Calculating the mean from a frequency distribution was well-understood and fully correct solutions were frequently seen. Most errors resulted from the use of an incorrect midpoint, from the use of values other than midpoints or from slips with the arithmetic.

(b) This proved challenging for many. Those answers displaying understanding that the heights of the blocks of a histogram represented the frequency densities usually had no difficulty. Some clearly showed the calculation of the scale factor for the first bar as 17.2÷ 0.86 = 20 and used this correctly with the remaining frequency densities. Many calculated the scale factor from the frequencies leading to a scale factor of 17.2 ÷ 43 = 0.4. As the second interval had the same width as the first this led to a correct value of 12.4 along with two wrong values of 10 and 8.4 .

(c) Almost all candidates completed the cumulative frequency table correctly. Common errors included listing the frequencies, attempts at the frequency densities and in some cases a list of four random numbers.

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(d) Almost all candidates plotted their cumulative frequencies at the upper boundaries of the intervals and at the correct height. In the majority of cases these were joined with a curve rather than straight line segments. Responses that were not fully correct usually resulted from mis-plotting one or more points, following through from their previous values and not getting an increasing curve or polygon or by drawing a block diagram.

(e) (i) Almost all candidates that had a cumulative curve were able to read off the median accurately.

(ii) Again, candidates found this straightforward and most gave an accurate value for the upper quartile.

(iii) The majority of answers were correct. Two common errors included calculating the cumulative frequency for the 40th percentile and giving this as their answer or simply reading off the mass for a cumulative frequency of 40.

(iv) Although a majority of the responses were fully correct, many were less successful in this part. Instead of reading off the cumulative frequencies for both of the masses 250 and 400, several read off for only one of these values and subtracted the reading from 120. A slightly higher number of scripts contained no attempt at a response.

Question 6

(a) Most response displayed good understanding of angle properties of a polygon. Using the sum of the interior angles was a more popular method than the sum of the exterior angles. However, it was more common to see mistakes when using the interior angles as the formula was sometimes written as $180(n – 2) = 156$.

(b) A small majority of candidates were able to give the correct value for angle *ACB*, in some cases with full reasons, although these were not required. However, a significant number of candidates made little progress. Although some were able to identify angle *AOB* as 76°, many did not recognise that this was an example of the angle at the centre and that angle *ACB* was the corresponding angle at the circumference. Common errors included assumptions that angle *ABC* was a right angle or that angle *AOB* was a right angle. Others assumed that triangle *AOB* was isosceles with *OA* = *AB*. In some responses it was possible to see the value of 76 in the working but this was not linked to angle *AOB*.

(c) This part was answered well with many scripts giving the correct answer. Some earned partial credit for finding the correct value for either angle *PSR* or angle *PQR*. The most common incorrect answer was 112.

(d) This proved to be one of the most challenging questions on the paper and few fully correct solutions were seen. Many answers correctly matched pairs of angles, but the reasons given often lacked precision and or did not use the correct vocabulary. For example, the radius for the angle between the tangent and radius was commonly omitted. Other answers described the position of angle *KMG* as in a triangle with the diameter rather than quoting the mathematical reason ‘angle in a semi-circle is 90°’. Some answers gave unnecessary information about the sides of the triangle, not all of which was correct. When the correct angles were identified with fully correct reasons, it was still common not to see a conclusion. When conclusions were given, they often referred to reasons associated with congruent triangles, such as RHS.

Question 7

(a) Success in this part was dependent on understanding that the linear scale factor was the square root of the ratio of the two areas and the order in which to apply it. The most common error was the use of the area factor for the linear scale factor leading to the common answer of 56.7. Squaring the ratio of areas was another common error.

(b) Many candidates identified that they needed to find the product of the upper bounds of the length and the width. Those who correctly identified these bounds as 15.25 and 10.75 often reached the correct area of 163.9375. However, this area was frequently rounded to 3 significant figures for the final answer which was not acceptable for the answer in this instance. ‘Correct to the nearest 5 mm’ was frequently misinterpreted and upper bounds of 15.5 or 17.5 for the length and 11, 10.55 and

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13 for the width were common errors. Only a small number of candidates calculated an area before attempting to apply the bounds.

(c) Many solutions calculated the reverse percentage correctly. Calculating either 118 per cent or 82 per cent of 33.21 or calculating 33.21 ÷ 1.18 were common errors. Occasionally, responses did not divide by 5 in an otherwise correct method.

(d) Most responses demonstrated a good understanding of exchange rates and ability to calculate the difference in the two prices. A common error was rounding issues resulting in incorrect final answers. Some rounded their conversion to 54.8 dollars resulting in an inaccurate price difference of 2.2 dollars. Others obtained the correct price difference of 2.23 dollars but then then rounded this value to the nearest ten cents giving 2.2 or 2.20 dollars as their final answer. A smaller number found the difference in euros rather than dollars. Very few responses used the conversion rate incorrectly, multiplying 48.20 by 0.88 rather than dividing.

Question 8

(a) Most answers set up a correct equation. Others either gave an equation with an incorrect time, such as 2 h 48 min, 2.48 h or 168 min, or gave an incorrect expression for Darpan's cycling time such as $\frac{26}{10x}$. A few gave an equation with an incorrect expression for the total time such as $\frac{12+26}{x+10+x}$. Some candidates gave an expression for the total time, and a few gave an expression for the cycling time only. Many of those giving an equation went further and simplified their equation but this was condoned.

(b) Those scripts with a correct equation in the previous part usually showed good algebraic skills to eliminate the fractions and expand the resulting brackets correctly. Slips with signs and the omission of = 0 at one or more stages in the working were the most common errors.

(c) Most answers gave the correct formula for solving quadratic equations and also made the correct substitutions. Errors with the negative terms, either writing –25 rather than –(–25) or omitting brackets around $(–25)^2$ were common errors as well as short division lines and short square roots. However, most reached the correct solutions although some gave 8.6 rather than 8.57 or better. Others with no working or incorrect working clearly used the equation solver facility on their calculators.

(d) A majority of candidates substituted their positive solution from the previous part into the correct expression. Most went on to convert their answer into minutes. A few calculated the cycling time rather than the running time. This question was omitted by a high number of candidates

Question 9

(a) Most responses started by using the formula for the volume of a cone to find its height, almost always completed correctly. The height and the radius of the cone were usually used with Pythagoras' theorem to find the slant height of the cone. Not all scripts displayed understanding that this was also the radius of the sector of the circle. The final step of the solution was found to be more of a challenge and many were unable to set up a correct equation relating either the length of the arc *AB* to the circumference of the base of the cone or the area of the sector *OAB* to the curved surface area of the cone. Using the height of the cone as the radius of the sector, equating the volume of the cone to the sector area or attempting to use trigonometry were common errors when trying to find the angle of the sector. Some solutions showed a completely correct method but reached an answer outside the acceptable range because of premature approximation of values or use of an inaccurate value of π.

(b) This question was found to be very challenging and few answers were fully correct. Responses displayed difficulty in using the rate of flow of fuel along the pipe and its cross-sectional area to calculate the volume of fuel entering the tank per second, leading to the volume entering in 24 minutes. Common errors included: using the diameter rather than the radius of the pipe when calculating the cross-sectional area, using inconsistent units in the calculation, or using an incorrect conversion factor between cubic centimetres and litres. Partial marks were given for a correct area or correctly converting their volume into litres.

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Question 10

(a) Many solutions carried out the algebraic multiplications carefully, usually opting to expand the first pair of brackets before multiplying the result with the third bracket. Most multiplied out the first pair correctly with just a small number of sign errors made. Some responses did not simplify the four-term expression to a three-term expression, and this made the next step more complicated, often leading to errors. Some candidates multiplied out the first two brackets but then incorrectly multiplied out the second and third brackets.

(b) Most responses displayed a good understanding of the steps involved but errors at the various stages meant that only a smaller majority reached the correct answer. Many started by attempting to clear $g - c$ from the denominator but writing this as $Mg - c$ was a common error. Stronger answers then isolated the terms in g, factorised and went on to give a correct answer. Others simply isolated the Mg term before finishing with a rearrangement with g on both sides.

(c) Most answers demonstrated good skills in simplifying an algebraic fraction and went on to obtain the correct answer. Others only factorised one of the two expressions correctly, with some not spotting the difference of two squares, or treating both expressions as the difference of two squares. Many of the weaker responses only attempted cancellation, usually $4x^2$ with x^2 and $-16x$ with -16.

Question 11

(a) (i) Most answers completed the tree diagram correctly. Errors were mostly confined to the branches for Tuesday. Some attempted probabilities as if they were without replacement and probabilities $\frac{1}{5}$, $\frac{4}{5}$, $\frac{1}{5}$, $\frac{4}{5}$ were seen several times. Others attempted partially combined probabilities and $\frac{1}{36}$, $\frac{35}{36}$, $\frac{5}{36}$, $\frac{31}{36}$ or similar were also seen. Only a few candidates gave incorrect probabilities for Monday.

(ii) Most responses gave the correct answer or used the correct method to follow through correctly from their incorrect tree diagram. Adding the relevant probabilities instead of multiplying was a common misunderstanding as was multiplying the product by 2.

(b) (i) A majority of answers demonstrated a good understanding of set notation with most opting for $(G \cup T \cup M)'$ with some opting for $G' \cap T' \cap M'$ and a few to other correct alternatives. Common errors included $G' \cup T' \cup M'$, $n(G \cup T \cup M)'$ and the universal set.

(ii) A small majority of candidates were able to identify the correct region and gave the correct answer of 28. The most common incorrect answer was 19 followed by 29.

(iii) Most answers gave the correct probability of $\frac{17}{50}$. Incorrect answers usually involved a numerator made up of different combinations of the 14, 3, 2 and 2 students who wore trainers.

(iv) This question proved to be very challenging. Candidates needed to identify that 21 students wear trainers and that only 16 of these have mobile phones. As two students were being picked then answers also needed to treat this as picking without replacement. Many identified the correct 16 students but did not take into account that they were being chosen from just those wearing trainers. Similarly, others identified the 21 students wearing trainers but not the 16 that have mobile phones. A small number gave a probability for picking two students with replacement.

Question 12

(a) Many responses used demonstrated correct use of the calculator, obtaining 84.99 or 85.0 and going on to find the second angle. Some did not give an answer to 3 significant figures and 84.9 was a common error. Another common error was to subtract the primary value from 360 rather than adding it to 180. Some solutions were out of range, usually negative.

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(b) To draw an acceptable sketch with the correct curvature, candidates needed a good understanding of the possible shapes of a positive cubic graph and that the given curve had three roots, one of which was zero. Most candidates attempted a sketch but few satisfied all of the above requirements. Many of the sketches displayed an understanding of some of the requirements, with some that had one maximum point and one minimum point, but the number of roots was sometimes fewer than three. In addition, the curvature of some sketches was affected by kinks in the curve. This was often due to candidates attempting to plot a scale (often inaccurate), plot some points and draw a curve. Others did draw a sketch with three roots but 0 was not always one of the roots.

(c) This was a very demanding question and that was reflected in a comparatively high proportion of scripts making no attempt at a response. Those attempting a solution produced a full spread of marks and a fully correct solution was achieved only by a minority. Fully correct solutions were dependent on differentiation and substitution to find the value of a, and substitution into the equation to find b and k. Many candidates did not attempt to differentiate and those who did often had errors in some of the terms. Poor notation was apparent with in some cases, initially equating the derivative to y rather than $\frac{\mathrm{d}y}{\mathrm{d}x}$. Most went on to equate the derivative to 0 but some equated it to one or both of the x-coordinates of the given points. Having found the value of a some did not progress. Several started by substituting the given coordinates into the equation of the curve with some successfully finding the value of b.

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