MATHEMATICS (WITHOUT COURSEWORK)

Paper 0980/11
Paper 11 (Core)

Key messages

Candidates who were most successful were those that had knowledge of the full syllabus, used their calculator throughout to avoid arithmetic errors and read the questions carefully. Not rounding values prematurely was a key part of maintaining accuracy throughout, as well as ensuring that answers were given in the format asked for in the question.

General comments

This paper proved accessible to many candidates. There were a considerable number of questions that were standard processes, and these questions proved to be well understood, and, in many cases, there did not seem to be much confusion about what was being asked. Many candidates showed some working with the stronger candidates setting their work out logically with all numbers clearly formed. A significant number used arrows or lines to show connections between numbers rather than forming proper equations which were not awarded marks.

Comments on specific questions

Question 1

Candidates who converted 15 months to 1 year 3 months and then subtracted were most likely to be successful. A wide variety of calculation errors were seen in this question. Those who converted Jacob's age into months, before subtracting 15 and then converting the answer to years and months frequently made errors. The most common error was 9 years and 3 months from using 10 months in a year.

Question 2

There were many correct answers given for this question. A significant number did not know the correct conversion factor or, if they did, divided instead of multiplying. A common error was to state that there were 100 m in a km.

Question 3

(a) Most candidates measured the angle to the required degree of accuracy. Only a few appeared to be using the wrong scale on their protractor, as shown by an answer of 97°. A few assumed the angle was 90°. There were some highly inaccurate answers, suggesting that these candidates either did not have access to a protractor or did not know how to use it.

(b) Most candidates identified the angle as being acute and the most common wrong answer was obtuse, with right angle and reflex also seen.

Question 4

Most candidates reached the correct answer. Some spoiled their answer by giving it in an incorrect format, for example 1032 rather than 1032 pm, by giving it as a time interval, for example 22 hrs 32 mins, or as 22°32'.

Question 5

There were some good answers here and most candidates got at least two symbols correct. A common error was to give > for the first line. Very few candidates showed any working to help them decide.

Question 6

Most candidates interpreted the stem-and-leaf diagram correctly and gave the correct answers. A small number looked only at the values for the 'leaves' in one or both parts of the question leading to the error 8 – 0 = 8 for the range in **part (a)** or the incorrect answer 2 for the mode in **part (b)**. 30, the median, was seen as answers in both parts.

(a) As well as the above error, some gave 54 (the maximum number of cars), –44 (subtraction in the wrong order), 22 (44 found then divided by 2) or gave an incorrect range because of arithmetic errors. A few showed 54 – 17, choosing the value at the wrong end of the first row.

(b) Some gave the answer 7, suggesting they had identified the correct entry in the table and were then unable to interpret the result.

Question 7

Few candidates answered this question correctly. Candidates were most successful when they chose to convert the mixed number first. Errors were seen in later conversion attempts or purely inverting the fraction leading to answers of $\frac{4}{1}$ or $1\frac{4}{1}$. The most common wrong answer was $\frac{1}{1\frac{1}{4}}$.

Question 8

Few candidates gained full marks for this question. Successful candidates took the approach of finding the internal angle 222°, then using the fact that angles in a quadrilateral sum to 360°. Some recognised that 138° was an external angle and correctly subtracted 49° and 28° from 138°. Many candidates did not realise that 138° was an external angle and used it as an internal angle, leading to the common error of subtracting all 3 angles from 360°. Some subtracted 49° and 28° from 180°, leading to a final answer of 103°, which did not gain any marks.

A significant number of candidates made incorrect assumptions about angles in the diagram. For example, some divided the given shape into two triangles and assumed this resulted in the given angles being bisected, or that one of the resulting triangles was right-angled.

Question 9

A good number of candidates answered this correctly with clear working. Arithmetic errors were common. Others used 2.6 per cent in their method instead of 0.26 or $\frac{2.6}{100}$. Some candidates did not read the question carefully as many gave the total amount of money, rather than just the interest earned or used compound interest instead of simple.

Question 10

(a) This question was done well, with most candidates reaching the correct answer. A few wrote '+6' or found the *n*th term, rather than the next term.

(b) There were some excellent answers here, with many candidates using inverse operations. Others showed a correct trial using 23, however some gave the answer 68 instead of the 23. Some candidates who used inverse operations to arrive at the answer 23, did not realise this was the final answer and went on to use this in further calculations, usually by subtracting 1 from 23.

Question 11

This question proved to be challenging for most candidates. Whilst some candidates scored full marks, many others scored two marks for finding the diameter in centimetres. Common errors included using an incorrect formula for the diameter such as multiplying the circumference by π, dividing the circumference by 2π, dividing by 2 or using the formula for the area of a circle. Some found the radius rather than the diameter and could only be awarded one mark if a conversion was correct.

Question 12

Many candidates found completing the diagram with the correct symmetry to be difficult, which may have been because the given line of symmetry is diagonal. Some drew a shape that had a vertical line of symmetry, rather than the sloping line indicated in the question.

Question 13

(a) This was done well, with the majority reaching the correct answer. Many gained one mark for a partly correct method. The most common error was to deal with the negative value incorrectly.

(b) This was tackled less well than the previous part. Candidates were more successful if they chose to keep the values positive whilst rearranging. Dealing with negatives proved problematic for candidates with an equation such as $-5x = 4$ or $17x = 12$ given. The last stage, of dividing by 5, was often handled incorrectly as an answer of 1.25 was frequently seen.

Question 14

Most candidates reached the correct answer of 42.5 although, a few gave the answer 43, which was not sufficiently accurate. The most common error was to multiply 34 and 80 and then divide by 100, leading to 27.2 per cent.

Question 15

Many candidates realised the need to multiply the number of people in each category by the frequency and then find the total of their products. Quite a few made an error and stated that $0 \times 1 = 1$ leading to a total of 62. As long as all the multiplications and additions were seen, this was awarded the method mark. However, if no method was given and only the 62 was seen, this gained no marks.

Some had found the correct total number of people, but did not divide this by 25 (the number of stops). Some candidates divided by 15 (from $0 + 1 + 2 + 3 + 4 + 5$), others divided by 6 (the number of categories) or by 5. A few did not realise that 25 had been given in the question and added the frequencies, making arithmetic errors.

Question 16

This question proved challenging to candidates. There were a few excellent responses, with clear working, leading to the correct answer. A reasonable number of candidates substituted the given values into the correct formula but were then unable to deal with the value $\frac{1}{2}$. A large number cancelled the 2 in the denominator with the 12 inside the bracket, but did not realise that w also needed to be divided by 2. Many attempted to multiply out the brackets and made errors. Some omitted one or more brackets, leading to errors as they tried to solve their equation. A few wrote $\frac{1}{2}(12 + w)8$ but did not equate this to 78. Many were unable to form a correct equation, and others did not use the correct formula.

Question 17

This was a standard process that was not recognised or well-remembered by many candidates. A few candidates obtained the correct values but reversed them in the answer space. Many responses were to one decimal place, rather than two.

Question 18

(a) Most candidates gave the correct answer, however some reversed the coordinates or gave an answer that was not written in a correct form, for example (x = 0, y = 5) which could not be accepted.

(b) There were very few correct answers for this question. Most gave the answer (7, 8), the coordinates of P before the enlargement had taken place. Those who did attempt to find the coordinates of the image of P rarely got both values correct. A common error was to double both 7 and 8, leading to the answer (14, 16). Another common error was to give the answer (12, 11) from adding the width and height of the rectangle to the original coordinates. Both of these examples were awarded one mark for one coordinate correct.

(c) This question was found to be challenging by many candidates. Most found the area of the original rectangle and gave the answer 15 whilst some went on to double this value. Some candidates also used incorrect formulas for the area of a rectangle.

Question 19

(a) A common error was to put 39 in the region for $A' \cap B$, either with the correct value, 12, in the intersection, or with the intersection left blank. There were many responses where candidates put two or more numbers in a single region of the Venn diagram, sometimes leaving other regions blank.

(b) This question caused some difficulty for candidates. Some candidates did not realise that they could use their diagram from the previous answer and so they started again. These candidates often reached an incorrect answer by adding the three given values and not taking account of the fact that people who owned both cars and motorbikes were counted twice.

(c) Some candidates demonstrated their knowledge of this notation by either giving the correct answer of 12 or following through their diagram. The common errors were to give the answer of 0 or 1, presumably because there was no number or one number in their intersection.

Question 20

Many candidates did well here. A few spoiled their final answers by rounding to 33. Some reached the stage of finding 67.5, the percentage remaining, finishing before taking the final step. A significant number found that the loss was $2535 and then divided this by 100 rather than by the original amount.

Question 21

(a) There were many good answers here, however some candidates gave their answer as $4x – 5$, with the factor of 7 discarded.

(b) This question caused real difficulty, with many unable to perform the first step correctly. Some tried to multiply by 4, but did not multiply every term, leading to the common error, $4T = \frac{r}{4} - p$. Some reached $T + p = \frac{r}{4}$, and then spoiled their final answer by omitting brackets, giving answers such as $4 \times T + p = r$.

Question 22

Some candidates were able to answer this question well. Most candidates attempted the elimination method, with the majority able to rewrite the given equations so that they had common coefficients. A significant number then performed the incorrect calculation, adding the equations when they needed to subtract or vice versa. Some added one side of their equations and subtracted the other. A large number of candidates made sign errors, often omitting a negative sign in one of the equations. Some candidates omitted the variable when using the elimination method, for example writing 28 = 112 not $28y = 112$.

Question 23

There were some excellent answers here, with most candidates showing their full working. A small number of candidates gave a correct answer with no working; this did not score any marks. A few showed full working, but did not give their final answer in the form specified in the question.

The majority opted to write both mixed numbers as vulgar fractions and then find a common denominator, which worked well. A significant number were unable to convert mixed numbers to vulgar fractions.

Question 24

Very few candidates produced good responses here. Most of those who reached the stage of writing a correct starting equation went on to find that $x = 24$, which some gave as the final answer. A significant number did not see that they needed to use angles on a straight line equal 180 and so were unable to form the initial equation. Some started incorrectly by stating that $x + 132 = 180$, or $x + 132 + x = 360$. A large number opted to use the formula for the total of the interior angles as their next step and were unable to resolve this to reach a solution. Those who recognised that x was an exterior angle and used the method of $360 \div 24$ were often successful.

MATHEMATICS (WITHOUT COURSEWORK)

Paper 0980/21
Paper 21 (Extended)

Key messages

Many candidates did not provide answers in the required format, especially in **Questions 8** (total interest was required) and **Question 17** (answers were required correct to 2 decimal places). It is crucial for all candidates to carefully read the question before providing their final answer.

Candidates should work to a higher degree of accuracy in their calculations than is required for the final answer. They should also be careful in the use of figures as using only two significant figures is insufficient.

General comments

There were instances when the formulae used were either incorrect or misapplied. Some examples of this were **Question 9** and **Question 16**.

In **Question 9** the formula $\frac{180(n-2)}{n}$ gives the internal angle for a regular n-sided polygon but many tried to use it with the external angle to find the number of sides. It is important to make sure to know the formula $\frac{360}{n}$.

In **Question 16** there were many different formulae used for the curved surface area of a cylinder such as πr^2, $\pi r^2 h$ or $2\pi rh + 2\pi r^2$.

There were also occasions in this paper when negative signs were misplaced during the course of the candidates' working, which invariably led to errors. This was particularly evident in **Questions 2** and **12**. It is also recommended to change a sign by overwriting it, minus can be easily changed to add or plus but not the other way round. This also makes assessing and marking work very difficult.

In questions which required several linked steps to reach the answer, in particular **Questions 14**, **16** and **20**, candidates sometimes lacked clarity in explaining their methods. This, once again, made accurate assessment and marking difficult.

It is recommended that candidates give a thorough explanation of the route or method they are attempting.

Comments on specific questions

Question 1

Most candidates correctly answered 22:32 or 10:32 pm as the solution. Some gave 22 hrs 32 min which is an expression of a period of time and so was not acceptable. Any answers that included notation that is used for degrees and minutes were also not awarded any marks.

Question 2

It was expected that $1\frac{1}{4}$ would be converted into $\frac{5}{4}$ and inverted, though many seemed to think they were merely being asked to undertake the first of those steps. Some that did produce $\frac{4}{5}$ felt that it required a negative sign in front of it.

Question 3

This was answered well by most. Those that were successful often showed some calculations, so finding $\frac{2}{7}$ = 0.2857142…from a calculator would have helped for the first part. Similarly using a calculator to check 99 divided by 900 and 1^3 and 4^0 should have made the other two parts straightforward.

Question 4

Most appreciated the need to divide 5.6 by the sum of 3 and 4 to produce 0.8, which they then multiplied by 4 to provide the solution. The most common error was to consider it as a proportionality problem and seek four-thirds or three-quarters of 5.6.

Question 5

(a) Most answered this correctly though some only multiplied the top element of the vector.

(b) This was answered well, a few seemed to be attempting some type of cross multiplication.

Question 6

(a) Most correctly found 58° by appreciating that 122° and *x* were angles on a straight line and so totalled 180°.

(b) Finding *y* = 39° proved more difficult for many. Some offered 58° which perhaps implies they saw some connection to **part (a)** or they thought that *y* and 122° were supplementary.

(c) Little working was shown in any of these three parts. In this part the easiest method involved subtracting the sum of *x*, 34°, and 17° from 360°. Alternatively, the value of *y* + 90° + 122° would also produce the solution.

Question 7

Most candidates produced the correct answer of 7(4*x* – 5). Those that did not usually appearing not to understand what was being requested or sometimes giving 1(28*x* – 35) as the answer.

Question 8

The majority of candidates found the simple interest correctly, though a common error was adding the original principal to the interest to give a final value of the investment. A few candidates did not recognise the question as simple interest and instead used the compound interest formula or attempted to find the value of the investment after three years by calculating the value year by year.

Question 9

Candidates who added the two angles of 132° + x and x together to equal 180° generally went on to get the value of x as 24°, although some of these appeared to be unfamiliar with the connection between the external angle and the number of sides. There were many who used various expressions involving n – 2, 180, x and n but they would usually write an incorrect equation down.

Question 10

(a) Those candidates who managed to obtain the correct answer used x as the probability of losing a game and then $2x$ as the draw. By writing this down, or mentally, they then solved $3x + 0.28 = 1$. The wrong answer of 0.36 occurred often as candidates just halved 0.72. The other common incorrect answer of 0.16 was from the wrong working of $1 - 0.28 - 0.56 = 0.16$.

(b) The majority of candidates gave the correct answer to this question. The most common mistake occurred where candidates used the answer they had obtained for the probability of a losing in the first part of the question, instead of using the 0.28 given in **part (a)**.

Question 11

The majority of candidates changed the mixed numbers to improper fractions and then found the common denominator. A small number dealt with the whole numbers first and then found a common denominator as well as dealing with the possibility of having whole numbers and a negative fraction. Both methods were carried out very well. A number of candidates left the final answer as an improper fraction and not a mixed number. Most errors occurred from the conversion from the mixed number to the improper fraction.

Question 12

The two main methods used were firstly obtaining two numerically equal coefficients in either x or y in both equations and eliminating that variable by adding or subtracting the two equations together. The candidates who attempted this method overall did well but a noticeable number fell down when adding or subtracting the numbers. This usually involved dealing with a double negative which many candidates did not do correctly. The second method was substituting one equation into the other once x or y had been made the subject. Most candidates managed to come up with the correct equation and achieved the correct substitution. Once the substitution had been made, some of these candidates then could not manipulate the fraction part of the equation to obtain the correct value for x or y.

Question 13

(a) This was generally answered correctly, the two common errors were to find the first term of 2 or to calculate the second term incorrectly as $(3 \times 2)^2 - 1 = 35$.

(b) The first part finding the nth term for a linear expression was done very well by most candidates. The majority worked out the difference between each term in the sequence and used this well to obtain $4n - 10$. Only a small number of candidates gave the correct answer for the second part. Many candidates had the correct idea that they needed to keep on finding the difference between terms and many managed to find a third difference of 12 but very few were able to write the correct cubic expression, though some did know it was a cubic expression.

Question 14

In the majority of cases candidates used the linear relationship between the two heights given to find the missing volume. A large number of candidates did not recognise that to find the volume of the large statue, the units for density or mass had to be changed so they were both in the same units, either grams or kilograms. Some candidates deduced volume incorrectly either by multiplying density and mass or dividing density by mass.

Question 15

(a) The majority of candidates manage to draw a box and whisker plot with the highest value, the median and the lower quartile correctly plotted. Many candidates could not work out the lowest value and the upper quartile value from the information in the question.

(b) Most candidates did compare directly the statistical terms given for marks in both tests P and Q, thus common answers included ‘P had the greater median’ and ‘Q had the greater interquartile range'. The question asked for a comparison of the distribution of marks thus we required a description and comparison of what these two meant for the marks.

Question 16

Most candidates calculated the volume of the sphere correctly but they often used the incorrect formulae for the cylinder. For the volume they would use $2\pi rh$ instead of $\pi r^2 h$ or they would use the correct formula but fail to take the square root. Few knew the correct formula for the curved surface area of the cylinder and would often use πr^2, $\pi r^2 h$ or $2\pi rh + 2\pi r^2$.

Question 17

A few candidates tried to factorise with no success whatsoever. Some of those who used the quadratic formula did not give the two correct answers because the fraction line did not include $-b$, the $-b$ was given as -7 not $+7$, b^2 was calculated as -49 not $+49$ and the value of c was given as 16 not -16. Some gave the answers to 1 decimal place and not 2 decimal places.

Question 18

(a) The correct answer usually came from $4^0 = 1$ hence $x + 3 = 0$. A common error was to work out 4^4.

(b) Many did not realise that they were solving $4^{x+3} = \frac{1}{16}$ and as $\frac{1}{16} = 4^{-2}$ thus $x + 3 = -2$. Common incorrect answers given were -1 and -3. Some attempted to use logarithms but were almost always unsuccessful.

Question 19

(a) The correct answer was seen quite frequently, though often with an additional number such as 1 or 3. Some gave the answer to **part (b)** here and gave this as the answer to **part (b).**

(b)(i) Not many gave the full correct answer as they would often omit the number 1.

(ii) Many gave the correct answer but most showed no working at all so common incorrect answers were 1, 4 and 5. Some did not know the notation so they gave another set of elements.

Question 20

The most common error was to calculate *QS* from $18 \times \cos 28°$ then $15.89 - 4 = 11.89$ so the only mark available was the final method mark for a correct angle calculation from their triangle. Many candidates truncated or rounded too early and inaccurate numbers crept into their calculations so they had the correct working but an inaccurate answer. There was also much unnecessary working as some calculated angle *PSQ* then using cos 62° and in triangle *TQR*, instead of using the tan ratio, they would calculate *TR* then use either sin or cos.

Question 21

Many did not reach $\tan x = -\frac{4}{3}$ so they were unable to find the correct answers. Those who did usually gave the angle as –53.13…..° The correct answers were found by calculating 360° –53.13° and 180° –53.13°, some found the lower solution but not the higher one, others added or subtracted 53.13 from 270°.

Question 22

(a) The majority of candidates completed the initial expanding of two of the brackets to achieve either $(x^2 - 2x + 1)$ or $(x^2 + x - 2)$ and this was multiplied by the third bracket. A few candidates made the mistake of writing the expansion $(x-1)^2 = x^2 - 1$ and some replaced one of the $(x-1)$ terms with $x+1$.

(b) The first part involved rearranging $y = x^3 - 3x + 2$ to $y = \frac{1}{2}\left(2x^3 - 5x\right) - \frac{1}{2}x + 2$. As $\left(2x^3 - 5x\right) = 0$, the required line is $y = -\frac{1}{2}x + 2$. Drawing the line $y = -\frac{1}{2}x + 2$ on the graph, the intersections of the cubic and the line gave rise to the required solutions of x. This proved difficult for most, though a number of candidates gained some credit for a line with a *y*-intercept of 2 or for a line of the correct gradient even if it did not have the correct *y*-intercept. Some candidates solved $2x^3 - 5x = 0$ algebraically to give the required solutions of x.

Question 23

Most did attempt this question by expanding the brackets, often getting $x^2 - 10x + 25$ but they did not equate the coefficients of the powers of *x*. The common incorrect answers were 5 and −10 for *p* and 46 and −21 for *k*.

MATHEMATICS (WITHOUT COURSEWORK)

Paper 0980/31
Paper 31 (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 communicate their answers effectively.

General comments

This paper gave all candidates an opportunity to demonstrate their knowledge and application of mathematics. There was enough time given for the majority of candidates to complete the paper, attempting most questions. The standard of presentation and amount of working shown was generally good. In a multi-level problem-solving question, the working needs to be clearly and comprehensively set out, particularly when done in stages. Centres should also encourage candidates to show which formulae was used, substitutions made, and calculations performed. Attention should be made to the degree of accuracy required. Candidates should avoid premature rounding as this often leads to an inaccurate answer. Candidates need to read questions carefully to ensure the answers they give are in the required format and answer the question set, using common sense to check if answers are reasonable, e.g. **Question 9(b)**. Candidates must write digits clearly and distinctly and, when correcting errors, rewrite their answers rather than writing over the original answer.

Comments on specific questions

Question 1

(a) This question was well-attempted, with most students responding correctly and demonstrating a clear understanding of place value. Common errors included too many or too few zeros between 6 and 3 or misplacing the 3 e.g. 6 300 000.

(b) Rounding to 2 decimal places was generally well-attempted, however only around half of the candidates answered this correctly. The most common error was omitting the zero, giving an answer of 7.9 instead of 7.90 when the question was explicitly asking for two decimal places.

(c) (i) Most candidates answered all parts to **(c)** well, understanding they needed to choose a number from the list provided. Weaker candidates, however, often gave values not in the list of numbers. Identifying a multiple of 16 was well answered with the majority identifying 48. The most common wrong answer was 8, a factor rather than a multiple.

(ii) More candidates were able to identify a factor of 24 from the list, although the most common error was to give a multiple of 24 instead of a factor.

(iii) Identifying a cube number from the list was the least successful part of **(c)**, the most common error was choosing 25 or 36, confusing square and cube numbers.

(iv) More candidates were able to identify the prime number in the list, although common wrong answers were to choose the odd numbers in the list (25 or 39). Prime numbers not in the list were also common wrong answers given by weaker candidates.

(d) Putting a pair of correct brackets in the statement was the most successfully answered part of question 1, with most candidates getting it correct. The use of more than one set of brackets was seen, but rare. The most common error was placing the brackets around the (12 ÷ 4). This question was not attempted by several candidates.

(e) This question was found to be challenging for candidates. It required both accurate rounding to 1 significant figure and careful calculation. Around a third of candidates managed to complete it correctly, showing each value rounded to 1 significant figure and a correct answer of 10. The most frequent errors seen were not rounding all numbers correctly to 1 significant figure, e.g. 596 or 6 instead of 600, 8.7 instead of 9 or 0 instead of 0.05. Adding trailing zeros to decimal numbers was also common, e.g. 9.00 or 0.050 instead of 9 and 0.05 or using calculators to perform the full calculation before rounding at the final stage, which did not follow the instructions given in the question.

(f) Many candidates were able to use their calculators to type in the values given and get an answer of 240 000 but most then struggled to turn this back into standard form. Therefore, the most common wrong answers given were 24×10^4 or 240×10^3 or 240 000. Candidates who converted each number from standard form to an ordinary number, then performed the sum and then converted back to standard form were less successful than those who multiplied 8 and 3 and 10^6 and 10^{-3}.

(g) This question required students to express 2160 as a product of prime factors. Around half of the candidates correctly multiplied the prime factorisation of 216 by 2 × 5. Many candidates did not use the fact that 2160 = 216 × 10 and used factor trees or tables to factorise 2160 from scratch – this often led to the correct answer but many candidates went wrong with the number of 2's or 3's in their answer. Candidates who did recognise that 2160 = 216 × 10 often left their answer as $2^3 \times 3^3 \times 10$ instead of factorising the 10 to 2 × 5.

Question 2

(a) (i) Most candidates were able to identify *x* as 38° however fewer were able to give the geometrical reason including the key words 'alternate angles'. Many referred to the angles as 'alt' or 'alternative' or as a 'Z' angle, none of these gained a mark. Common errors were 52 (angles adding to 90) or 142 (angles adding to 180).

(ii) Similar to part **(a)(i)** candidates were generally good at finding the missing angle but not as good at stating the geometrical reason. As before, 'F angles' was seen frequently but gained no mark. The most common wrong answers were 38, or 111 (180–69) or 90.

(iii) Around half of the candidates were successful in finding the value of *z* to be 31. The most common wrong answer was 73 from 180 – 69 – 38. 111 was awarded B1 if seen in the correct place on the diagram, however this was rare. Candidates who could answer **(a)(i)** and **(a)(ii)** with the correct angle, usually went on to score 2 marks here. Candidates who used the diagram, by adding missing angles, tended to do better than those that did not.

(b) (i) The vast majority of candidates correctly gave the mathematical name of line XY as tangent, although many alternative spellings were seen and condoned. Common errors were 'chord' or 'straight line'.

(ii) Fewer candidates gave the correct name for line SR although around two thirds did identify it as a chord (or cord – which was condoned). Common wrong answers were sector, diameter, arc or rope.

(iii) Giving a geometrical reason to explain why shape RST was not a right-angled triangle was one of the most challenging questions on the whole paper, with few correct answers seen and many candidates not attempting the question. A significant number of candidates tried to explain by measuring or noting that none of the angles were right angled and therefore not a right-angled triangle. The question required the application of a circle theorem and explanation of why the criteria was not met, not simply saying one of the angles was not a right angle. Some candidates attempted to use the correct circle theorem statement but did not state what was incorrect about Toby's statement. Others attempted to use the wrong circle theorem statement about the right angle formed between a radius/diameter with a tangent. The most successful answers simply said that 'line ST did not go through the centre of the circle'.

Question 3

(a) (i) Nearly all candidates correctly identified the percentage from the bar chart.

(ii) Most candidates correctly used the percentage from the bar chart to calculate the number of people who use a bicycle as 392. The most common errors involved the calculation of 40% of 980 (often seen as 980 / 40), or the correct method spoilt by finding 40% (392) and then subtracting this from 980, therefore calculating 60% and scored no marks.

(b) The majority of candidates were able to gain part marks by calculating the total time by multiplying 18 by 23 (414) minutes, but many then struggled to convert this to hours and minutes. The most common errors seen were 6h 9mins from 414 / 60 = 6.9 hrs or 4 h 41 mins. Some weaker candidates were confused by the phrase 'trips in one year' and included facts from a year – 365 days, 12 months or 52 weeks, which were not needed to complete the question.

(c) (i) Most candidates were successful in filling in the missing angles for the pie chart. Some weaker candidates made errors with the angle calculations, either due to poor arithmetic or calculating the percentages, rather than the angles. Few candidates showed any working out so, if they did not get the correct values, few method marks were awarded.

(ii) Completing the pie chart was well-attempted by most candidates. Presentation was good with most using a protractor, ruler and pencil to complete the pie chart. There was a FT available from the table, although this was rarely given due to most errors on the table leading to values that did not add to 360°. Candidates generally lost marks for inaccurate drawing of the sectors – with many sectors more than the allowed 2° tolerance.

(d) This question was well-attempted by most candidates, with a significant number solving it correctly. Most successful candidates found the 1/5 of $720 first, then subtracted from $720 and finally divided by 16. Common wrong answers included, 9 (from 1/5 × 720 = 144, 144 / 16 = 9) or 45 (either from 720 / 16 or 720 – 0.2 = 719.8 and 719.8 / 16 = 44.9875 rounded to 45). A significant number of candidates misread the question or misinterpreted the 'one-fifth of the cost' and used $150 instead of 1/5 × 720 = 144. This led to an answer of 36 but from incorrect working (720 – 150 = 570, 570 / 16 = 35.625 = 36 monthly payments) and did not gain full marks.

Question 4

(a) Constructing the triangle ACD was challenging for most candidates. Successful candidates drew clear arcs from A and C and completed the triangle by using a ruler to join A to D and C to D. Some candidates drew a correct triangle but with no arcs or rubbed them out. There was also some confusion with the notation used, resulting in the lines being interchanged. Those who used arcs generally did it correctly and, if not, got B1 for a correct arc, an incorrect arc and a triangle drawn. However, weaker candidates often just drew the line AC or drew various arcs around the diagram, none correct. A significant number of candidates did not attempt the question.

(b) (i) This part was answered reasonably well with most candidates able to identify the given transformation as a translation, although common wrong answers were 'translocation', 'movement' or 'shifted'. Only stronger candidates were able to give the vector, either as a column vector or in words. Errors given were usually incorrect format (often given as a co-ordinate), order of numbers or incorrect negative signs.

(ii) Fewer candidates were able to rotate the shape with most struggling with the centre of rotation being one of the vertices. Many did manage to rotate the shape by 90° anticlockwise but using a wrong centre. This allowed them to gain 1 mark for a correct orientation. The other most common error was to rotate through 180° or reflect.

Question 5

(a) (i) True was given correctly by most candidates, but many struggled with the reason, which was often not specific enough to get the mark. Many referred to the scatter graph rather than describing the shape of the points or just a definition of positive correlation instead of giving a reason that relates to the graph. A lot of comments such as 'it's going up' were seen. The most successful answers linked the distance and cost e.g. as the distance increases so does the cost.

(ii) Around half of the candidates identified the correct point, while a large proportion incorrectly circled (9.6, 22.5).

(iii) Only around a third of all lines of best fit drawn were accurate enough to gain the mark. Although most lines were long enough, the gradient was usually too steep and not within the tolerated area of the overlay. Most lines were borderline, however, did not gain the mark because they started at (0, 0). There was also a significant number who joined all the points.

(iv) Most candidates were able to estimate the cost of an 8 km journey, even if they had not gained the mark for the line of best fit. Most gained the mark for an answer in the acceptable range or with a correct follow through. Some weaker candidates did not gain the mark through misreading of the vertical scale, using 0.1 for each square instead of 0.5.

(b) (i) Most candidates gained this mark with the correct answer of $8.80. $13.2 (0) was the only common incorrect answer where the candidate had divided by two instead of three.

(ii)(a) Many candidates were able to give a simplified ratio but not the simplest form. The correct answer was seen rarely with the overwhelmingly most common answer of 4 : 1 : 2.5 gaining 1 mark. Some candidates worked out the share for each person and used those values for the ratio, although this should have been done in part **(b)(ii)(b)**.

(ii)(b) Most candidates were able to gain part marks but only the strongest candidates gave complete solutions, remembering to find out how much more he paid. Many candidates scored B2 for 14.08 or M1 for a correct calculation using their ratio but did not then subtract the answer to **(b)(i)**. A common error was rounding prematurely, for example, using the multiplier 1.17 instead of 1.17333… (26.40/22.5) gave the answer of 14.04 instead of 14.08 and therefore could only gain 1 mark for use of the ratio.

(c) Most candidates attempted this question although there was a 50–50 split between those that attempted compound interest and those that attempted simple interest. Those that attempted compound interest generally gained one or two marks, but few were able to gain full marks as they did not round to the nearest dollar, commonly giving 20 579.68. Those who did simple interest did not gain any marks. A proportion of candidates subtracted 18 600 to give the interest only and only gained one mark.

Question 6

(a) (i) The majority of candidates were able to calculate the amount of milk needed for 10 people. 2700 was a common mistake by multiplying the volume of milk by 10. Another common answer was 1620, by multiplying by 6, or 1080 from 270 x (10 – 6). Those who used the correct method, usually went on to score both marks, so M1 was rarely awarded.

(ii) Candidates were equally successful at calculating the mass of the mixture after heating. B1 for 165 was given frequently, by calculating 15%, but not subtracting from 1100. The method of using a 15% reduction as a (100–15) % = 85% multiplication was rarely seen, but usually candidates were successful in gaining both marks by either method.

(iii) Most candidates correctly found the difference in the temperatures as 23 or –23 degrees. The most common wrong answer was (–)13. Candidates need to know that 'difference' requires a subtraction, but there are two ways of doing this: –18 -5 = -23 or 5 - –18 = 5 + 18 = 23. The second method often led to the incorrect answer (–)13.

(b) (i) Most candidates answered this question correctly. Incorrect methods included: working out how many tubs were packed in an hour rather than a minute, dividing by 8, but not 60 (giving 3240), or dividing by 60, but not 8 (giving 432) and $8 \times 60 = 4800$ not 480, with the answer of 5(.4) instead of 54.

(ii) Around half the candidates were successful at finding the number of tubs on the truck. The most frequent incorrect methods were seen in which only two of the three given values were used to multiply or divide.

(c) (i) Only the strongest of candidates were able to gain full marks on this probability question, however most candidates gained 1 mark, generally for calculating the total relative frequency of the missing items as 0.36. Many who found 0.36 then did not know how to find the relative frequency for chocolate and banana. Most divided by 3, rather than 4, so a common wrong set of answers were 0.36 and 0.12 or 0.24 and 0.12. Similarly, candidates understood that the two solutions had to add to 0.36 but made errors in this calculation – e.g. 0.3 and 0.04 or 0.27 and 0.9 (instead of 0.09).

(ii) This question was generally answered well with many candidates giving the answer of 81. The most common error was dividing by 0.18 rather than multiplying, even though this gives 2500 out of a total of 450. Candidates should use their time to make sense checks of their answers.

(iii)(a) This question was answered well with most candidates correctly completing the tree diagram. There were a variety of incorrect responses, e.g. 0.7 or 0.35 for each, values >1 and different values in each of the three spaces.

(iii)(b) This question was one of the most challenging of the whole paper, with few correct answers seen. The most common incorrect methods were 0.7×2 or $0.7 + 0.7$, or just 0.7 given. Many answers greater than 1 were seen, which again should encourage candidates to revisit their method.

Question 7

(a) Most students correctly calculated the perimeter of the triangle by adding up the given side lengths. Common wrong methods involved multiplication, maybe confusing area for perimeter.

(b) This more complex area question was well-attempted but only the strongest candidates gained full marks. Nearly all candidates showed that they needed to break down the shape into smaller rectangles, however most made errors in calculating the individual areas correctly. Common errors were, not dividing the complex shape into appropriate smaller rectangles (multiplying the given values together) or made errors in calculating the area of each rectangle (usually using the wrong length side). Some weaker candidates multiplied the length and width but then also multiplied by 2 for each rectangle. Common errors in splitting into wrong rectangles included $7 \times 4 + 7 \times 4 + 9.5 \times 4.6$ and $18.6 \times 4 + 13.5 \times 4.6$. Most candidates who did make errors in calculating the area of the rectangles were still able to gain a mark for finding the missing lengths of 9.5 or 4.6.

(c) This part was challenging to all but the strongest of candidates. Most candidates however managed to apply the formula for the area of a triangle correctly. The most successful solutions were done in two parts. The first calculating the height of the triangle (AB), either using Pythagoras theorem or trigonometry correctly. The second, applying the area of a triangle formula using their height and base. Candidates who omitted the first part and simply used 27.2 and 24 as the height and base gained no marks. The most common error in the first part was to apply Pythagoras' theorem incorrectly, $27.2^2 + 24^2$ instead of $27.2^2 - 24^2$. Most candidates who used trigonometry were only able to find an angle and did not go on to find the height AB. A few candidates were successful in calculating the height as 12.8 but then did not go on and find the area of the triangle.

(d) Around half the candidates were able to successfully apply the formula for the volume of a sphere. Most candidates showed understanding that they needed to calculate the radius first by dividing the diameter by 2. Most candidates then substituted their radius into the formula. However, many lost accuracy at this point by rounding 2.625 to 2.63 or 2.62 or 2.6 and therefore, did not gain full marks. Many candidates showed correct substitution but then gave wrong answers – either due to incorrect rounding or incorrect use of their calculators. Some weaker candidates were unable to substitute correctly often doing π^3 or r^2 instead of r^3. The most common wrong method was $4/3 \times \pi \times 5.25^3$.

Question 8

(a) (i) The majority of candidates knew that the solid was a cuboid or rectangular prism. Cube was the most common wrong answer.

(ii) A similar number of candidates successfully found the volume of the solid. A common error was to find the total surface area (192). 40 or 400 or 16 were seen often from 4×10 or $4 \times 10 \times 10$ or 4×4.

(iii) Most candidates found this question challenging. Many candidates gave the correct expression for the volume but then spoilt it by adding = 160. Candidates need to be aware of the difference between an expression and an equation.

(iv) Candidates were more successful at finding the value of *x*. The candidates who gained the mark in **(a)(iii)** often went on to gain marks here. Some candidates wrote down the correct formula in this part, even though they did not in part **(a)(iii)** and then went on to gain a mark or both. Many candidates wrote 6 without any working or $6 \times 6 \times 10$ [= 360] was seen as the working, leading to an answer of 6. A common algebraic error was $x \times x = 2x$, leading to an answer of 18. A large proportion of candidates did not attempt both **(a)(iii)** and **(a)(iv)**.

(b) (i) Most candidates were able to gain full marks by completing the table correctly. The few errors seen involved an attempt to make a straight line with the points already given, e.g. treating it as a linear sequence going up in 7s (17, 24, 31) or going up in 5s (15, 20, 25).

(ii) Most candidates gained full or part marks as they were able to plot the points correctly, with only occasional slips in accuracy. The curves were generally well drawn with the most common error being to join the points with straight lines. Other common errors seen were plotting the points with no curve or not plotting $x = 0$.

(iii) Around half the candidates were able to give a value for *x* in the correct range. Some candidates tried solving the equation instead of reading from their graph, as stated in the question. If this led to a correct value for *x,* it gained full marks – although this was rare. Despite having drawn clear graphs, many candidates did not attempt this question.

Question 9

(a) Most candidates found drawing the travel graph for Samir's journey challenging. Very few, fully correct, answers were seen but many candidates were able to gain 1 mark for a horizontal section lasting 1 hour. Ruled lines were used by most candidates but some freehand lines were seen. There were a variety of incorrect first lines, the most common error was finishing at 6 km, but not at 2.45 pm or finishing at 2.45 pm, but at 8 km. The third line was more successfully drawn, however most candidates found it hard to finish the line at 4.36 pm (the most common wrong time was 4.39 pm).

(b) Calculating Samir's average speed proved the most challenging question of the whole paper. Most candidates showed understanding that they needed to divide distance by time, but a high proportion of candidates used 6 km instead of 12 km, meaning they gained no marks. Those who did use 12 km found converting 2 hr 36 mins into hours challenging and it was common to see 2.36 instead of 2.6. A significant proportion of candidates did not attempt this question.

Question 10

(a) This solving question was well answered by most candidates. Common errors included incorrect rearrangement of the equation ($4x = 3 - 7$) or not fully processing the answer, leaving it as 10/4.

(b) (i) Around half the candidates were able to apply the correct law of indices to this simplification question. A common error was x^8, where the candidate had added the powers instead of multiplying. x^3 was also occasionally seen where the candidate had divided the powers.

(ii) A similar number of candidates were able to simplify this more complex expression. The most common wrong answer was $10x^6y^8$ from multiplying the powers rather than adding them. Many candidates correctly dealt with the powers of x and y but kept the 5 and the 2 in their answer, e.g.

$5x^5 2y^6$ or added 5 and 2 to get 7. Some left multiplication signs in their simplified expression, which was condoned. A large number of weaker candidates attempted to multiply out the two brackets using a FOIL method and gained 4 different terms instead of just one.

(c) (i) Candidates were slightly more successful at expanding and simplifying the two brackets. The most frequent wrong answer was 2a + 3 (+3 coming from 5 – 2). Candidates had most difficulty dealing with the signs, with 3a and 6 being common in wrong answers.

(ii) Again, around half the candidates were able to successfully expand and simplify the double bracket. Most managed to correctly multiply out the brackets, giving a correct 4-term expansion for 1 mark but then lost the second mark as they struggled to simplify the +7d and –3d giving +10d or –10d instead of +4d.

MATHEMATICS (WITHOUT COURSEWORK)

Paper 0980/41
Paper 41 (Extended)

Key messages

To achieve well in this paper, candidates must be familiar with all aspects of the extended syllabus. They must be able to recall and apply formulae and mathematical facts in both familiar and unfamiliar contexts. Additionally, they must be able to interpret situations mathematically and solve unstructured problems.

Work should be clear and concise. Answers should be written to at least three significant figures unless otherwise instructed. Exact answers should generally not be rounded.

Candidates should show full working, writing values to at least 3 significant figures throughout. They should store accurate values in their calculators to ensure that method marks are considered for incorrect answers. Candidates should not round intermediate calculations.

Candidates should not erase or cross out working unless it is being replaced. When starting a new approach to a question, candidates must clearly indicate which method they want the examiner to mark.

In 'show that' questions, candidates must ensure that no steps are missing and must show a more accurate value than the given value.

It is important that candidates take sufficient care with the writing of their digits and mathematical symbols. Candidates using π as $\frac{22}{7}$ or 3.14 are likely to achieve answers out of range.

Candidates must show their working when solving quadratic equations. If using the quadratic formula, they must show the substitution of values for a, b, and c. The calculator's quadratic equation function should not be used.

In all questions, candidates must show their method using correct mathematical operators, not symbols like crossed arrows or dashes. This applies to unit conversions and proportional reasoning.

General comments

Candidates scored across the full mark range and appeared to have sufficient time. A small minority of candidates were less prepared for the demands of the extended paper. In general, if candidates could not answer one part of a question, they still made a significant attempt at other parts.

Solutions were usually well-structured with clear methods shown in the space provided on the question paper. Very few candidates offered solutions without working out which meant it was possible to award part marks to many responses which were not fully correct, however the situation of e.g. $\frac{x}{y}=\frac{p}{q}$ without then writing $xq = py$ is seen quite frequently and if an error is made by the candidate in their calculation, we do not imply the method mark without the $xq = py$ being seen.

Throughout the paper a common reason for candidates to lose marks was through rounding answers too early; using truncated or rounded values in multi-step calculations often led to answers which were outside the range of tolerance and so did not gain full marks. This was particularly evident in **Question 6(b)** when using sine rule, **9(c)** and **(d)** when using Pythagoras theorem followed by trigonometry or further Pythagoras, and in **6(c)** which required a multi – step solution.

Aspects of the paper that were tackled well by many candidates included the mean from grouped data, recall and use of the cosine rule, recall and use of the sine rule, volume and surface area of a cuboid and the angle between a diagonal and the base. Generally, diagrams were neat, ruled and accurate and this was seen in the transformation and inequality questions.

Difficulty was found with applying rates of change and percentage decrease in context in **Question 4,** calculations with bounds, and visualising right angled triangles to use Pythagoras in 3 dimensions. Sketching graphs was also a challenge. Candidates also need to be aware that a ratio in its simplest form should be written using integer values only. In 'show that' questions such as **10b(i)** candidates must never use the value they are trying to establish as part of their method. In **Question 6(a)** candidates were required to establish the result to the nearest integer and so for full marks needed to show their value to at least 1 decimal place to achieve this. In **Question 10(b)(i)** where they were required to establish the value to 1 decimal place candidates who correctly re-arranged a quite complex equation often did not finish by showing their value to at least 2 decimal places to achieve full marks.

<u>Comments on specific questions</u>

Question 1

(a) (i) This part was correctly answered by almost all candidates. A few candidates gave the list of the prime factors instead of a product.

(ii) This part was also well answered although not as successful as **part (i).** Many candidates without the correct answer did gain the method mark for breaking 112 into its prime factors. So, almost all candidates earned 1 or 2 marks.

(iii) This lowest common multiple involving algebra proved to be more challenging. There were many correct answers, and many candidates earned one mark by giving the correct lowest common multiple of 70 and 112. A small number of candidates found the correct lowest common multiple of the x^4y^2 and x^3y^5 but gave an incorrect lowest common multiple of 70 and 112.

(b) (i) Almost all candidates were successful with this straightforward index division. It is pleasing to note that very few candidates divided the indices.

(ii) This product of algebraic fractions was found to be more challenging than perhaps expected. There were many correct but unsimplified answers such as $\frac{bc}{8b}$. Such answers earned the method mark. A surprising number of candidates thought they needed to find a lowest common denominator.

(c) This straightforward equation was very well answered by almost all candidates.

(d) This equation involving an algebraic fraction was more challenging. There were many correct answers and these usually came from multiplying $(4 – x)$ by 5 as a first step. A common error here was to write this as $20 – x$. This error lost the first method mark but most candidates did earn the second method mark by simplifying their four term equation into the form $ax = b$.

Another quite common error was to move the $–x$ to join the $2x$ without realising that the $2x$ was part of a fraction.

(e) (i) This substitution into a formula was generally well done with candidates correctly squaring –8. The omission of brackets to give the incorrect notation $7 + \sqrt[3]{-8^2}$ often led to the error 7 + –4 = 3 and gained no marks.

(ii) This rearrangement of a formula was challenging but there were many fully correct answers. The first step needed was to move the d to the left-hand side. Then candidates could cube both sides instead of cubing separate terms. Many candidates did take a square root for the final step, but this depended on an attempt at cubing in the previous step. The most common error was cubing separate terms, but another error seen was to take the cube root instead of cubing and similarly squaring instead of taking a square root. This part was a good discriminating question.

Question 2

(a) (i) This reflection was usually correctly drawn. The errors which did gain a mark were to reflect in the line $y = 1$ or in the line $x = 0$. A few candidates reflected the triangle in the line $y = 0$ but this gained no marks.

(ii) This enlargement with a fractional scale factor was more challenging. There were many correct images and many triangles with the correct orientation but in the wrong position. The latter gained one mark. There were images with incorrect scale factors and a few candidates omitted this part.

(b) This description of a single transformation was generally well answered. Almost all candidates stated that the transformation was a rotation, and many gave the correct angle. Some described the angle as 90° anticlockwise and some stated 90° but omitted the clockwise. The centre of rotation was more challenging, and many candidates gained two of the three marks. A small number of candidates described the transformation as a rotation followed by a translation. The word single is emboldened on the question paper and so combining transformations did not gain any marks.

(c) This part was probably the most challenging question on the whole paper. Only the strongest candidates scored full marks. Many candidates did not attempt this part.

Incorrect answers were often numerical or included the inequality.

Few diagrams were seen and so most candidates could not find an approach to find the *y*-coordinate. A few candidates realised that the *x*-coordinate would be unchanged and so did gain one of the two marks.

Question 3

(a) There were many fully correct solutions with care taken to show a clear method. Whilst the majority of candidates applied the correct method to obtain the correct answer, errors included: Summation and evaluation errors; incorrect mid-points being used seemingly without consideration that these often lay outside some or all of the boundaries of the intervals (e.g. using the interval widths 10, 10, 20, 10, 30 as the midpoints or dividing these results by 2 and using 5, 5, 10, 5, 15 as the midpoints); using the end points of the intervals as mid-points; dividing by a value other than 120; giving an answer of 30.8 or 31, following correct working, without a more accurate answer being seen; adding together the correct mid-points and dividing the total by 5.

(b) The second part of the question was more challenging to candidates. Some candidates opted to miss out this part of the question completely and others drew a bar of incorrect height without showing any working at all. Some candidates drew two bars of differing heights within the space of the interval. A small number of candidates drew the heights of the bars outside of the grid lines (with a frequency density greater than 2). Occasionally, when the correct height had been obtained, this was not drawn accurately, with the top of the bar not touching or only partially touching the correct grid line. Various incorrect methods were seen. For example, using the width of the interval divided by the total number of patients as the height $\left(\frac{20}{90}\right)$, or the reverse $\left(\frac{90}{20}\right)$. The best solutions indicated with clear working the frequencies for each bar on the histogram. Some candidates then appeared to be confused between the number of patients and the waiting time.

Question 4

(a) (i) Expressing the number of lengths swum by Enzo as a percentage of the total number of lengths was completed successfully by most candidates.

(ii) This question part required a three-part ratio to be expressed in its simplest form. Many candidates did not express the ratio using integers only and so did not score. A minority of candidates correctly reached the ratio 45:75:80 but did not complete the process by dividing through by 5 to get the simplest form.

(iii) (a) Many candidates showed the correct method for finding Blessy's average speed and expressed their final answer as the simplified fraction $\frac{5}{9}$ or as a decimal with accuracy of at least 3 significant figures. Many other candidates gave an answer of 0.5, 0.6, 0.55, 0.56 or 0.555 which did not gain the final accuracy mark. The correct method required candidates to use the given table to find the number of lengths swum by Blessy, 20 and multiply this by the 25 m length of the pool to find the total distance. A common error was to use 20 alone or 25 alone. Many of these candidates correctly divided by 900 to express their speed in metres per second but others omitted the division by 60 to convert from metres per minute to metres per second.

(b) To find the time taken for Rashid to swim a total of 5 km the most successful candidates used the given table to find the number of lengths swum by Rashid in 15 minutes, 18.75 and multiplied this by the length of the pool, 25 m to first find the distance swum in 15 minutes. Almost all these candidates correctly converted 5 km to 5000 m and completed the calculation 5000 ÷ (18.75 × 25) to find out how many sets of 15-minute swims were needed. The final multiplication by 15 to find the total time in minutes, 160 and conversion from this to 2 hours and 40 minutes was then usually completed correctly. Instead of this approach many candidates chose instead to try to find Rashid's speed in metres per second or metres per minute. These candidates sometimes lost accuracy by prematurely rounding Rashid's speed to 0.52 m/s or 31.3 m/min.

A common misinterpretation of the question was that Rashid continues to swim at the same rate *as Blessy* and the mark scheme catered for this. Candidates who separated the distance he covered in the first 15 minutes at a speed of 31.25 m/minute using the information in the table, from the distance covered for the rest of his swim at a speed of $\frac{5}{9}$ m/s were still able to score full marks. However, most candidates incorrectly simplified the problem by assuming Rashid swam at a speed of $\frac{5}{9}$ m/s for the whole of the 5 km.

(iv) Candidates found this question part challenging. Although correct answers were seen from use of $20(1-\frac{5}{100})^3$, the answer 16.3 was very common from using $20(1-\frac{5}{100})^4$ or the equivalent step by step process of reducing the number of lengths swum by 5 per cent after each 15-minute swim. Candidates focused on there being four 15-minute swims in one hour and did not account for the final 15-minute swim being only the 3rd reduction. Other candidates used a power of 15 in the formula. Another common error was to reduce the number of lengths by 5 per cent of *20* repeatedly, so by 1 length each 15 minutes. Some candidates worked with distance covered instead of the number of lengths.

(b) This calculation with bounds question was also found to be challenging by many candidates. Most candidates were able to write down a correct upper or lower bound for 450 m to the nearest 25 m or 10 minutes to the nearest minute. The required calculation to find the minimum distance in one hour was $\frac{437.5}{10.5}\times 60$. The two 'times' in this calculation were confusing for some. Common errors seen were $\frac{437.5}{9.5}\times 60$, 437.5 × 9.5 × 60, $\frac{437.5}{10.5\times 60}$ or attempts to apply bounds to the 60 such as using 59.5. Some candidates chose to work with seconds instead of minutes and made conversion errors. Some candidates did not consider bounds at all and evaluated $\frac{450}{10}\times 60$.

Question 5

(a) This question was answered correctly by almost all candidates. Most chose to answer with a fraction with a small minority working with decimals or percentages. Some of the candidates who used decimals gave the answer 0.6 instead of the more accurate 0.625, which had an impact on the remainder of the question.

(b)(i) Many candidates were able to complete the first section of the tree diagram successfully however many did not achieve full marks. The biggest issue amongst the candidates scoring only 1 of the 2 available marks was a failure to recognise that this was a 'replacement' scenario; had the first ball not been replaced then they would have scored full marks. A less common error was to use the number of each colour in the bag at each stage, rather than the probability.

Many candidates who had chosen to work with decimals in **part (a)** switched back to fractions to complete the tree diagram.

(ii) Candidates generally showed a good understanding of how to combine 2 events. Some candidates who had completed the tree diagram without replacement recovered to a correct solution by not using their tree diagram. Most candidates who did use their original tree diagram followed it through correctly to score both method marks. Some candidates knew to multiply to combine two events but then either stopped working or multiplied their two fractions together instead of adding. It was pleasing that candidates usually showed the products of the fractions they were using in both **part (b)(ii)** and **part (c)** so that method marks were available. There were a few answers greater than one by candidates who added the fractions for each colour of pen.

(c) Candidates found this part of the question much more challenging. The most common error was to include only 1, or sometimes 2 of the 3 possible combinations. For a significant number of candidates there seemed to be a lack of understanding of how to deal with a third event with many of those trying to add the third fraction or to ignore the third step altogether. Some candidates recognised that the denominators of their fractions reduced by 1 each time but did not correctly reduce the numerator for blue or reduced the numerator for red unnecessarily. There were also some solutions where the numerator decreased by one, but the denominator stayed the same. Very few candidates treated the problem as a 'with replacement' situation.

Question 6

(a) Most candidates were able to apply the cosine rule correctly in this question, but it was notable that some candidates had memorised the alternative version of the cosine rule reserved for calculating an angle. The subsequent re-arrangement proved challenging for many, and errors with signs etc. were seen regularly if this method was employed. A significant majority of candidates did not fully demonstrate that the answer was 1028 as we require their answer to be shown to more accuracy than the stated value in this type of question. Candidates should appreciate that they need to show an answer which has at least one more significant figure than given in the question. There were relatively few attempts at using an incorrect cosine rule formula.

(b) This part proved to be accessible for most with many candidates achieving at least three out of four marks. There were many successful attempts at using the sine rule in the correct triangle, but some candidates misread the question and attempted to find an incorrect angle (albeit with a correct method). The most common omission in this part was when interpreting the calculated angle *ACB* to find the obtuse angle, with many candidates seemingly unaware of how to convert their acute angle into the correct obtuse angle. An answer of 81 was seen often.

(c) This part proved to be the most challenging in this question. Most candidates began by attempting to find the area of triangle *ACD* using $\frac{1}{2}ab\sin C$. Then they began the process of dividing this area by 10 000 and then dividing 41500 by their result. Although candidates appreciated the process needed, transcription errors in accuracy when carrying forward calculated values in subsequent calculations, and premature rounding, were all seen on a regular basis. Some candidates misread the question and used triangle *ACB* instead. The final detail which requested answers be given to the nearest dollar was often missed. There were also some attempts at using $\frac{1}{2}$ base × height scoring no marks.

Question 7

(a) Most candidates were able to interpret the given inequalities correctly and gave the correct values. A few candidates included the inequality signs.

(b) The majority of candidates tried to create the correct inequality and show that it could be simplified by dividing by 6 for the 1 mark available. The most common error was to try to use numerical values to demonstrate the inequality.

(c) Candidates were able to make a good attempt at this question. Most were able to draw the lines $x = 180$ and $y = 90$ accurately. Candidates were aware of using solid/broken lines but sometimes got them the wrong way around. Sometimes, because of overzealous shading, it was difficult to distinguish between dashed and solid lines. Most candidates were able to draw the $x + y = 240$ line, but accuracy was sometimes a problem. Candidates needed to ensure that the line would intercept the axes at (240,0) and (0,240). Candidates found drawing the line $2x + 3y = 450$ the most challenging. To ensure sufficient accuracy it is advised that candidates use $x = 0$ and $y = 0$ to find the intercepts with the axes. Candidates usually followed the instruction to shade the unwanted regions, but some forgot to label their region *R*.

(d) This part was not as well answered, and some candidates omitted this part completely. Some got the correct answer without using their graph and calculated the profit from 150 scientific and 90 graphical calculators. Other candidates were awarded the method mark for using values that lay in their region and multiplying them correctly by \$10 and \$30. Some failed to be awarded this mark as they used a point that was not in their region.

Question 8

(a) (i) This question was generally well answered by candidates. Most candidates scored 2 marks here by adding 16 and then taking the square root, recognising two solutions were required. Some candidates chose to subtract 20 and then factorise using the difference of two squares. These were just as successful. A small number of candidates still only achieved B1 by giving positive 6 as a correct solution and something else or a blank space was left for the second root. Some candidates found $g(20)$ instead of solving $g(x) = 20$.

(ii) This question part was very well answered. Some candidates dropped the negative when dividing or rearranged incorrectly at the start but generally they understood what was required. There were very few cases of candidates giving the reciprocal of $f(x)$ instead of the inverse function.

(iii) Most candidates understood the correct order to process the composite function $gf(x)$ and gained credit for the initial substitution with many going on to gain full credit. Some candidates made errors when expanding $(7-3x)^2$ such as $-9x^2$ or just $9x$ and some writing $(7-3x)^2 = (7-3x)(7+3x)$ Others expanded correctly but did not subtract 16 or add one. A few candidates obtained the correct simplified expression but then went on to solve $9x^2 - 42x + 34 = 0$. A small minority of candidates did not understand composite functions and instead began with $g(x) \times f(x)$.

(iv) The full range of marks were awarded for this question part. Most candidates knew the general shape, and many were able to identify either the roots or the y intercept. Some candidates produced parabolas that curved back in at the top. Some knew where the y intercept was but did not make this an obvious minimum turning point. The best solutions had a sketch of a smooth curve in all four quadrants with clear labelling of any intercepts and the turning point.

(v) This question part proved to be challenging for many candidates. The need to differentiate to find the gradient was not obvious in the context of the question. The strongest candidates had a clear strategy of using differentiation to find the gradient followed by substitution to find the *y* value when $x = -3$. This then invariably led to the correct solution. Candidates who did not see the requirement to differentiate to find the gradient could usually still find the *y* value at $x = -3$. The common error from these candidates was usually to attempt to find the gradient by using two points on the curve.

(b) (i) There were a variety of responses to this question including parabolas and reciprocal graphs. If candidates knew the correct shape, to gain both marks they needed to indicate that their graph tended towards the *x* axis. In many cases following the candidate knowing the general shape they produced a diagram which did not tend towards the *x* axis but was horizontal over much of the 2nd quadrant. Another common error was for the sketch to have the correct shape but only exist in the first quadrant, stopping at the y axis. Candidates were not required to label the y intercept, but it was common to see it labelled incorrectly as (0,3). In both question parts requiring sketches some candidates worked out a table of values and then attempted to plot these points, often resulting in the correct general shape but making it difficult to produce a fully correct smooth sketch.

(ii) There were not many correct responses to this question as it was hard to gain credit if the shape of the graph in **(b)(i)** was not known. Those candidates that understood answered correctly with $y = 0$ rather than stating the *x* axis.

Question 9

(a) Nearly all candidates made a positive start and multiplied the dimensions correctly to calculate the volume.

(b) Again, many correct responses were seen. Some candidates who found the areas of the three different faces first, sometimes omitted the final multiplication by 2. Another common error was to presume that four of the faces were the same dimensions, leading to answers such as $17 \times 8 \times 4 + 10 \times 8 \times 2$ or other combinations in a similar form. A small proportion of candidates got volume and surface area mixed up completely and the answers in **(a)** and **(b)** were reversed.

(c) Candidates did well on this familiar style of question and usually identified the correct angle within a right-angled triangle in 3D. Most used Pythagoras correctly to find the length of AC which would have been enough to calculate the required angle using tan. Candidates often failed to retain accuracy here and if they then used 12.8 instead of $2\sqrt{41}$ then sometimes their final answer fell out of range. This was even more apparent with candidates who went on to use Pythagoras again to calculate *AG* to use sine or cosine. Cases of finding angle *AGC* instead of angle *GAC* were relatively rare; those that made errors in recognising which angle was required usually thought it was angle *GAB*.

(d) Candidates found this part extremely challenging, and it was rare to see a fully correct response. Visualising a correct right-angled triangle proved to be very difficult for the majority. Most thought the point vertically below *Q* was directly opposite *P* and just used $17^2 + 8^2$ even if they had identified $QG = 2$. Those that identified '3' as the missing length on the horizontal right-angled triangled, usually went on to achieve a correct answer, but that step was missing from most of the responses.

Many other attempts at Pythagoras were often seen e.g. $17^2 + 2^2$; $5^2 + 8^2$ etc. Some candidates worked with triangle *QPC* which was not right-angled and did not have the required angles to allow the use of the sine or cosine rule. Most candidates did however get 1 mark for identifying $QG = 2$.

Question 10

(a) (i) Nearly all candidates understood that the area of a rectangle was length × width and wrote their first line as $(2x + 3)(x + 1) = 190$

Many were able to expand the brackets correctly and collect terms to obtain $2x^2 + 5x - 187 = 0$.

A few made errors when multiplying out the brackets and/or rearranging.

Using the formula was the most popular method used to solve the resulting equation and was usually well done.

Those candidates who chose to factorise were also successful.

Often the negative root was given as well as the required answer 8.5 and not all candidates clearly rejected this negative root to achieve full marks.

A handful of candidates attempted completing the square with their quadratic = 0.

(ii) The correct answer was seen often although some candidates made errors in the substitution of 8.5 or only completed an algebraic answer of $6x + 8$.

(b) (i) In this part of the question it was necessary to subtract the area of the triangle from the area of the sector and equate to 30. Although some candidates were able to do this, the resulting rearrangement to show the radius as 23.7 proved to be too challenging for many. Those who managed to rearrange successfully often did not give their answer to enough accuracy. To 'show that ' r = 23.7 we need to see an answer which has more accuracy than the value given in the question. Many just equated one of the formulae to 30, generally the sector area. Other candidates substituted r = 23.7 into their formulae to establish equality to 30. No credit is given for using the value that they have been asked to show.

(ii) In this part candidates needed to calculate the length of the arc *AB* and the length of the chord *AB*. This was completed by many, but some just found one of them, generally the length of the arc. Successful attempts at finding the chord came equally from use of the cosine rule and use of the sine rule in triangle *AOB*.

A few candidates used a formula for an area instead of a length for this part.

Some candidates misunderstood the question and added a value equivalent to 2 radii onto their other working which was usually their attempt at finding the arc *AB*.