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, focusing on key words.

General Comments

Candidates must check their work for sense and accuracy as it was very noticeable that there were many answers in context that weren't realistic for the context. Candidates must show all working to enable method marks to be awarded. This is vital in two or multi-step problems, in particular with algebra, where each step should be shown separately to maximise the chance of gaining marks in, for example, **Questions 4**, **5**, **8**, **14**, **18** and **19**. This will also help candidates check their own work. It is also worth noting that candidates should use HB pencils for diagrams. Some candidates used pens, and then could not alter their diagrams.

The questions that presented least difficulty were **Questions 1**, **2**, **13(b)**, **18**, and **20(a)(i)**, Those that proved to be the most challenging were **Questions 9**, **11**, **14**, **20(a)(ii)** and **22**. In general, the number of questions with no responses was similar to past series. It is likely that the blank responses were down to the syllabus area being tested rather than lack of time.

Comments on Specific Questions

Question 1

This was a straightforward start to ease candidates into the paper and many gave the correct answer. Workings were useful here for candidates to check they had the correct day and the most successful way was to make a mini calendar.

Answer: Sunday

Question 2

Sometimes this type of question asks for the difference between two temperatures so a negative answer is acceptable, but here, the question asks how many degrees colder it is in Berlin so –4 is not correct. This negative answer showed some understanding but could not gain the mark. Candidates were much more successful in part (**b**) although a common incorrect answer was 30.

Answers: **(a)** 4 **(b)** 16

Question 3

In part **(a)**, the majority of candidates were able to calculate 8% of 300kg, but went on to add this increase to 300kg. As this is a one mark question, this could not receive any credit. A much larger number got part **(b)** correct.

Answers: **(a)** 24 **(b)** 70

Question 4

This question was answered correctly by many candidates. The method was to divide 2000 by 50 for the mass of one spoon then to multiply by 9 to calculate the final mass. Candidates were less successful with the division step.

Answer: 360

Question 5

Many candidates knew how to calculate the simple interest but good work was often spoiled by the principal being added at the final stage. A significant number of candidates attempted compound interest. Questions on interest have various aspects for candidates to consider; is what is asked for compound or simple interest and is the answer required just the interest earned or the interest and the principal? If candidates consider these two aspects they may be able to gain at least some marks. Candidates also need to check that their answer makes sense in context so a value that is larger than the original sum is not likely to be correct. There were no rounding issues in this question as the answer was an exact number of dollars.

Answer: 600

Question 6

This construction caused difficulties for some candidates maybe because the given line was vertical not horizontal. Many triangles did not have a correct pair of arcs so could only score one mark. A fairly common error was to assume that the triangle was right-angled, which left candidates unable to construct a triangle that had sides of the lengths given in the question.

Question 7

Candidates were more successful with part **(b)**, parallelogram, than with the circle in part **(a)**. Regular hexagon was the most common incorrect choice for part **(a)** probably due to candidates not appreciating that they were asked for the shape with more than 6 lines of symmetry rather than just 6 lines alone.

Answers: **(a)** Circle **(b)** Parallelogram

Question 8

This question was either answered very well or very poorly. The most able candidates applied the two required operations efficiently and arrived at the correct answer. For those candidates who showed some understanding of the required method, the most common error was to use the inverse operations incorrectly by applying them in the wrong order. Many candidates started by multiplying both sides by two but then cancelled all the twos so that they disappeared entirely. Some candidates did not show all the steps in their work, meaning that partial credit was unavailable to them.

Answer: [x =] $2y + b$

Question 9

There were many responses left blank for this question. For part **(a)**, most candidates who answered were correct and very few wrote 'negative'. Alternative answers that did not score included, direct proportion, linear, increasing, scattered, number of sales, symmetrical, and 5 : 2. This last was maybe an attempt to link the sales of each item and this idea fed through into some of the comments in part **(b)**. Candidates found it challenging to articulate the relationship between the sales of the two items. What is required is the trend that a line of best fit will show. Some candidates assumed that the trend was over time with the low plots at the start of the two weeks and higher at the end but any comment about time cannot be made from this diagram.

Answers: **(a)** Positive **(b)** The more ice creams sold, the more sun hats sold

Question 10

Most candidates answered this question well, gaining at least one mark. The most common incorrect answer was $24uw^3$. As two of the three components were correct, one mark was scored. Another fairly common error was that candidates did not understand that the indices must be added not multiplied and as this is a method error, did not score. Some candidates did not finish the multiplication of 6×4.

Answer: $24u^2w^3$

Question 11

This was very poorly answered. Most candidates calculated C(8), with varying degrees of success. The few candidates who did recognise what was required usually gave answers that covered a continuous rather than a discrete set of values. When candidates see this type of function question, the words, 'range' or 'domain' should trigger a realisation that they are being asked about the sort of values used in the particular context. One aspect is the limits on the minima and maxima and then whether the variable is discrete or continuous. Here, domain means number of people, not the money (the range). The minimum is 1 person (if there are no people there is no cost) and the maximum is 8. Then the last aspect is that this is a discrete variable as you cannot have part of a person so integers are required.

Answer: 1, 2, 3, 4, 5, 6, 7, 8

Question 12

Many candidates left this question blank and candidates continue to find this topic challenging. In part **(a)**, (3, 5) was the most common incorrect answer, presumably since these two numbers were in the question. As part **(b)** built on the understanding of the equation of a line, those who did not score in part **(a)** were generally not successful in this part. The common error was to change the gradient to $\frac{1}{3}$, –3 or another multiple of 3.

Answers: **(a)** (0, 5) **(b)** $y = 3x + k$, $k \neq 5$

Question 13

This was one of the more straightforward factorising questions as there was only one factor to consider. However some candidates wrote only the w or $3w - 2$ as their final answer. As this question was only one mark, the factorisation had to be completely correct to score. Candidates were more successful in part **(b)** and many were awarded at least one mark for multiplying out one of the brackets. A common error was to attempt to combine the x^2 and x terms.

Answers: **(a)** $w(3w - 2)$ **(b)** $2x^2 + 8x - 35$

Question 14

This question had no scaffolding so candidates were left to determine the approach which raises the difficulty level of the question. The consequence of this is that this was poorly answered or left blank in many cases. The most common error was to ignore one of the given pieces of information – underlining each piece as it is used is a good technique here – the most common piece to be omitted was the two spoons a day. Once the amount of medicine for 10 days was found, candidates had to convert this into litres. This conversion stage was not performed well with many candidates assuming there is only 100 or 10 ml in 1 litre.

Answer: 1.8

Question 15

This question involved a reverse volume calculation as instead of starting with the three dimensions and finding the volume, candidates had to divide the volume by the given dimensions to find the third. There were some very good answers to part **(a)** but the two stages had to be shown in order to earn the method mark. A number of candidates divided 330 by one of the given dimensions but then multiplied by the other. Again, it was the process of division that proved to be problematic with many candidates showing the correct calculation, but being unable to evaluate it correctly. Some candidates multiplied the two dimensions giving 60, a common incorrect answer. In part **(b)**, there were many correct answers; however, a very wide variety of errors was also seen.

Answers: **(a)** 5.5 **(b)** 1320

Question 16

This question was answered well by many candidates, who showed complete and convincing working. The first step was for candidates to convert to an improper fraction and the majority of these went on to show a correct method for division. Some candidates made arithmetical errors. A few candidates arrived at $\frac{15}{63}$, but did not do the final simplification.

Answer: $\frac{5}{21}$

Question 17

Many candidates find scientific notation challenging and the main error in this question was having more than one digit before the decimal point. Many appeared to be counting zeroes, with the answer to part **(a)** given as 826×10^2. Candidates must remember not to round the given number to less figures unless told to do so. There were some good answers to the calculation in part **(b)**, with most opting to write the numbers in the ordinary way before performing a column subtraction. The most common error in these cases was to set the subtraction out incorrectly, lining up the first significant figure rather than the digits that had equal place values. Some candidates appeared to be attempting to apply the laws of multiplying or dividing indices.

Answers: **(a)** 8.26×10^4 **(b)** 7.5×10^8

Question 18

This question was correctly answered by many candidates including some who had problems with algebraic manipulation earlier in the paper. The weaknesses in algebra skills were exposed in this question as some candidates were unable to correctly multiply out the bracket or to divide both sides by 5. Almost all of the candidates who were able to perform this first step went on to produce the correct solution by the reverse operations. A few left their answer as $\frac{45}{15}$.

Answer: 3

Question 19

This question caused significant problems for many candidates. Many used an incorrect formula, despite the formula being given on the paper. Many candidates did not leave their answer in terms of π but went on to perform further multiplication. Candidates should note what form their answers are required in, be it scientific notation, two significant figures, to the nearest 1000 or in terms of π like here. The units were often not of area or frequently omitted altogether**.**

Answer: 144π cm^2

Question 20

Some candidates left one or more of the last two parts blank of this question on sequences but for many, part **(a)(i)** was much more accessible. Candidates had difficulty in expressing the rule for continuing the sequence in part **(a)(ii)**. Some candidates explained how to find the difference, but not how to use it, others made reference to odd numbers but did not explain that the sequence involved adding the next odd number. Some candidates made erroneous or ambiguous statements, such as 'add 2 each time'. Candidates were generally more successful in part **(b)** with many giving the first three terms correctly. Some started with $n = 0$ or $n = 2$ instead of $n = 1$. A few used the nth term as the first term in the sequence so gave $4n – 3$, $8n – 6$ and $24n – 18$. Other candidates gave 4, 1, –2 from misunderstanding $4n – 3$ as 'start with 4 and then keep subtracting 3'. There were other incorrect answers that had no workings to show how they had been calculated.

Answers: **(a)(i)** 27, 38 **(ii)** Add the next odd number **(b)** 1, 5, 9

Question 21

Candidates had difficulties writing 30 as a product of its prime factors as they included 1 or wrote the factors as a list rather than showing the multiplication. Some just gave two numbers that multiplied to 30. More candidates correctly answered part **(b)** or gave workings showing they were more familiar with multiples than factors. However, there were some that identified a common factor instead i.e. 3, 5 or 15.

Answers: **(a)** $2 \times 3 \times 5$ **(b)** 90

Question 22

For the large majority of candidates, this was the most challenging question on the paper. This was not a completely straightforward question on similar shapes as candidates had to scale down the triangle and the scale factor was not an integer. Some candidates assumed that the connection was 'subtract 2' so gave an answer of 8 for x and then y in the larger triangle became 11. If candidates calculated the scaling factor (in either direction) this was worth one mark in part **(a)**. If candidates had used their incorrect x and the 10 in a correct method to calculate y a follow through method mark was available. This did not score both marks as it is possible and preferable to calculate y without involving x.

Answers: **(a)** 7.5 **(b)** 12

MATHEMATICS

Paper 0444/21
Paper 2

Key Messages

To succeed in this paper candidates need to have completed full syllabus coverage, apply formulae correctly, show all necessary working clearly and use efficient methods of calculation.

General Comments

The level and variety of the paper was such that all candidates were able to demonstrate their knowledge and ability. There was no evidence that candidates were short of time, as almost all attempted the last few questions.

Candidates showed some good number work in **Questions 1**, **2** and **4**, a good understanding of expanding brackets and simplifying in **Question 3** and good functions knowledge, both graphical in **Question 22** and algebraic in **Question 23**.

Candidates particularly struggled with fractional indices in **Question 9,** finding the *n*th term of a quadratic sequence in **Question 10(b)**, inverse proportion in **Question 11**, reasoning with vectors in **Question 13(b)**, area scale factor in **Question 18(b)** and the perhaps unfamiliar factorisation in **Question 19(b)**.

Candidates should be aware that they would not be required to carry out complex calculations involving decimals or multiply by π on a non-calculator paper. They should also be advised to look for efficient methods of calculation, for example cancelling fractions before multiplying as in **Questions 8** and **12** and using fractions rather than decimals as in **Questions 18** and **20**.

Comments on Specific Questions

Question 1

Almost all candidates obtained the correct answer to this question. Where an incorrect answer was given, it was usually 1.5 or –1.5.

Answer: 9.5

Question 2

The majority of candidates answered this question correctly. Other answers involved an incorrect number of zeros, usually 0.001.

Answer: 0.0001

Question 3

Most candidates were able to successfully expand the brackets and collect like terms. If candidates did not gain 2 marks, they were often able to earn 1 mark for a correct expansion of one of the brackets, most often showing $5x - 35$. Following a correct expansion, most candidates could successfully simplify the terms. Following a completely correct simplification, there were a number of candidates who then went on to spoil their answer by halving all the terms, trying to re-factorise or equating to zero and attempting to solve for *x*.

Answer: $2x^2 + 8x - 35$

Question 4

Candidates were successful with this question and understood that they needed to show a comparison of the 2 values, usually showing 28% or $\frac{26}{100}$ alongside $\frac{28}{100}$. It was a minority of candidates who wrote down a name with no supporting working.

Answer: Paul with correct reasoning

Question 5

Most candidates demonstrated knowledge of simplifying indices by gaining 1 out of the 2 marks available; this was commonly for the answer of $24uw^3$. Candidates need to recognise that without an index number, it is equivalent to a power of 1. Other incorrect answers involved w^{-18} and some answers indicated that candidates did not recognise that index laws should be used or did not know the relevant laws.

Answer: $24u^2w^3$

Question 6

Many candidates demonstrated a correct method to simplify surds with a good number gaining both marks for the correct simplification. Sometimes the answer was left as $2\sqrt{3} + 3\sqrt{3}$. Candidates often gained 1 mark for either term simplified and this was usually for $3\sqrt{3}$. Candidates often correctly stated that $\sqrt{12} = \sqrt{3 \times 4}$ and then confused the simplification, giving $3\sqrt{2}$. A common incorrect answer was $\sqrt{39}$ from those candidates who did not know how to deal with surds.

Answer: $5\sqrt{3}$

Question 7

There were a reasonable number of fully correct answers to this question. A large number of candidates made a correct start by finding ±8 and ±6 as the difference in x and the difference in y and gained 1 mark for this. They then often went on to find the gradient and sometimes the equation of the line rather than the length. Those who scored zero were commonly either adding the two x and the two y co-ordinates or subtracting the x and y values from one co-ordinate pair. Many made a sensible start by drawing a diagram and this may have helped those who were struggling to comprehend the situation.

Answer: 10

Question 8

This was a well attempted question with most candidates gaining some marks. Those who were most successful tended to use the method of inverting and multiplying $\frac{9}{5}$, often sensibly cancelling down before multiplying which avoided arithmetic errors later. Others found a common denominator, usually $\frac{15}{35} \div \frac{63}{35}$ which was also a successful method. Some got to this point and were then unsure how to continue. Even those candidates who did not know a suitable method for dividing a fraction often gained a mark for making a correct 1st step of changing the mixed number into $\frac{9}{5}$. A common misconception after this was to invert the 1st fraction rather than the second before multiplying.

Answer: $\frac{5}{21}$

Question 9

Part **(a)** was answered more successfully than part **(b)** where the correct answer of 2 was seen from many candidates. The most common misconception was to find a third of 8. This was also seen commonly in part **(b)** with $\pm\frac{3}{8}$ often given as the answer. A number of incorrect approaches to dealing with the power were observed; these included ignoring the negative sign, removing the negative sign by inverting the fractional power and attaching the numerator of the power to the numerator of the fraction and the denominator of the power to the denominator of the fraction. There was a fairly large number who did not attempt this question, especially part **(b)**.

Answers: **(a)** 2 **(b)** 8

Question 10

Many of the candidates found the linear *n*th term successfully in part **(a)**. The other common answers were 24 (the next term in the sequence) and $n + 4$. In part **(b)** by far the most common answer was 116, i.e. the next term in the sequence. Many candidates showed that there was a second difference of 6 in part **(b)** and some gained a mark for interpreting this by giving a quadratic expression as their answer. Few candidates were able to find the correct expression. Candidates need to be able to interpret the meaning of differences within a sequence and be equipped with methods to find *n*th term expressions, including quadratic.

Answer: **(a)** $4n$ **(b)** $3n^2 + 8$

Question 11

There were a good number of successful candidates in this question and they usually started off by showing $p = \frac{k}{(q+4)^2}$ to find $k = 72$. There were some careless arithmetic errors within a correct method, especially involving −2. Using the incorrect value of q, i.e. $2 = \frac{k}{(-2+4)^2}$ was not uncommon. Some attempted to define an incorrect relationship, often showing p varying directly with $q + 4$ or $(q + 4)^2$ and perhaps more who worked with p being inversely proportional to $q + 4$ or to $\sqrt{q+4}$.

Answer: 18

Question 12

Many candidates multiplied 18 by 1000 to make a correct start in part **(a)**. They often went wrong from here, either dividing by 60 rather than 60×60 or multiplying by 60. Where a correct answer was found in part **(a)** candidates usually went on to use this correctly in part **(b)** and some gained a follow through mark for using their answer to part **(a)** correctly, especially where they had found 300, 50 or 0.5 in part **(a)**. The most common calculation seen was 270 ÷ 18. There was a significant number who did not answer part **(b)**. There were some extensive calculations involving both large numbers and decimals seen in both parts of this question.

Answers: **(a)** 5 **(b)** 54

Question 13

Many candidates were able to obtain 2**b** as the correct answer to part **(a)**. There were many who did not know how to attempt the question and so left it blank. There was a wide range of incorrect vectors as answers and sometimes vectors added to numbers. In part **(b)** few candidates identified the shape as a parallelogram; some of the common answers given were trapezoid, rhombus and polygon. Candidates could have scored a mark for stating trapezoid with the reason that *QR* is parallel to *PM* but most referred to *PS* and so were not using the given shape. Of those who did correctly identify the shape as a parallelogram, very few went on to gain the second mark as they only gave a partial answer, usually omitting to say that *QR* and *PM* are equal as well as parallel.

Answer: (a) 2**b** **(b)** Parallelogram with reasons

Question 14

Many candidates were able to score at least 1 mark on this question, commonly from identifying $y<8$ or for finding the correct equation(s) of the other 2 lines and leaving as an equation or for having an incorrect inequality sign. More candidates could give the equation of the line $y = x + 2$ than $y = 6 – x$. Successful candidates understood the meaning of broken and unbroken lines when describing the region. A large number of candidates did not understand what was being asked, with many writing down the co-ordinates of the 3 vertices of the triangle, referring to a shape, often triangle, or not attempting the question at all.

Answer: $y < 8$, $y \geqslant x + 2$, $y \geqslant 6 – x$

Question 15

There were many correct answers to this question along with a large number worthy of 2 marks for calculating the interest and then omitting to add this on to the original investment. One common error was to convert 2% to 0.2 as a decimal; another was to multiply the $5000 by 3 before adding on the $300 interest. Candidates should check the reasonableness of their answers in questions such as this. The other error was to attempt to calculate compound interest which led to significant workings on a non–calculator paper.

Answer: 5300

Question 16

A large number of candidates scored both marks in part **(a)** or 1 mark for listing the prime factors or including 1 within their otherwise correct prime factorisation. Those who drew a factor tree / ladder usually went on to gain at least 1 mark for identifying the correct prime factors. The most common misconception was to list all factors of 30 or write out the factor pairs. Candidates tended to gain either 2 marks or zero in part **(b)** with very few giving a multiple which was not the least common multiple. The most common method seen was to list the multiples of both numbers rather than use prime factors which proved efficient in this case as the numbers were fairly small. About half of the candidates were confusing least common multiple with common factors and answers of 3, 5 and 15 were very common.

Answer: **(a)** $2 \times 3 \times 5$ **(b)** 90

Question 17

This was a well understood question with the most successful candidates employing the elimination method - multiplying the equations to equate one of the coefficients followed by an appropriate addition or subtraction. The 2nd method mark was sometimes lost through inconsistent adding or subtracting within the equations. A significant number of candidates were rearranging one of the equations and substituting into the other which usually gained them 2 marks for the correct method but they then went on to make far more algebraic and arithmetic errors than those using the elimination method and this prevented them from gaining the 2 answer marks. More candidates would have realised that they had incorrect values if they had checked them within both equations. Candidates should also be encouraged to make their working clearer within this type of question as multiple attempts at the question in the working space made it very difficult to award marks at times.

Answer: $x = 3$, $y = –1$

Question 18

Many candidates gave the correct answer in part **(a)**. Some made the calculation far more difficult by trying to work in decimals rather than the straightforward fractional scale factors and so lost the accuracy mark. The most common misconception was to simply look at the difference in the lengths and then take 2 away from 10 to give 8 as the answer. Some candidates were trying to find the missing length using Pythagoras' theorem. Part **(b)** proved far more challenging, resulting in a small proportion of correct answers and a number of blank answer lines. Candidates need to understand the difference between length and area scale factor as most were using the length scale factor found in part **(a)** to give an answer of 24. There was a high success rate from those resourceful candidates who used the given area to find the perpendicular height of the larger triangle and then used the length scale factor to find the height of the smaller triangle and subsequently its area.

Answers: **(a)** 7.5 **(b)** 18

Question 19

The factorisation in part **(a)** was well attempted with a good number gaining both marks. Candidates understood that they were looking for common factors and often managed to gain 1 mark with the partial factorisation of $y(p + t) + 2x(p + t)$ or $p(y + 2x) + t(y + 2x)$. The last mark was often lost with a final answer of $(p + t) + (y + 2x)$ or missing brackets such as $p + t(y + 2x)$. Part **(b)** proved to be a much more unfamiliar type of factorisation with only a few of the most successful candidates scoring any marks. The most common approach was to multiply out the brackets rather than look for the common factors within each term. Those who did identify $(h + k)$ or 7 as a factor often cancelled them from both terms leaving just $7(h + k) – 21$ or $(h + k)^2 – 3(h + k)$. Some thought that hk or $7hk$ were factors.

Answer: **(a)** $(p + t)(y + 2x)$ **(b)** $7(h + k)(h + k – 3)$

Question 20

The most successful working shown was for the volume of the cone and a large number of candidates gained 1 mark for this. Fewer candidates were able to calculate the value of the hemisphere, often forgetting to halve. Candidates often had difficulty with the arithmetic and a number were losing marks if they had not shown sufficient working. Those who showed all their correct substitutions could gain 2 out of 3 marks even if they then went on to make errors in their calculations. There were instances of candidates attempting to multiply by π rather than leaving their answer in terms of π and this added significantly to their work.

Answer: 45π

Question 21

Most of the successful candidates understood that they should convert one of the powers of 10 to be the same as the other in order to add them together i.e. obtaining either 20×10^{11} or 0.3×10^{12}. Many candidates went down the more inefficient route of writing out the numbers in full and were sometimes successful, although they were much more likely to make errors in the arithmetic with this large number of zeros and were likely to leave the answer as a number rather than put back into scientific notation. A larger number of candidates did not choose a suitable method and 5×10^{23} was a very common answer. Part **(b)** proved even more challenging with a large proportion of candidates not making any response. A number of candidates made a correct 1st step by showing the division by 10^2 but then did not simplify this.

Answers: **(a)** 2.3×10^{12} **(b)** $a + 100b$ or $a + b\times10^2$

Question 22

This question differentiated candidates well with a full range of marks being awarded and most did score some marks. Candidates tended to choose the correct type of curve for each equation but sometimes picked the incorrect one from the type, so for example one of A, D or F was chosen for the 2 quadratic functions even if they decided on the incorrect one. The quadratic curves were slightly better recognised than the exponential ones.

Answer: *F C*
A E

Question 23

Candidates demonstrated a good understanding of functions, especially in parts **(a)** and **(b)**. Most candidates knew that they had to substitute x for 6 in the function in part **(a)** and most reached the correct value. There were some arithmetic errors with positive 13 being a common incorrect answer. In part **(b)** most candidates demonstrated a correct starting point which gained credit even if this was simplified incorrectly. Some did spoil this correct starting point by turning it into an equation which they then solved. Many candidates also demonstrated a correct starting point in part **(c)** which earned a mark but then was often simplified incorrectly and so did not score the 2nd mark. Common incorrect simplifications were $5 – 3(5 – 3x) = 2(5 – 3x) = 10 – 6x$ and $5 – 3(5 – 3x) = 5 – 15 – 9x = –10 – 9x$. Common incorrect starting points were $5 – 3x(5 – 3x)$ and $(5 – 3x)(5 – 3x)$. In part **(d)**, many candidates scored 1 mark for making a correct 1st algebraic step or for interchanging x and y. There were many algebraic errors either in the 1st step or subsequent steps, usually involving the $-3x$ where the negative sign was often lost. For example $y – 5 = 3x$ was commonly seen as a 1st step and following a correct 1st step of $y – 5 = –3x$, $\frac{y-5}{3}$ was often given.

Answer: **(a)** –13 **(b)** $-3x – 1$ or $5 – 3(x + 2)$ **(c)** $9x – 10$ **(d)** $\frac{5-x}{3}$

MATHEMATICS (US)

Paper 0444/31
Paper 3 (Core)

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, and most of the candidates were able to make an attempt at all questions. The standard of presentation was generally good and there was evidence that most candidates were using the correct equipment to answer the construction question. Candidates continue to improve in showing their workings and gaining method marks. However many candidates were unable to gain marks in the questions which asked for a reason for their answer as they did not use the correct mathematical terms. Attention should be paid to the degree of accuracy required in each question and candidates should be encouraged to avoid premature rounding in workings. Candidates should also be encouraged to fully process calculations 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.

Comments on Specific Questions

Question 1

This question gave all candidates an opportunity to show their understanding of number.

(a) (i) The vast majority of candidates were able to identify two factors of twelve correctly. The most common pairs of factors were 2 and 6 or 3 and 4, with very few candidates giving all six possible factors. Very few candidates confused multiples for factors.

(ii) Candidates were successful in identifying the correct prime number of 23. The most common incorrect answer was 21.

(iii) Many candidates knew or calculated correctly the cube root of 64. Some candidates confused square root for cube root and gave the incorrect answer of 8, with very few cubing 64 instead of cube rooting.

(iv) Candidates found writing the number in figures challenging. A large proportion of candidates did not include enough, or too many, zeros in their answers. The most common incorrect answers were 20 507, 200 507 or not putting the digits in the correct place value, hence writing 2 507 000 or 2 500 007.

(v) A large proportion of candidates attempted to give factors instead of multiples. Successful answers were commonly 75 and 150 or 150 and 225.

(vi) This question caused some candidates difficulties in two ways. Firstly a number of candidates did not know π beyond 3 decimal places and did not use their calculators to find π beyond this accuracy. Those candidates who used their calculators confused significant figures for decimal places and often gave their answer to 5 decimal places, i.e.3.14159. Some significant errors in rounding were evident by less able candidates, with the answer of 3.1426 often seen.

(b) (i) Virtually all candidates gave answers containing the figures 163. However common errors were to divide by 100 to give the answer of 0.0163% or multiply by 10 to give an answer of 16.3%.

(ii) Candidates were more successful at converting fractions to percentages with the correct answer given by the majority of candidates. A common error was to divide by 100 after dividing the numerator by the denominator.

(c) (i) Most candidates showed their ability to round to 1 decimal place correctly. Very few answers gave answers to more decimal places. However a common error was to truncate and the answer of 63 521.7 was often seen.

(ii) Candidates found rounding to the nearest hundred a more challenging question with only the most able candidates giving the correct answer. Often candidates misread the question and rounded to the nearest hundredth or retained the 3 decimal places and gave the answer of 63 500.000. Some candidates confused place values and rounded the last 3 digits and gave a common incorrect answer of 63 521.800.

(d) (i) The best answers showed an understanding of conversion between mm and m, showing knowledge that there are 1000 mm in a metre. The most common errors were to assume 100 mm in a metre or to misread the question and convert 234 cm into metres. This led to the most common incorrect answer of 2.34 m.

(ii) Converting square metres to square centimetres proved to be one of the most challenging questions on the whole paper. The most common error was again to misread the question and convert metres to centimetres or to use 100 cm² = 1 m². This led to the most common incorrect answer of 87 600 cm². Many less able candidates did not attempt this question.

Answers: **(a)(i)** At least two of 1, 2, 3, 4, 6, 12 **(a)(ii)** 23 **(a)(iii)** 4 **(a)(iv)** 2 000 507 **(a)(v)** e.g. 75, 150,… **(a)(vi)** 3.1416 **(b)(i)** 163 **(b)(ii)** 7.5 **(c)(i)** 63 521.8 **(c)(ii)** 63 500 **(d)(i)** [0].234 **(d)(ii)** 8 760 000

Question 2

Most of the question was well answered giving candidates the opportunity to show their understanding of money, ratio and solving simultaneous equations.

(a) (i) Nearly all candidates were able to gain full marks. Not all candidates chose to show working for this question.

(ii) Candidates who showed working often gained 1 of the 2 marks despite not getting the correct final answer of 0.21. A large number of candidates gave the incorrect answers of 0.2, 0.20 or 0.22 with no working seen. These candidates hadn't used the correctly rounded value of 5.79 and by not showing how they got their answer, missed out on a potential method mark. Candidates should be reminded and encouraged to show all their working out.

(b) (i) The majority of candidates showed good understanding of ratios and correctly identified the numbers of marbles. However this was again often given without any working seen. A very common misconception was to divide the total number of marbles by the values in the ratio.

(ii) Good answers showed the addition of the 11 red, 9 blue and 20 green to their values in part **(i)**. However this ratio was often not given in its simplest form. The most common error was to not read the question carefully enough and not add the 11 red, 9 blue and 20 green to their previous answer. Candidates should be reminded to reread the question once they have answered it to check they have answered it correctly.

(c) (i) This part proved to be the one most often incorrect. Candidates did not read the whole question carefully enough and did not spot that they had to complete the equation in cents rather than dollars. The correct answer of 570 was rarely seen.

(ii) Candidates who continued to give their answers in dollars rather than cents were not penalised in this part therefore the majority of candidates gained full marks for their second equation, despite using $2.40 instead of 240 cents. The vast majority of candidates correctly gave the algebraic part of the equation.

(iii) Simultaneous equations proved to be a challenging question for many candidates. Those who had given the previous two answers in dollars were not penalised again for giving their answers in dollars in part **(iii)**. Very few candidates did not show any working out. Less able candidates who were unable to solve the pair of equations often gained 1 mark for giving two values which correctly satisfied one of their equations. However this was often lost if they did not give their answers in the same units as their original equations, dollars or cents.

(d) Candidates who gained full marks had to demonstrate a number of conversions. The most common correct method was converting 3.4 metres to 340 cm, dividing by 20, multiplying by 99 cents and finally converting to dollars. However often one (or more) of these conversions was not completed correctly.

Answers: **(a)(i)** 6 **(a)(ii)** 0.21 **(b)(i)** 5, 15, 20 **(b)(ii)** 2 :3 : 5 **(c)(i)** 570 **(c)(ii)** $b + 2t = 240$ **(c)(iii)** 90, 75 **(d)** 16.83

Question 3

Candidates demonstrated a good understanding of probability and averages in this question. The question tested a range of mathematical skills including bearings, scales, speed, probability, averages, exchange rates and upper and lower bounds.

(a) (i) Bearings continue to cause difficulties for some candidates. The most common error was to measure the line *KH* and give the answer of 9.5 cm.

(ii) Candidates who had measured the length of *KH* in part **(i)** correctly converted this to km and gained full marks. Very few candidates could not use the scale correctly. The most common error was not measuring the length of the line accurately and therefore their converted answer was not within the range of accepted answers. Some candidates who did not know how to convert using the scale usually gained 1 of the 2 marks for correctly measuring the length of *KH* within tolerance.

(iii) Most candidates showed that they understood how speed is calculated. However this question tested the candidate's ability to convert a speed from km/h to m/s. This required the candidates to know that 1000 m = 1 km and 3600 seconds = 1 hour. Most candidates showed one of these conversions but very few knew both. The best solutions gave full working by converting to metres and then dividing by 3600 seconds (often given as two division sums, e.g. divide by 60 then divide by 60 again). Less able candidates often missed this question out or most common was to divide by 60 only, reaching an answer of 7.5 m/s.

(b) (i) The majority of candidates showed understanding that the probability of an event not happening is '1 – the probability of it happening'. Very few candidates showed this sum and the most common incorrect answer was 0.75, where candidates had performed the subtraction incorrectly.

(ii) Many candidates had not read the question carefully enough. A large proportion of candidates used their previous answer, which was the number of flights not on time. Candidates should be encouraged to reread the question once they have given their answer to check it has actually answered the question given.

(c) (i) Most candidates showed understanding of range. Many candidates just gave the correct value of 6, however some gave the solution as 21 – 15, or 15 to 21, which did not gain the mark.

(ii) This was the best answered part of this question with the vast majority of candidates correctly identifying 16 as the mode. Very few candidates did not attempt this question with only a small number of candidates calculating the median or mean instead.

(iii) The majority of candidates showed understanding of median. However a large number of candidates missed out on the mark as they did not calculate the value between 16 and 18 and gave their solution as '16,18'

(iv) Candidates showed good understanding of mean, with the best solutions showing full working out, including an addition sum and division by 6. The most common errors were to not divide by 6, or to do the whole sum on the calculator as 15 + 16 + 16 + 18 + 19 + 21 ÷ 6 = 87.5. Candidates should be encouraged to calculate the total first then divide by the number of values.

(v) Candidates continue to improve in giving probabilities as fractions, percentages or decimals, with very few ratios or worded descriptions seen. Many candidates simplified their fraction, although this was not essential to gain full marks, and candidates who gave their probability as a percentage or decimal generally gave it to the desired level of accuracy (at least 3 significant figures). The most common error was to misread the question and give the probability of choosing a suitcase with 18 items ($\frac{1}{6}$) or choosing a suitcase with 18 or more items ($\frac{3}{6}$).

(d) Candidates often gained full marks in this question. However some candidates multiplied the values given and a number of candidates gave an answer of 2.6 with no working. Candidates must be encouraged to show all workings out and to round to an appropriate degree of accuracy.

Answers: **(a)(i)** 292 **(a)(ii)** 380 **(a)(iii)** 125 **(b)(i)** 0.85 **(b)(ii)** 36 **(c)(i)** 6 **(c)(ii)** 16 **(c)(iii)** 17 **(c)(iv)** 17.5 **(c)(v)** $\frac{2}{6}$ **(d)** 2.62

Question 4

Candidates described the single transformations in part **(a)** well, with very few describing two transformations instead of one.

(a) (i) Good answers contained all three parts to describe a rotation, including angle, direction and centre of rotation. The most common error was to omit the centre of rotation. Less able candidates were able to correctly identify the transformation as rotation and often included 90° but did not include the direction or centre.

(ii) Candidates found describing a reflection easier with the majority of candidates gaining full marks. The equation of the mirror line was given as the y-axis or $x = 0$ in equal measures. However a large number of candidates gave the incorrect answer of $y = 0$ for the y-axis.

(iii) Less able candidates often attempted a description rather than the vector. However many did not give enough description, often giving an unacceptable answer of 'eight *across* and five down'. Candidates need to be reminded to give directions fully if they are not writing the vector.

(b) Drawing the enlargement proved to be the most challenging part of this question. Some candidates drew the correct enlarged shape but often in the wrong place. Some candidates chose not to attempt this question.

Answers: **(a)(i)** rotation, 90° clockwise, [centre] (0,0) **(a)(ii)** reflection, y-axis or $x = 0$
(a)(iii) translation, $\begin{pmatrix} -8 \\ -5 \end{pmatrix}$

Question 5

This construction and angles question offered candidates the opportunity to show they could bisect an angle and to use symmetry and parallel lines to answer angle problems.

(a) (i) Many candidates were able to identify the correct order of rotational symmetry. The most common incorrect answer was 4, or to not give the order in a number form but to use letters to describe a rotation, e.g. *A-B-C-D*.

(ii) The number of lines of symmetry proved to be more challenging for the majority of candidates with 2 being the most common incorrect answer (with 1 and 4 also seen often).

(iii) The angle sum of a quadrilateral was the most successful part of this question with the majority of candidates correctly identifying 360°. Common incorrect answers were 4 or 180°.

(b) (i) Those who drew a correct bisector within the tolerances generally scored 2 marks as candidates left in clear construction arcs. The arcs on the lines *AB* and *AD* were sometimes not left clearly enough. A number just drew a line from *A* to *C*. Candidates had clearly read the question fully as the majority of correctly drawn bisectors were extended to reach *DC* and the letter *E* marked on the diagram.

(ii) To gain the mark for this explanation question candidates had to clearly identify that the two angles were alternate angles, or 'Z' angles. Candidates often gave lengthy descriptions why they were the same size but did not include the correct mathematical terms.

(iii) Candidates who had correctly bisected the angle in part **(i)** generally were able to identify that the triangle *ADE* was isosceles. The reason why was not answered well. Candidates had to identify which two angles or sides were the same size. Nearly all candidates simply wrote that two angles or two sides were the same, without saying which ones.

(iv) Candidates found identifying the mathematical name of the quadrilateral *ABCE* difficult, with the most common answer being parallelogram.

Answers: **(a)(i)** 2 **(a)(ii)** 0 **(a)(iii)** 360 **(b)(ii)** alternate [angles] **(b)(iii)** isosceles, [angle] *DAE* = [angle] *DEA* **(b)(iv)** trapezoid

Question 6

This question tested candidates' understanding of finding the co-ordinates of the midpoint of a line, vectors and graphical transformations.

(a) (i) A variety of methods were used by candidates to find the midpoint. Often candidates used the graph to correctly find the x co-ordinate but then were unable to find the y co-ordinate using this method. Those that attempted the formula for the midpoint of a line were more successful. A common incorrect method adopted was to calculate the gradient of the line.

(ii) Only the most able candidates were able to correctly write the vector. Some missed the minus sign or gave the answer with a fraction line in their vector.

(iii) Again candidates found using the vector given in this part very challenging with very few correct answers seen. A large proportion of candidates did not attempt the question or gave the values in the vector as the co-ordinates.

(b) (i) The best attempts were drawn with a ruler, with lines parallel to f(x). However many good attempts did not pass through (0, 1) but (0, 2) instead. Very few lines drawn gained the full 2 marks. A large proportion of candidates did not attempt this question.

(ii) The very best attempts at this question demonstrated a horizontal transformation to the left. However very few full marks were given as the majority of good attempts showed a horizontal transformation to the right of one square. A very common incorrect answer had the graph stretched in the x direction. Again a very large proportion of candidates chose not to attempt this question.

Answers: **(a)** (0, 1 ½) **(a)(ii)** $\begin{pmatrix} 6 \\ -7 \end{pmatrix}$ **(a)(iii)** (2, 3)

Question 7

This shape question tested candidates' understanding of circle theorems, area of circles and triangles and Pythagoras' theorem.

(a) Candidates were generally successful in reaching 153° or in calculating 27° for angle *BCA*. Giving reasons proved to be more challenging. Many candidates wrote the calculations down that they had performed as sums or as worded descriptions without reasons why these sums were correct. Candidates often left out key words or descriptions. Candidates need to be reminded that they must use exact phrases to describe their reasons. In particular when describing the angle sum of a triangle, many candidates simply wrote 'a triangle adds up to 180°'. To gain the mark candidates must use the word 'angles' in this reason. Similar comments apply for angles on a straight line. Most candidates clearly identified angle *ABC* as 90° but very few correct reasons were seen. Candidates often confused 'radius and tangent meet at 90°' with 'an angle in a semi-circle is 90°'.

(b) Most candidates were able to gain at least 1 mark for the area of the square. A variety of methods were then used to calculate the shaded area. The most common method was to calculate the area of the square and circle, then find $\frac{3}{4}$ of the circle and take that away from the square. Candidates who followed this method generally got full marks, although some did lose a mark for incorrect or premature rounding of their area of the circle. A large number of candidates attempted part of this method but found $\frac{1}{4}$ of the circle and added or subtracted it from the area of the square. Depending on the amount of working seen this method gained a variety of marks. Candidates need to be reminded that on a large mark question it is essential to show all working out to be able to gain the part marks if their final solution is incorrect or inaccurate. Candidates generally used the correct value for π with very few using 3.14 or $\frac{22}{7}$.

(c) (i) The majority of candidates correctly identified that they had to use Pythagoras' theorem with many excellently presented answers seen. The most common error was to add the squares of each side. Candidates should be reminded to check the validity of their answers in relation to the triangle as it is clear from the diagram that *FG* is the longest side and that *GH* should be shorter than 45 cm.

(ii) Candidates who attempted part **(i)** generally gained a follow through mark in part **(ii)** for correctly adding the other 2 sides to their previous answer.

(iii) Candidates who had attempted part **(i)** generally gained a 2 mark follow through in part **(iii)** for correctly calculating the area of the triangle. This was often given with no working out shown, and in some cases this led to no marks being awarded when the candidate had rounded their answer to less than three significant figures.

(iv) Trigonometry proved to be very challenging for many candidates. A large proportion of candidates were able to quote 'SOH CAH TOA' but were unable to proceed any further. Less able candidates often did not attempt this question or gave one of the common incorrect answers of 45˚ or 90˚ with no working out.

Answers: **(a)(i)** 153˚ and two correct geometrical reasons **(b)** 14.8 **(c)(i)** 36 **(c)(ii)** 108 **(c)(iii)** 486 **(c)(iv)** 36.9

Question 8

This question gave candidates the opportunity to demonstrate their ability to calculate missing values and draw a quadratic curve.

(a) (i) The majority of candidates successfully completed the table. A common error was to calculate $-x^2$ as x^2 which caused problems in part **(ii)** when plotting the graph.

(ii) Points were generally plotted correctly and curves were drawn accurately with smooth curves and few instances of "sketching". The most common error was to join the points (2,6) and (3,6) with a straight line giving the curve a flat top.

(b) Candidates showed understanding of what was required in this question but were unable to gain the mark if they had not drawn the curve accurately enough in part **(a)(ii).** The most common error followed a flat top of their curve and (2,6) and (3,6) were very common incorrect answers. It was essential that candidates recognised the symmetry of the curve to give the *x* co-ordinate as 2.5.

(c) Many candidates used the intersection of the *x*-axis and their curve rather than drawing the line $y = -3$. Some candidates misread the scale.

(d) (i) Candidates who had plotted the graph correctly generally drew the line of symmetry correctly. A large proportion of candidates did not attempt this question, either because they had not plotted their graph in part **(a)(ii)** or their graph had no line of symmetry following errors in part **(a).**

(ii) The more able candidates could correctly write the equation of their line of symmetry. A large number of candidates omitted the $x =$ or started their equation with $y =$.

(iii) The most common error in this part was to assume the symmetry was around the *y*-axis and to give the answer as 10. Very few correct answers of 15 were seen.

Answers: **(a)(i)** 0, 6, 6, –6 **(b)** (2.5, k) where $6 < k \leqslant 6.5$ **(c)** 5.4 to 5.7 and –0.4 to –0.7 **(d)(ii)** $x = 2.5$ **(d)(iii)** 15

Question 9

This question provided candidates with the opportunity to show their understanding of pie charts.

(a) The vast majority of candidates correctly identified green as the least favourite colour, with only a very small number finding the most favourite colour as yellow.

(b) Calculating the total number of children in the school proved to be very challenging to many candidates. Of those candidates who used a correct method, most commonly they divided 135° by 27 to find the number of degrees for each child (5°) and then divided 360° by 5°. The other method seen was to divide 360° by 135° and then multiply by 27. Candidates who showed all working generally gained full marks. Candidates who were not as accurate with their measuring of the yellow sector often gained full marks as they completed the calculation correctly and then rounded to 71 or 73 children. Candidates who gave their answers as decimals gained 2 of the 3 marks. The most common error was not to measure the yellow sector and to assume that it was a third of the circle.

(c) Calculating the percentage of children who chose red proved very challenging for the majority of candidates. A large proportion of candidates did not measure the red sector and assumed it was 90° and therefore gave the answer as 25%. Candidates who tried to use their previous solution generally went wrong, often calculating the number of children who chose each colour from their incorrect total number of children in part **(b).** Some candidates were able to gain a mark for correctly following through their previous incorrect answer.

Answers: **(a)** green **(b)** 72 **(c)** 22.2

MATHEMATICS (US)

Paper 0444/41
Paper 4

Key Messages

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

General Comments

Most candidates seemed well prepared for the paper and demonstrated a clear knowledge of the wide range of topics tested. Candidates used their time efficiently and attempted all of the questions. The standard of presentation was generally good; however, there were occasions when candidates did not score as they did not show clear working. For less able candidates, working tended to be more haphazard and difficult to follow making it difficult to award method marks when the answer was incorrect. All candidates need to be aware of the need to retain sufficient figures in their workings so that their final answer is accurate; a number of marks were lost due to premature approximation of values. Centres should continue to encourage candidates to show the formulas they use and the calculations performed.

Comments on Specific Questions

Question 1

(a) (i) The vast majority of candidates gained the mark but it was quite common to see the reverse method.

(ii) Almost all responses were correct. There were just a few candidates, with a variety of responses, who did not understand what was required. Some who had a poor response to part **(a)(i)** also couldn't answer this part correctly.

(b) Most candidates showed the individual totals for the different vehicles and indicated the correct addition. Just a few did not show any indication of addition of the 3 amounts. One rare error seen was addition of the charges and then multiplication of $8 by 12 000.

(c) Candidates struggled with this reverse percentages question. Addition or subtraction of 8% was very common but just as common was finding 92%, resulting in an answer of $31 740. Candidates should decide whether the answer is to be a smaller or larger amount, which at least would eliminate some of the possible incorrect responses.

(d) Most candidates obtained the correct answer with just a few candidates earning 1 mark for a correct fraction but not in its simplest form.

(e) Although many correct answers were seen there were a significant minority who obtained one of a variety of incorrect responses. Common incorrect answers were 89 995, 85 000, 87 500 and 85 500.

Answers: **(a)(ii)** 4000 **(c)** 37 500 **(d)** $\frac{11}{26}$

Question 2

(a) A small majority of candidates completed the table correctly. Errors often occurred with the negative values of *x,* suggesting misuse of the calculator. A few candidates had calculated the –0.75 and 0.5 correctly but then seemed to assume symmetry rather than working out the other two values, leading to answers such as 0.75, –0.5 for the negative values of *x*. More than a few times the value of 0 was seen for either $x = 0.5$ or $x = 1$ as candidates spotted the change from negative to positive.

(b) Most candidates were able to plot their values correctly, although the four points at $x = \pm\ 0.25$ and at $x = \pm\ 0.2$ were sometimes plotted incorrectly as a result of misinterpreting the scale. The quality of curves was good with only a few joining the two sections or joining the points with ruled lines.

(c) Many candidates had drawn the line $y = 2$ but a lack of accuracy in reading from their graph sometimes resulted in loss of marks.

(d) Candidates struggled with this part of the question and many made no attempt. Those attempting the question sometimes gave a single value for *k* rather than a range of values.

(e) Most candidates attempted this part but only a few earned all 3 marks. Loss of marks often resulted from inaccurate tangents, in some cases running along the curves or from good attempts with a gap between them and the curve. Another common cause for the loss of marks resulted from misreading the horizontal scale.

Answers: **(a)** 1.5, 1.25, –0.75, 0.5 **(c)** –1.35 to –1.25, –0.27 to –0.251, 1.51 to 1.55 **(d)** $k < 1.2$
(e) –1.7 to –1.3

Question 3

(a) (i) Most candidates were able to draw the correct image with a few earning 1 mark for a translation with either the correct horizontal displacement or correct vertical displacement.

(ii) Candidates were less successful with the reflection in the line $x = -2$. A large minority reflected correctly for 2 marks. A few reflected in the wrong vertical line. It was rare to see any candidate reflecting in the line $y = -2$ in error.

(iii) Less than half of the candidates scored any marks with roughly equal numbers drawing the correct image as were drawing an image with the correct orientation but in the wrong position. A significant number made no attempt at all.

(b) (i) The negative enlargement proved a challenge for most. Candidates sometimes attempted to deal with this by combining a positive enlargement with a rotation, reflection or translation. Only a few fully correct responses were seen. Enlargement of 3 with centre (1,0) was the most common answer. The use of negative enlargement with factor 3 did not earn the mark for the scale factor.

(ii) Only the most able candidates were able to describe the stretch correctly. Some were able to state it was a stretch but this was then spoilt by the inclusion of a second transformation. Common incorrect answers included enlargement and translation.

Answers: **(b)** enlargement, (1, 0), factor –3 **(ii)** stretch, factor 3, *x*-axis invariant

Question 4

(a) (i) Most candidates obtained the correct answer with just a few using incorrect notation such as ratio.

(ii) A small majority of candidates gave the correct probability. Errors tended to involve candidates using the wrong list or incorrect notation.

(b) (i) Many candidates were able to complete the tree diagram correctly with just a few careless slips or treating List 2 as if it was without replacement.

(ii) A few candidates understood how to work out the probability of exactly one I being chosen, although in some cases errors with the multiplication of fractions led to the loss of the final mark. However many attempted to find the probability of both letters being I. There was much confusion of whether to add or multiply the probabilities, both processes often involving errors. Many gave an answer of $\frac{6}{17}$ for the probability of I being chosen twice.

(c) A small minority of candidates were able to obtain the correct probability. Some were able to identify the individual probabilities $\frac{6}{8}$ and $\frac{8}{9}$ but did not indicate which operation was required and combined them to give the common incorrect answer of $\frac{14}{17}$.

Answers: **(a)(i)** $\frac{3}{8}$ **(ii)** $\frac{7}{8}$ **(b)(i)** $\frac{6}{8}$, $\frac{5}{9}$, $\frac{4}{9}$, $\frac{5}{9}$ **(ii)** $\frac{34}{72}$ **(c)** $\frac{48}{72}$

Question 5

(a) (i) With no diagram given, this question proved quite demanding. While most realised right-angled triangles were involved, many did not appreciate that 'angle of elevation' was from the horizontal. Consequently, although the tangent ratio was used, it was often the wrong angle identified. Many candidates felt they had to find the hypotenuse first and then use sine (or occasionally cosine) which often led to errors or lack of accuracy.

(ii) Those who used the wrong angle in part **(a)(i)** generally made little progress in this part. Many did progress to finding the new distance from the tower but only a minority of these progressed to the value of x. Those who identified the side as $294 - x$ often found the tangent ratio involving an algebraic expression beyond their capabilities. Many who were able to give a correct implicit form for the tangent expression could not rearrange it correctly and often ended up with $55 \tan 24.8$.

(b) (i) Some candidates gave the acute angle correctly, but very few realised that the obtuse angle was '180 – acute'. Many gave random answers, including 90 and 180, and many others made no attempt.

(ii) The vast majority of candidates appeared unaware of the relationship between $\tan y$ and $\tan(90 - y)$ and correct answers were rare. There were many who made no attempt.

(iii) Again, not a well answered question, the mixture of trigonometry and algebra proving too difficult for the majority of candidates. Fully correct answers were rare although some candidates did find the value of p. Again, many candidates made no attempt.

(iv) Many candidates did not attempt this part. Those who did often gave a numerical answer or some other expression, often unrelated to $\tan x$. There seemed to be a basic lack of understanding of 'functions' and their transformations. Common incorrect answers included $\tan 2x$, $2\tan x$ and $\tan x + 2$.

Answers: **(a)(i)** 10.6 **(ii)** 175 **(b)(i)** 11.5 and 168.5 **(ii)** $\sqrt{3}$ **(iii)** 2 and 0.5 **(iv)** $\tan(x - 2)$

Question 6

(a) (i) Almost all candidates gave the correct modal time interval.

(ii) This standard question of mean from a frequency table was generally well answered, with marks lost occasionally due to arithmetic errors or not taking the mid-values. Some candidates had a partial understanding and multiplying the frequencies by the class widths or the bounds of the interval were reasonably common errors. However, there were some who clearly had no idea of the method and simply added the frequencies or class widths before division by 6.

(b) (i) A large majority of candidates were able to complete the table correctly with only occasional slips in addition producing an error. Less able candidates appeared not to understand cumulative frequency so gave confusing values or omitted this part completely.

(ii) The graph was frequently drawn correctly with most candidates scoring at least 2 marks. Poor accuracy with plotting points prevented quite a number gaining full marks. Common errors usually involved plotting the points at mid-values or misreading the scale.

(c)(i) Throughout part **(c)** the accuracy of the graph was most important in getting an answer in the required range. Most candidates gained the mark for the median, or at least were close to a value in the required range.

(ii) Inter-quartile range was probably the least well answered of the four parts. In cases where the answer was incorrect it was more likely that the lower quartile of 24 was identified than the upper quartile of 36 to 38.

(iii) It was common to award a mark for identifying the correct cumulative frequency of 60 as the 15th percentile. The lack of accuracy of the graph and/or the poor reading of the scale prevented some candidates gaining the second mark. A common error involved interpreting the 15th percentile as a cumulative frequency of 15 on the vertical scale instead of 60.

(iv) Candidates were more successful in this part of the question. As long as the graph was reasonable, most earned the 2 marks. Some earned 1 mark for giving the number of people who took less than 50 minutes.

Answers: **(a)(i)** $24 < t \leqslant 30$ **(ii)** 30.875 **(b)(i)** 235, 320, 390 **(c)(i)** 27.5 to 29 **(ii)** 12 to 14 **(iii)** 18 to 20 **(iv)** 30 to 45

Question 7

(a) (i) Most candidates were able to start the cosine rule correctly. Some candidates misquoted the rule, some were missing the 2, + instead of – and the use of sine instead of cosine. When the formula was correct there were two common errors. Some gave their final answer as 8.3 and did not show a more accurate value and some gave an incorrect value of PQ^2 after prematurely approximating the value of $\cos 62$ to too few figures. Some of the less able candidates used right-angled trigonometry (dividing 7.6 by 2), the sine rule or Pythagoras' theorem.

(ii) The area of the triangle was usually correctly calculated. A few candidates decided to calculate the perpendicular height first. Some introduced errors by unnecessarily working with inaccurate or incorrect values calculated in part **(i)**.

(b) A lot of candidates struggled to find the angles they needed to solve the problem. Some attempted to put parallel north lines through the diagram but were unable to find the one angle they needed from this. A very common error was treating angle *HGJ* as 126°. Where candidates were able to find the necessary angles most realised they needed to use the sine rule and quoted it correctly with their angles. Having quoted a correct version of the sine rule some struggled to rearrange it correctly to find *GJ*.

Answers: **(a)(i)** 8.27 **(ii)** 28.2 **(b)** 55.8

Question 8

(a) There were two common errors which resulted in an incorrect equation from the start. One of these involved misinterpreting "12 more than" as being '12 times more'. The other involved Luther having three times as many badges as Jamil rather than Kiera. More able candidates coped well, derived the equation and solved it correctly. Almost always, a correct equation led to a correct solution. Many less able candidates attempted trial and improvement – a correct answer from this method did not score full marks.

(b) Only the more able candidates were able to solve the inequalities. Some made a good attempt but 'integer values of *t*' was missed or ignored by many. A common incorrect approach involved attempts to solve both inequalities together. Relatively few candidates tried to solve the question by substitution of numbers into the inequalities. Correct answers were seen but the values of 5.29 and 8 were more common.

(c) (i) This was an equation that many were able to solve. Less able candidates struggled with the rearrangement and $4x + 3$ was often seen as a result of eliminating the fraction. Following $5x = 9$ a few gave the answer as $\frac{5}{9}$.

(ii) Many candidates earned full marks but for some, poor presentation was an issue. Candidates need to ensure the division line is completely drawn under the numerator and that the root sign encloses all of '$b^2 - 4ac$'. Others substituted 5 rather than –5. Some were able to recover but many lost marks needlessly. Some of those obtaining the correct solutions then wrote their answers to the wrong degree of accuracy. A few less able candidates misquoted the quadratic formula. Attempts to complete the square were rarely seen.

Answers: **(a)** 15 **(b)** 6, 7 **(c)(i)** 1.8 **(ii)** –2.91 and 0.57

Question 9

(a) (i) Some candidates started with $11x + 25x = 180$ and went on to solve the equation correctly. Many others either made no attempt or struggled to make any progress.

(ii) This part proved more challenging for the candidates and many made no attempt. Others, including those with a correct answer in the previous part, struggled and use of angle at the centre is twice the angle at the circumference was rarely seen. A few did attempt this but had the relationship reversed.

(b) (i) The given shape proved challenging for many of the candidates and only the most able candidates scored well. Many were aware of the formula for the circumference of a circle but some forgot to divide their answers by 2 while others substituted the radius for the diameter or vice versa. Some were able to calculate the three correct values but then subtracted the smaller arc from the sum of the larger two. Even when the method was applied correctly, premature approximation of the calculations sometimes led to a final answer outside of the acceptable range.

(ii) Very similar issues arose in this part of the question; incorrect formula for area, incorrect use of the formula and premature approximation of the various areas. Added to that was the issue of inconsistent units. Many multiplied their area in cm^2 by the thickness in millimeters. Some did attempt to change the units – those that changed the radii to millimeters were more successful than those attempting to convert their areas to mm^2. Only the more able candidates scored full marks.

Answers: **(a)(i)** 5 **(ii)** 35 **(b)(i)** 37.7 **(ii)** 12100

Question 10

(a) (i) The vast majority of candidates obtained the correct length of *BC*.

(ii) The majority of candidates measured the angle correctly although 60° was a common incorrect answer.

(b) (i) Only a minority of candidates were familiar with the procedure for constructing a bisector of a line. Those that were, usually earned both marks with the occasional mark lost for lack of accuracy. Some had a bisector drawn but without any arcs or with just one pair and these could only score 1 mark for an accurate bisector. Many of the others scored 0 for random lines on the diagram or made no attempt.

(ii) Very similar issues arose in constructing the angle bisector as with the line bisector in the previous part. Bisectors without arcs were common. Only a minority scored both marks.

(c) Those with bisectors (even incorrect ones) usually picked up the mark for drawing a circle with *AD* as tangent.

(d) Most candidates were unfamiliar with the construction for copying an angle with the result that a majority made no attempt. Some used their protractors but the correct use of a compass was rarely seen.

Answers: **(a)(i)** 13.1 **(ii)** 120

Question 11

(a) Candidates found this part challenging although most candidates could gain 1 mark, usually for a correct first step. Common errors involved not multiplying both terms by *t* and not isolating the *x* terms. After some progress, few used factorisation as they simply tried to eliminate *r* by division while ignoring the *x* or *xt* term. Presentation of the solution tended to be haphazard, sometimes with more than one attempt in the working space. A significant number of candidates attempted to indicate each step of the process by combining each line of their solution with the method required to reach the next line. This tended to produce incorrect lines of algebra such as $t \times A - x = \frac{xr}{t} \times t$.
Some were able to recover but in many cases the working became confused and difficult to follow as each new line was embellished with more method.

(b) Very few candidates gained full marks on this question with the majority not able to make an appropriate start. Many gained a mark from correctly multiplying out the right hand side of the identity but all too often the 2*xb* term was missing or incorrect. Attempts at completing the square were rare. However, the question was a good discriminator and a significant number of very able candidates found the correct values.

(c) Many candidates made a worthwhile start to the question and a majority of them went on to obtain the correct answer. The numerator was often seen as 6(3x – 2) – 5(x – 4) and similarly the denominator as (*x* – 4)(3*x* – 2). Most errors resulted from incorrect expansion of the brackets and with the collection of the resulting terms, usually the constant terms. Some candidates spoiled their correct answers by attempting inappropriate cancelling of algebraic terms.

Answers: **(a)** $\frac{At}{t+r}$ **(b)** $a = 64$, $b = -8$ **(c)** $\frac{13x+8}{(x-4)(3x-2)}$