MATHEMATICS (US)

Paper 0444/11
Paper 1

Key messages

To succeed in this paper, candidates need to have completed the full Core syllabus, be able to apply formulae and to give answers in the form required. Candidates are reminded of the need to read the question carefully, focussing on key words and instructions.

General comments

Candidates must show all working to enable method marks to be awarded. This is vital in multi-step problems, where each step should be shown separately to maximise the chance of gaining marks. Often workings were scattered all over the working space with little thought to logic which made it difficult for candidates to check their own work. Candidates must take note of the form or units that are required, for example, in **Questions 1**, **2**, **5** and **9**. Many candidates incorrectly handled negative numbers, for example in **Questions 6**, **10(b), 11** and **12**.

The questions that presented least difficulty were **Questions 3**, **10**, **16(a)**, **17(a)** and **20(a)(i)**. Those that proved to be the most challenging were **Questions 5(b)** scientific notation, **9(b)** conversion to litres, **17(b)** indices, **23** systems of linear equations, **24** functions and **25(a)** understanding equations in context. The questions that were most likely to be left blank were **Questions 9(b)**, **20(b)** and **24**. It is likely that the blank responses were due to the syllabus areas being tested rather than a lack of time.

Comments on specific questions

Question 1

This question was a straightforward start to the paper and a majority gave the correct answer. Incorrect answers were usually due to rounding up to 4700, rounding to the wrong accuracy, 4650 or missing a zero. A few candidates divided by 100.

Answer: 4600

Question 2

This was very well answered. The numerator, 7, was more likely to be correct than the denominator when that was sometimes a different power of ten. Some candidates gave the incorrect answer of $\frac{0.7}{100}$ showing a lack of understanding of how to form a fraction.

Answer: $\frac{7}{1000}$

Question 3

Again, this was well answered but some candidates made arithmetic slips in their subtraction. These slips lost candidates the mark.

Answer: 140

Question 4

This question was only worth one mark so all three terms had to be correct. Some candidates gave –3, 2, 7 from starting with $n = 0$ rather than $n = 1$. A few focused on the constant term only giving terms such as 2, –1, –4 or 5, 2, –1. Some candidates did not know what the *n*th term meant and gave answers such as, 5, n, –3 or $5n - 1$, $5n - 2$, $5n - 3$.

Answer: 2 7 12

Question 5

Part **(a)** was not handled nearly as well as **Question 1** even though the skills tested were similar. Some of the incorrect answers seen were, 2.68, 0.268, 0.0026, 0.002 and 0.003. A few answers of the form 000.268 were also seen. Candidates found part **(b)** more challenging with answers such as 3.87^{-5} or 3.87^{5}. Also, frequently there was more than one digit in front of the decimal point or the minus sign was missed off the exponent.

Answers: **(a)** 0.0027 **(b)** 3.87×10^{-5}

Question 6

This question was very well attempted by candidates. Those that did not get both marks were able to access a method mark for one of the two substitutions and multiplications, i.e. for 84 or –18. Generally, it was the signs in the second term that caused problems for the occasional candidate.

Answer: 66

Question 7

There were many correct responses here. Candidates had a choice of methods and had various steps to go through to get to the answer, for example, alternate angles, recognition of the isosceles triangle then application of angles in a triangle or to drop a perpendicular and say, $\frac{1}{2}x = 90 - 43$, then to double the value to find x. Some got as far as 47 but did not take the final step. 137 was seen as the most common error (from $180 - 43$). A few candidates gave an incorrect answer with no working to back it up. A small number gave 90° maybe just assuming that it looked like a right angle.

Answer: 94

Question 8

This question was done reasonably well sometimes with clear, well set out working. Candidates must remember to show one step at a time as combining steps into one can obscure a correct move. A few candidates started by ‘moving’ the y when the first step should be to multiply both sides by 8, or to take away $\frac{2}{8}$ (or equivalent) from both sides – this is the more complicated route to solving this equation. Some did focus on the 8, but ‘added’ it to both sides giving $y + 2 = 7 + 8$. Others subtracted the fraction incorrectly leaving $y = 7 - \frac{1}{4}$.

Answer: 54

Question 9

In part **(a)** the conversion of kilometres to metres was done reasonably well although a significant number multiplied by 100, 10 or even 10 000. In some cases, candidates changed the given figures and it was not clear what candidates thought they had to do. Part **(b)**, the conversion of cubic centimetres to litres, was less well answered as it appears that the conversion factor is not generally known. This was a question that was often left blank.

Answers: **(a)** 6540 **(b)** 7.85

Question 10

This was the best answered question on the paper. However, for part **(a)** occasionally, –3, the temperature was given instead of the day of the week with the warmest temperature. Sometimes Tuesday was given, maybe because of misunderstanding negative numbers. For part **(b)**, sometimes the subtraction was not performed correctly so it became $-7 - 12 = -19$. Sometimes there were arithmetic slips in part **(c)**.

Answers: **(a)** Wednesday **(b)** 5 **(c)** 2

Question 11

The algebra here was handled better than that in **Question 8**. Most errors occurred when candidates did not deal with the negative numbers correctly or made numerical slips in the initial multiplication. The most common working was $12y - 18 - 5y + 5$ and an answer of $7y - 13$; this gained only one mark for either multiplying of the first bracket correctly or for the $7y$ seen in the answer.

Answer: $7y - 23$

Question 12

Candidates did well here with many correctly stating one or other of the values. The easier value to find was by substituting $x = 3$ into $0.5x + 1$. The other value involved more manipulation as candidates had to solve $6 = 0.5x + 1$, giving 10 as the answer. Another way to approach this was to use the gaps in the domain and range to find the two values but this method relies on the first answer being correct.

Answer: 2.5 10

Question 13

To succeed with this type of question on LCM (or even HCF), candidates should break down each number into its prime factors so $18 = 2 \times 3^2$ and $21 = 3 \times 7$. Then the LCM will be $2 \times 3^2 \times 7 = 126$. There is another method which can go wrong if candidates make arithmetic slips, that of listing out multiples of each number, until the first number that is common to both lists is found. The most common misunderstanding was to give the HCF, 3.

Answer: 126

Question 14

Sometimes these types of questions have a diagram to aid candidates so the first step is to draw a diagram of an octagon and mark one or all the exterior angles. The majority of candidates correctly identified this as an 8-sided shape and a significant number showed $360 \div 8$ but many spoilt their work by then subtracting the answer, 45, from 180 (this is the interior angle) or from 360. A few calculated the exterior angle as 225 (from $360 - 135$).

Answer: 45

Question 15

Many candidates drew an enlargement of the correct size but did not use the given centre of enlargement. Some attempted an enlargement from the correct place of 4 times the original size as if they started counting 3 times the length of rays from the shape instead of starting at the centre of enlargement. It was quite common to see a small rectangle (of 3×2 or 2×2 squares) to the immediate right of the original shape. Many candidates did not use a ruler.

Question 16

Part **(a)** was very well answered but part **(b)** far less so. For part **(a)**, it did not matter what form the probability was given, but this is not always the case so candidates must check the form of their answers. In part **(b)**, some gave their answer as a probability, for example, $\frac{40}{240}$ or $\frac{6}{240}$.

Answers: **(a)** $\frac{8}{15}$ **(b)** 40

Question 17

Like with the last question, part **(a)** was well answered but part **(b)** less so. Incorrect answers to part **(a)** include x^7 or x^{81}. Many candidates found part **(b)** more challenging; there were a variety of incorrect responses, most commonly seen were $\frac{1}{4}$, $\frac{1}{16}$, $\frac{1}{64}$, 4, 2 and 4^{-2}. This last did not earn the mark as it was only the power of 4 that was asked for. Many struggled to find the starting point.

Answers: **(a)** x^{12} **(b)** –2

Question 18

The majority of candidates wrote at least one correct value but relatively few got both. It was fairly evenly split between $\sqrt{3}$ and π being chosen alongside an incorrect value; most often this was 3^{999}.

Answer: π $\sqrt{3}$

Question 19

For part **(a)**, the common incorrect quadrilateral given was square. However there were plenty of incorrect answers that were not quadrilaterals – polygon, pentagon, hexagon and equilateral. Part **(b)** was not answered well. Candidates should have looked at part **(a)** again to see the kind of statements that were made there and adapted them for a parallelogram. Of those that gave an answer, many were correct for other quadrilaterals but incorrect for parallelograms, for example, 1 or 2 lines of symmetry, rotational symmetry of order 1 or 4 right angles but others were completely wrong for any shape for example, all the sides are parallel, the sides add to 360° or the angles are parallel. Like with **Question 14** a reasonably sized diagram would help candidates pin-point the properties. The correct properties most often seen were: opposite sides (or angles) are equal and opposite sides are parallel. There were other acceptable properties, for example, has no lines of symmetry or the diagonals are not equal in length.

Answers: **(a)** rectangle

Question 20

Most candidates gave the correct mode for the number of visits to a movie theatre in a month. Many gave the mean correctly or had the correct method but made arithmetic slips. For part **(b)**, many were not successful at producing the full method but did gain a method mark for giving $\frac{2}{10}$, the fraction who went to the movie theatre 3 times or $\frac{360}{10}$, the number of degrees for each person in the pie chart. Some candidates went on to draw the pie chart or just this sector, neither of which is asked for in the question.

Answers: **(a)(i)** 1 **(ii)** 1.7 **(b)** 72

Question 21

Although many struggled with factorising the expression in part **(a)**, there were a number of correct responses. Misconceptions about combining terms meant that the answer $26w$ was seen quite regularly as well as the 'solution', $w = -6$. Some candidates showed $\div 2$ in their working and gave $5 + 8w$ as their answer. Another misconception was to list all the factors of 10 and 16. For part **(b)**, similar errors were seen, as those that combined terms in part **(a)** also did it in part **(b)**. Often the candidates who gave $5 + 8w$ gave a similar answer, $3x - 2t$, for this second part. Some candidates thought the 8 was to be squared as well as the t as 64 appeared in their answers. A mark was available for those who only partially factorised this second expression.

Answers: **(a)** $2(5 + 8w)$ **(b)** $4t(3x - 2t)$

Question 22

There were some candidates who showed complete, logical working. A few candidates made arithmetic errors, which should have been picked up when checking. The wrong methods seen most often were for candidates to ignore the whole number, so worked with $\frac{3}{4}$ only, or to invert the second fraction (sometimes changing the $\times$ sign to $\div$). A further wrong method was to 'cross multiply'. The answer was asked for in its simplest form but many left their answer as $\frac{42}{140}$ so could not earn all three marks.

Answer: $\frac{3}{10}$

Question 23

There are various methods to solve simultaneous equations and candidates should be aware that sometimes, depending on the structure of the equations, one method might be quicker or involve fewer opportunities for arithmetic slips to spoil good method. The elimination method for these simultaneous equations involves multiplying both equations by different numbers. Re-arranging one equation and substituting this into the other equation was sometimes seen. Candidates should check their values in both equations. Correct answers with no working or wrong working only got one mark out of the four available.

Answer: [$x =$] 7, [$y =$] 8.5

Question 24

This was the question that candidates found the most challenging. Candidates need to learn the terms associated with working with functions. The domain of a function is the x-values (starting values) it takes (given in the question as $1 \leqslant x \leqslant 10$) and the range is the y-values, (resulting values) so what was asked for was the part of the y-axis that was used for the curve, i.e. from 0.5 to 5. A few candidates got one mark for stating these end points as they did not go on to put them in the more formal notation as shown below. The domain was given in the question to help candidates focus on the axes and show them the correct form for their answer.

Answer: $0.5 \leqslant f(x) \leqslant 5$

Question 25

For this context, n must be a whole number. Candidates struggled with this as they automatically thought n as a whole number, but did not say it. Many said that n could not be zero, but it can and it gives negative profit, i.e. a loss, which many candidates said was impossible. Many thought that a kayak could be rented out multiple times in a week but this is not correct as the question said that they are rented for the week. In part **(b)** some candidates substituted 5380 for n, others divided the profit figure by 20 or by 100. Others chose a value for n and substituted into the profit equation to try and get to 5380 which gains no marks unless the correct value for n is reached. Others gave non-integer answers for the number of kayaks that were rented out. There were very few logical, algebraic solutions.

Answers: **(b)** 30

MATHEMATICS (US)

Paper 0444/21
Paper 2

Key messages

To succeed in this paper candidates need to have completed full syllabus coverage, remember necessary formulae, show all necessary working clearly and use efficient methods of calculation. They should be encouraged to spend some time looking for the most efficient methods suitable in varying situations.

Candidates should be aware that they would not be required to carry out complex calculations involving decimals or multiplying by π on a non-calculator paper.

General comments

The level and variety of the paper was such that candidates were able to demonstrate their knowledge and ability. There was no evidence that candidates were short of time, as there was no drop in the response rate for the last few questions.

Candidates showed good number work in **Questions 1** and **15**, demonstrated good algebra skills in **Questions 4**, **6** and **8** and a sound recollection of shape facts and formulae in **Questions 5** and **7**.

Candidates particularly struggled with the equation involving an index number, **Question 9**, scientific notation in **Question 11**, trigonometry in **Questions 16** and **23**, direct proportion in **Question 17,** and probability in **Question 25**.

It was noted that many candidates were crossing through all workings once they had the answer to put on the answer line. This made it difficult for Examiners to see which work candidates intended as their working and also made it difficult to read. Workings leading to the final answer should be legible so that part marks can be awarded if a final answer is incorrect.

Comments on specific questions

Question 1

The majority of candidates gained the mark by giving one (or both) prime numbers. The most common error was to give a prime number outside of the given range. The most common incorrect values within the given range were 25 and 27, often alongside a correct value.

Answer: 23 or 29

Question 2

Many candidates knew what was meant by scientific notation and could write the number correctly. The most common error was to give a positive power of 5 and some wrote the number as a fraction or used indices without including 10.

Answer: 3.87×10^{-5}

Question 3

Some candidates demonstrated an understanding of the index notation and took the most efficient route of cube rooting 8 and then squaring it. The majority of candidates did not understand the notation and had the common misunderstanding of treating it as a mixed number, giving an answer of $\frac{26}{3}$, 8.66… or just 26.

Answer: 4

Question 4

There were very few candidates who did not gain both marks for this substitution. Any errors made were generally arithmetic, and in these cases candidates were usually able to gain 1 mark.

Answer: 66

Question 5

Candidates demonstrated a very good knowledge of the angle facts involved in this question, with the majority gaining both marks. A small number of candidates gave an answer of 137 from 180 – 43 and a few got as far as 90 – 43 to give 47 but then did not double it.

Answer: 94

Question 6

Candidates demonstrated a sound understanding of solving the equation and were successful in reaching the correct answer. Many scored 1 mark for the correct first step of $\sqrt{y} = 11$ but then went on to give the solution as $\sqrt{11}$ and others made errors squaring 11. Candidates should ensure that their lines of working are easy to follow and that they do not try and show the next operation within a line of working. This leads to incorrect statements which cannot be credited.

Answer: 121

Question 7

Candidates demonstrated a good recall of Pythagoras' theorem and applied it correctly. Some arithmetic errors were made but the majority gained the correct answer or gained a part mark for demonstrating the correct process. The most common error was to add the sides without squaring to give an answer of 14.

Answer: 10

Question 8

This question was generally well answered with the majority of candidates scoring full marks. Candidates who were awarded part marks were generally aware of the need to expand the brackets and did so correctly for at least one of the two. Arithmetic slips were sometimes made when expanding the brackets or collecting terms. The most common incorrect answer was $7y - 13$ from $-5y + 5$ as the expansion of the second bracket. A minority of candidates correctly expanded the two brackets but then multiplied these together to give a quadratic expression.

Answer: $7y - 23$

Question 9

This question proved challenging for the majority of candidates, with many multiplying 27 by 81 to get 2187 rather than looking to see if they could make the numbers have the same base as the unknown index number. Some who got to 2187 did arrive at the correct answer by trial and error and there were lots of calculations seen in the work space. 729 was a popular answer from those who got to 2187 and then divided by 3. Some candidates scored 1 mark as they did not deal with the negative power, hence giving an answer of 7.

Answer: –7

Question 10

Candidates struggled with this question, often due to problems with long multiplication. More efficient methods of calculation would have resulted in a higher success rate, such as 1.5% of 100 is 1.5 so 1.5% of 200 = 3 and then multiply by 6. Candidates who were able to change 1.5% to a decimal and then multiply their answer by 200 and 6 scored a method mark but then often got lost trying to multiply. A very common answer was 1800, where candidates simply used 1.5 as a multiplier rather than 1.5 ÷ 100. Many answers which were far too high could have been spotted with a check using estimation or at least a check of the likely interest at such a small percentage.

Answer: 18

Question 11

There were very few candidates who could manipulate this expression in scientific notation to simplify it. Those who were successful tended to choose a nominal value for *p*, putting it back into the required form once they had added. It was extremely rare to see a solution involving the manipulation of the numbers to equate the power of 10. The vast majority of candidates gave an answer of 9.6 multiplied by 10^p, 10^{p+1}, or 10^{p+2}.

Answer: $6.45 \times 10^{p+1}$

Question 12

A large number of candidates were able to rearrange correctly and gain the first mark. Dealing with the inequality proved more challenging, with a high proportion of answers given as an equality, or with the incorrect inequality sign. Some had the misconception of making the –4.4 positive by reversing the inequality sign. Candidates who were not able to obtain –4.4 had generally made sign errors when attempting the process of rearrangement.

Answer: $n < -4.4$

Question 13

This simplification was dealt with fairly well and many candidates gained 1 mark for dealing with the indices or, more commonly, the numbers. The most popular misconception was to divide the indices, so leading to the answer $\frac{x^2}{2x}$.

Answer: $\frac{x^8}{2}$

Question 14

Some candidates demonstrated a sound grasp of manipulating surds with many scoring a part mark, usually for showing $3\sqrt{3}$, even if they made an error with the other number or could not combine them. A very popular incorrect answer was $\sqrt{75}$, and sometimes this was then correctly simplified to $5\sqrt{3}$. Many candidates used a method involving writing 48 and 27 as products of their prime factors and whilst some were successful, many didn't get the correct answer this way. Candidates may want to consider writing a list of square numbers in order to inspect for multiples.

Answer: $7\sqrt{3}$

Question 15

A good understanding of the multiplication of a mixed number with a fraction was demonstrated with many gaining all 3 marks for this question. The final answer mark was occasionally lost by those not fully simplifying the fraction or making arithmetic errors when simplifying. Candidates should be encouraged to cancel fractions before multiplying, in order to reduce these errors. Some showed confusion in the methods of dealing with fractions and made the denominators equal or cross multiplied the fractions.

Answer: $\frac{3}{10}$

Question 16

It was clear that the sine rule was unfamiliar to many candidates and those that did know it struggled to apply it to the question. Many did not use the given fact sin $y = 0.6$, using sin 0.6 within their equation. Some did get to 0.5 but thought that was the angle and the majority who did reach sin $x = 0.5$ could get no further. There was some evidence of guessing the final answer but with no working did not gain any marks. Many assumed that the triangle was right-angled and so were using right-angled triangle trigonometry.

Answer: 30

Question 17

Candidates should ensure that they read the information in proportion questions very carefully, as the majority of errors come from setting up the incorrect relationship at the beginning of the working. It was often seen as an inverse relationship, or without the square. The few candidates who set up the correct relationship usually went on to gain full marks. A mark was sometimes lost when candidates arrived at $k = 4$ following $16k = 4$, although they usually gained both method marks here. By far the most common answer was 36, gained from ignoring the information given in the question and simply substituting 7 into $(x - 1)^2$.

Answer: 9

Question 18

In part **(a)** some candidates knew that the amplitude was 3 but could not find the period of the function. Common responses were $3\sin$ for the amplitude and 2x for the period. Part **(b)** was rarely answered correctly with $9\sin(6x)$ being a common response. Both parts of this question had a high rate of nil response, demonstrating that the topic was unfamiliar to many.

Answer: **(a)** 3, 180 **(b)** $9\sin(2x)$

Question 19

Those who understood the need to find a common denominator usually went on to gain the second and third marks by combining the fractions correctly and simplifying. Arithmetic errors were sometimes made when expanding the bracket and the number in the numerator often became –13. Some understood the need for a common denominator but did not multiply the numerator, resulting in $\frac{5}{x-3}$ for the first fraction. The most common error was to go straight to an answer of $\frac{3}{x-3}$.

Answer: $\frac{5x-17}{x-3}$

Question 20

The majority of candidates did not recognise this as a reverse percentage and so the majority of answers involved finding 20% of 672. Many who did set up an equation as a reverse percentage struggled with the arithmetic of dividing 672 by 0.8. Once again, candidates need to look for efficient ways of carrying out calculations and recognising equivalents such as 6720 ÷ 8 or 672 $\times\frac{5}{4}$. Some had success using trial and improvement, but tended to take a lot of time with multiple calculations. Candidates should be advised to check if their answer is reasonable, i.e. an answer a bit bigger than 672, not an answer in the thousands of dollars.

Answer: 840

Question 21

Many candidates scored 1 mark for this question by recognising that the intercept was 2 and so giving an equation which reflected this. Far fewer candidates understood that the gradient of a perpendicular is the negative reciprocal and so values of 2 and –2 were commonly seen as the coefficient of *x* within the answer.

Answer: $\frac{1}{2}x+2$

Question 22

The nature of this problem solving question put many off making an attempt, resulting in a lot of blank working space and guessed answers, often 16π. Incorrect formulae for the circumference and area of circles caused some problems. Some substituted in a numerical value for π and got lost in long multiplication.

Answer: 16

Question 23

Candidates' inability to remember exact trigonometric ratios meant that the vast majority who did make a sensible start, came across a stumbling block and could get no further than writing out the trigonometric ratio with two unknowns. Some made an alternative first step of realising that length *RP* was half of *RQ* and gained credit for this, but then did not make the connection to use Pythagoras' theorem in order to find *PQ*. Candidates should be aware of the ratios they are expected to know on a non-calculator paper in order for the marks on a question to become accessible.

Answer: 6

Question 24

Finding the interquartile range from a cumulative frequency diagram proved challenging for most candidates with a range of incorrect answers seen in part **(a)**. Some candidates gave the range, some worked out 90−30 and gave the answer 60 or then referred to the diagram and read off 25 (the value corresponding to 60). A small number of candidates were able to find the value of the lower quartile or upper quartile correctly, but did not correctly identify the other value. A higher proportion of candidates were aware of the process that needed to be followed in part **(b)** with many scoring both marks and some gaining the part mark for 116, not recognising the need to subtract from 120. The majority of marks were lost due to mis-reading the scale on the graph rather than not understanding the process involved and candidates need to take care to check their answers.

Answer: **(a)** 10 **(b)** 4

Question 25

The majority of candidates gave the correct probability in part **(a)**. Dealing with the probability in part **(b)** proved much more challenging, even for higher achieving candidates. Many treated the pens as being replaced, and multiplied fractions all with 15 as a denominator. Others recognised the need to consider probabilities with denominators of 15 and 14 respectively, but did not consider all of the possible combinations. Finding the probability of only one of the combinations or omitting the probability of two orange pens was common. Few candidates chose the most efficient route of calculation of 1 – probability of two black pens.

Answer: **(a)** $\frac{8}{15}$ **(b)** $\frac{168}{210}$

Question 26

Using inequalities to describe regions proved challenging, with only the most able candidates gaining more than one or two marks. There were various combinations of ways to score marks within the question and many scored a mark for $y \geqslant 1.5$ alongside being rewarded for finding the equations of the other lines, even if the inequality signs were incorrect. Candidates should be encouraged to choose a point within the region to check whether their inequality sign is the correct way round. Common errors in finding the equations of the lines were to have $\frac{4}{3}x$ rather than $\frac{3}{4}x$ or $2x$, $-2x$ or $\frac{1}{2}x$ instead of $-\frac{1}{2}x$. It was quite common for x to be omitted after the gradient within the equations of the lines. Candidates who did not understand what the question was asking often used the example given as a starting point to continue with, for example, $y \leqslant x + 2$, $y \leqslant x + 3$.

Answer: $y \geqslant 1.5$, $y \geqslant \frac{3}{4}x$, $y < -\frac{1}{2}x + 3$

Question 27

Candidates struggled to find the mean in part **(a)** with many showing no understanding of finding the total number of visits; 20 (total frequency) ÷ 4 (number of groups) being an extremely common response. Some did start correctly by finding the total number of visits to gain a mark but then also divided by 4. There were some correct answers in part **(b)** but there were many who struggled to find a method to find the angle of the pie chart. One mark was often scored, usually for showing a correct step of dividing 360 by 20 or for 3 divided by 20, which was often left as 15% rather than being converted into an angle.

Answer: **(a)** 1.7 **(b)** 54

MATHEMATICS (US)

Paper 0444/31
Paper 3

Key messages

To be successful in this paper, candidates had to demonstrate their knowledge and application of various areas of mathematics. Candidates who did well consistently showed their working out, formulas used and calculations performed to reach their answer.

General comments

This paper gave all candidates an opportunity to demonstrate their knowledge and application of mathematics. Most candidates were able to complete the paper in the allotted time. Few candidates omitted part or whole questions. Candidates generally showed their workings and gained method marks. However many candidates were unable to gain marks in the 'show that' question (**8(c)(ii)**) if they used the value they had to show from the beginning.

Attention should be paid to the degree of accuracy required in each question and candidates should be encouraged to avoid premature rounding in workings. This was particularly evident in **Question 10(c)** and **Question 5(d)**. Candidates should also be encouraged to process calculations fully and to read questions again once they have reached a solution so that they provide the answer in the format being asked for and answer the question set.

The standard of presentation was generally good; however candidates should be reminded to write their digits clearly. Many candidates overwrite their initial answer with a corrected answer. This is often very difficult to read and is not clear what the candidates' final answer is. Candidates should be reminded to re-write rather than overwrite. There was evidence that most candidates were using the correct equipment.

Comments on Specific Questions

Question 1

(a) (i) All candidates attempted this question with most gaining the mark. Errors involved the correct number of zeros or zeros in the correct positions. The most common incorrect answers seen were 27 360 45 and 7 360 045. Candidates who were not consistent with their use of commas or dots were also penalised.

(ii) Candidates showed very good understanding of factors, with the vast majority gaining full marks for a correct list of six factors. Common errors were omitting the 1 or the 20 or writing a list of multiples instead of factors.

(iii) Finding an equivalent fraction was attempted by all candidates with the most common fractions being $\frac{14}{18}$ and $\frac{70}{90}$. Some candidates attempted to write as a decimal, and candidates should be reminded to reread the question once they have given their answer to check it is in the form asked for in the question. $\frac{77}{100}$ was a common incorrect fraction from rounding the decimal equivalent to two decimal places and then rewriting as a fraction.

(iv) Nearly all of the candidates correctly identified 31 or 37 as the prime number. Common incorrect answers were 33 or a prime number outside of the range. Again candidates must reread the question once the answer is given to check it satisfies all criteria asked for in the question.

(b) (i) The majority of candidates placed their brackets in the correct position. Common errors were around 17 – 3 and 3 · 5.

(ii) This question proved more challenging with less than half the candidates placing the brackets in the correct position. Common errors were around 2^2 or using two brackets. A significant number of candidates did not attempt this question.

(c) Candidates demonstrated good use of their calculators to find the cube root of 4913 as 17. Common errors indicated that candidates had square rooted instead of cube rooted or divided by 3.

Answers: **(a)(i)** 27 360 045 **(ii)** 1, 2, 4, 5, 10, 20 **(iii)** $\frac{7k}{9k}$ **(iv)** 31 or 37 **(b)(i)** 17 – 3 · (5 – 3) = 11 **(ii)** $(3 + 2)^2 - 4 = 21$ **(c)** 17

Question 2

(a) (i) The vast majority of candidates correctly found the range of the data by subtracting the fewest number of letters from the largest number of letters. Errors seen included finding the median or mode instead of the range.

(ii) Nearly all candidates found the correct value for the median. Again errors were finding the mean or mode instead.

(iii) All candidates attempted this question with the vast majority giving the correct frequencies. Errors seen were usually one error in counting.

(iv) Most candidates drew a correct dot plot for the information in their frequency table. The most common error was not including all dots in each column and only giving the highest dot in each column.

(b) (i) All candidates attempted to complete the table. All candidates gave the frequencies of 3 and 9 but a large number of candidates did not complete the tally for romance books and gave the frequency as 0. These candidates had not used the total number of students as 60 to complete the table.

(ii) Every candidate correctly found how many more students chose crime books than music books.

(iii) The majority of candidates found the correct fraction of students who chose comedy or science fiction books. Candidates who had made errors in the table gave the incorrect denominator of 58 instead of the total number of students of 60.

(iv) Errors in calculating the percentage of students who did not choose poetry books again came from errors in the frequency table.

Answers: **(a)(i)** 7 **(ii)** 4 **(iii)** 1, 4, 4, (3), 5, 2, 0, 1 **(b)(i)** 3, 9, 2 **(ii)** 11 **(iii)** $\frac{26}{60}$ **(iv)** 95

Question 3

(a) Most candidates gave one of the acceptable answers of rhombus, parallelogram or kite. The most common error was quadrilateral.

(b) (i) The vast majority of candidates gave the correct co-ordinates with very few incorrect answers which included (–2, 0).

(ii) Measuring the obtuse angle was more challenging. Candidates struggled to measure angles with many using the wrong scale on their protractor and giving an acute angle or 157 which was measured from the horizontal rather than between lines *RS* and *PS*.

(c) (i) Candidates demonstrated good use of rulers to measure accurately the length of the line *PQ*. Few candidates rounded to the nearest whole number of centimetres and the vast majority measured within acceptable tolerances.

(ii) Candidates who had correct answers for part **(i)** multiplied their length by 4 to gain the mark here. Many candidates were able to gain a follow through mark if they had made an error in part **(i)**.

(d) (i) Good solutions in this part contained the correct transformation, reflection, and a correct line described either as the *y*-axis or as the equation $x = 0$. The most common error was describing the line as $y = 0$. Very few double transformations were seen.

(ii) Good answers contained all three parts to describe a rotation. Less able candidates could correctly identify the transformation as rotation but did not include the centre. A common error was to describe two reflections over the *y*-axis and then the *x*-axis which gained no marks.

(e) Candidates found translating the triangle by the given vector challenging. Many less able candidates translated in the wrong direction, often one left and two up. Some candidates translated the whole rhombus instead of triangle **D**.

Answers: **(a)** rhombus **(b)(i)** (0, −2) **(ii)** 136 **(c)(i)** 5.4 **(ii)** 21.5 or 21.6 **(d)(i)** reflection, *y*-axis **(ii)** rotation, 180, (0, 0)

Question 4

(a) Most candidates were able to plot two of the points and gained one mark. The vertical scale caused most difficulty with the most common error being to use one square to equal one level rather than two squares. Similarly the horizontal scale was often read as one square equalling one hour rather than one square representing two hours.

(b) Around half of the candidates correctly identified the point representing the person who completed more levels per hour than any others. The most common incorrect points indicated were (90, 22) or (70, 7).

(c) Candidates generally identified the correlation as positive. However a significant number described the correlation using levels and hours rather than the type of correlation seen. Few candidates gave negative or no correlation, although a large number of candidates did not attempt this part.

(d) Over half of the candidates drew an acceptable line of best fit. The most common wrong line simply joined the corners of the grid. Less able candidates often joined all the points with straight lines.

(e) Few candidates gave a number of hours within the acceptable range. Some candidates correctly used their line of best fit to gain a follow through mark. Most common errors involved values around 40 and 50 hours from the middle of the horizontal scale.

Answers: **(b)** (40,18) indicated **(c)** positive **(e)** 76 to 80

Question 5

(a) Successful solutions showed candidates' ability to find a fraction of a quantity and then to subtract. Candidates who used the fraction $\frac{1}{3}$ generally found the correct answer. However a large number of candidates attempted to find $\frac{1}{3}$ of \$13.50 by using decimals or percentages. This led to inaccuracies due to rounding their decimal to 1 or 2 decimal places. $0.3 \cdot 13.50 = 4.05$ and $0.33 \cdot 13.50 = 4.455$ both gained no marks and therefore 9.45 and 9.045 also gained no marks. Candidates who used the decimal to 3 decimal places were able to gain one method mark if they then subtracted from 13.50. Many candidates successfully found $\frac{1}{3}$ of 13.50 as 4.50 but then did not complete the question by subtracting.

(b) (i) Candidates showed understanding of 24-hour and 12-hour times and the vast majority of candidates changed the time to 1 45. However fewer candidates gained the mark as the time was often given without the required pm for a 12-hour clock time.

(ii) Candidates were less successful in finding how long the train took to travel from Redtown to Southford. Less able candidates attempted this question with a vertical subtraction sum 16 39 – 13 45 = 2 94 which was interpreted in a variety of ways including 3 h 34 min and 4 h 54 min. This method does not take into consideration that 60 minutes equals 1 hour.

(iii) There was a wide variety of correct methods to find by how many minutes Georgina missed her train. Most candidates showed understanding that they had to add 46 mins to 16 39 and then find the difference from 17 12, although many errors were seen in using time. 16 39 + 46 = 16 85 was a common start but then 17 12 – 16 85 = 27 mins. Good solutions included using minutes past 16 00, i.e. 39 + 46 – 72 = 13 mins or finding the difference between 16 39 and 17 12 = 33 mins and then 46 – 33 = 13 mins.

(c) Successful candidates divided monetary values by quantities or vice versa. Many different versions of this method were seen including $\frac{\$}{\text{ml}}$, $\frac{\$}{\text{l}}$, $\frac{\text{ml}}{\$}$, $\frac{\text{l}}{\$}$, $\frac{\text{cents}}{\text{ml}}$, $\frac{\text{cents}}{\text{l}}$, $\frac{\text{ml}}{\text{cent}}$ or $\frac{\text{l}}{\text{cent}}$. Some good solutions saw candidates calculating the same quantity from each cup, often converting regular and large cups to 500 ml. When completed correctly candidates generally identified the correct cup. The most common incorrect approach was to investigate the difference in price and quantity. Most candidates identified the Extra large cup as best value but to gain any marks it had to be accompanied by a correct division or multiplication.

(d) Most candidates used the speed, distance, time formula correctly to find the time as 1.583 hours. Errors then followed when attempting to change this time to hours and minutes, commonly because of premature rounding. 1.583 was rounded to 1.6 which converted to 1 h 36 mins, leading to the common incorrect answer of 19 48. 1.58 hours was commonly converted to 1 h 58 mins leading to a very common incorrect answer of 20 10. A large number of less able candidates did not attempt this part of the question.

Answers: **(a)** 9 **(b)(i)** 1 45 pm **(ii)** 2 [h] 54 [min] **(iii)** 13 **(c)** Extra large **(d)** 19 47

Question 6

(a) (i) Candidates demonstrated good measuring and conversion skills. The vast majority of candidates measured the line accurately and converted correctly by multiplying by 300.

(ii) Candidates struggled to measure bearings. A number of candidates did not attempt this part or gave a measurement of length rather than an angle. Most candidates showed evidence that protractors were used but many measured Annika's house from Bernhard's or read the wrong scale.

(iii) Few candidates gained full marks by drawing the bearing correctly and then indicating the point *C* 5.5 cm from *B*. However a large number of candidates were able to gain one mark for either drawing a line at the correct bearing or more commonly drawing a line 5.5 cm from *B*.

(b) Only the most able candidates could gain marks on this question. The perpendicular bisector of *GR* was more successful with candidates gaining both marks for an accurate bisector with arcs or one mark for correct arcs without the line. The angle bisector was less successful with few correct bisectors seen. A small number of candidates bisected all three sides but did not bisect the angle.

Answers: **(a)** 3300 **(b)** 117

Question 7

(a) (i) All candidates attempted this question but few found the correct volume of the water. Most candidates found the volume of the vase rather than the volume of the water contained within it. It was crucial that candidates read the information given under the diagram rather than just using the values given on the diagram. A common incorrect answer was therefore 8100. Candidates did not also appreciate that the base of the vase was a square and therefore had equal sides. An equally common error was to use the 20 cm as the width of the vase and find the volume using $15 \cdot 20 \cdot 36 = 10\,800$.

(ii) Most candidates understood that they needed to divide their volume of water by the volume of water for one packet of food (500). Most candidates did not have the correct volume of water but often gained the method mark for dividing by 500.

(b) (i) Successful solutions recognised that the small vase was an enlargement of the larger vase with scale factor $\frac{1}{3}$. Most candidates who gave the correct solution divided 36 by 3 or multiplied by $\frac{1}{3}$. Common errors in this question involved working with the volume rather than the lengths of the sides.

(ii) Candidates needed to use the area of the square base of the vase to find the height of the water in the vase. As mentioned in part **(a)(i)** many candidates thought the base was rectangular and therefore did not divide the volume of water by 25 ($5 \cdot 5$) and divided by a variety of values because they had attempted to find the width by dividing 20 by 3 instead of 15 divided by 3. Good solutions showed each step in their working, including the calculation of the area of the square base and the division of 150 by the area of the square.

Answers: **(a)(i)** 4500 **(ii)** 9 **(b)(i)** 12 **(ii)** 6

Question 8

(a) (i) The correct answer of diameter was seen the most. Hypotenuse was also accepted as a correct answer. Common incorrect answers were chord and radius.

(ii) Identifying the line *AB* as a chord was less successful. A wide variety of incorrect answers were seen including adjacent, bisector, rope, string, tangent, sector and segment.

(b) Giving a geometrical reason why angle *ABC* is 90° was the most challenging question of the whole paper with few correct answers seen. Candidates had to use the circle theorem that angles in a semi-circle are 90°. Most candidates stated that the angle was a right angle without any geometrical reason.

(c) (i) Using trigonometry proved challenging for many candidates and was only answered correctly by the most able candidates. Many were able to quote SOH CAH TOA but were unable to go further. If candidates correctly used cosine another common error was prematurely rounding $\frac{20}{52}$ to 0.38 which gives the common incorrect answer of 67.6… or 67.7. Candidates should use the whole calculator value or the fraction when using trigonometry. Rounding errors were common with 67.38… rounded to 63.3.

(ii) Successful answers included squaring, subtracting and square rooting. To gain full marks candidates must show all elements without errors as this is a ‘show that’ question. Many less able candidates attempted to find 48 without the use of Pythagoras’ theorem, by using angles or adding values. Some more able candidates used their previous answer and trigonometry to find *BC* correctly. A large proportion of candidates did not attempt this question.

(iii) More candidates attempted to find the area of triangle *ABC*. However most did not use the correct base and height. The most common error was to use 20 and 52, giving the area as 520.

(iv) Finding the shaded area proved challenging for most candidates. Good solutions showed all working and utilised the area formula for a circle. Most candidates who attempted the question used the correct formula but often did not use the radius as 26, using 52 instead. The circumference formula was also seen. Many candidates found the area of the whole circle and then the area of the triangle was subtracted without halving the area of the circle to find the area of the semicircle. A very large proportion of candidates did not attempt this question.

Answers: **(a)(i)** diameter **(ii)** chord **(b)** angle [in] semi-circle [is 90] **(c)(i)** 67.4 **(iii)** 480 **(iv)** 582

Question 9

(a) (i) A large proportion of candidates did not attempt any part of part **(a)**. Identifying the gradient proved challenging with many incorrect answers seen, the most common being 4, $-4x$, $4x$, 7 and 3 or $3x$.

(ii) Writing the equation of a line parallel to $y = 2x + 3$ proved equally challenging. The most common incorrect answer was $y = 4x + 6$. Also seen were $5x$, $-2x - 3$ and $2x + 3$, in equal proportions.

(iii) Equally challenging for most candidates was identifying the co-ordinates of the point where the graph of $y = 6x - 5$ crosses the y-axis. The correct answer was rarely seen with (6, –5) the most common incorrect answer.

(iv) Of the candidates who attempted this question only the most able candidates found the correct answer. Most candidates who attempted it substituted 7 into the expression $4x - 3$ reaching the most common incorrect answer of 25. Candidates who formed the correct equation $4k - 3 = 7$ were able to then solve it and reach $k = 2.5$.

(b) (i) Completing the table was the most successful part of this question. All candidates attempted the question and most gained at least one mark for at least three correct values. The most common error was $y = -7$ for $x = -2$ from $(-2)^2 = -4$.

(ii) There was good plotting of points with many scoring at least three marks following an incorrect value for y in their table. The follow through from part **(b)(i)** was seen often. Very few straight lines joining points were seen and even fewer thick or feathered curves drawn.

(iii) Very few correct co-ordinates were seen in this part. Most candidates who attempted this gave the lowest point from their table (0, –5) or (1, –5) or (0.5, –5) and did not take into consideration the curvature of the graph.

(iv)(a) Of those that did attempt to draw the line of symmetry the majority got it correct, with few hand drawn lines seen.

(iv)(b) More candidates did not attempt this question. The most common error was to repeat the equation of the curve or to omit the $x =$ in the equation and just give the value 0.5.

Answers: **(a)(i)** –4 **(ii)** $2x + k$ where $k \neq 3$ **(iii)** (0, –5) **(iv)** 2.5 **(b)(i)** 1, –5, –3, 1, 7
(iii) (0.5, h) where $-5.5 \leqslant h < -5$ **(iv)(b)** $x = 0.5$

Question 10

(a) (i) Most candidates showed understanding of ratios and percentages. Good solutions saw $240 found as 40% of $600 and then using the ratio to find the amount spent on music. Those that did not gain full marks either found the 40% but then made errors with the ratio, or did not find 40% but used the ratio correctly with the $600. In both cases these candidates gained one mark.

(ii) Candidates who had correctly found the amount spent on music usually gained full marks for this part of the question. Candidates with incorrect answers in part **(i)** were able to gain one mark by dividing the amount spent on music by 3 and then multiplying by 10, 2 or 8. Some candidates started again with the $600 and found the amount spent on clothes and books separately and then found the difference. This still only gained one mark as they were not using the 40% of $600.

(b) Calculating compound interest proved to be the most challenging part of this question with many less able candidates not attempting it or calculating simple interest instead of compound interest. The correct formula was seen often and the full amount of $684.70 was a very common answer. This however only gained two marks as the question asked for the interest received not the total amount of the investment after 3 years. Candidates again should be encouraged to reread the question after giving their answer to check they have satisfied all parts of the question. Other common errors were using 1 + 0.45 instead of 1 + 0.045 in the formula and rounding errors often led to answers of $684.69 or $684.6 or $84.69 or $84.6.

(c) Candidates showed understanding of exchange rates with the majority of candidates able to do one conversion correctly. However only the most able candidates gained full marks as candidates were required to multiply by the exchange rate, subtract and then divide by the exchange rate. Often candidates did the first two steps but did not convert back to dollars. Very good solutions saw candidates convert the €325 to dollars and then subtract. Many candidates who did complete all three steps correctly often did not gain full marks as they did not round their final answer to the nearest cent. Common errors were to round to 1 or 3 decimal places with 223.8 and 223.843 seen often. A small but significant number of candidates divided, subtracted and then multiplied.

Answers: **(a)(i)** 48 **(ii)** 128 **(b)** 84.7[0] **(c)** 223.84

MATHEMATICS (US)

Paper 0444/41
Paper 4

Key messages

Candidates need to ensure that they have a good understanding and knowledge of all of the topics on the extended syllabus. Some candidates offered no response to a number of questions.

Candidates need to read the questions carefully. In particular, when questions have been completed candidates should read the question again to ensure that they have a sensible answer and one that precisely answers what is asked.

Candidates need to be careful that when they use a formula from the formula list they choose an appropriate formula and copy it precisely.

Some candidates are giving answers to less than 3 significant figures without a more accurate answer being seen. If a candidate has shown working they are likely to lose only one mark but those candidates showing no working may not be awarded any marks.

Questions that include the word 'show' require candidates to work towards the result rather than using the given result. They also require candidates to show all the steps in their working.

General comments

Many candidates demonstrated that they had a clear understanding across the wide range of topics examined. The majority of candidates attempted every question on the paper.

The presentation of some working makes it very difficult to follow the thought processes. In addition, by setting their work out in a clearer order, some candidates would make fewer slips and mistakes.

The most able candidates were able to demonstrate their ability to apply their knowledge to problem solving. However, some candidates would benefit by thinking more carefully about the mathematical skills required so that they use the most efficient route to answer questions.

Candidates should avoid rounding prematurely in the middle of a response, as this can affect the accuracy of their final answer.

The questions involving money (**Question 3**), transformations (**Question 8**), graphs (**Question 6 (a)**, **(b) and (c)**), angles (**Question 7**), probability (**Question 9**) and functions (**Question 11**) were completed well.

Weaker topics included responses to the questions which included the word 'show', (**1(a)**, **4(d)** and **6(d)**), the algebra questions, (**Question 4** and **Question 12(d)**), solids (**Question 5**), vectors (**Question 10(a)**,**(b)**), wordy questions (**Questions 1(d)**, **(e)**) and interpretation of graphs (**Question 6(e)**).

Comments on specific questions

Question 1

(a) Many candidates did not know how to approach a 'show that' question and by starting from the $306 could not score the mark. Those candidates gaining this mark mostly used a 2-stage solution. Both the division and the multiplication were needed to be seen. The second step of multiplying 34 by 9 was missed by some while a few others multiplied each person's share by 34 without showing the first step of 680 ÷ 20.

(b) Despite many candidates not scoring in the previous part many did correctly find the other shares. The main error seen was to share the remainder, after 680 – 306, equally between Barbara and Collette.

(c) Most candidates knew that they had to either multiply or divide by the exchange rate. Candidates did not think about whether they should receive more or less euros than dollars and almost as many candidates multiplied as divided.

(d) Quite a number of candidates found $4.11 but then did not complete the question and omitted to divide by 3. Some misreading of the question was evident occasionally with the two fruits being mixed up. Otherwise just some arithmetic slips resulted in the question not being done quite as accurately as it might have been.

(e) Almost all candidates correctly found the amount of money Collette spent on clothes. A very common error was then to work out one-fifth of the remainder rather than one-fifth of the original share. Those who did find the correct amounts often then correctly completed the question but a significant number did not go on and subtract the total spent from her share. This question was one where candidates clearly had the basic mathematics skills but lost marks through not following precisely what the question was asking.

Answers: **(b)** 238, 136 **(c)** 272 **(d)** 1.37 **(e)** 40.80

Question 2

(a) Many candidates drew a line parallel to *BC* but not always through *A*. Construction arcs were required but these were rarely seen, with most lines having been drawn by measuring rather than the required 'copying an angle' method.

(b) Again, the evidence was that a right angle was measured rather than constructed. Although some had construction arcs they appeared to be put on after the angle as there was no evidence of arcs on the line *BC*. Common errors including constructing the perpendicular bisector of *BY* or drawing a line through *C* parallel to *BA* to form a parallelogram.

(c) A correct answer here was dependent on the accuracy of the angles drawn at *A* and *C*.

(d) Of the few construction arcs seen most were drawn for the angle bisector and quite a few were correct. A common error was to draw the diagonal *BD*.

(e) There were only a small number of correct answers, partly because this relied on the previous accuracy and also because few candidates had an angle to measure, although most gave an answer. Errors included giving the acute angle *BPC*.

Answer: **(e)** 143 to 147

Question 3

(a) Whilst some correct answers were seen, a common error was for candidates to use 77 500 as the denominator. Answers of 6 or 6.1, without a more accurate value seen or incomplete working shown, lost marks.

(b) Only a minority of candidates seemed to be aware of the formula for compound interest. A few attempted year-by-year calculations but these were often not accurate and others worked out simple interest. Of those using the correct method, few rounded to the nearest dollar which lost a mark. Inaccuracy came from working out 1.022^6 but rounding it to 1.14 before multiplying by 12 000.

Answers: **(a)** 6.06 **(b)** 13 674

Question 4

(a) (i) Very few candidates were able to factorise the expression correctly and it was evident that most were clearly not familiar with expressions of this form and the process for factorising them. Of those who understood the process, it was quite common to see errors made with the negative signs.

(ii) Only a few candidates recognised that this was the difference of two squares. A common incorrect approach was for candidates to try to solve $4y^2 - 81 = 0$.

(iii) More candidates were successful with this part as it was of a more usual form. Common errors included slips with negative signs within the brackets. Candidates who factorised correctly but went on to multiply the brackets back out or then solve the correct factorised expression equated to zero and gave these as their final answer, were penalised.

(b) Few candidates knew the approach to take when rearranging a formula with x appearing more than once. Misunderstanding of BIDMAS was very evident here with candidates unsure as to which stage to do first. However, a significant number of candidates were able to score the first method mark by correctly multiplying both sides by x. Candidates more often than not could not then correctly combine the *x*s together with $2x$ and x^2 frequently seen. If a candidate reached the stage of correctly factorising the x out they usually went on to correctly complete the question. It was very difficult to award any marks to candidates who unsuccessfully tried to complete more than one operation at a time.

(c) Candidates were required to show their working in this part and some clear and accurate solutions were seen. Those who made slips with signs were often able to either gain a method mark or a special case mark for solutions which satisfied one of the original equations. However, many candidates just added the two equations together as they were given and could make no progress.

(d) (i) Few candidates were familiar with the process required to combine algebraic fractions and rearrange the given equation to a quadratic. Some of these candidates had the general idea but there were frequent errors seen with signs and lack of brackets. Candidates who recognised they had made sign errors went back to amend their errors but often made their work unclear or missed some of the changes and were penalised for these slips. The least able candidates had little idea where to start with this.

(ii) This should be a routine question involving the quadratic formula but there were a wide range of errors seen. These included incorrectly copying or not using the formula on the formula sheet, short square root sign, short division sign, errors with negatives, premature rounding of $\sqrt{241}$ and incorrect rounding of answers. Candidates not showing any working before giving the correct answers could only score a maximum of two marks.

Answers: **(a)(i)** $(2n+m)(m-3)$ **(ii)** $(2y-9)(2y+9)$ **(iii)** $(t-4)(t-2)$ **(b)** $\frac{2m}{k+1}$ **(c)** 6, –2 **(d)(ii)** –0.79, –3.38

Question 5

(a) Whilst there were many accurate answers, a very significant error was that many candidates did not recognise the need to adapt the given formula for the volume of a sphere to that of a hemisphere. In addition it was quite common to see r^2 rather than r^3 being used. Furthermore, rearranging the formula was not done very well, with the most common errors arising from mistakes in dividing by the $\frac{2}{3}$ and the inability to be able to find a cube root using a calculator. Consequently this fairly straightforward question was not done very well.

(b) (i) Only a few candidates had any idea as to how to approach this question. A lot of confusion was evident in this part due to many candidates not reading the question carefully. Instead of recognising that the volume of the cylinder was 70 cm^3 often the volume of the whole toy or just the hemisphere was used. Many had an incorrect expression for the volume of the cylinder, with $2\pi rh$ and $2\pi r^2h$ seen a number of times as well as $2\pi rh + \pi r^2h$.

(ii) Candidates struggled with this question. For those candidates that understand similar solids this question was straightforward. Whilst many realised that 19 200 had to be divided by 300, few then cube rooted 64 but simply multiplied the answer of 64 by 1.6. A variety of attempts were seen involving much more complicated methods that usually started by dividing 19 200 in the ratio 230 : 70 but these candidates generally made little progress.

Answers: **(a)** 4.79 **(b)(i)** 8.70 **(ii)** 6.4

Question 6

(a) Whilst the correct answer was often seen, common incorrect answers included *y*-axis, *x*-axis or $y = 0$.

(b) Whilst many candidates clearly did not know what a tangent is, some candidates drew accurate ruled tangents touching the given graph and were able to find the gradient well within the given answer range. Errors included drawing the tangent at $x = –0.5$, lines that were close to but either crossed the graph or had a gap between the tangent and the graph, gradients without the minus sign, or gradients arising from misreading of the scales.

(c) (i) Most candidates completed the table correctly.

(ii) Candidates were generally able to plot the points accurately and smooth curves were drawn. Errors mainly arose from misreading the *y*-axis and points mis-plotted. Smooth curves were required and candidates were penalised if they either used a ruler, had the wrong curvature between the points or had multiple lines or feathering between points.

(d) Few candidates understood that they needed to arrive at this equation by equating the equations of the two curves. Many candidates tried to substitute *x* values which they had read off from the intersection of the two curves and try to make the result zero.

(e) Only a few candidates understood how to find the correct equation of the line to draw and these usually went on and scored full marks. A common approach, which was not asked for, was to draw the graph of $y = x^3 + 5x + 2$ and read off where this cut the *x*-axis. In addition, a common misconception was that this cubic could be solved using the quadratic formula.

Answers: **(a)** $x = 0$ **(b)** –9 to –6.5 **(c)(i)** 0, 2.4, 4 **(e)** $y = –2x + 2$, –0.45 to –0.35

Question 7

(a) Many candidates gave clear and concise correct solutions to this question. Most candidates attempted to take the approach of $8x + x = 180$ but it was quite common to see the error $8x + x = 360$. In addition, candidates who correctly found $x = 20$ did not always go on and complete the question by finding the number of sides. Those who attempted to use the sum of the interior angles and nothing else could make no progress as they frequently had two unknowns in their equation.

(b) Many candidates gave the correct answer with most doing the working on the diagram. Of those who did not get to 32, many picked up one mark for either *DBC* = 58 or *BCD* = 90 and sometimes got both. Some assumed triangle *ADC* was isosceles and gave 61 as their answer, even showing it on the diagram as angle *ADC*, and others just wrote an answer of 58.

(c) (i) Fewer scored full marks here than in part **(b)**. The majority used the parallel lines correctly but many assumed that *PRQ* was 48 and therefore so was *OPR*. Many remembered something about angles at the centre and circumference but got them the wrong way round and gave *PRQ* as 96 and hence 96 as their answer. Others assumed *OQ* and *PR* intersected at right angles.

(ii) There were few fully correct answers to this part. Most calculated an arc length with the majority giving the length of the minor arc and a few giving the total circumference as the answer. A common error made by some was to use the formula for the area, finding either the area of the whole circle or a sector with angle 48 or 312.

Answers: **(a)** 18 **(b)** 32 **(c)(i)** 24 **(ii)** 29.4

Question 8

(a) (i) Most candidates recognised this as a translation but the word translate was not always given. Other words such as transformation, translocate, shift, slide and move were seen which were not acceptable. A correct vector was often seen and in addition answers such as 8 left and 2 up were also seen. Errors included an incorrect number of units, incorrect negative signs, translations from *B* to *A* or answers expressed as co-ordinates.

(ii) Whilst the words enlargement or dilation were frequently given, words which did not score included reduce and shrink. Many candidates combined enlarge with a movement and this did not score as it is not a single transformation. Common errors in the scale factor included –0.5, 2 and –2. The centre of enlargement was often incorrect. Some candidates just wrote 'origin', others used inaccurate construction lines which did not meet at (−4, 0).

(iii) Those that recognised rotation often went on to give an angle and a centre. The direction of the rotation was often omitted when using 90°, although some correctly used 270°. The centre again was often inaccurate and some again just wrote 'origin'. As in the previous part, those giving rotate with another transformation, usually translation, scored zero.

(b) Whilst there were some accurate answers there were many triangles drawn that were either not twice as long in each linear direction or were drawn in the wrong position. Many answers were drawn with part of the triangle off the grid to the right and it seemed that candidates were not recognising the triangle had to be to the left of triangle *A*, or indeed understanding how to use the centre of enlargement.

Answers: **(a)(i)** translation $\begin{pmatrix} -8 \\ 2 \end{pmatrix}$ **(ii)** enlargement, 0.5, (–4, 0) **(iii)** rotation, 90° clockwise, (1, –1)

Question 9

(a) Many candidates were unable to fill in the tree correctly. Whole numbers were seen or the probabilities interchanged. Other errors included probabilities given as decimals or percentages with accuracy less than the 3 significant figure accuracy required.

(b) Few candidates gave the correct answer. Those who had probabilities often added rather than multiplied the probabilities.

(c) Most candidates who answered this selected $\frac{5}{6}$ and $\frac{3}{10}$ and tried to combine these rather than put them together with the fractions in the first stage. When a candidate did select $\frac{5}{8}$, $\frac{5}{6}$, and $\frac{3}{10}$, $\frac{3}{8}$ they usually did not know when to add or multiply. In addition, although candidates can use calculators, there were a number of basic arithmetic errors seen.

Answers: **(a)** $\frac{5}{8}, \frac{3}{8}, \frac{1}{6}, \frac{5}{6}, \frac{7}{10}, \frac{3}{10}$ **(b)** $\frac{5}{48}$ **(c)** $\frac{304}{480}$

Question 10

(a) (i) A few candidates were able to correctly find the vector $\overrightarrow{OB}$ but only the most able candidates went on to use Pythagoras' theorem to find the length. Of those using Pythagoras' theorem, a common error was $\sqrt{12^2 + -4^2}$ resulting in $\sqrt{128}$. Candidates who chose to work out the length of one of the given vectors were not credited.

(ii) Most candidates did not use $\overrightarrow{BC} = -\overrightarrow{AB} + \overrightarrow{AC}$ but more commonly found either $\overrightarrow{AB} - \overrightarrow{AC}$ or $\overrightarrow{AB} + \overrightarrow{AC}$.

(b) This vector question proved challenging for most candidates. Candidates rarely showed any valid method or intermediate working so it was rare to award any part marks. The most common incorrect answer seen was $\frac{1}{2}(\mathbf{b} + \mathbf{a})$.

Answers: **(a)(i)** 12.6 **(ii)** $\begin{pmatrix} -11 \\ 13 \end{pmatrix}$ **(b)** $\frac{1}{2}(\mathbf{b} - \mathbf{a})$

Question 11

(a) Many candidates calculated the powers of 2 correctly although some went on to find the difference between 0.125 and 8. Common errors were $2^{-3} = -8$ and $2^0 = 0$.

(b) There were many correct answers but it was quite common to see $9^2 + 8 = 90$. Less able candidates only found g(1) and left the answer as 9.

(c) There were many correct answers but 2^{32} was frequently calculated. Other incorrect answers included 16 and $\sqrt{32}$.

(d) Most attempted to substitute $2x$ but few reached $4x^2$, leaving their final answer as $2x^2 + 8$. Some less able candidates gave a numerical answer.

(e) Most errors made were in calculating h(3) but many did reach the correct answer. $\frac{3}{-2}$ as the final answer was seen a number of times.

(f) There were many correct answers, the most common written as $\frac{x-5}{-2}$. Two common incorrect answers were $(5-2x)^{-1}$ and $\frac{1}{5}-\frac{1}{2x}$.

(g) This part was answered well with a number of candidates scoring full marks. A common slip was to forget to reinstate the 8 after expanding $(5-2x)^2$ correctly. A common misconception seen was $(x^2+8)(5-2x)$.

Answers: **(a)** 0.125, 1, 8 **(b)** 89 **(c)** 5 **(d)** $4x^2+8$ **(e)** –1.5 **(f)** $\frac{5-x}{2}$ **(g)** $4x^2-20x+33$

Question 12

(a) Most candidates were able to complete the table correctly.

(b) Most candidates scored at least one mark in this part. Candidates usually gave the expression in its simplest form but other equivalent expressions scored full marks. Common errors included $n+3$, $3n$, $n=3n+3$ and $6n+3$.

(c) This question proved straightforward for most candidates with many of them extending the table to the 7th pattern. A few arithmetic errors were seen but otherwise many scored full marks. A more complex correct solution, seen by a few, was to find the formula for the total mats as $\frac{1}{2}(n+2)(n+3)$, or equivalent, with $n=7$ correctly substituted to give 45. Otherwise, the most common error seen was 24 substituted into their expression in part **(b)** and an attempt to find the number of mats relating to 75 grey mats. This usually resulted in a long string of numbers because the formula for the total mats was not given.

(d) This part was challenging for the majority, with only a few correct solutions seen. These candidates also usually demonstrated an efficient method of solving their equations. Some candidates were able to score some marks for one or more correct equations. Many candidates could not connect this part with the previous part and did not even substitute values for n.

Answers: **(a)** 18, 28 **(b)** $3n+3$ **(c)** 45 **(d)** $\frac{3}{2}, \frac{13}{3}$