MATHEMATICS

Paper 0580/11
Non-calculator (Core)

Key messages

To succeed with this paper, candidates need to have completed the full Core syllabus, must not round figures in the middle of a calculation to ensure accuracy throughout and need to check that their answers are in the correct form and make sense in context.

General comments

There were a considerable number of questions that were standard processes, and these questions proved to be generally well understood, and, in most cases, there did not seem to be confusion about what was being asked. Other questions were more testing, for example, the problem-solving aspect of questions such as **Questions 3**, **6**, **14**, **19** and **22**. Many candidates showed some working with the stronger candidates setting their work out clearly and neatly. Some candidates did not show any working before they gave an answer.

The questions that presented least difficulty were **Questions 1(a)**, **1(b)**, **4(a)**, **10(a)** and **14**. Those that proved to be the most challenging were **Questions 6(b)** a problem-solving question to insert brackets in a calculation, **10(d)** complete a travel graph, **17** estimate the answer to a calculation, **19(b)** find a probability and **22(b)** find the LCM of two number given in prime factors. The questions that were most likely to be left blank were **Questions 3**, **10(d)**, **16(b)(ii)**, **22(a)**, **23(a)** and **17(b)** and **26**.

Comments on specific questions

Question 1

Parts (a) and **(b)** of this opening question were accessible to a very large majority of candidates.

(a) This was the best answered question on the paper. The occasional wrong answers, involving the misunderstanding of where the zeros were placed, were seen. A few used numbers in combination with words.

(b) Answers that were rounded to the wrong level of accuracy were sometimes seen, for example 10 000. A few changed the number into 10.070.

(c) This was much less well handled with candidates dividing by the wrong power of 10, rounding to the nearest metre or changing the digits.

Question 2

Some candidates did not use an efficient method to work out the cost of 10 bags of sweets, using repeated addition instead of multiplication. If candidates got an answer greater than \$5 for the cost of the sweets, then they often subtracted \$5 from this showing misunderstanding of the context. Those that got to \$3.40 for the cost of the sweets sometimes made a carry error in their subtraction so ended with an answer of \$2.60.

Question 3

This was the first problem-solving question of the paper. Candidates often realised that $15 = 3 \times 5$ but then were not successful in producing the 2 numbers that multiplied to -15 that also had a sum of -2. This condition of summing to -2 was complex for many.

Question 4

The success rate of candidates fell as they moved through the parts of this question.

(a) This was mostly correct. Some candidates chose 99 or 39 instead of 112.

(b) 39 and 27 were incorrect answers that were often seen.

(c) Some gave 112, a multiple of 56, not a factor. 49 was chosen sometimes perhaps as it is also in the 7 times table.

(d) Some candidates did not give 7 as the prime number. Instead, they chose one of the other numbers ending with a 9.

Question 5

Many that attempted this question showed little understanding of the term, ‘reciprocal’. Wrong answers included $\frac{5}{1}$ or –5. It was noticeable that many of the answers were values from the previous question.

Question 6

Candidates were more successful if they used the space around the calculations to try out positions for the brackets. As the question included the instruction to insert one pair of brackets, if candidates used more brackets, the mark could not be awarded.

(a) Candidates were often correct with the placement of the brackets.

(b) Here, the bracket enclosed 3 numbers and 2 operations. Some only tried combinations of 2 numbers and 1 operator.

Question 7

In general, candidates misunderstood the difference between an expression and an equation.

(a) Although the majority showed 18 and t in their answer, the answer was often an equation. The equation, t = 18 was seen very regularly or just 18.

(b) The majority of candidates gave a correct response then spoilt it by turning it into an equation rather than an expression. Total = or x =, n + 16 was seen regularly.

Question 8

(a) Some gave a decimal, 0.9 or the fraction, $\frac{90}{100}$ both of which are equivalent to 90%, but they are not in the form required for the answer.

(b) Candidates were more successful here than with the previous part. Wrong answers included 3 and 0.3, showing that some candidates did not understand the positions of hundredths in a decimal number.

Question 9

(a) (i) There were many correct variations of the term-to-term rule, subtract 7. Some gave add 7, +7 or 7 without an operation. Many candidates did not distinguish between the term-to-term rule and the formula for the *n*th term.

(ii) Candidates were more successful here, giving the next two terms correctly. Some gave the next term, 5 and then made an arithmetic error subtracting 7 from 5. Some gave 40 and 47 which are the two numbers before the start of the sequence.

(b) Some candidates used the formula, *n*th term = *a* + (*n* – 1)*d*, incorrectly when substituting for *a* and *d*. Some were awarded a mark for 4*n* in their answer. More often, the 4 was a constant term in answers such as 15n + 4, 19n + 4, 19n – 4 or even n = 4 or +4 by itself. Sometimes the next term, 35, was given as the answer. As in previous years, a small number thought *n*th term meant 9^{th} term so gave 51 as their answer.

Question 10

This question was a good discriminator with accessible parts as well as the most complex question on the paper.

(a) This was generally correct.

(b) This was reasonably well answered with some candidates miscounting squares or misapplying the scale so answered with 50 minutes instead of 40 minutes.

(c) The same problems of miscounting or use of an incorrect scale applied here. In general, the answer was the correct 11:50 or the incorrect 12:00.

(d) There were some excellent, accurate lines drawn supported with correct workings. In general, this part was not done well with many replicating a journey of 50 min, the same as the return journey. A few drew a line that did show the same speed but not from the correct start time and were awarded a method mark. The question also had a significant omission rate.

Question 11

Many candidates did not work out the volume of the cube as 3^3. Many answers of 6, 9, 12, 18 or other multiples of 3 were seen. An answer of 54 (cm^2) could have been an attempt at surface area of the cube.

Question 12

There were a reasonable number of candidates getting this correct or showing one step correctly for a method mark. Some showed two steps in one line of working and if this was wrong, a method mark could not be given. Many made mistakes with both the signs meaning that often 5x + 3x = – 2 + 8 was seen. When the correct 5x – 3x = – 2 – 8 was given, candidates made arithmetic errors with the right-hand side, giving that as +10 or ± 6. The final step was to solve 2x = –10, and some gave x = – 8 or –12 by adding or subtracting 2.

Question 13

As with the pervious question, similar uncertainly in dealing with directed numbers was seen here.

(a) This was often answered with –20, showing misunderstanding multiplying negative numbers or with –9, showing misunderstanding of the operation.

(b) This was less well handled than the previous part. Here, answers seen were –24 (multiplication instead of addition), 24, 11 (ignoring the negative signs), –5 (–8 + 3) or just arithmetic errors giving an answer of -10.

Question 14

Candidates did well with this question. Some did not remember the rules of indices giving 2, 4 or 2.5 as their answer. Occasionally, the answer was given as 3^6 which was not awarded the mark as only the value of *p* was required.

Question 15

There were a good number of fully correct nets seen which were generally well-presented and accurately drawn. Sometimes the side faces were drawn as 4 × 4 instead of 4 × 3. A few candidates only gave 5 faces, missing out the second 6 × 3 face. Some candidates drew a 3D shape like the one given in the question.

Question 16

(a) A common misconception was to multiply the *a* terms getting a^2 and multiply the *b* terms getting b^2 or to treat this as two brackets to multiple out. This was another question where some had problems with directed numbers as common wrong answers included, for example, $5a \pm 9b$, $7a \pm 9b$ or $7a - b$. Occasionally, after a correct answer was seen, candidates then went on to combine both terms together, thus spoiling their answer.

(b) (i) Many did not understand what factorising meant, giving their answer as $21xy$. Some omitted the common factor, giving 2x + 5y as their final answer.

(ii) Candidates found this factorisation quite challenging. Whilst there were a number of correct responses, there was a range of incorrect answers, and many did not attempt this. Here, there were no numbers to factorise. Some candidates factorised only the *x* or the *y:* if this was successful for example $x(xy - 5y)$ or $y(x^2 - 5x)$, a mark was awarded. Again, the common factors were omitted by some, leaving an answer of $x - 5$. There were also single term responses from combining unlike terms together. There were also attempts to put this into two backets.

Question 17

This was a question that many misunderstood. The instruction to round each number correct to 1 significant figure was frequently ignored, as candidates tried addition and long multiplication of the original expression. Candidates were often correct with the rounding of the numbers in the denominator 2×6, however the numerator was often rounded to 43 + 17.

Question 18

(a) Candidates were much more successful finding the value of *x* than giving the geometrical reason. Some used other incorrect geometrical reasons or mentioned angles in parallel lines but this is not sufficient for the mark.

(b) This followed a similar pattern to the previous part.

(c) Candidates were more successful with this part to find the value of *z*.

Question 19

(a) This problem-solving question involved ratios and a probability tree. Most candidates attempted this question. Relatively few candidates were awarded all 3 marks. Many were not correct in their conversion from ratio to fractions or decimals and proceeded to use the whole numbers 1 and 4 or the words red and green on the tree. Some candidates also put different probabilities on the second set of branches, despite the counters being replaced after the colour noted.

(b) This question was found to be challenging to many as it depended on values found in the previous part and, in fact, was the question where candidates had the most difficulties. Any follow through values had to be probabilities i.e., be between 0 and 1 for any marks to be awarded. As before, these values were often 1 and 4 but also, 2 and 8 were used. Of those who did attempt this part, the majority did not use multiplication along the branches but added instead.

Question 20

(a) A reasonable number of candidates accurately plotted the two points; both plots were needed for the mark.

(b) Fewer candidates were correct here. Candidates who were not successful, tried to describe the relationship or used words such as linear, directly proportional, downwards, decreases or irrational.

(c) (i) Candidates were marginally more successful here than with the previous part. As well as straight lines that were not quite accurate enough or not drawn with a ruler, other incorrect answers were zig-zag lines made up of many line segments.

(ii) Those that drew an acceptable line were successful in using it to estimate the number of litres sold at the given price.

Question 21

A method mark was available to those who marked 90° for angle *ABC*, however, this circle property was not well known to the majority of candidates. Many showed the angle sum for a triangle as 180° but were unsure how to use this in the question. Some treated this as an isosceles triangle so gave the answer 39°. A few gave 141°, the sum of the other two angles.

Question 22

(a) Most candidates attempted this question with less than half having a correct response. Some seemed to think that 2^3 and 3^2 were the same value so gave an answer of 6. Many worked out the values of *A* and *B,* i.e., 24 and 45. Some gave the LCM or another multiple.

(b) Many did not attempt this. Of those who did attempt this, relatively few got a correct answer or a value that was worth a method mark. Often the answer was a factor from the given *A* or *B*.

Question 23

(a) There were many correct rotations, accurately drawn with a pencil and ruler. A few drew anticlockwise rotations or used the correct angle around a different centre. Others drew different transformations than the rotation specified, often a translation or reflection. Most retained the correct size of the triangle. A few did not attempt this question.

(b) Many responses were awarded 1 mark for 'translation' and almost all of the responses gave a single transformation. Also seen were unacceptable words such as move, shift, translocation, transformation or goes, instead of translation. Some gave an incorrect vector as they had made counting slips.

(c) Slightly more candidates attempted this part, with many giving the correct transformation, 'enlargement'. Relatively few were awarded full marks as often one or other of the centre or scale factor were missing. Some described the movement of the shape to its new position, instead of writing the centre of enlargement.

Question 24

This was reasonably well answered with those that changed the mixed numbers to improper fractions being more likely to be award some or all marks. Those who decided to work with the fraction parts separately often forgot to add the 2 back into their calculations. If they did remember to include it, their answer was often $2\frac{13}{12}$ and so 2 marks were awarded, as this was not in its simplest form.

Question 25

(a) In general, candidates did not understand the correct form of a number in standard form as their answer started with more than one digit in front of the decimal point. Some candidates gave their answer in words.

(b) This was handled slightly better than the last part. Incorrect answers included 5.6, 0.56, 00056 without a decimal point and 00.056.

Question 26

This question was perceived as challenging by many, but this might have been caused by the need to sustain their method through all the stages. Some only multiplied one equation when both needed to be multiplied. Some candidates got confused within their methods. When using the substitution method, candidates must be careful they do not substitute back into the equation that they had just rearranged – this error was seen a few times. When one value is found, candidates must still be careful with directed numbers when they substitute their answer back into an equation to find the second – this was also a place where errors were seen.

MATHEMATICS

Paper 0580/12
Non-calculator (Core)

Key messages

To be successful, candidates should cover the whole of the Core syllabus. A non-calculator paper does not have arithmetic operations that would normally require the use of a calculator, and so candidates should think about which method to use before attempting these calculations.

General comments

There was a wide of range of marks for this paper, most candidates presented work well and generally with clear working where necessary. Time was often wasted with long and inefficient calculations, and this prevented many candidates from having a meaningful attempt at questions later in the paper. There were clearly weaknesses from many in the area of decimals, fractions, percentages and order of arithmetic operations.

Comments on specific questions

Question 1

While the majority of candidates had no problem with the digits, some had a problem with place value. A common error was to leave out the zero in the hundreds column (1662) or the 1 in the 'tens of thousands' column. Too many zeros and 16 written as 6 or 62 occurred, but overall, the question was a confident start for candidates.

Question 2

Candidates who were familiar with the relationship between fractions and decimals generally scored on both parts of this question. However, many did not show understanding of conversions between common fractions and their decimal equivalents.

(a) Incorrect responses included three-quarters**,** written in words, or decimals that often started with 0.3, going on to 0.34 or 0.033, for example. Many were clearly confident with this straightforward conversion, even though the incorrect value of 7.5 was seen occasionally.

(b) Unfortunately, those who had part **(a)** incorrect rarely scored the mark for percentage, since their incorrect part **(a)** multiplied by 100 did not score. It was quite rare for those with part **(a)** correct to not have the correct percentage. Those who did make errors at this stage had answers such as 7.5 from multiplying by 10 or 0.0075 from dividing by 100.

Question 3

(a) Most candidates understood the symbol for square root and so this straightforward case was usually correct. A common incorrect answer was to half to give 18, while some squared 36 or wrote 6^2 as their answer. Doubling, to give 72, was also seen.

(b) Again, this was generally well done with most understanding that 10^3 had to be calculated as $10 \times 10 \times 10$. Most errors were from the incorrect number of zeros, mainly two or four, but answers of 300 and 30 were also seen.

Question 4

(a) Provided they had a ruler, the vast majority were able to measure the length within the 2 millimetre tolerance. However, some gave an answer in centimetres, 8.3, or added extra zeros to their answer. Some did not read the question correctly by measuring the distance to *P* instead of *A*.

(b) Measuring an angle of 90° from a line was more challenging and while there were many correct responses, accuracy to within 2° was quite poor. Many lines were at an angle far removed from 90°, possibly as they felt the line should be horizontal. Some had a very good perpendicular bisector of the line *AB*, but the question asked for a line through point *P*.

Question 5

Nearly all candidates understood the question and clearly knew the fact that a week is 7 days. A response of 17 from 10 + 7 was seen as well as 77, 7 and 50 plus other unrelated answers.

Question 6

The most common shading of 14 squares was for two of the five horizontal rows. Those who shaded vertically often made errors by only shading two instead of four squares in the third column. A few misunderstood the question and simply shaded 2 squares. Calculating the number of squares was often seen but unfortunately led to errors in a few cases.

Question 7

(a) While many candidates had a correct answer to the reciprocal of the fraction, there were two main reasons why so many others did not get the mark. Firstly, there is strong evidence of a lack of understanding of ‘reciprocal’ as answers of 0.33, 33, 6, 13 and 1.20 were some of the many unrelated responses. Many candidates who did understand that the fraction needed inverting left the answer as $\frac{3}{1}$ which was not acceptable for the mark.

(b) While a significant number of ‘no response’ was seen, many showed evidence of understanding the negative index. Unfortunately, most of these did not then take the step from 2^3 to 8 in order to have the fraction answer which required whole numbers in both numerator and denominator. Many did not understand negative indices as evidenced by many varied responses containing a negative value.

Question 8

(a) While some candidates showed the ability to work through the choices for brackets, the majority found the topic difficult with many not attempting a response. Many had numerous calculations scattered around, although these rarely led to a correct placing of the brackets. More than 1 pair was seen at times. Some of those who appeared to make progress were careless in their positioning of the brackets by including the division sign in their answer.

(b) The same comments apply to part **(b)** as for part **(a)**, but this was more challenging, with even more no responses. Many did not realise that there could be 3 numbers within a pair of brackets. Two other errors were to include the negative sign before the ‘4’ inside the brackets and to bracket (5 – 7). A misunderstanding on wording was taking ‘a pair of brackets’ to mean four actual brackets, thus ignoring the instruction for ‘**one** pair of brackets’

Question 9

For comparing the sizes of fractions, candidates needed to change them to a common denominator or to decimals. Overall, more able candidates did much better on the question than others. Many showed little or no sign of working. Converting to decimals was poorly done with few correct examples seen. Decimals with values greater than 1 were seen at times. A common wrong method seen was ranking according to the size of the denominator or numerator, in order or in reverse order. Of those gaining 1 mark for one out of order, it was often $\frac{5}{8}$ or $\frac{3}{4}$ that was in the wrong position.

Question 10

(a) Without one face being given, this question was more challenging than similar ones previously seen on papers. There were many well drawn, correct responses, although others only drew 5 of the 6 faces. 3-D drawings were more common, as well as wrong size faces, usually 3 by 3, since no starting face was given.

(b) While a significant number did not attempt finding the volume of the cuboid, most of those who did knew to multiply the dimensions. However, there was sometimes confusion with surface area, or wrong units, usually cm^2.

Question 11

(a) The vast majority of candidates correctly identified the mode from the list. The few errors were usually from confusion between mode and range.

(b) Again, the range was well understood, although a significant number of candidates wrote their answer as a range of values, 7 – 0 or 0 – 7, rather than a single number, as required.

(c) While many candidates found a correct single value for the median, some highlighted 2 and 3 but failed to complete the calculation to find the middle value.

(d) The mean was found correctly by most candidates. Unfortunately, some candidates could not add up the numbers or divide the total by 6 correctly. Other errors included ignoring the zero, to divide by 5 or dividing 18 by 2. Some even regarded the data as a frequency table resulting in a complex and incorrect calculation with midpoints and frequencies.

Question 12

Tim's method was replicated correctly by many candidates, most often leading to the 2 marks. However, a significant number of incorrect subtractions of 85 from 8500 led to 8425 or 8515 as the final result. A few answered the question by long multiplication which, correct or not, did not follow the instruction. More often, the number 53, from the example, was subtracted.

Question 13

(a) While some candidates managed to identify the quadrilateral from the given properties, most had difficulty visualising the shape. Just about every quadrilateral and even cube came up in the responses but most common were rectangle and square.

(b) Many candidates gained 1 mark from the properties, but 2 marks was not very common. Properties like 4 sides or 4 angles were too general and two parallel sides did not indicate that the other 2 sides were also parallel. Correct properties about line and rotational symmetries were valid and gained the 2 marks for many.

(c) Firstly, candidates needed to know what a trapezium was, and, from the considerable number of no responses, it was clear many did not. Otherwise, the question was done quite well with many working out that the height was 3 cm, very often with no apparent working seen. Various types of trapezium were seen but some only gained 1 or 2 marks for just correct parallel sides or correct height respectively. A number of drawings were of a parallelogram or rectangle which could score a mark for a correct height drawn.

Question 14

(a) Having a quadratic equation expressed by the product of two brackets seemed more of a problem for finding the y values in the table than the more familiar, fully expanded, quadratic equation. However, many did work out the 5 missing values correctly. The substitution of the negative values was found to be challenging by many. Values of 5 and −5 were often seen when x values of −3 and 2 were substituted into the equation.

(b) It was only possible that the 4 marks could be gained for the curve if the table was fully correct, unless a restart was made at this stage. Some scored 3 marks from a correct plotting of their points, regardless of the strange looking graphs that resulted. Of those in line for the fourth mark it was missed by having straight lines joining points, having a flat line between (−1, –6) and (0, −6) or a poor-quality curve, often with double lines in certain parts.

(c) Only those candidates who showed part of their curve below $y = -6$ could score this mark and even then, it was rarely gained. It needed both the x to be −0.5 and $-6.6 \leq y < -6$. Points (−1, −6) or (0, −6) were often seen as the lowest point, possibly from looking at the table rather than the graph.

(d) Many did not attempt this part of the question but some of the more able candidates did realise that it had to be a vertical line halfway between the two lowest points plotted. Many of those who attempted a line had responses that had no relevance to the question.

(e) This part had the highest omission across the paper. Those who persevered gained the mark for their 'curve' intersecting the line $y = 3$. The common error was to quote the two points where the curve crossed the x axis, (–3, 0) and (2, 0).

Question 15

The question was done well with many fully correct answers. A mark was gained by many from recognising that 64 was involved, from 55 + 9 or from setting up the equation $n^2 - 55 = 9$. Errors were from subtracting 9 from 55 instead of adding, multiplying 64 by 9 and dividing 64 by 2 instead of finding the square root. Many did not see a way of approaching this question, resulting in a fair number of no responses.

Question 16

(a) Most did manage this calculation successfully while the usual error of not halving base × height for the area of the triangle was evident quite often. A few candidates gave the lengths of the sides rather than calculating the area.

(b)(i) The error of having the coordinates the wrong way round was evident from some responses, but the vast majority correctly stated the coordinates of point P. Just a few got confused with the signs, for example (−4, 3).

(ii) Those who understood translation gained the mark for this part, but many candidates struggled with understanding how to apply the vector to the point P. For those who did understand what to do, the problem of combining directed numbers, adding 4 to −20 and −3 to 12, was evident.

(c) Many candidates either gained full marks for the correct triangle drawn or 1 mark for reflecting correctly in $y = k$ (often in the x axis) or in $x = -1$. There were a few who translated or even rotated instead of reflecting the triangle.

(d)(i) While there was a good response from many candidates, many did not appear to be aware of the three requirements, name, scale factor and centre, for this transformation. Most did recognise the name, but descriptions such as double could have applied to the area, rather than to a scale factor. Descriptions about how the coordinates changed, did not contribute to the required property.

(ii) In this transformation, most identified the movement correctly but the angle of 90° was often quoted without direction, or the wrong direction. Again, a centre appeared the most difficult property to identify and this was often omitted. Some candidates ignored the instruction to give a single transformation adding a translation which, automatically scored zero for the question.

Question 17

There was a good response to this question with very few attempting to work out the calculation as it appeared rather than rounding the numbers. Unfortunately, many rounded 17.8 to 18 when the question asked for one significant figure, not to two or to the nearest whole number. There was a few rounding 5.5 to 5, rather than to 6.

Question 18

While there was a good response to this question, many had the working to find the HCF but either gave the LCM or simply gained one mark for one of the factors, 2 or 11. Factor trees or tables were commonly used but those showing a type of double table usually went too far. Individual factor tables for the numbers 66 and 110 did lead more easily to picking out the common factors 2 and 11.

Question 19

(a) A high proportion of candidates gave a correct prime number showing their understanding of primes and inequalities. Incorrect responses showed lack of understanding primes with answers, for example of 15 and 16, or had numbers outside the inequality or listing all the numbers inside. An answer of 13 or 19 showed a misinterpretation of the inequality symbols.

(b) For those who understood inequalities, this was a straightforward question. However, it was a topic that many less able did not understand at all with the positioning of the inequality symbols often incorrect or the wrong way round. Several responses were only numeric, such as $-2 < 7$ and some listed all the numbers inside and on the ends of the range.

Question 20

Most candidates knew the diagram showed the union of two sets and they were familiar with the symbol for it. However, there were quite a number of cases of carelessness, particularly by not using the letters in the diagram but others, most often A and B. Some were uncertain of the symbol so the intersection and even complement symbols were seen.

Question 21

Many candidates managed the first step of changing the mixed numbers to improper fractions successfully, or at least one of them, which could secure a mark. The second step of cancelling at this stage was sometimes seen. Those multiplying 6 by 25 often had a resulting numerator of 125.

It was quite common to see attempts to find a common denominator and calculations from cross multiplying to give $(125 \times 54)45$. Those who did the second stage correctly usually managed some cancelling of the resulting improper fraction, but many did not follow the instruction to give the answer as a mixed number, thus not getting the final mark.

Question 22

The mixture of units in this question on bounds made it slightly more demanding. While it was sensible to change all to grams to add and subtract 50 from 3200, the answer then needed to be changed back to kilograms for the 2 marks. This often did not happen. Most tried to work with the decimals, often successfully, but there were many with incorrect results. There were various incorrect attempts at adding and subtracting what they believed was half of 100 grams as a decimal of a kilogram, meaning answers of 2.7 and 3.7 as well as 3.1 and 3.3 were often seen. Other incorrect responses seen involved the figures 32 such as 320, 3.2 and 3200.

Question 23

(a) While some did not understand the process of factorisation, the majority managed to achieve a fully correct factorisation. Others recognised one of the factors to take outside the bracket, (this was more often the 3 than the x) which gained 1 mark. Unfortunately, a few candidates had the correct $3x$ outside the bracket but left an x inside the bracket.

(b) Many core level candidates seemed to lack familiarity with the expansion of 2 brackets, a topic recently added to the syllabus. However, those who were familiar with it usually made good progress to gain at least 1 mark for 3 of the 4 terms correct in the expansion. Again negative terms proved problematic, addition of directed numbers, in this case $-8x + 3x$ became $-11x$ and multiplying $+3$ with -4 became $+12$ occasionally.

Question 24

Most candidates were familiar with simultaneous equations and while some used a substitution method, the majority tackled the question using elimination. While most made good progress on multiplying one or both equations correctly, a common error was, for example, to subtract the x's correctly but then to subtract the numbers the wrong way round, giving 21 instead of −21. Some multiplied the algebraic side correctly but did not multiply the numerical value on the other side at all. Those using substitution often reached a correct equation in terms of either x or y, but the complication of a denominator usually resulted in an error when finding the value of the variable. Many did gain a mark for their values of x and y fitting one of the equations.

Question 25

Many candidates did not attempt this question, either through lack of time due to doing many unnecessary, complex, calculations or poor time management of the whole paper due to an increase in the number of marks available.

The question wanted answers in terms of π, but this was ignored by large numbers who insisted on substituting 3.14 or 3.142 or even $\frac{22}{7}$ resulting in unnecessary work on complex calculations. The other major error was to totally ignore the straight parts of the perimeter and just to attempt the semicircle lengths. Regardless of the formula for circumference being in the list of formulas, a significant minority chose to use the area formula. Where circumference was found correctly it was common for it not to be halved, meaning 22π was often seen as the answer.

MATHEMATICS

Paper 0580/13
Non-calculator (Core)

Key messages

Candidates need to read questions carefully to ensure answers are given as required, for example, in the simplest form. Ensure all steps of working is shown for 'show that' questions. Pencils should be used for diagrams so errors can easily be corrected.

General comments

The majority of candidates attempted all the questions, with many setting out their working in a clear and logical way. Candidates found the number topics and specific mathematical terminology relating to shape and space quite challenging in the first part of the paper.

Comments on specific questions

Question 1

(a) Most candidates were able to write 70 000 000 in words correctly. A small number of candidates gave incorrect answers such as 70 million (mixed numbers with words), seven thousand million, seven billion, seven million, or seventeen million, suggesting some confusion with large number values.

(b) (i) This part was not as well answered with common incorrect answers of 5, 0.05, $\frac{25}{100}, \frac{1}{5}, \frac{1}{4}, \frac{1}{0.5}$.

(ii) Some candidates gave the correct answer, but a large number did not know how to deal with the decimal.

Question 2

(a) Candidates found both parts of this question difficult, however more were successful in the first part than the second. Common incorrect answers included right angle and acute angle.

(b) This question had a large omission rate. Common incorrect answers included similar, identical and equal but there were also many cases where isosceles, regular polygon, square, equilateral, parallel and symmetry were given. The term congruent was not well known.

Question 3

(a) This was well answered by around half of all candidates. The most common error was to half 169.

(b) Most candidates gave the correct answer. Common incorrect answers were 8 and 32.

(c) Few gave the correct answer with common incorrect answers of $\frac{1}{10^2}$, –100, 100 and 0.1 seen.

(d) The question was generally well answered with incorrect answers stemming from candidates understanding of negatives.

(e) Some candidates gave the correct answer. The majority of errors included incorrect placement of the decimal point in their final answer e.g. 0.32 or 0.0032.

Question 4

(a) Some candidates were able to identify the shape as a rhombus; common incorrect names given were parallelogram and trapezium.

(b) Many candidates were able to work out the value of a as 60, using methods such as $3a = 180$ or $6a = 360$, showing a good understanding of angle relationships. Many candidates who did not reach 60 were awarded method marks.

Question 5

(a) Generally, this question was well answered with candidates understanding what was required and many correctly writing the next term rather than a rule.

(b) 24 and 6 were common incorrect answers.

Question 6

(a) (i) Many candidates gave the correct answer. A common error was 7 from not ordering the numbers first.

(ii) Most were able to correctly give the range.

(b) Few candidates gave the correct answer to this part. The main errors were 1.15 hours or 1 hour 15 minutes.

Question 7

Most candidates were able to find the number of students who study German by first identifying the number of students represented by one part of the ratio, then calculating the value for 7 parts before subtracting 15 and 35 from 70. Many candidates were able to gain one mark from their working.

Question 8

(a) Many candidates gave the correct answer. Common incorrect answers were 3,3,8 or 3,5,5.

(b) Many candidates correctly drew the other 4 faces. However, some only drew one face and scored 1 mark. A small number of candidates had a net with more than 6 faces.

(c) This was generally well answered. If errors did occur it was usually from attempting to calculate the surface area rather than the volume.

Question 9

(a) Few candidates scored 2 marks on this question. Many only calculated the area of the triangles, others did not use the correct formula.

(b) The majority of candidates answered this question incorrectly, with common wrong answer including 5 and 4. A 3D diagram was not given; these responses suggest a misunderstanding between the number of edges in the 3D shape and those visible in the net.

Question 10

(a) Generally, candidates were able to identify only one description (although for some their choice was spoilt by a second or third description indicated). Many candidates had worked through the list of descriptions, crossing out those that were not suitable in order to help them identify the one that was.

(b) Of the candidates who were able to draw a correct line, several scored 1 mark as their line did not extend across the whole grid. A line with a positive gradient through (0, –1) seemed a more accessible part mark for candidates than a line with a gradient of 2. Few candidates plotted coordinates.

Question 11

(a) Many correct answers were seen, although some candidates did not know how to attempt this question.

(b) Many were able to correctly draw a sector of 80° on the diagram.

(c) (i) A common error on this part was just adding the given angles 120, 100, and 80 and subtracting from 360, not considering that there were two sectors left in the pie chart.

(ii) Candidates who had answered parts **(a)**, **(b)** and **(c)(i)** correctly usually gained this mark for completing the pie chart.

Question 12

(a) The majority of candidates scored 1 mark for this question, many provided incorrect values on the Venn Diagram with common answers being 12, 7, 10, or 1 placed inaccurately. A small number of candidates either shaded the Venn diagram instead of filling in the values or left the diagram blank.

(b) The majority of errors in this question came from giving only the value in section C of the Venn diagram and not including the intersection. However, some were able to answer this question accurately, even if they had only scored partial marks in **(a)**. Many showed a clear understanding that both the value in section *C* and the intersection should be added, with 17 (from 7 + 10) being the most common response.

Question 13

The Special Case mark was awarded frequently, candidates who had attempted to round to one significant figure at the start, struggled to round 0.52 to this level of accuracy, it was often rounded incorrectly to 1, leading to a final answer of 6.

Many candidates did not take note of the request to round and spent time on complicated multiplications and divisions. If candidates rounded the three numbers correctly, they tended to go on to get the final answer.

Question 14

More able candidates were able to give the correct answer. Some gained 1 mark for correctly substituting into the equation but were unable to rearrange it correctly. Others did not equate their substitution to 42.

Question 15

(a) Most candidates were able to correctly write the inequality represented on the number line. Some candidates managed to score partial marks by correctly identifying one part of the inequality. A significant number scored zero due to common errors such as using incorrect inequality symbols, placing the inequality between numbers (e.g., –4 < 3, –4 > 3) or simply listing –4 or 3 without forming a complete inequality statement.

(b) Very few correct answers were seen; the most common error was not giving an integer answer. A significant number of candidates did not attempt this question.

Question 16

Few candidates gave the correct answer or knew how to approach this question. Many candidates worked with 9x = 270 and 30 was a common incorrect answer. Those that were able to write 20% as $\frac{20}{100}$ tended to be more successful.

Question 17

(a) The majority of candidates demonstrated a good understanding of the laws of indices and gave the correct final answer y^{10}, showing a good overall overstanding of the topic. However, a small proportion of candidates made errors, such as multiplying the indices 4×6 instead of adding them.

(b) Most candidates were able to apply the correct index law and gave the correct answer p^{-3} or $\frac{1}{p^3}$.

Common errors included multiplying the indices (giving p^{40}), subtracting in the wrong order (resulting in p^3), or dividing the indices.

(c) Many correct answers were seen in this part. Common incorrect answers included 12*w*, $3w^{12}$, and w^7, which indicate confusion of applying index rules.

Question 18

(a) The value of the angle was correctly found by most candidates, although giving sufficient reason was challenging and very few candidates were awarded two marks.

(b) This was generally well answered. Finding and indicating the 90º angle on the diagram gained a mark for many candidates who found this question difficult, often candidates went on to find ORS and the value of *y*. It was more common to get the B1 for OSR than ROS. There were arithmetic errors when adding or subtracting angles. 155 was a common incorrect answer from 180 – 25.

Question 19

This question was not well done overall. Candidates who knew the correct formula for the sector of a circle were able to substitute correctly and gain a method mark, several who had done this did not evaluate it correctly. Some worked out the area of a full circle, others tried to use a numerical value for π despite not having a calculator.

Question 20

Around half the candidates scored full marks on this question, common errors included miscalculations, or having correct factor trees but then multiplying all the factors, confusing HCF and LCM. Some left their answer in the form $2 \times 3 \times 3$ without simplifying. Others scored zero for multiplying 36 by 54.

Question 21

Answers to this question were mixed, some candidates knew how to create an equation given the information about the two shapes. The most common error was to use only one length and height of the rectangle. Often the perimeters of the two shapes were dealt with separately for the entire question, the *x* terms were equated to the constant terms and two values of *x* were found. Overall, an appreciation of needing to add lengths (rather than multiply) to find perimeter was evident. There were several cases of candidates equating the perimeter of the triangle (or the rectangle) to 180, perhaps getting confused with the sum of the angles in a triangle.

Question 22

Many candidates did not know how to rearrange formula, several wrote *g* – 8 as their first step. Those who removed the 8 often realised the need to multiply by 3 to leave *h* as the subject. Many only applied the multiplication to either g or + 8, rather than both terms, which led to incorrect rearrangement. A noticeable number of candidates swapped the positions of *g* and *h* in the original equation.

Question 23

This was generally well answered. Most candidates were able to identify the need to multiply the length of rectangle *B* by something to get to the length of rectangle *A*. Many took the same approach as the method in the mark scheme, although it was clear that some realised they needed to multiply by 4. Arithmetic errors did arise when doing 1.5×4 with 4.5 a common incorrect answer, although in most cases method was clearly shown, and method marks were awarded. 7.5 was a common incorrect answer coming from $8 - 2 = 6$ and $1.5 + 6 = 7.5$.

Question 24

This was well answered by more able candidates. Some gained 2 marks for $\frac{27}{14}$ but did not convert this to a mixed number. Others scored 1 mark for correctly changing $3\frac{1}{2}$ or $1\frac{4}{7}$ to an improper fraction but were unable to make further progress.

Question 25

Although many candidates were able to give the correct answers, a significant number struggled to achieve full marks on this question. The most common errors occurred when eliminating a variable. It was common to see one part of the equation added and the other subtracted, spoiling the method. Others substituted values without proper algebraic manipulation, resulting in incomplete or incorrect solutions. In many cases, answers only satisfied one of the two original questions and scored the SC mark.

MATHEMATICS

Paper 0580/21
Non-calculator (Extended)

General comments

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. It is also important that candidates read the question carefully to establish the form, units and accuracy of the answer required and to identify key points which need to be considered in their solutions (for example, the requirement to give the answer in the simplest form in **Question 15(b)** or to use factorisation to solve the quadratic equation in **Question 18(d)**).

This examination provided candidates with many opportunities to demonstrate their skills. It differentiated well between candidates, with a full range of marks being seen. A good number of high-scoring scripts were seen, and there was no evidence that the examination was too long. Some candidates omitted questions or parts of questions, but this was likely due to a lack of knowledge rather than time constraints. It would have been helpful if candidates had written their numbers more clearly, as some of them were difficult to distinguish, particularly 4s and 9s, and 1s and 7s. Some candidates' handwriting was not as legible as others, which may have contributed to the errors in their work. There were also instances where working was not shown or was not shown clearly; showing working allows for the awarding of partial marks when the correct answer is not seen. Structuring of working was particularly important when candidates were asked to show a result or show their working, or in questions where more steps were required in their method (for example **Question 13(a)**, **18(c)** or **21(b)**).

It is important to take care when manipulating algebraic expressions. Some errors were caused by poor writing and some by not applying the laws of algebra correctly. For example, in **Questions 14(d)**, **18** or **23**, all of which required candidates to manipulate algebraic terms.

There were some questions where candidates demonstrated a lack of familiarity with non-calculator working, for example trying to multiply by π rather than working in terms of π in **Question 13**. Candidates should also be mindful that completing working in one line when they should use several lines, particularly when performing two steps of algebraic rearrangement in one line, means that they can miss the opportunity for method marks.

Comments on specific questions

Question 1

In this question candidates were asked to simplify an algebraic expression. There were lots of correct answers seen, but there were also many responses where errors were made in dealing with the negative term when simplifying, or where a correctly simplified expression was spoilt by further working such as incorrectly combining the terms in c and d or attempting to factorise the simplified expression.

Question 2

Candidates needed to work with angle rules for parallel lines and transversals together with a combination of some of vertically opposite angles, sum of angles on a straight line and angle sum of triangles to find three missing angles. Many candidates were able to gain full marks on this question.

The majority of candidates were able to identify that angle w was 158° which could be determined by identifying corresponding angles. It was also common to see angle x correctly identified as 76° which could be determined by identifying alternate angles. Angle x was also sometimes incorrectly identified as 82° (180 – 22 – 76 from angle sum of a triangle and with an incorrect value for y of 76°), or 68° (from incorrectly assuming that y was 90°) or 22° (from incorrect working with the sum of angles on a straight line and the 158° angle). Where angle x was incorrectly identified, many candidates were able to go on to gain a mark for correctly labelling 22° on the diagram or for calculating $y = 158 -$ *their* x correctly.

Question 3

In this question candidates were asked to work with simple interest and find the total value of an investment at the end of 6 years. There were many fully correct answers seen, and a reasonable proportion of candidates also scored 2 marks for finding the interest ($270) rather than the total value of the investment at the end of 6 years. The most common error was to attempt to use compound interest.

Question 4

In this question candidates needed to use the correct order of operations, multiply fractions and subtract fractions with different denominators. Candidates were generally able to multiply fractions, and many also correctly subtracted by writing the fractions over a common denominator. The most common errors were to work from left to right in the calculation (ignoring order of operations), incorrect attempts at subtraction of fractions (subtracting numerators and subtracting denominators) or incorrect attempts at multiplying fractions. Some candidates had correct processes but had changed the subtraction to an addition.

Question 5

This question gave candidates the interior angle of a regular polygon (150°) and asked them to find the number of sides of this polygon. Candidates who recognised that they could find the exterior angle of the polygon, and who worked with the sum of exterior angles being 360°, were generally successful in working out that the polygon had 12 sides. Others tried to work with the interior angle sum of a regular polygon to set up an equation to solve, but this approach was less successful, with errors seen in the formula for the interior angle sum. Some candidates were not able to make progress with this question and, in these cases, it was common to see sketches of polygons.

Question 6

(a) In this part of the question, candidates were asked to draw the line $y = 2x + 1$. There were a good number of candidates who were able to complete this accurately. Common errors included drawing inaccurate lines which were seen to be missing the coordinates that needed to intersect, or inaccuracies due to lack of use of a ruler. Some candidates had a correct intercept but an incorrect gradient for their line, often $y = \frac{1}{2}x + 1$, which could be awarded 1 mark as long as the gradient was positive. There were also some candidates who drew incorrect lines with a negative gradient, sometimes intersecting the y-axis at 1 and the x-axis at 2.

(b) This part of the question required candidates to use their graph to solve a pair of simultaneous equations. Many candidates recognised that the intersection of the given line and the line that they had drawn in **(a)** would give the answer required and read off the appropriate x and y values (allowing for follow through from their line in **(a)**). Some candidates did not show evidence of using the graph to find the solutions to the simultaneous equations, which was condoned. Some candidates did not demonstrate understanding of how to use the graph for this part of the question and either did not attempt it, or unsuccessfully attempted an algebraic method to solve the simultaneous equations, or gave an algebraic expression for x and for y.

Question 7

Candidates found writing the recurring decimal $0.2\dot{6}$ as a fraction relatively challenging. A number of candidates misinterpreted the recurring decimal notation as 0.2626… which meant that they could not gain credit, and it was also very common to see candidates working with 0.26 (ignoring the recurring notation). Where candidates knew a non-calculator approach for this type of question, they were generally relatively successful. Many set up a pair of equations such as $100x = 26.66\ldots$ and $10x = 2.66\ldots$. then subtracted to find that $90x = 24$, which often led to a fully correct answer, although some struggled with the subtraction due to used differing numbers of decimal places in their two equations, and did not successfully eliminate the recurring part of the decimal. There were a significant number of candidates who reached $\frac{12}{45}$ but did not fully simplify. Common errors seen included 26/100 = 13/50.

Question 8

(a) Candidates were given column vectors **m** and **n** and asked to find 2**m** – **n**. Many candidates were able to do this successfully. Some candidates struggled with subtracting the negative number and so gained 1 mark only. There were some candidates who incorrectly included a fraction line in their vector calculations; these candidates were often able to gain 1 mark. Where incorrect answers were seen, these generally came from combining the numbers within the vectors.

(b) In this part of the question, candidates were told that the vector $\begin{pmatrix} 5 \\ \sqrt{y} \end{pmatrix}$ has a magnitude of 7 and were asked to find the value of *y*. This proved challenging for many candidates, and they often worked with *y* instead of $\sqrt{y}$ or did not recognise the need to use Pythagoras' theorem in order to find the unknown.

Question 9

In this question, candidates were given a frequency table and were told the mean mark. Some candidates were able to set up an equation and solve this successfully to find the missing frequency. A smaller number of candidates worked with a trial and improvement approach, which was acceptable if the correct final answer was obtained, but gained no credit otherwise. Many candidates did not form a suitable equation, nor did they make partial progress by forming one of the relevant expressions. The most common errors were to calculate a mean of the test marks in the table (4, 5, 8) or to look for a pattern in the numbers in the table.

Question 10

Candidates were given a circle with a tangent, an inscribed triangle and two radii drawn. They were given two of the angles in the diagram and were expected to find different angles in each of the question parts.

(a) In this part of the question, candidates were asked to find angle *AOC*, which was the angle at the centre of the circle. This involved identifying that *OA* and *OC* were radii and therefore triangle *AOC* was isosceles. The missing angle was often correctly found by candidates. Where incorrect answers were seen, these generally involved working with the different angles in the question and also with 90° in a variety of different incorrect calculations. In some cases, candidates gave answers which were less than 90° and did not recognise that this was inconsistent with the relative size of the angle shown in the diagram.

(b) In this part, candidates were asked to find angle *ABC*. This required candidates to know that the angle subtended at the centre is twice the angle subtended at the circumference. Around half of the candidates were able to find the correct angle or, less commonly, correctly follow through from their incorrect answer to **(a)**. A common incorrect answer was 75° which came from assuming that angle *ABC* was the same as angle *ACB*.

(c) This part of the question required candidates to use the alternate segment theorem or the angle between radius and tangent together with angle *OAC* to find angle *DAC*. This was answered correctly by around half of the candidates. Common incorrect answers generally involved writing one of the two given angles.

(d) This part required candidates to use the angle sum of a triangle together with triangle *AOC* being isosceles in order to work out angle *OAB*. A significant minority were able to find the correct answer (around two fifths); however, there were a wide range of incorrect answers and around a fifth of candidates did not attempt the question.

Question 11

(a) In the first part of this question, candidates were asked to draw a tangent touching the given curve and passing through the point *P*. They were asked to identify the coordinates of the point where this tangent touched the curve. Candidates who understood what was required for a tangent generally drew this accurately using a ruler, and correctly identified the required coordinates. The most common error was to draw a line which was not a tangent.

(b) For this part of the question, candidates were asked to find the equation of the tangent. Not many candidates answered this part of the question successfully. Whilst some candidates accurately managed to find the equation of the line that they had drawn, it was common to see incorrect answers or blank responses where candidates had not attempted the question part. Candidates often struggled to work out the gradient of the line, and there were also errors seen in trying to use the given form ($y = mx + c$). Where part marks were scored, this was generally for an equation with a correct y-intercept.

Question 12

(a) In the first part of this question, candidates were asked to use the cumulative frequency diagram provided to find an estimate of the interquartile range. There were some candidates who were able to work accurately to read the upper quartile and lower quartile from the cumulative frequency diagram and use these to calculate the interquartile range. There were, however, a significant proportion of incorrect answers. Common incorrect approaches included identifying that the quartiles related to the cumulative frequencies of 90 and 30 but then subtracting these to find 60, or finding the time corresponding to a cumulative frequency of 60. Others gave the lower quartile of 4.2 as their answer or the attempted the range giving an answer of 10.

(b) In this part of the question, candidates were told that 70% of adults spent less than k hours on the internet and were asked to use the cumulative frequency diagram to find an estimate of the value of k. Candidates found this slightly more accessible than part **(a)**, possibly because they did not need to interpret mathematical terminology (interquartile range). There were a reasonable number of fully correct answers, and candidates also often managed to gain 1 mark for 84 (70% of 120) even though they did not go on to find the value of k. A common error was for candidates to read off from a cumulative frequency of 70 rather than to work with 70% of the 120 total.

Question 13

(a) The first part of this question was based on working with the surface areas of two solids: solid *A*, made from a hemisphere and a cone, and solid *B*, which was a cylinder. Only a minority of candidates were able to find the height of the cylinder from forming an equation equating the surface areas of the solids. Where candidates did work with the correct formulae, it was common to see errors in attempts to solve this to find h, either through errors in collecting terms or errors in rearrangement. Some candidates attempted to multiply the terms by 3.14 or another numerical value for π rather than working in terms of π, leading to a loss of accuracy and arithmetic errors. Some candidates worked with an open-ended cylinder, leading to an answer of 16.5 which was awarded SC2. Candidates who were not able to form the appropriate equation were often able to gain 1 or 2 marks for a correct expression for one or both of the surface areas. A common error was to work with incorrect formulae for the surface areas.

(b) In this part of the question, candidates were asked to find the height of the solid made from a hemisphere and a cone. There were a minority of candidates who had a fully correct answer, and it was more common to see the height of the cone (8 cm) found without the addition of the radius of the hemisphere. Some candidates did not recognise the need to use Pythagoras' theorem to find the height of the cone and so did not make progress with the question.

Question 14

(a) Substituting into a function was generally well done by candidates and the majority were able to find the correct final value.

(b) Finding the inverse function was attempted by most candidates. Some were able to correctly complete the process and find the required inverse function. Where candidates did not find the correct inverse function, they were occasionally able to gain partial credit for a correct first step.

Some candidates could not demonstrate knowledge of how to find an inverse function, and often made attempts using numerical values, or misinterpreted the notation as a power of negative 1 rather than an inverse function.

(c) This part of the question differentiated well between candidates. Many candidates were confident with how to find a composite function and were able to find the value of a and the value of b successfully. Others understood the notation and how to find a composite function, showing the correct substitution of $3(4x + 1) – 4$, but made errors in simplifying this in order to find the values required. Common incorrect answers involved attempting to multiply the two functions.

(d) In this part of the question, candidates were asked to simplify $\frac{2}{\mathrm{f}(x)} - \frac{5}{\mathrm{g}(x)}$ and give their answer as a single fraction in terms of x. There were a good proportion of correct answers seen, most commonly with the denominator expressed as $(3x – 4)(4x + 1)$ rather than as $12x^2 – 13x – 4$. There were also a significant number of candidates who gained 2 marks for a correct common denominator and a correct unsimplified numerator, often seen as two separate fractions; however, sign errors in expanding and simplifying the numerator meant that the correct final answer was not obtained. Some candidates identified a correct common denominator but made errors with their numerator, sometimes through not showing an unsimplified form and trying to complete multiple steps in one go without showing working. There were also instances where 1 mark was awarded for either a correct common denominator or a correct expression for the numerator. Some candidates did not know how to start to subtract the two fractions and a variety of incorrect approaches were seen in the attempts to combine the fractions.

Question 15

(a) The majority of candidates showed an awareness of how to start this question by multiplying out the pair of brackets containing surds. The fully correct answer was only seen in a minority of cases due to errors in multiplying out terms or in simplifying terms, with $-\sqrt{5} \times -3\sqrt{5}$ causing particular issues due to the product of the two surds and the product of two negative numbers.

(b) There were a significant proportion of fully correct answers to this question on rationalising the denominator of the fraction and giving their answer in the simplest form. The most common approach was to multiply the numerator and denominator of the fraction by $\sqrt{10}$, although some chose to attempt multiplication by $\frac{-\sqrt{10}}{-\sqrt{10}}$. Generally candidates multiplying by $\frac{\sqrt{10}}{\sqrt{10}}$ were more successful than those multiplying by $\frac{-\sqrt{10}}{-\sqrt{10}}$ due to confusion between multiplication and subtraction. Incorrect responses generally did not attempt a method for rationalising denominators and instead attempted to cancel the values as seen in the fraction.

Question 16

This question on expanding the product of three brackets differentiated well between candidates. The strongest responses showed clear working leading to a correct unsimplified expansion, which was then simplified. It was common to see a correct expansion of a pair of brackets accompanied by incorrect further working; in the majority of cases this was where candidates had incorrectly attempted to expand the three brackets by multiplying them out in a pairwise fashion. It was common to see errors in multiplying algebraic terms and also in collecting like terms.

Question 17

(a) This question on calculating a probability with replacement proved challenging for candidates, with only the stronger candidates able to identify and complete the required calculation. A common incorrect answer was $\frac{3}{10}$ which was the probability of a single green marble being obtained when one marble was selected, or $\frac{6}{10}$, presumably from doubling the probability of a single green marble being picked.

(b) (i) The majority of candidates were able to correctly complete the tree diagram for the counters being picked from the bag without replacement. Where incorrect responses were seen, it was common for part marks to be awarded on the branch for a yellow second counter following a red first counter. The branches following on from the first counter being yellow were sometimes incorrectly completed, with probabilities for 'with replacement' rather than 'without replacement', or a probability of $\frac{1}{6}$ on each which came from dividing the $\frac{2}{6}$ on the first branch by 2.

(ii) Calculating the probability that one of the two counters is yellow proved challenging for candidates, with only the strongest responses finding the correct probability. Candidates who were successful generally showed clear working either in the working space or on the tree diagram. Some candidates found the probability of just one of the possibilities for getting one yellow counter (red then yellow or yellow then red) and could gain 1 mark. A common error was to find the probability of at least one yellow counter being picked, including the case of yellow then yellow. Other candidates added the three probabilities of yellow seen in their tree diagram (from the different branches). Some incorrect responses used addition when multiplication was needed, or vice versa.

Question 18

(a) Candidates were asked to give an expression for the time that someone spent running based on a distance of 12 km at a speed of *x* km/h. Some candidates gave a correct expression, often with the inclusion of units (which was condoned). There were a range of incorrect answers which appeared to stem from lack of familiarity with how to calculate time from distance and speed. Common errors also included writing equations where *x* appeared in more than one place in the equation, for example $x = \frac{12}{x}$, or to find a numerical value from working with numbers in the question or assumed numbers.

(b) Candidates who had answered **(a)** correctly were generally successful in responding to the second part of the question, which also asked for an expression in terms of *x*. Similar errors were also observed.

(c) This part of the question proved challenging for the majority of candidates, with only a small proportion of fully correct responses seen. There were some responses where candidates started with a correct equation but made errors in trying to rearrange this. In other instances, the initial equation was incorrect, often due to the 1 being included on the wrong side of the equation or being omitted entirely; however, this was sometimes followed by correct processes to rearrange which could gain credit provided two fractional algebraic terms, and the 1 in their attempted equation, were seen.

Where an initial equation containing relevant expressions was seen, candidates often multiplied through by the denominators of the fractions in order to clear these, rather than collecting all of the terms into a single algebraic fraction. The most common error when multiplying through to remove the denominators of the fractions was to forget to multiply the 1 by one or both of the expressions. Candidates often made sign errors when rearranging, or algebraic errors when combining fractions or multiplying out brackets.

Where candidates had not found appropriate expressions in **(a)** and **(b)** they did not make any progress with this part of the question; these responses were often left blank. A common incorrect response to this part of the question was to attempt to solve the equation that the candidates were asked to derive.

(d) In this part of the question candidates were asked to solve the quadratic equation by using factorisation. There were a good proportion of correct responses, with a correct factorisation seen followed by correct *x* values. Where candidates attempted factorisation, common errors included incorrect signs or factorisations that only gave some of the correct terms when expanded. There were a significant proportion of candidates that opted to use the quadratic formula in order to try to find the solutions to the equation. Since this was not what had been asked for in the question, these responses gained 1 mark only if the correct *x* values were found.

(e) This part of the question proved challenging. In order to find the required answer, candidates needed to use the positive root of the quadratic equation (from part **(d)** of the question) and divide 12 by this. Candidates who had successfully solved the quadratic sometimes identified the process to find the time spent running.

Question 19

This question required candidates to interpret a negative fractional index. It proved challenging for most candidates, with only a minority of fully correct answers seen. Some candidates gained partial credit for working out $27^{\frac{2}{3}}$ as 9, which was sometimes seen in the working and at other times seen as an answer of either 9 or –9; in these cases it appeared that the candidates did not know how to deal with the negative index. Common errors included multiplying 27 by the fractional power.

Question 20

Finding the exact length of the side in the right-angled triangle required candidates to use their knowledge of trigonometry in right-angled triangles together with the exact value of tan30, or of both sin60 and sin30. In the best answers, candidates showed clear use of the tangent ratio or of the sine rule, then rearranged and substituted in the exact values of the appropriate trigonometric ratios to reach a correct answer. It was common to see answers which gained partial credit for setting up a correct equation using the tangent ratio or the sine rule, either in an explicit or implicit arrangement, that were not then coupled with identifying the appropriate exact value(s) of the trigonometric ratios used.

Some candidates listed a table of trigonometric ratios for 30°, 45° and 60° angles, but often did not identify the one that they intended to use. In other instances, incorrect values were quoted for the relevant trigonometric ratios.

Where candidates did not identify that they should use trigonometry, or perhaps could not recall the appropriate trigonometric ratio or the sine rule, then there were a range of incorrect answers. These included attempts at using Pythagoras' theorem, incorrect trigonometric ratios and incorrect sine or cosine rules. In some cases, candidates assumed that the triangle had side lengths in the ratio 3 : 4 : 5, and gave an answer of 8 cm.

Question 21

This question on vectors was found to be challenging for the majority of candidates. In part **(a)**, candidates were asked to find simplified vectors for $\overrightarrow{OA}$ and $\overrightarrow{OC}$. In part **(b)**, candidates were asked to use vectors to show that the given shape was a trapezium.

(a) Part **(a)(i)** required writing $\overrightarrow{OA}$ in terms of **m** and **n** in its simplest form and part **(a)(ii)** required writing $\overrightarrow{OC}$ in terms of **m** and **n** in its simplest form. Some of the stronger candidates were able to correctly write down the required vectors for the two parts. Common errors included sign errors due to neglecting the directionality of vectors. It was also very common to see answers which were not actually vectors, for example where **m** and **n** were multiplied together in the final answer or where an attempt at a magnitude had been made using Pythagoras' theorem. Some answers also included a mixture of vector terms and constants.

(b) In this part of the question, candidates were asked to show that shape *OADC* is a trapezium. This proved to be the most challenging question on the paper and few candidates were able to make progress with answering it. There were a variety of incorrect attempts seen and there were also a significant number of candidates who did not attempt the question part.

Question 22

(a) Candidates needed to work with basic calculus in order to find an unknown power and unknown coefficient of x^2 in the equation of a curve, having been given $\frac{dy}{dx}$. Stronger responses identified the required unknown values. There were also quite a few candidates who gained 1 mark for identifying one of the two unknowns correctly. Incorrect responses included a range of different numerical answers.

(b) This part of the question asked candidates to work out the turning points of the curve. Having been given $\frac{dy}{dx}$ in part **(a)** of the question, candidates needed to equate this to 0, solve for x and substitute to find the corresponding y values. Candidates who attempted the question were generally able to equate $\frac{dy}{dx}$ to 0 and then attempted either factorisation or use of the quadratic formula in order to solve to find x. Errors in factorisation and in the use of the formula were seen. Similarly, where candidates reached correct x values, it was not unusual to see an incorrect y value obtained. Where candidates did not know to equate $\frac{dy}{dx}$ to 0, there were instances of long tables of values being calculated or answers which appeared to be guesses. Around a third of candidates did not attempt this question.

Question 23

This question on simplifying an algebraic fraction differentiated well between candidates. The best responses showed clear working, with correct factorisation of both the numerator and denominator of the fraction and then cancellation to the correct final answer. Some candidates were able to factorise the numerator by taking out a common factor of $2x$, or the denominator by using difference of two squares, and gained 1 mark. In attempts to factorise the numerator, some candidates only took out a factor of 2 rather than $2x$, and in other cases candidates attempted to factorise into two pairs of brackets and struggled with the absence of a constant term. In attempts to factorise the denominator the most common error was to have a sign error in one of the two brackets, for example $(x - 5)(x - 5)$. A common incorrect approach was to cancel terms from the numerator and denominator in a pairwise fashion, for example subtracting x^2 from both numerator and denominator to give $\frac{x^2 + 10x}{-25}$.

MATHEMATICS

Paper 0580/22
Non-calculator (Extended)

Key messages

To succeed in this paper, candidates need to have completed full syllabus coverage, remember necessary formulae, show all working clearly and use a suitable level of accuracy. Candidates are reminded of the need to read the questions carefully, focusing on instructions and key words. Candidates also need to check that their answers are accurate, are in the correct form and make sense in the context.

General comments

It is generally expected that candidates show some mathematical working. This is particularly important if a question is worth more than 1 mark and they make an error. Without working shown, they are usually unable to score any method marks.

Candidates should write all numbers clearly and legibly. Several examiners commented that there were many illegible numbers seen and therefore they were unable to give credit for some answers. If a candidate wishes to amend an answer, they are advised to clearly delete the first attempt and replace it completely. Overwriting one or more digits makes answers very difficult to read.

When candidates use extra sheets or write on the blank page in the question paper, they should clearly indicate which question the working is related to.

The standard of the whole paper was generally very good, and most candidates adapted well to a change to a non-calculator paper. A small number of candidates were unsure of how to address the non-calculator nature of the paper. For example in **Question 21(a)** some felt they needed to give a decimal equivalent to $\sqrt{3}$. There is some evidence that the less able learners found the non-calculator paper harder due to poorer arithmetic skills; for example, in **Question 13(a)(i)** it was very common to see 50×40 evaluated as 200.

There was little evidence that candidates were short of time as almost all answered at least one or two of the last three questions. Where candidates had omitted question parts, this appeared to be due to insufficient knowledge rather than time constraints. Non-response was far more common in **Question 15(b)** and **21(b)(ii)** than in the last three questions.

Candidates occasionally had difficulty giving answers in the required form, in particular on **Questions 10** and **16**, where some candidates incorrectly either included or omitted π. In **Questions 9(b)**, **18(b)**, **20(b)**, candidates were also asked to find particular values, and in many of those cases non-numerical answers, or answers of an incorrect form, were offered.

Candidates who did less well on this paper generally left many questions blank, or did not read or interpret questions correctly. They showed a familiarity with topics but not a good understanding of them, showing little or no working out or attempting a variety of methods without clearly identifying their final method by crossing out work they did not want marking.

Candidates performed particularly well on **Questions 2(a)**, **3**, **4(a)**, **6** and **7(a)**, showing they had a good understanding of scale drawings, angles, probability, solving linear equations and sequences.

Areas for development are the topics from **Questions 9(c)**, **15(b)**, **20(b)**, **21(a)**, **21(b)(ii)** and **23**, showing more practice is required on the topics of position vectors, asymptotes, proportion problems and understanding cubic graphs, particularly roots and turning points.

Comments on specific questions

Question 1

(a) There were a high number of incorrect answers. Often the idea of the line of symmetry being a diagonal of the square did not seem to have been considered, as some drew a vertical or horizontal line on their diagram then offered no answer or shaded more than one square. Many seemed to be trying to find rotational symmetry instead of reflectional symmetry. The most common incorrect answer, which was almost as common as the correct answer, was to shade the third square from the right in the bottom row to create a shape with rotational symmetry of order 2. Not everyone who made a slip and tried to correct it made their intentions clear – candidates are advised to use a pencil rather than a pen in diagrams.

(b) This part was generally well done, with many candidates selecting the correct square, though some shaded more than one square contrary to the instructions. A few candidates seemed confused and produced solutions in part **(a)** that had rotational symmetry and in part **(b)** that had one line of symmetry.

Question 2

(a) Most candidates were able to score well on this question with answers within range, the most common being 4.5 or 4.55 found from measurements of 9 cm or 9.1 cm respectively. More able candidates clearly showed their calculation although for a small number this was incorrectly evaluated (e.g., by doubling to 18 rather than halving to 4.5). A very few measured accurately but then in halving their length reached the answer of 45 instead of 4.5.

(b) Candidates found this part harder than part **(a)**; about a third of them were unable to find the correct bearing. However, the most commonly seen answer was the correct bearing of 110°, whilst some less accurate candidates were still able to score the mark with an answer between 108° and 112°. Rather than from inaccurate measuring, the most commonly seen incorrect answers appeared to be from incorrect use of protractors (using the wrong scale) with 70°, or sometimes 250°, which was seen a number of times. Occasionally 110° or 70° were seen mistakenly subtracted from 360° or added to 180°, whilst others were perhaps finding the bearing of P from Q rather than of Q from P as asked.

Question 3

This was generally a very well-answered question, with candidates showing a good knowledge of working with angles and parallel lines. The majority of candidates scored full marks on this question and of those who did not, most at least gained 2 marks by getting one answer correct. The more able candidates made good use of the diagram with relevant correct angles annotated. The most successful approach was to use vertically opposite angles, followed by using the angle sum of 180 for the internal triangle or corresponding angles, followed by angles on a straight line, in order to reach $x = 70$. Whilst some candidates were unable to follow these processes, many marks that were lost were the result of calculation errors in subtracting from 180. Those that scored 1 or 0 typically had less supporting working and some even just had the answers on the answer line, so had no opportunity for partial marks.

Question 4

(a) Another well-answered question, with the majority of candidates giving the correct answer of $\frac{4}{7}$. It was rare to see other equivalent answers as most candidates sensibly left their answers as fractions rather than converting to a decimal or percentage. Candidates that indicated the odd numbers in the list by circling or ticking them were successful. The most common incorrect answer was $\frac{3}{7}$ which could have arisen from mistaking odd for even or miscounting. A small number of candidates gave a whole number as the answer.

(b) Candidates generally followed through from a correct part **(a)** to achieve this mark. Of those who did not achieve part **(a)**, some managed to achieve the follow through mark, particularly when the response for **(a)** was $\frac{3}{7}$. Candidates who did not gain this mark often gave the answer $\frac{20}{35}$ rather than 20 or they did not complete the calculation to reach an integer answer and gave their answer as $\frac{140}{7}$. Others incorrectly multiplied both the numerator and denominator by 35 for an incorrect response but arithmetical mistakes were less common.

Question 5

(a) This part was generally well attempted, with many candidates correctly applying the translation. However, a small number of responses revealed a misunderstanding of the direction, as some candidates incorrectly translated the triangle along the direction of the *x*-axis instead of the y-axis. Another error was to count 2 squares down from a bottom corner and start to draw the top of the triangle from there. There were also a few candidates that translated triangle *U*.

(b) Many candidates showed clear understanding of what was needed and scored all 3 marks. Those candidates who scored 2 marks normally did so for rotation with an accurate direction and angle. There were some who were confused about direction, with clockwise 90 being a common error. The centre of rotation proved the most difficult part for candidates to get right, with (0, 0), (0, 1) or (1, 0) being common wrong answers. There were a few who identified the correct centre but then spoilt this by giving it as a vector. A few candidates also spoilt their answer by using two transformations, usually rotation and translation; however, this was seen far fewer times than in previous years.

Question 6

(a) Almost all candidates could solve the equation correctly. A small number gained 1 mark for showing working but made an arithmetic slip in 39 – 7 or in the division of 32 by 8. Those who did not score were generally adding 7 to 39, but this was rare.

(b) The vast majority of candidates answered this part correctly. Most chose to expand the brackets first, occasionally forgetting to multiply –1 by 2. A small number of candidates proceeded to rearrange incorrectly and subtracted 2 from both sides of the equation instead of adding 2. In the final stage, the majority divided correctly after isolating the term in *y*, but subsequent errors in cancelling the fraction were sometimes seen, either to another fraction or a decimal. The majority of candidates set out correct line-by-line working but there are still those who show the next step in the same line. This is always discouraged in case there is any incorrect working which invalidates a correct step: for example, the working $10y - 2 = 24 - 2$ would indicate that the candidate has carried out a first correct step and intends, incorrectly, to subtract 2 in the next step. However, this is not a correct line of working and as such cannot be awarded a mark.

Question 7

(a) Almost all candidates found the next term correctly. Most of those who scored the mark showed how they obtained the common differences, which they used to obtain the next term in the sequence. A few found a term before the start of the sequence, using 11 + 3 to give a wrong answer of 14, and some added 3 to give an answer of 5. A small minority also gave the nth term instead of the next term, but many corrected this presumably when they reached part **(b)**.

(b) Candidates who simply wrote down their answer from the term-to-term difference and the 'zero term' mostly gave the correct answer. The method used for finding the common difference was clear, however some candidates made the error of using the common difference as 3 instead of –3, which led to answers of 3n + 14 or 3n – 8. Those who used the formula $a + (n - 1)d$ were more likely to make mistakes, by mixing up the first term and common difference, by using the wrong formula, for example $a - (n + 1)d$, or by writing 11 + (n – 1) –3, and then subtracting 3 rather than multiplying by –3. Those who used brackets around negative values were less likely to make this mistake. There were also difficulties with expanding the brackets correctly.

Question 8

Most candidates scored full marks on this question by identifying the prime factors of each number, using factor trees or tables, and using these to identify the highest common factor. Not all candidates were then able to use the product of prime factors to derive the correct answer of 18 and the most common incorrect answers seen were other common factors, notably 9 and 6. Some candidates confused highest common factor with lowest common multiple, and an answer of 108 was common. This was sometimes after correct factor trees or after a combined factor tree that displayed non-common factors in the left-hand column.

Question 9

This question, as a whole, was quite challenging for candidates. It would be beneficial for candidates to practice the routine methods involved with vectors and vector notation.

(a) More able candidates did better on this question and the majority were able to achieve at least one mark by finding $\overrightarrow{AC} = \begin{pmatrix} 4 \\ -8 \end{pmatrix}$. A common error was to write (4, –8) as the final answer from the result of $\overrightarrow{AC}$. Following a correct $\overrightarrow{AC}$, the most common error was to subtract, either $\overrightarrow{OA} - \overrightarrow{AC}$ to reach the answer (–1, 7) or $\overrightarrow{AC} - \overrightarrow{OA}$ to reach the answer (1, –7).

(b) This question was a good discriminator. Many candidates recognised that Pythagoras' theorem was required, although some did not use vector $\overrightarrow{AB}$, using the coordinates of *A* instead. Some candidates successfully found the length of *AB* but did not simplify the surd correctly, leading to a common incorrect answer of 4 from $\sqrt{20} = 4\sqrt{5}$. Some wrote a negative number without brackets under the square root sign, $\sqrt{2^2 + -4^2}$, which alone could not gain any credit but was often recovered with the correct values of 4 + 16 or 20. In some cases, the general formula to use coordinates for calculating length was written but candidates were not able to apply the formula to calculate the length of the vector. Some did find the coordinates for point *B*, but sign errors were often made within the formula or the coordinates of point *B* not correctly found. This inefficient method showed a lack of understanding of the meaning of a vector. Some candidates did not fulfil the demand of the question to give the value of *k* and so could not be awarded the final mark for an answer of $2\sqrt{5}$. Just over 10 per cent of candidates offered no response to this question.

(c) Only the most able candidates gave the correct answer for this part of the question: less than 30 per cent scored 2 marks and about 15 per cent offered no response. Those who drew a diagram, even if not at all to scale, tended to demonstrate better understanding of the question. It was quite common to achieve a vector of $\begin{pmatrix} 0.5 \\ -1 \end{pmatrix}$ but then not add this to the position vector of A.

Less able candidates misunderstood the ratio, and worked with a multiplier of $\frac{1}{3}$ or 3. A few candidates did not multiply $\begin{pmatrix} 2 \\ -4 \end{pmatrix}$ correctly by $\frac{1}{4}$; for example treating the vector $\begin{pmatrix} 2 \\ -4 \end{pmatrix}$ as a fraction and reaching an result such as $\begin{pmatrix} 2 \\ -16 \end{pmatrix}$.

Question 10

Just over half of candidates scored 1 or 2 marks on this question; this question was a good discriminator, as the more able candidates were generally more successful. The successful candidates used efficient non-calculator methods and cancelled fractions before multiplying, for example following $\frac{45}{360} \times 36$ with $\frac{45}{10} \times 1$. A large number of candidates set up the correct calculation and gained the method mark but then could not evaluate it correctly. A common error was to write $\frac{45}{360}$ as 8 instead of $\frac{1}{8}$, and many calculations involving multiplication of large numbers were seen. Here, candidates did not seem to recognise that the resulting very high values did not make sense when comparing with the length of 18 cm for the radius. The arc length is unlikely to be, for example, 50 times the length of the radius. Some candidates multiplied by 3.14 or $\frac{22}{7}$ and sometimes divided by the same value at the end of their calculation; these candidates were mostly unsuccessful. Candidates are advised, on a non-calculator paper, to avoid the use of 3.14 or $\frac{22}{7}$ and to use π in calculations such as these, particularly when the question tells them to. Those who did not gain any marks were usually using an incorrect formula, often missing the 2, using 9 rather than 18 or using the area of a circle. Less able candidates did not understand the question and multiplied 45 by 18 or used a formula involving sin45. Once again, many candidates did not read the demand and included π in the answer when the question asked for the value of n.

Question 11

(a) The majority of candidates were familiar with writing a number in standard form and many of these went on to score the mark. The most common error was for candidates to replace the power of –3 with +3, and 708×10^5 was also seen a number of times.

(b) Candidates generally found this part of the question difficult. Successful candidates usually changed one of the original values so that it had the same power as the other. This usually then led them almost straight to the correct answer. Among those who did not obtain full marks, several gained 1 mark for correctly calculating the sum but then did not express it in correct standard form. 41.8×10^{22} was a common incorrect answer, and a mark was often awarded for an answer containing the figures 418. Less able candidates tried to process the number and the power separately, resulting in 7.6 from adding or 14.44 from multiplying, combined with powers of 10^{44} or 10^{45}. 7.6×10^{45} was a very common answer, almost as common as the correct answer. It appeared that some candidates were not confident with adding two numbers with different powers of 10 and tried to evaluate the answer by converting both standard form numbers to ordinary numbers, carrying out the addition, and then converting back to standard form. In most cases this did not result in the correct answer being found because of incorrect place value due to the very large number of zeros they needed to write down.

Question 12

Only a small minority of candidates were able to score full marks on this question. The majority of candidates, however, were able to correctly give the size of angle *PRQ* as 16°. A small number, however, seemed to think that the triangle was isosceles and reached an answer of either 74° or 32° (or 74°, wrongly stating there were angles in the same segment). Others subtracted the given angle from 180° and gave the answer 106°. Candidates were asked for geometrical reasons (not just a single reason), but many candidates offered just one of the two required reasons, omitting either that the sum of angles in a triangle is 180° or that the angle in a semicircle is 90°. Where appropriate reasoning was attempted, it did not always include sufficient appropriate equivalent wording, such as omitting ‘angle’ or reference to a ‘semicircle’. Candidates would be well advised to use standard wording directly from the syllabus (such as ‘angle in a semicircle’) rather than their own descriptions such as ‘the angle opposite the diameter’, which on its own is not sufficiently robust. A small number of candidates missed the demand for geometrical reasoning and instead gave calculations, which are not an acceptable alternative to reasoning.

Question 13

(a) (i) Under two thirds of the candidates scored full marks in this question. There were many arithmetic errors, but the majority of candidates were showing well-presented working so that all 3 method marks could be awarded. Candidates struggled with place value in the multiplications, and it was common to see, for example, $30 \times 30 = 90$ or $50 \times 40 = 200$. A minority of candidates used either the lower or upper value in the class boundary rather than the midpoint. It was more common to see the class widths being multiplied by the frequencies. The least able candidates summed some values, for example the midpoints or the class widths, and divided by 3.

(ii) Many candidates were awarded both marks in this part of the question, with most gaining at least 1 mark for a correct height of 2 at 40 to 60 seconds. Some calculated the correct frequency density of 0.75 for the second bar but were not accurate in drawing it, putting the height on the graph at 0.7

or 0.8. A common error was to divide the class width by the frequency; for example, for the bar at 40 to 60 seconds, dividing 20 by 40 gave a height of 0.5 instead of 2. Many candidates did not show any working for the frequency densities, which could have gained a mark if the graph was drawn inaccurately.

(b) (i) The majority of candidates understood how to draw a cumulative frequency curve or polygon and used the correct upper boundary with accurate plotting. Some did not gain the mark for the curve as they were too inaccurate with their plotted points. Very few made the error of plotting at the midpoints for the times. The point at (20, 0) was the one most often missed out. There were a number of bar graphs or lines of best fit drawn, which lost the marks in this part but also created problems in the following parts, as those were dependent on the correct type of graph drawn.

(ii)(a) The majority of candidates understood that they had to read the time corresponding to a cumulative frequency of 40 and did this accurately. Follow through marks were available providing they had drawn an increasing curve in part **(b)(i)**. The most common error here was candidates incorrectly reading the scale, where each small square on the horizontal axis was read as 1 second not 2 seconds, meaning often 61 was given as an answer when it should have been 62. Less able candidates gave the answer 40, rather than understanding that the value required was the time.

(ii)(b) This part was slightly more challenging than the previous part, although again most candidates understood that they had to read the time corresponding to a cumulative frequency of 20 and did this accurately. There were similar problems here with the scale, with 43 instead of 46 often given as an answer. Again, follow through marks were available providing they had drawn an increasing curve in part **(b)(i)**. Less able candidates gave the answer 20, rather than understanding that the value required was the time. A few candidates tried to find the interquartile range instead of the lower quartile.

Question 14

A large majority of candidates used a successful strategy to convert the recurring decimal to a fraction, most commonly by multiplying by both 100 and 10 and then subtracting. Some candidates multiplied by 10 and then subtracted, proceeding to $\frac{2.3}{9}$, which was sometimes not converted to a fraction with integers. A small minority of candidates multiplied by 1000, often leading to the correct answer $\frac{253}{990}$. Arithmetic errors in the subtraction were occasionally seen, particularly when candidates only multiplied the given decimal by a single multiple of 10, with some candidates obtaining answers of $\frac{25}{90}$ from 25.55… – 0.2555… = 25. The more successful candidates correctly lined up the values before the subtraction, which often prevented such errors. Some candidates misinterpreted the given decimal as 0.25 or $0.\dot{2}\dot{5}$, leading to common incorrect answers of $\frac{1}{4}$ and $\frac{25}{99}$.

Question 15

(a) This question was answered correctly by most candidates. A very common error was (0, 2) instead of the intended point.

(b) This question was the most challenging part of the paper with about a quarter of candidates making no attempt. Very few candidates got one asymptote correct and even fewer two. Less than a fifth of candidates scored any marks. Some candidates muddled the x and y and gave them reversed, i.e. $x = -1$ and $y = 0$. There was a wide variety of answers, the most common being $y = x$, $y = -x$, $y = \frac{2}{x}[-1]$, $y = \frac{2}{-x}[-1]$ and $y = \tan x$. Many gave numerical values only rather than an equation. Others gave answers as inequalities. A few candidates gave answers of $y \neq -1$ and $x \neq 0$ rather than the correct equations of the lines. Those who scored 1 mark normally had $x = 0$ correct often with $y = 0$ as the other answer.

(c) This part also had a high omission rate, although not quite as high as part **(b)**. Many candidates were unsure which line needed to be drawn on the graph, resulting in either incorrect line placements or no line drawn at all. Common incorrect lines were $y = -x$ or a line between (–2, 0) and (0, 2) or (–2, –2) and (2, 0) or other combinations of these coordinates. Others tried drawing tangents on both sections of the curve. Some did gain a follow through mark for correctly giving the two values where their line crossed the curve; however, many made mistakes in reading the scale used on the axes. Instead of using the graph as intended, many candidates attempted to solve the equation algebraically by forming a quadratic equation. While this approach led to correct values obtained in a few cases, most candidates struggled to apply it successfully. Some candidates were able to find a correct value for x, normally $x = 1$, without showing working.

Question 16

This question was a good discriminator. It was answered well by the more able candidates with fully correct answers regularly seen. However, partially correct methods were very common on this question too. Method marks were nearly always gained for these incomplete methods. The majority of candidates scored at least 1 mark. Although full marks were awarded frequently, 2 marks was awarded most commonly for this question. Common errors seen included calculating the surface area of the cylinder using the formula $2\pi rh + 2\pi r^2$ and forgetting that the top of the cylinder was joined to the bottom of the hemisphere. Some candidates used the formula for the surface area of a sphere and forgot to divide by 2. Some candidates calculated the surface area of half a sphere correctly using $\frac{4\pi r^2}{2}$, and the curved surface area of the cylinder correctly using $2\pi rh$, but forgot to add the circle on the base of the solid. There were quite a lot of arithmetic errors, particularly among the less able candidates, as candidates did not have a calculator to evaluate the coefficients of π. However, these candidates had often already shown the correct substitution to gain the relevant method mark. There were a few candidates who only gained 1 method mark from calculating the surface area of a complete sphere using $4\pi r^2$ and the curved surface area of the cylinder using $2\pi rh$. Only able candidates successfully combined all three of these to get 168π and some candidates missed the final mark as they gave their answer as 168 instead of 168π. A small number of candidates chose to replace π with 3.14 or $\frac{22}{7}$. Candidates are advised that this approach is not sensible in questions like these when answers are required in terms of π. This issue was less common in this question than in **Question 10**. Less able candidates struggled with the non-calculator aspect of this paper in different ways. It was common to see incorrect working such as dividing more than one factor of an expression by 2, for example $(4\pi \times 36) \div 2$ often became $2\pi \times 18$. Others were unsure how to add expressions in terms of π; it was common, particularly among the less able candidates, to see incorrect simplifications such as $2\pi36 + 2\pi30 = 4\pi66$.

Question 17

(a) This part of the question was well attempted with many reaching the correct answer of 25. Those candidates who were most successful in this question wrote $\left(\sqrt[3]{125}^2\right)$ as their starting point, realising they needed to take the cube root first, and then often reaching the correct answer. A small number of candidates left their answer as 5^2 or evaluated this to 10. The less successful candidates did not consider the most sensible strategy for a non-calculator paper, and attempted to square 125 first, then take the cube root of the result. The less able candidates did not demonstrate the required understanding of indices and instead calculated $125 \times \frac{2}{3}$.

(b) Candidates struggled to deal with the negative power appropriately in this question, with fewer than half scoring full marks. Many candidates were able to calculate $4^{\frac{5}{2}}$ as 32 but then wrote their final answer as –32 or 32. Some candidates reached $\frac{1}{2^5}$, but then made numerical errors resulting in a final answer of $\frac{1}{16}$ or $\frac{1}{64}$. Another common approach was to reach 2^{-5} correctly, but then to give this as their answer or to make no correct step after this point. Many candidates could not interpret the separate parts of the index, and interpretations included $4^{\frac{2}{5}}$, $\frac{1}{\sqrt[5]{4^2}}$ and $\frac{1}{4^5}$. The less able candidates multiplied 4 by $-\frac{5}{2}$.

Question 18

(a) A large number of candidates demonstrated a correct method of multiplying by $\frac{\sqrt{3}}{\sqrt{3}}$, although some did not simplify correctly. Some left the answer as $\frac{9\sqrt{3}}{3}$ or $\frac{3\sqrt{3}}{1}$ and others could not deal with multiplying the surds correctly. Some used a correct alternative of multiplying by $\frac{-\sqrt{3}}{-\sqrt{3}}$, but this was much less successful as many did not deal with the signs correctly in the simplification, or followed with $9 - \sqrt{3}$ as the numerator. Common errors from less able candidates were to multiply by 3 or $\sqrt{-3}$, or to square the fraction.

(b) This question was one of the best discriminators on the paper, with the more able candidates performing best. Manipulating surds seemed to be challenging for many candidates. It was common to award 1 mark in this question as many candidates made a good start when multiplying out the brackets, usually for getting the terms 5, $15\sqrt{2}$ and $-\sqrt{2}$ correct but not $-3\sqrt{2}\sqrt{2}$ which was often $-3\sqrt{2}$. The most common misconceptions for candidates were to think that $\sqrt{2}\sqrt{2}$ was equal to 4 or $\sqrt{2}$. It was also apparent that many candidates did not realise that they had to equate the terms on the LHS and RHS to find *c* and *k*. Attempts at rearranging an equation in terms of *c* and/or *k* were generally unsuccessful and led to some complex algebraic expressions on the answer line; some did not realise that what was required was to multiply out and simplify to $-1 + 14\sqrt{2}$ in order to equate to $c + k\sqrt{2}$ and reach the final answer $c = -1$ and $k = 14$.

Question 19

(a) This part of **Question 19** was the least well-answered part. Although many candidates did obtain a correct fraction, fully simplifying it was a problem for many. The answer was often given as $\frac{15ab}{6a}$, $\frac{5ab}{2a}$ or $\frac{15b}{6}$. A minority of candidates did not leave their answer as a fraction and instead gave an answer of 2.5*b*; this was not the required form requested in the question. Some candidates added the fractions instead of multiplying, leading to $\frac{5a^2 + 18b}{6a}$, or attempted to write the fractions over a common denominator before multiplying. This was generally unsuccessful as candidates were then unable to manipulate the expression they found.

(b) Most candidates obtained the correct answer, although candidates sometimes left their answer as an unsimplified fraction such as $\frac{4p + 6t}{8}$. There were a significant number of candidates who spoiled the correct answer by incorrectly cancelling individual factors in the numerator and the denominator, often obtaining a final answer of $\frac{p + 3t}{2}$. Others spoilt a correct step of $\frac{2p + 3t}{4}$ with an incorrect answer of $\frac{5pt}{4}$. A very small number of candidates did not use a common denominator, instead summing the denominators to give 6.

(c) This question was generally well answered, with candidates who worked step by step often obtaining the correct answer. Candidates who did not obtain the correct answer usually gained partial credit for either the correct numerator or denominator, with the correct denominator seen most often. Incorrect expansion of the numerator was common, with some candidates expanding $-3(x - 2)$ as $-3x - 6$. A few candidates chose to needlessly expand the denominator, sometimes making errors that cost them the final mark. Following a correct fraction, either unsimplified or simplified, some candidates then incorrectly cancelled x from terms in the numerator and denominator.

Question 20

(a) There were many concise fully correct solutions. The most common and most successful strategy was to introduce a constant of proportionality, i.e. k, to form an equation, then substituting in the values of x and y to find k. This then formed an equation which was correctly used to find y when x was known. Some errors in rearranging were seen when finding the value of k but the majority of candidates showed full working and so could gain method marks. Some candidates chose to keep the proportion symbol in all the lines of their working which, if their answer had been incorrect, would not have scored any partial marks. Errors were made by some candidates in setting up the initial relationship where direct proportion, usually written as $2 = \frac{k}{\frac{1}{\sqrt{9}}}$, or omitting the root was seen. Less able candidates did not consider a constant of proportionality and wrote $y = \frac{1}{\sqrt{9}}$ and $y = \frac{1}{\sqrt{36}}$, giving an answer of $\frac{1}{6}$. A small number of candidates tried to use an entirely numerical approach without any algebra at all but usually did not reach a correct solution.

(b) This part was very challenging for most candidates; very few were awarded the mark and many did not attempt this part. It was clear that some candidates did not connect this question with the previous part. Some candidates did not apply the square root to 4 and gave $\frac{1}{4}$ as their answer. Some tried an algebraic approach, which meant that their answers contained both numbers and x, although most answers were numerical. A more successful approach, seen in some responses, involved choosing a fixed value for x, multiplying it by 4, and comparing the corresponding y values. Once again, not reading the demand of the question, to give the value of p, cost some candidates the mark as they gave an explanation such as 'divide by 2' or 'it halves'.

Question 21

(a) Fewer than a third of candidates were able to answer this question correctly. Many did not realise they needed to start by equating the equation of the curve to 0. Most commonly, the more successful candidates factorised to reach $(3 - x^2)$ for M1, although some were then unsure how to proceed. More able candidates were able to reach $\sqrt{3}$ for 2 marks but only the most able candidates were able to give both x-coordinates in the correct order. Some proceeded incorrectly from a factorisation, or $x^2 = 3$, to an x-coordinate of 3. The main reason the final mark was not gained was due to assigning $\sqrt{3}$ and $-\sqrt{3}$ incorrectly to A and B. A small number gave pairs of coordinates rather than the x-coordinates asked for. The most common reason for scoring no marks in this part was with the large number of candidates who gave the answers of –1 and 1 from equating the derivative of the curve to 0 (which was the required working for part **(b)**).

(b) (i) The concept of differentiation was clearly understood by the candidates as this part of the question was well answered. Full marks were awarded to a majority of candidates, with 1 mark given when they only differentiated one of the terms correctly. Those candidates who were awarded 0 marks usually tried to factorise the expression $3x - x^3$ instead of differentiating.

(ii) About a fifth of candidates offered no response to this part of the question; some of those had already differentiated and solved to reach –1 and 1 in part **(a)** so were not sure what was expected here. Of those candidates who did respond, many were able to achieve some success. Of those scoring 3 marks, many candidates reached the two correct *x*-values but others obtained one correct pair of coordinates. Some of those with two correct *x*-values had both pairs of coordinates but wrongly assigned to *P* and *Q*, not appreciating the difference between the local minimum and maximum points on the curve. A small number of candidates were unable to score full marks as they did not simplify their answers, for example leaving *P* as $(-\sqrt{1}, -2\sqrt{1})$. Some, having reached $x^2 = 1$, gave only one root, omitting the second x-value of –1. When mistakes were made in part **(b)(i)** some candidates managed to score at least one method mark by equating their derivative from **(i)** to 0. Candidates would be well advised to start by stating their clear intent that $\frac{dy}{dx} = 0$, as this would have gained them credit. Some candidates stopped at $1 - x^2$ and did not equate it to 0, meaning they made no further progress with this question and only scored 1 mark. Some of the least successful candidates in this question did not use their answer from part **(b)(i)**, instead equating the original equation to 0 (the work that was expected for part **(a)**).

Question 22

(a) A variety of answers were seen for this question, with the correct value often seen. Other common answers were $\frac{\sqrt{3}}{2}$, $\frac{1}{2}$ and $\frac{1}{\sqrt{3}}$. The majority knew the concept of 'exact value' and therefore wrote answers which contained $\sqrt{2}$ or $\sqrt{3}$, although a few candidates gave decimals including 1.7 or 0.33. Some candidates used their knowledge of the 90, 60, 30 triangle or used the identity $\tan x = \frac{\sin x}{\cos x}$, leading to unsimplified answers such as $\frac{\sqrt{3}}{1}$ or $\frac{2\sqrt{3}}{2}$ which were accepted in this question. Others had memorised the exact values and wrote a table showing these values, often written on the formula page. The latter was the most common and most effective method of gaining the correct answer. However, it was evident that many candidates did not have a method of deriving tan60 without a calculator.

(b) A significant number of candidates offered no response to this question. Of those candidates who did offer a response, the majority gained at least 1 mark for rearranging the equation to $\sin x = \frac{1}{2}$. Many could then convert this to x = 30 to gain 2 marks. A significant number of candidates who reached 30 then struggled to identify the second value within the given range. A common error was giving 330° (from 360° – 30°), indicating a misunderstanding of the symmetry properties of the sine function. Some reached 30 and then gave 2 different angles as answers, often 210 and 330, using the negative quadrants. The most effective methods in gaining full marks included sketching a sine graph or drawing the quadrant diagram. Candidates who did not relate sin30 to $\frac{1}{2}$ could still gain 2 marks if they understood that the resulting angles added up to 180, and the most common pairs of angles in this scenario were 45 and 135, along with 60 and 120.

Question 23

A significant number of candidates offered no response to this question. The most successful candidates began by writing the route $\overrightarrow{OA} + \overrightarrow{AM}$, then found $\overrightarrow{AC}$ as $\overrightarrow{AO} + \overrightarrow{OB} + \overrightarrow{BC}$, giving $-\mathbf{a} + \mathbf{b} + 3\mathbf{a}$, and then $\overrightarrow{AM}$ as half of that result. Quite often these steps were undertaken correctly but often the calculation stopped at $\overrightarrow{AM}$, which was being offered as the position vector (not all candidates understood what a position vector was, even though the principle was implied by the information given in the question). This was the most common incorrect answer. Sometimes $\mathbf{a} + \frac{1}{2}\mathbf{b}$ scored 2 marks if the candidate labelled it correctly as $\overrightarrow{AM}$ in the working, but it was more common to see incorrect labelling such as $M = \mathbf{a} + \frac{1}{2}\mathbf{b}$.

Many did not label any vector routes. It was common to see the unlabelled – **a** + **b** + 3**a** in the working followed by 2**a** + **b** then followed by **a** + $\frac{1}{2}$**b** as the answer. This scored 0 marks without labels. Others made mistakes with the direction of their vectors, so $\overrightarrow{CM}$ and $\overrightarrow{AM}$ were often viewed as being the same. Many thought $\overrightarrow{AC} = \overrightarrow{OB}$ even though they were clearly not parallel. Those who began with the starting point $\overrightarrow{OB} + \overrightarrow{BC} + \overrightarrow{CM}$ usually went wrong because they frequently used **a** + $\frac{1}{2}$**b** as $\overrightarrow{CM}$ instead of –**a** – $\frac{1}{2}$**b**. They still often scored 1 mark provided they wrote the correct route $\overrightarrow{OB} + \overrightarrow{BC} + \overrightarrow{CM}$ in their working, which not all did.

Question 24

This question was well-approached by just over half of the candidates, who correctly identified the need to form and solve a quadratic equation. Many candidates were then able to follow a correct procedure to find both coordinates correctly and score 5 marks. A few struggled with the final substitution and (–3, 18) was a common error seen, although normally with a correct (5, 38) for 4 marks. The method used for solving the quadratic was equally split between those factorising and those using the formula. A common error when factorising was to give $(x + 5)(x – 3)$ as the answer which resulted in sign errors when stating the values of x. However, these candidates normally scored 3 marks as they went on to correctly substitute their values of x into one of the original equations to score the SC mark. There were also sign errors and arithmetic errors when using the formula. Neither method was more successful than the other. Solving by completing the square was rarely seen. Very few candidates rearranged the linear function and substituted into the quadratic function, or tried to solve by substituting for x and finding y first. Of those not scoring full marks, a significant number achieved 0 marks. Those candidates scoring 0 marks usually offered a response although there were still many who did not attempt this question. Those who did not correctly equate attempted alternative methods, such as differentiation, substituting trial values, graphical sketching, or trying to solve the initial quadratic given. A small number of candidates tried to find solutions through completing tables of values and/or rough graphing. These were usually not successful, and it was clear time was not well-spent in doing this.

MATHEMATICS

Paper 0580/23
Non-calculator (Extended)

Key messages

Many candidates made errors in dealing with quadratic equations. They need to be able to expand two linear brackets and to factorise a quadratic expression into two linear terms. When solving a quadratic equation, candidates need to learn to select the most appropriate method, noting that it is rare for completing the square to be easier than either of the other two methods.

General comments

It is important to read a question carefully and to answer the question asked, find the information requested and to write it in the form required. It is particularly important to recognise square numbers, because when there is a square root of a square number, it should be easy to work out. Too many candidates leave square roots in their working when they could be calculated easily.

In manipulating algebraic expressions and equations, candidates need to ensure they apply the laws of algebra correctly and consistently. In trigonometry, it is useful to know the trigonometric ratios for the angles 0°, 30°, 45°, 60° and 90°, with the exception of tan90°.

Comments on specific questions

Question 1

This was usually answered correctly giving either 0.83, 83% or $\frac{83}{100}$. The few incorrect answers were either 17 or 1.83.

Question 2

Both values given were usually correct. Although many showed angle *CDA* as 76°, some candidates thought that *x*° and 70° were supplementary, giving an answer for *x* of 110°. Angle *y* was answered correctly more often than angle *x*, but a few thought that *y* and 76° were supplementary. There was also correct working seen but with arithmetical errors; where working was shown then the method marks were available.

Question 3

(a) Many candidates were unfamiliar with the concept of planes of symmetry in 3D shapes. The most common incorrect answer was 5, which may have come from confusion of planes with faces. Other candidates incorrectly identified the number of planes of symmetry as 1 or 2, failing to recognise that each plane must pass through the apex *E* and a pair of opposite sides or vertices of the square base.

(b) Many answered correctly but some gave incorrect answers of *C* and *D*, *A* and *B* or *A* and *E*.

Question 4

Many gave the correct answer of positive whilst others gave linear or proportional and a few negative. Some candidates did not answer at all.

Question 5

(a) This was answered well; some candidates gave a double transformation, with the second usually being a translation. A few answered with one-way stretch. When candidates gave enlargement, the centre was often (0, 0) rather than (1, 2). The scale factor was sometimes 2 or $\frac{1}{3}$ rather than 3.

(b) (i) This part was well answered; the most common error was to produce a reflection in the line $y = -1$.

(ii) This part was well answered; the most common error was to rotate the triangle using another centre, usually (0, 0). Some responses used the correct centre but rotated 90° anticlockwise.

Question 6

Many candidates showed the 6 in the top row and some showed the 8 in the bottom row, but very few showed the middle row correct; a common error involved the incorrect assumption that the modal length would be 3.7, based on the presence of two existing values at that length; it was therefore common to see four 7s, or two 7s and two 9s, in that row. Some engaged in unnecessary and lengthy calculations, and a reasonable number of candidates spent time copying out the stem-and-leaf diagram rather than adding their figures to the printed one, which was not the best use of time.

Question 7

(a) Most candidates answered this correctly using the method $\frac{10}{12} - \frac{7}{12} = \frac{3}{12} = \frac{1}{4}$; a common error was to leave the answer unsimplified as $\frac{3}{12}$. Some used common denominators which were multiples of 12, such as 72.

(b) This was well answered, with the most common method being $\frac{4}{3} \div \frac{8}{15} = \frac{4}{3} \times \frac{15}{8} = \frac{60}{24} = \frac{5}{2} = 2\frac{1}{2}$.

A common error was to give the answer as an improper fraction such as $\frac{5}{2}$, rather than as a mixed number. An alternative method involved equating the denominators and then simplifying, i.e.
$\frac{4}{3} \div \frac{8}{15} = \frac{20}{15} \div \frac{8}{15} = \frac{20}{8} = 2\frac{1}{2}$.

Question 8

(a) This was answered very well; the common errors seen were 2, 3 and 7 listed rather than written as a product, or 2×21 or 6×7. There were instances where candidates listed all the factors of 42, i.e. 1, 2, 3, 6, 7, 14, 21 and 42, instead of identifying only the prime factors. This indicates a lack of clarity about what constitutes prime numbers and the specific expectation of expressing a number as a product of its prime factors. A small number of candidates also gave 1 as a prime factor.

(b) This was answered very well; the common errors seen were answers of the factors 2 or 7, or the lowest common multiple 420. Many used appropriate methods such as listing factors or prime factorisation to arrive at the correct answer. Some used a single division table but many then misread this to give an incorrect answer.

Question 9

(a) Most candidates managed to rearrange the equation but unfortunately those using $-5x^2$ often made errors further on when solving their equation, and rarely gained any more marks. Some rearranged the equation correctly but were then unsure what to do from there. Those that failed to rearrange the equation correctly often went on to use incorrect values for a, b and c in the quadratic formula. The most common methods seen were factorising or using the formula. Only a small number attempted to solve the equation using the method of completing the square. Those who used the formula to solve their equation often made errors in calculating $b^2 - 4ac$, or left their answer in surd form as they failed to recognise 529 as a square number.

(b) Generally candidates produced either the correct answer or no answer at all; some answers of 0 and $-\frac{1}{6}$ were seen. Some attempted to solve the equation using the quadratic formula.

Question 10

Most candidates used a correct method to solve these equations. The most common method was to multiply the first and second equations by 3 and 4 respectively, then subtract the equations. Some candidates had problems with $-15y - (-8y)$, which many gave as $7y$ leading to $7y = 7$ and $y = 1$. Multiplying the equations instead by 2 and 5 did not lead to such a difficult subtraction. Some used substitution, but not all those who did use this method were successful. The most common error with substitution was around fractions arithmetic, such as $x = \frac{8+2y}{3}$ followed by $4\left(\frac{8+2y}{3}\right) - 5y = 13$, which was then often incorrectly simplified to $\left(\frac{32+8y}{12}\right) - 5y = 13$.

Question 11

(a) Most candidates answered correctly; the most common error was to see 10, 11 and 12 from adding 5 to the top line and 16, 17 and 18 from adding 6 to the previous line.

(b) Most candidates found this difficult; a common answer was $\frac{1}{15}$, from one 3 amongst 15 numbers in the grid, or $\frac{1}{3}$, from the three columns with 3 at the top of one of them. Other errors were $\frac{1}{9}$ or $\frac{2}{9}$, from the nine numbers in the grid.

Question 12

(a) Almost all answers were correct, and most errors were slips either from leaving out the minus sign, or writing 15 as 5. There was some confusion between vectors and coordinates which was evident in the responses here.

(b) A number of candidates could not correctly find point *J*; a common error was to subtract the vectors, i.e. $\begin{pmatrix}-3\\8\end{pmatrix} - \begin{pmatrix}7\\-2\end{pmatrix} = \begin{pmatrix}-10\\10\end{pmatrix}$, rather than add them. However, it was quite common for the correct vector $\overrightarrow{JK}$ to be given as the answer, demonstrating that many candidates did not understand the magnitude notation. Some candidates who obtained an incorrect point *J* did then correctly apply Pythagoras' theorem using their incorrect vector.

Question 13

(a) Most responses gave the correct angle of 120°, but the reason was usually not acceptable, either because the word 'cyclic' did not accompany quadrilateral or candidates did not use the phrase 'opposite angles'.

(b) Of the candidates who did not answer this part correctly, some did not realise angle *ABC* = 60°, while a few were not able to deduce that angle *ABD* = 35°.

Question 14

This question was answered well; the most common error was to find the highest common factor $3xy$. Candidates were able to get the lowest common multiple (LCM) of 15 and 18 but struggled to find the LCM of the algebraic parts.

Question 15

(a) Some common errors involved incorrect factorisation and failure to extract perfect square factors. Another common error was to add the surds directly, i.e. $\sqrt{27+12}$, leading to $\sqrt{39}$, indicating difficulty with simplifying or finding a common surd form. The most common misunderstanding was writing $\sqrt{12} = 4\sqrt{3}$ or $\sqrt{27} = 9\sqrt{3}$.

(b) In this part, candidates dealt with the square roots usually by writing $\sqrt{8}$ as $2\sqrt{2}$, or by dividing: $\sqrt{8} \div \sqrt{2} = \sqrt{4}$. A common error was to write $40\sqrt{8} = 40 \times 2\sqrt{2}$ and then $42\sqrt{2}$. Some candidates failed to fully process their answer and left it as $8\sqrt{4}$.

(c) Most candidates knew that they had to multiply both numerator and denominator by $3 + \sqrt{5}$. The main problem was multiplying the denominators correctly. Some candidates made an error with the sign and gave 14; others wrote –16, coming from 9 – 25. The most common error in rationalising the denominator was to multiply by $(3 - \sqrt{5})/(3 - \sqrt{5})$.

Question 16

The initial errors on this question included writing the number as 0.328328…, then labelling the number n and attempting to subtract, for example, $100n - 10n$, for which the repeating digits do not line up. Many candidates could not simplify the fraction that they had, such as $\frac{325}{990}$ or $\frac{32.5}{99}$. There was evidence that some candidates had memorised the method by rote, directly using $10x - x$, which led to results like $\frac{k}{99}$ or $\frac{k}{999}$.

Question 17

The most common error was to calculate $\frac{540}{60} \times 7 = 63$. The best method was $\left(\frac{H}{7}\right)^2 = \frac{540}{60}$, followed by $\frac{H}{7} = \sqrt{\frac{540}{60}}$ or simplifying first, leading to $\frac{H}{7} = \sqrt{9}$ then $H = 7 \times 3 = 21$. Those who did not find the square root wrote $\frac{H^2}{49} = 9$ then this led to $\sqrt{441}$, which was commonly left as the answer.

Question 18

Many candidates made one or two correct steps, usually multiplying by pt and expanding the brackets, leading to $2pt = m - mt$. The main error which followed was that candidates did not collect the terms with t together on one side of the equation. Many candidates proceeded to accidentally undo the steps they had just carried out. Some candidates kept fractions and terms containing t on both sides throughout their working. In addition, many candidates attempted two steps at once, often making errors that invalidated both steps.

Question 19

The numerator was factorised correctly more often than the denominator. Some factorised the denominator as $(x - 7)(x + 7)$ even when the numerator had been factorised as $x(7 - x)$. Those with incorrect factors such as $x(7 - x)$ and $(x - 7)(x + 7)$ tended to make further errors such as cancelling the factors $(7 - x)$ and $(x - 7)$.

Question 20

Many candidates found the length of the minor arc *AB*. Many others found the area of the sector rather than the length of the arc. Some candidates did not simplify their answer, particularly if they had as an answer $\frac{96}{9}\pi$. Some candidates attempted a valid method by subtracting the minor arc from the full circumference, but often made errors in simplifying their expression or left their answer in the form $12\pi - \frac{12}{9}\pi$.

Question 21

(a) There were many correct answers; common errors included $3x^2 - 6x + 1$ or attempts to factorise such as $x^2(x - 3) + 1$.

(b) Most candidates who completed part (a) correctly generally understood the concept that turning points occur where $\frac{dy}{dx} = 0$ and used appropriate methods, usually factorising, to find the required points. Most errors were arithmetic, especially when calculating the *y*-values corresponding to correct *x*-values. Some used the second derivative of $6x - 6$, getting $x = 1$.

Question 22

(a) Almost all responses gave the correct answer of 11. A few candidates thought the question was asking for 3f(*x*) and gave the answer $6x + 15$ or $21x$.

(b) Most candidates started by writing $x = 2y + 5$. There were some errors in the manipulation, such as $2y = x + 5$. Some gave the correct expression but labelled as *y*. Other incorrect responses included, for example, $-2x - 5$, $\frac{5 - x}{2}$ and $\frac{1}{2x+5}$.

(c) For most candidates the starting point was $2(x - 4) + 5 = 25$. Some made errors in manipulating the equation, the most common being $2x - 8 + 5 = 25$ leading to $2x + 5 = 25 - 8$. The main error at the start was to treat fg(*x*) as a product of two functions, writing it as $(2x + 5)(x - 4)$ and then multiplying out this expression.

(d) Most candidates struggled with this part. The best method began with $x = \text{h}(2)$. It was not uncommon to see an answer of $\frac{1}{25}$ or $\sqrt{5}$. Other incorrect methods seen were $\frac{5}{x} = 2$, $5^{\frac{1}{x}} = 2$ and $\sqrt[x]{5} = 2$.

Question 23

(a) The most common error was to answer 1; other values given were $\frac{1}{2}$, $\frac{\sqrt{3}}{2}$, $\frac{1}{\sqrt{3}}$ and $\frac{\sqrt{2}}{2}$.

(b) It seemed that many candidates thought that the hypotenuse of the lower triangle was equal to *x* as well, possibly interpreting both triangles as being congruent; however, the triangles are not congruent but similar. Therefore, many statements such as $x = \frac{n}{\sin 30}$ and hence an answer of $2n$ were seen. Some candidates reached the hypotenuse of the lower triangle of $2n$, but where the next step should have been $\cos 30 = \frac{2n}{x}$ which rearranges to $\sqrt{3}x = 4n$, after finding the hypotenuse of the lower triangle many candidates could not write an expression involving the upper triangle to find *x*.

Question 24

(a) (i) Most candidates did answer correctly. Many wrote their answer as a coordinate such as $\left(\frac{a+b}{2}, \frac{39}{2}\right)$, rather than giving the answer as requested.

(ii) The best method was to write the gradient as $3 = \frac{27-12}{b-a}$ and to manipulate this to make *a* the subject. There was an alternative method using $y = mx + c$, but this required more working. The most common error was to write the numerator and denominator of the gradient the wrong way round, i.e. $3 = \frac{b-a}{27-12}$.

(b) The best method involved the use of ratio to form equations such as $x = 23 - \frac{5}{2}(23 - 22)$ and $y = 39 - \frac{5}{2}(39 - 34)$. Some candidates used vectors, and if they obtained the vector $\begin{pmatrix} 2.5 \\ 12.5 \end{pmatrix}$ then they would usually obtain the correct answer after attempting $\begin{pmatrix} 23 \\ 39 \end{pmatrix} - \begin{pmatrix} 2.5 \\ 12.5 \end{pmatrix}$. Some found this vector, but subtracted it from an incorrect position vector. An incorrect starting point for many was to begin to find the length of *DE* as $\sqrt{(23-22)^2 + (39-34)^2}$ or $\sqrt{26}$. Subsequent attempts to use this length to find the missing point were carried out with very little success.

MATHEMATICS

Paper 0580/31
Calculator (Core)

Key messages

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

General comments

This paper gave all candidates an opportunity to demonstrate their knowledge and application of Mathematics. The majority of candidates completed the paper and made an attempt at most questions. The standard of presentation and amount of working shown was generally good. Centres should encourage candidates to show formulae used, substitutions made, and calculations performed. Attention should be paid to the degree of accuracy required in particular questions. Candidates should be encouraged to avoid premature rounding in workings as this often leads to an inaccurate answer and they are then unable to gain the accuracy mark. Candidates should also be reminded to show all steps in their working for a multi-stage question and should be encouraged to read questions again to ensure the answers they give are in the required format and answer the question set. Candidates should use their calculator efficiently, though it is still advisable to show the calculation performed as transcription and miscopying errors can occur.

Comments on specific questions

Question 1

(a) This part was answered very well with nearly all candidates correctly working out the number of goals scored by team B.

(b) This part was again answered very well by the candidates, with most gaining full marks for a correct drawing representing 5 goals. Common errors were mistakes in addition or subtraction of the correct numbers, candidates should be reminded to use their calculators to check calculations done mentally or when using a pen and paper method.

Question 2

This question was generally well answered with the majority recognising the type of angle as obtuse. Common incorrect answers were acute, reflex or right angle.

Question 3

This question was answered very well with nearly all candidates correctly working out the square root of 1.96 as 1.4.

Question 4

This question was the most successfully answered on the whole paper, with nearly all candidates correctly working out the number of months in 5 years. The few errors seen generally included candidates working out the number of days in 5 years rather than months.

Question 5

(a) Around half of the candidates correctly identified the order of rotational symmetry of the shape as order 2. A significant number did not attempt the question.

(b) Candidates were more successful at drawing all the lines of symmetry on the shape, although a common error was to draw the correct two lines but also two incorrect diagonal lines. Most lines were drawn freehand and not always very accurately, but the intention was there and still gained full marks.

Question 6

This question was generally well answered with successful candidates using compasses and a ruler to construct an accurate triangle ABC. Many candidates gained one mark for an accurate triangle without arcs or did not use the compasses and drew arcs freehand. Candidates who did not measure or set their compasses inaccurately scored no marks.

Question 7

This algebra question was very well answered by most candidates who solved the equation correctly. Common errors were 54 (18×3), 15 ($18 - 3$) and 21 ($18 + 3$).

Question 8

(a) Most candidates successfully found the value of T by substituting the value of P into the equation. Common errors were not multiplying both terms in the bracket by 3 (leading to the common wrong answer of 176) and adding the 4 before multiplying by 3 (leading to 168).

(b) Fewer candidates were able to find the value of t by substituting the value of W and then solving. Common errors were adding 8 instead of subtracting 8 when solving and substituting 369 for t rather than W. Many candidates showed no working which meant those that did not round their answer correctly to 3 sig fig or did not give the exact answer of 90.25 scored no marks.

Question 9

This question proved difficult and demanding and was generally poorly answered, with few candidates able to represent the inequality on the number line. A wide variety of wrong answers were seen, including dots or vertical lines as end points (rather than circles), circles shaded the wrong way round, a line drawn with no circles and jumps drawn instead of a line. A significant number of lower attaining candidates did not attempt the question.

Question 10

This question was attempted by all candidates with approximately three quarters scoring full marks. Most candidates were able to correctly order 3 numbers with no working out shown. Candidates should be reminded that they need to give answers to 3 significant figures or more as those who wrote the numbers as decimals to 2 significant figures were unable to order correctly as two of their answers were both 0.41.

Question 11

This question was well answered, with the majority doing the necessary working in stages. Most successful candidates first added 10 hours and 55 mins to 07 30, to get 18 25. They then added the 16 hrs to find the arrival time of 10 25 on Wednesday. There were a variety of errors made; not considering am and pm accurately (so 18 25 became 6 25 am and a final answer of 10 25 pm), errors in adding minutes by using 100 mins in an hour instead of 60 mins and subtracting 16 hours instead of adding. The most common error was candidates writing out long lists of times – usually in jumps of 1 hour – but miscounting or missing a particular time in the sequence.

Question 12

(a) This question proved difficult for most candidates, with few able to give the gradient of line L as 5. Common errors were 5x, 8, 2 or –3. Many lower attaining candidates did not attempt the question.

(b) Candidates found writing down the equation of a line parallel to line L equally challenging with few correct answers seen. A significant number of candidates did not attempt this question. Common wrong answers were $y = 5x - 3$, $y = 3x + k$ and $y = -3x$.

Question 13

This question was well answered by around half of the candidates who measured and drew accurately a point 6 cm from A on a bearing of 105 degrees. Candidates were more successful at drawing the correct length rather than drawing the correct bearing. This question was attempted by nearly all candidates.

Question 14

Most candidates who gained full marks worked out the amount of flour needed for 70 cakes and then divided this by 500 to work out the number of bags, correctly rounding 3.15 to 4. A significant number of candidates made errors by using 225 g of flour for each cake. Many candidates did not take into consideration that Tom could only buy whole bags of flour and gave decimal answers or rounded down instead of up. An alternative method using how many cakes could be made from one bag of flour was regularly seen but this often led to inaccurate answers as most gave 1 bag = 20 cakes, rather than 22.2… cakes per bag.

Question 15

(a) This part was well answered with many candidates identifying graph E as the correct answer.

(b) This part was generally poorly answered with very few candidates able to identify graph B as the correct answer. Most common wrong answers were A or C.

Question 16

This multi-step area question was challenging for most candidates and was a good discriminator. Successful candidates generally found the area of the square and 4 triangles separately and then added correctly. Some able candidates realised that two of the triangles could be halved and rearranged to make the whole shape into a rectangle with width 7.8 cm and height 14 cm which led to a very concise method of $14 \times 7.8 = 109.2$. Most candidates gained one mark for a correct area of the square but made errors calculating the area of the triangles, often finding the height of the triangle incorrectly or not adding the correct number of triangles. Some lower attaining candidates calculated the perimeter of the shape instead of the area.

Question 17

This question about volume proved difficult and demanding and was another good discriminator, although a small number were able to score full marks. Able candidates selected and wrote down the correct formula from the formula sheet, but few were able to correctly rearrange to find the radius of the cylinder. Many were able to form an equation but then did not know how to use it or divided the volume by the height only. Some candidates who did substitute and rearrange correctly rounded prematurely, leading to answers of 4.72 or 4.7. A significant number of candidates did not attempt this question.

Question 18

This part was generally well answered, with the majority able to convert Thai baht to dollars. The most common error was to multiply by the exchange rate rather than divide.

Question 19

This part was generally poorly answered with very few candidates able to calculate the mean from the frequency table. Successful candidates showed each step well – multiplying the frequency by the number, adding the 4 results and dividing by 50. Common incorrect methods were to add up the frequency column and divide by 4 (giving the most common incorrect answer of 12.5), attempt to find the range using the highest and lowest frequency or divide by 4 instead of 50.

Question 20

Calculating the probability of picking a yellow sweet was very well answered by the majority of candidates. Most candidates attempted to add the probabilities for red, green and brown and then subtract this from 1. Errors occurred when candidates added the probabilities but did not check on their calculators or did not subtract the results from 1.

Question 21

This question about right-angled triangles proved difficult and demanding and was another good discriminator. Successful candidates used Pythagoras' Theorem and squared each of the sides given, subtracted and then square rooted. Some candidates understood the need to use Pythagoras but added instead of subtracting. Some lower attaining candidates just added the two numbers together or subtracted the total from 180. Many of the more able candidates attempted to use trigonometry, but this required using trigonometry twice and often candidates did not get further than calculating one of the angles.

Question 22

(a) Around half of the candidates were able to write the ratio in its simplest form. Common errors involved answers which included decimals e.g., 2 : 7.5 or 1 : 3.75.

(b) Calculating the total amount of money shared by Kamil and Lavik proved one of the most challenging questions on the paper. Only the most able candidates were able to use the difference in the ratio (4) to represent how much more Lavik receives than Kamil ($72) and therefore could work out that one part equals 72 ÷ 4 = $18 and the total amount being 14 × 18 = $252. The most common errors were adding the ratio (5 + 9 = 14) and dividing the difference by this (72 ÷ 14 = 5.14) or dividing the difference by 5 or 9. A large proportion of candidates did not attempt this question.

(c) This part was poorly answered, with the majority unable to use the formula for compound interest. Common errors included using simple interest, writing the multiplier as 1.35 instead of 1.035, or premature rounding of the 1.035^5 value, which led to an inaccurate answer. Another common error was that candidates did not understand that they needed to subtract the original value of $4000 to 'calculate the total interest' as asked in the question. A small number of candidates attempted to calculate the total amount each year for 5 years – often using the correct method five times but losing accuracy due to premature rounding.

Question 23

This question about percentage increase proved difficult and demanding for most candidates. The most common successful method involved finding the increase (1 380), dividing by the original amount (18 400) and multiplying by 100. Common errors were dividing by the new amount (19 780), dividing correctly but not multiplying by 100 or using a trial and improvement method to attempt to find the percentage, often leading to answers of 7% or 8%.

Question 24

Candidates found this question on similar triangles equally challenging. Successful candidates found the scale factor between the two triangles as 21 ÷ 12 = 1.75 and then used this to find AB (14 × 1.75). The most common error was to find the difference between 21 and 12 and subtract this from 14.

Question 25

Candidates were more successful at calculating the mass of the bar of gold with around half the candidates gaining full marks. Calculating the volume of the bar proved the most challenging – with many adding the dimensions instead of multiplying. Most candidates were able to use the formula given to find the mass by multiplying the density by their volume. A significant number of candidates did not attempt this question.

Question 26

(a) Completing the Venn diagram was challenging for many candidates although most were able to gain one mark for placing the number 6 in the correct place. Most candidates put 15 and 12 in the E and S circle and left the intersection blank – not recognising that some of the students who speak English also speak Spanish and vice versa. Some candidates used tally marks and scored no marks.

(b) Most candidates understood which part of the diagram represented the students who speak English but do not speak Spanish but as their total was not 28 were unable to gain the mark for this part.

(c) Understanding the notation n(EUS) was challenging for all candidates except the most able. Few candidates recognised this was the number of students in the circles (10 + 5 + 7 = 22) with most confusing it for the number of students in the intersection (5). Few candidates were able to gain the follow through mark as their total was not 28.

Question 27

Around a quarter of candidates were able to correctly complete the statement about the value of h. Most candidates did not understand the importance of the phrase 'correct to the nearest metre' and gave answers with whole numbers, e.g. 100 and 110 or 105 and 110 or 104 and 106. A few candidates gained one mark for answers of 104.5 and 105.4 or the correct answers reversed.

Question 28

(a) (i) Most candidates were able to find the missing values of y for x = 0, 1 and 4. For x = –3 however, candidates struggled to deal with the negative sign (often getting –7) and did not recognise the symmetry of the quadratic graph.

(ii) Candidates were successful at plotting their coordinates from their table in part **(a)(i)**. However, some candidates used a ruler to connect points or drew a curve missing the points by more than half a small square. Many curves were drawn in pen which made it difficult to rectify errors.

(b) This part was poorly answered with very few candidates able to write down the equation of the line of symmetry. Common wrong answers were 0.5 (no x =) and y = 0.5. Nearly half of the candidates did not attempt this question.

(c) This part proved equally challenging with very few candidates able to use their graph to solve the equation. Some candidates gained follow through marks from correctly reading where their curve intercepted the x-axis, however the majority of candidates did not use their graph and gave answers of –3 and 4 (the extreme values from the x-axis) or attempted to solve using the quadratic formula (which in general led to incorrect answers). Again, nearly half of the candidates did not attempt this question.

Question 29

This question about perimeter proved difficult and demanding and was another good discriminator. More candidates managed to correctly calculate the perimeter of the curved portion of the shape than the perimeter of the straight sections which was often calculated incorrectly as 9 + 9 + 16 + 16 = 50 or 9 + 9 + 10 + 16 + 16 = 60 or 9 + 9 + 10 + 16 = 44. Many lower attaining candidates did not read the question carefully and calculated the total area of the shape instead of the perimeter.

Question 30

This question involving trigonometry proved difficult and demanding and was another good discriminator. Successful candidates labelled the sides of their triangle with O, A and H and identified they needed to use the Sin ratio to find the angle QRP. Errors included using Pythagoras' Theorem only, finding the wrong angle (QPR), using the wrong trig ratio or using 90 degrees in a trig ratio. Some candidates successfully used the sine rule with 90 degrees, but many made errors rearranging to find angle QRP.

MATHEMATICS

Paper 0580/32
Calculator (Core)

Key messages

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

General comments

This paper gave all candidates an opportunity to demonstrate their knowledge and application of mathematics. Many candidates completed the paper and made an attempt at most questions. The standard of presentation and amount of working shown, was generally good. Candidates should be encouraged to avoid premature rounding in workings as this often leads to an inaccurate answer. Candidates should also be reminded to show all steps in their working for a multi-stage question and should be encouraged to read questions again to ensure the answers they give are in the required format and answer the question set. Candidates should use their calculator efficiently, though it is still advisable to show the calculation performed as transcription and miscopying errors can occur.

Comments on specific questions

Question 1

This question was generally well answered, although common errors included 15 45 pm, 03 45 and 15h 45 min.

Question 2

This question was generally poorly answered, although a significant number of fully correct answers were seen. Common errors included 5 edges and 8 vertices, 4 or 5 edges and 4 vertices, with several responses showing a misunderstanding of the three-dimensional diagram given.

Question 3

This question was generally well answered, although the common errors of 300 000, 300, 30, 3, 0.3, 0.03 and 0.003 were all seen.

Question 4

(a) This part was generally well answered. The common error was not appreciating that a conversion was required, which led to the incorrect calculation of $3 \times 1.20 + 7 \times 35 = 248.6$.

(b) This part was generally very well answered by those candidates who got part **(a)** correct. Common errors included $20 \div 6.05$, $20 - 248.6$ and $248.6 - 20$.

Question 5

This question was generally very well answered although common errors included 72, 73, 80 – 58 = 22, 80 ÷ 58 = 1.38 and 27.5 (from 100 – 72.5).

Question 6

This question on finding 57% of 45 caused very few problems. Common errors included misunderstanding the question, writing one number as a percentage of the other, such as writing 45 ÷ 57 × 100 or 57 ÷ 45 × 100 or forgetting to divide by 100 after multiplying 45 and 57. Sometimes 25 or 26 was seen with no working.

Question 7

(a) This part was generally well answered, although the common errors of 16 74, 10 14 and 17 04 were all seen.

(b) This part was generally poorly answered. Although the correct formula was often used, the required time in hours was often incorrect with 3.3, 330. 210, 30 and 17 14 all seen.

Question 8

Many candidates did not understand the steps needed to solve the problem. As a result, less than half obtained the correct answer. Some candidates worked through the correct steps but rounding issues resulted in inaccurate answers. Some were unsure of the operation required and a significant number divided the $846 by the exchange rate. A common incorrect method involved converting the $846 into euros and the €750 into dollars and subtracting the answers.

Question 9

(a) This part was generally very well answered, mostly with 0.48 but also the correct answer given as a percentage. A small number of candidates misinterpreted the word ‘not’ and gave an answer of 0.52. Other common errors included, 100 – 0.52 = 99.48, and 100 – 52 = 48.

(b) This part was less successfully answered; a common error was dividing 0.48 by 3 instead of 4, leading to incorrect values in the table for pink as 0.32 and red as 0.16. Another error was halving 0.48, leading to answers of 0.24 and 0.24 in the table. A significant number of candidates left this part blank.

(c) The majority of candidates found this question straightforward; some errors were the result of combining 200 and 0.52 in a calculation that was not multiplication. This led to answers such as 199.48, 384.61 and $\frac{0.52}{200}$.

Question 10

(a) Many candidates gave the correct value, 65, for the angle but only a minority were able to give the appropriate geometric reason. Some reasons were insufficient, for example ‘angle in a triangle’ or ‘a triangle has 180°’ or ‘*A* and *B* are equal’ or ‘the triangle has equal sides’ omitting the crucial fact that the triangle was isosceles. Some gave incorrect reasons for example ‘angle in equilateral triangle’ or ‘two angles are equal’. Many paired up the wrong angles for example, *ABO* = *AOB* and hence gave x = 57.5 or 57. Some thought x and 65 should add to 180 and gave the reason ’angles on a line’. Several candidates wrote down calculations rather than geometric reasoning.

(b) This part was answered poorly. Few candidates quoted the circle theorem as stated in the syllabus. Many descriptions such as ‘the angle opposite the diameter is 90’, ‘chord touches the circle = 90’, ‘it’s a right-angled triangle’ or ‘triangle in a semicircle’ were given, none of which were sufficient to be awarded the mark.

(c) Again, many candidates found $y = 25$ but did not give a fully correct reason as stated in the syllabus. It was very common for candidates to just show or describe the calculation they used, 180 – 90 – 65. The common error for the angle was 65°, assuming triangle *ABC* was isosceles. The incorrect answer $y = 115$ was seen regularly from those who gave the reason that angles 65 and y were 'angles on a line'.

Question 11

This question was well answered by around half of the candidates who measured and drew a point 5.5 cm from *H* on a bearing of 155 degrees accurately. Candidates were more successful at drawing the correct length rather than drawing the correct bearing.

Question 12

This question on the dual use of the bar chart and the pie chart proved difficult and demanding and was a good discriminator, with a significant number able to score full marks, but also many of the lower attainers were unable to attempt this question.

(a) (i) Candidates found finding the height of the bar for Chemistry extremely challenging with a significant proportion of candidates not attempting it. Candidates found linking the 120 degrees given on the pie chart to the bar chart extremely difficult. Little working was seen from most candidates. The most common wrong answer was 3 or 3.33…., this was from the misunderstanding that as 120 degrees was a third of the pie chart, they found one third of 10, the height of the y axis. Heights of 2 to 10 were all seen and a small number of candidates drew heights with halves e.g., 3.5, 4.5 etc., which demonstrated misunderstanding that the bar chart represented people – and half a person is impossible.

(ii) Candidates found calculating the missing angle sectors and drawing the pie chart equally as challenging, again with a significant proportion of candidates not attempting the question. Very few correct answers were seen and many who did calculate 105 and 135 for the angles then made errors in measuring and drawing the angles accurately. Most correct answers were seen with no working. Successful candidates generally used their answer to part **(a)(i)** and calculated the angle sector by dividing 360 by 24 and then multiplying by 7 or/and 9.

(b) Candidates were more able to give an advantage of reading results from a bar chart compared to a pie chart, however only the most able candidates were able to give a reason that was acceptable to gain the mark. To be successful, the advantage given had to relate to the frequencies or number of students shown on the bar. Common incorrect answers were: 'it is easier', 'it's more accurate', 'we can see the numbers easily' and 'numbers clearly shown'.

Question 13

(a) This part was generally well answered, although a very common error was $k = 26$ from taking it to be the next term in the sequence. A small but significant number did not appreciate how to work out the common difference when two consecutive terms were not given. This resulted in some sequences with increasing differences such as 2, 7, 13, 20.

(b) This part was generally reasonably well answered, although the common errors included $n = 2$, $n = –2$, $n – 2$, and $2n + 7$; the result obtained by incorrectly using $d = 2$ in the rule $a + [n – 1]d$.

Question 14

(a) A good number gained full marks, with answers more commonly stated in decimal form although both $4\frac{4}{5}$ and more commonly $\frac{24}{5}$ were seen. Most others gained one mark for the correct substitution of *P* and *a* to give 25 = 6 x 3 + 5b but were unable to solve the resulting equation. Those not scoring at all often substituted incorrectly making errors such as $25 = 6 + 3 + 5b$ or $25 = 63 + 5b$. Others tried to rearrange at the same time as substituting, but this proved difficult with results such as $b = 25 – 6 \times 3 – 5$.

(b) This part was reasonably well answered with most successful candidates showing a first correct step in their working. The majority of those that did not score showed no working to their incorrect answer. When the initial step was seen, a variety of incorrect responses were observed, including the common $kT = y - W$, $\frac{W}{k} = T + y$, and $W - k - y = T$.

Question 15

Many candidates did not appreciate that $y = mx + c$ could be used to answer both parts of this question.

(a) This part was not well answered. Common errors included $-5x$, $5x$, 7, $\frac{7}{5}$ and $\frac{5}{7}$.

(b) This part was not well answered. Common errors included (–5, 7), (5, 7) and (2, 7).

Question 16

(a) A large majority gave the correct answer. A few divided 187 by a single ratio part, either 3 or 8, rather than the total sum of the parts, 3 + 8. A few were awarded the method mark if they only found the value of 1 part or had found the amount spent on gas.

(b) This part was answered well with the majority giving the ratio in its simplest form. A few answers were incorrect due to arithmetic slips in cancelling and a few did not fully simplify their ratio giving answers such as 90 : 75, 18 : 15, 30 : 25 or simply stating 180 : 150. A couple of candidates wrote the ratio in the wrong order i.e., 5 : 6.

(c) Candidates found this part very difficult and only a small minority gave the correct expression. Some answers were spoilt by writing ‘=’. There were many varied incorrect answers. Some realised $E + G$ was required, and this often appeared in an otherwise incorrect answer, sometimes as the numerator. The denominator was often EG. Some of the other errors included $\frac{E}{G}$, $\frac{G}{E}$, $E : G$, $\frac{E}{E} + G$, and ‘x money’. A few candidates gave numerical solutions. A significant number were unable to attempt this part.

Question 17

This question was generally very well answered, with the majority able to use the formula for compound interest correctly. Common errors included using simple interest, not subtracting the principal, and premature rounding of the power of 5 value which led to an inaccurate answer.

Question 18

(a) This part proved difficult and demanding and was a good discriminator. Successful candidates understood that kg had to be changed to grams by multiplying by 1000 and hours to seconds by dividing by 3600 or 60, twice. Most candidates did a part of this process but very few did the full, correct, method and therefore gained no marks. The most common wrong answers were 2866.66 (candidates had only divided by 60 rather than 60×60), 172 000 (172×1000), 619 200 ($172 \times 60 \times 60$) and 0.172 ($172 \div 1000$).

(b) Candidates were slightly more successful at calculating the percentage increase however, the most common error was to divide by the new rate rather than divide by the initial rate. All three methods on the mark scheme were seen often, however the most common was $(176 - 172) \div 172 \times 100$. Common wrong answers were 0.04 or 4% from $(176 - 172) \div 100$ and 2.27 from $(176 - 172) \div 176$.

Question 19

(a) This part was generally well answered. Common errors included 3.47×10^{-7}, 3.47×10^{8} and 347×10^{-10}.

(b) This part was generally very well answered, with the majority able to give their answer in standard form, as required. Common errors included 15×10^{10}, 35×10^{10} and 15×10^{24}.

Question 20

(a) This part was generally very well answered, although common errors included 1, 3, 9 and 6.

(b) This part was generally less well answered, with the most successful first step being $5y = 24$, although a variety of incorrect first steps were seen. Common errors included 5, 1, $\frac{15}{8}$ and incorrect first steps of $y = \frac{40}{3} = 13.3$, $5y = (8 - 3)$, and $3y = \frac{8}{5}$.

Question 21

(a) This part was generally well answered, with the majority able to give their answer in the correct, simplified, form. Common errors included 30, w^{13}, w^7, and $3w^{10}$.

(b) This part was generally well answered, with many able to give their answer in the correct simplified form. Common errors included $t^{18}v^{-14}$, tv^{14}, $45tv$, and a variety of other incorrect answers.

Question 22

(a) This part was generally well answered with many candidates demonstrating a good understanding of perimeter and algebraic addition to give the correct expression. Common errors included slips in the addition of the three sides, usually obtaining an answer with one of the two terms correct, not giving an expression and spoiling their answer by equating the perimeter either to a numerical value or to another variable. Simplifying to $2x - 3$, not $4(2x - 3)$, was also seen.

(b) Many of those with a correct expression for the perimeter were able to set up a correct equation and solve it. Some slipped up at the first step, starting with $8x - 12 = 40$ and rearranging it as $8x = 40 - 12$. Others were able to use their incorrect equation and show a correct method for solving it.

(c) Candidates were less successful in this part. Some were able to take their value of x from the previous part and use it successfully to find the correct value for the area. Others used an incorrect formula, usually omitting the $\frac{1}{2}$ and some tried to calculate a volume. Some knew the required method but often omitted brackets with expressions such as $\frac{1}{2} \times 2x - 5 \times 2x + 2$, then often making no substitution, tried to give an algebraic expression, in terms of x, for the area of the triangle. Many lower attainers were unable to attempt this part.

Question 23

Many made use of the formula sheet effectively, although a few chose the incorrect formulae. Most candidates correctly substituted the radius into one of the equations, gaining the first mark. Many got no further. The number of candidates who equated the two formulae was limited and for some, errors in substitution or further processing meant that they did not reach a correct equation linking the two volumes. Some got to the correct equation but did not recognise that division was needed to find the height, often subtracting the volumes instead. Recognising that the π on either side of the equation could be cancelled was rarely seen, though not necessary to gain full marks. A few appeared to recognise the connection between the volumes intuitively and reached the answer with little or no working.

Question 24

This question was a challenge for many candidates. Most of those who attempted it understood that it required the use of Pythagoras' theorem and trigonometry. Most realised the need to find length *BD*. Some premature rounding of *BD* to 9.9 or 10 led to answers outside the acceptable range. Inaccuracy also arose when candidates chose a longer route, finding *CD* first then using *CD* to find *d.* Some candidates used Pythagoras' theorem incorrectly as 14.72 + 10.82 but a few were awarded the final SC mark. Some used the wrong trigonometric ratio in triangle *BCD*, for example tan 52 ÷ 9.97, sin 52 x their *BD* or cos 52 × their *BD*. Some chose to use tan 38 = 9.97 ÷ *BD* but then failed to rearrange and evaluate *d* correctly. Some candidates assumed triangle *ABD* was isosceles and hence used *BD* = 10.8 and a few thought the shape was a parallelogram with *CD* = 14.7. The weakest solutions came from those who did not attempt Pythagoras or trigonometry and just combined the given sides and angles in some way.

MATHEMATICS

Paper 0580/33
Calculator (Core)

Key messages

To do well in this paper, candidates need to demonstrate that they have a good understanding of all topics in the syllabus, remember necessary formulae, and use a suitable level of accuracy. In addition, candidates need to read the questions carefully to ensure that they are answering the question asked.

It is generally expected that candidates show some mathematical workings. This is particularly important if they make an error as, without workings, they are usually unable to score any method marks.

General comments

This paper gave all candidates an opportunity to demonstrate their knowledge and application of mathematics. Overall, there were some excellent responses. Some of the weaker candidates did not attempt some of the more difficult parts. The standard of presentation and amount of working shown was generally good.

Centres should continue to encourage candidates to show formulae used, substitutions made, and calculations performed. Attention should be made to the degree of accuracy required. Candidates should be encouraged to avoid premature rounding in workings as this often leads to an inaccurate answer. Candidates should also be reminded to write digits clearly and distinctly.

Comments on specific questions

Question 1

(a) The large majority gave the correct answer. A common error was to list 2 and/or 6, the factors of 12 given in the table.

(b) The large majority gave the correct answer. Incorrect answers were usually 2 or 27.

(c) The large majority gave the correct answer. Incorrect answers varied but included 16, 6 and 2.

Question 2

Nearly all candidates identified the correct square to complete the symmetry.

Question 3

Nearly all candidates inserted the brackets correctly.

Question 4

(a) This part was answered well with the majority giving the correct answer. The most common error was to give the time of arrival at home, 15 20, and a few gave the answer 14 30, when Tim stopped. A few misread the scale as 14 05 instead of 14 10.

(b) (i) This part was answered well with the majority giving the correct answer. The most common error was to give the answer 12, the distance from home when Tim stopped. A few gave the answer 36, the total distance.

(ii) A good majority gave the correct answer. The most common incorrect answer was 30 but other errors included 70 the total time, 10 and 50.

Question 5

About half the candidates gave the correct rounded answer and a good proportion had a correct but unrounded answer. When rounding 76.926 to 2 decimal places, errors such as 76.92, 76.90, 7692.6..., 77, 77.0 and 76.9 were seen. When using a calculator, some candidates omitted brackets round the numerator. Another common error was to evaluate the numerator and denominator separately, then round each of these values before dividing them. While some candidates were able to score the part mark for rounding their incorrect answer to 2 decimal places, in many cases the incorrect answer was only shown to 2 decimal places so this mark could not be awarded.

Question 6

A minority gave the correct answer. Most candidates just gave the answer 0.2, the position of the arrow on the number line. Some tried to progress but did not know how; errors such as 6×0.2, 0.2 + 6 or $\frac{0.2}{6}$ were seen. Some misread the scale, giving 0.1 for the position of the arrow.

Question 7

Less than half of the answers given were correct. Many varied errors were made. Poor use of time notation was evident in calculations such as 21 45 + 3.30 = 24 75 = 25 15 or, for example
21.45 + 3.50 = 24.95 = 01 35 or for 21°45° + 3°50° = 25°35° = 1°35° = 1 35 or for 21.45 + 3.5 = 24 50 = 0 50. Subtracting 3.5 hours was a common error leading to 18 15. Again, poor use of time notation was very common; for example, 21 45 – 03 50 = 17 95 = 18 35.

Question 8

The large majority of candidates gave the correct answer. Most others used the incorrect calculation 350 ÷ 0.92.

Question 9

(a) A minority of candidates gave a fully correct response. Nearly half of all candidates were able to identify the angle 32 but the reason was incorrect. The word parallel was most often cited as the wrong reason but many others were quoted; alternative angles, parallel lines, opposite angles, corresponding, angles in a triangle, to list a few. Better candidates with the correct reason often went on to score 2 marks as well in **Question 9(b)**.

(b) There were relatively few fully correct answers with the correct reason attached. The mark for the angle = 53 was often awarded with either an incorrect reason or an explanation on how it was calculated. Similar incorrect reasons tried in part **(a)** appeared in this part. Those who found angle ABE first often gave an incomplete reason ‘angles in a triangle’ when they needed to state both, ‘angles on a line add to 180’ and ‘angles in a triangle add to 180’.

Question 10

This part was answered very well with a very large majority giving the correct answer. The most common error was to rearrange the first step as $4p = 25 + 11$.

Question 11

(a) The majority of answers were correct, and nearly all the remaining candidates gained a part mark for correctly expanding either or both brackets. Common incorrect answers usually contained the terms $2x$ and/or -11. These errors often resulted from sign changes made when the terms were re-ordered before collecting them. For example, $8x - 21 + 10 = 8x - 11$, $5x - 3x + 10 - 21 = 2x - 11$. A few errors resulted from incorrect/incomplete expansions e.g., $5x - 2 + 3x - 7$. Some equated the expansion to zero and solved the equation.

(b) A slight majority gave a fully correct factorisation. A few candidates were awarded a part mark for a partial factorisation; the most common being $2a(2a + 8)$. Several candidates used a division technique similar to prime factorisation. However, whilst many completed algebraic division by 2, 4 or a correctly, they struggled to extract the information from their working. Many candidates that used this approach scored zero marks because of this. Of those that scored zero marks, it was clear that many did not understand the meaning of the command word 'factorise,' which led to frequent incorrect answers such as $20a^k$ or $32a^k$ where $k = 1, 2$ or 3.

Question 12

(a) This part was nearly always correct.

(b) A small majority gave the answer 40. Incorrect answers were usually 70, the height of the highest bar.

(c) This part was answered correctly by a good majority of candidates. A common incorrect answer was 40, often from listing the bar heights in order and choosing the median or sometimes with no working. A few candidates just found the correct total, 240 but did not divide by 5.

Question 13

(a) A minority gave the correct answer. The most common incorrect methods were $\frac{542}{600} \times 100$ and $\frac{600 - 542}{600} \times 100$. Some candidates got as far as 1.107... which did not score and some rounded too much to 1.1 and 11. A few candidates just found the difference in the profits and gave the answer as 58 or 0.58.

(b) This part was answered correctly by most candidates. A variety of errors were made. The most common being finding $\frac{2}{5}$ of \$600, the profit from June, while a few found $\frac{2}{5}$ of their answer in **Question 13(a)** or of 58. Incorrect methods included $542 - 0.4$ and 542×1.4. Candidates who made these types of errors often repeated them in a similar way in **Question 13(c)**. For example, $600 - 0.38$ or $600 - 38$, 600×1.38, 0.38×58.

(c) A good majority of candidates gave the correct answer. A few candidates calculated (100 – 38)% of 600 and a few calculated 38% of \$542 for May.

Question 14

About a third of candidates gave the correct answer. Those candidates who did not score full marks often found the correct interest, \$345 but did not add it to the initial investment. The other common error was to apply the method for compound interest.

Question 15

(a) The majority of responses were fully correct, and many others found the cost for hiring 1 road bike for 3 days. Many varied errors were made, and many candidates did not write down their working. The incorrect answer \$90 appeared several times. This came from the calculation $2 \times 25 + 2 \times 20$ not putting brackets round the correct calculation for 1 bike or from those who worked in stages: doing the first day correctly for 2 bikes but forgetting to double the extra days. Other incorrect methods seen repeatedly include 85 (from 25 + 3 × 20), 110 (from 25 × 2 + 20 × 3) and 150 (from 25 × 3 × 2).

(b) (i) The majority of candidates found the correct formula. The most common incorrect response was an answer of 50*d* + 5, from copying the format of the formula given for the mountain bike but without the necessary adaptation. Less often was the answer 50*d* + 70, forgetting the $50 was for the number of extra days and not the total number of days.

(ii) This part required a good understanding of the information given. Around half of the answers were correct and showed clear and efficient working; many found the cost, $320, for the electric bike for 6 days using their correct formula in **Question 15b(i)** and solved the equation 320 = 35d + 5. Others referred back to the information in the table 70 + 5 × 50 = 320 and proceeded from there. A significant number used an inspection strategy (for example, 40 + 35 + 35 + 35 …). Those with incorrect answers were often awarded the part mark for 320. The most common incorrect answer was 8 and came from 320 = 35 × 8 + 40; forgetting to account for the first day. A few tried to solve 50*d* + 20 = 35*d* + 5.

Question 16

(a) A large majority gave the correct answer. Only a few gave the correct distance in centimetres with no conversion. A few measured the distance inaccurately as 6 cm or 7 cm but by showing this measurement and converting it correctly, they were able to score the partial method mark.

(b) Around half of candidates measured the bearing correctly. Answers in the range 36 to 40 came from reading the wrong scale on the protractor, some answers came from a clear incorrect method for example 360 – 140 or 180 + 141 but otherwise there were many varied random incorrect answers. Some gave the distance *SP* in centimetres.

(c) Around half of candidates marked the correct location of point *E*. Others plotted *E* either with just the correct distance from *P* or with just the correct bearing.

Question 17

(a) Around half of candidates were able to describe the error made in the vector by stating the correct vector or the value 1 should have been –1. A few incorrect vectors that included fraction lines were seen as well as those candidates who miscounted 6 squares across. Answers such as 'because shape B should go up 1' or 'Sue drew B one square lower' did not link the error with the given vector and did not score.

(b) About a third of the candidates drew the correct rotation and about half of the other candidates were able to score a part mark for drawing a rotation of the shape 90° clockwise about an incorrect centre. A few rotated the shape anticlockwise about the origin.

(c) A minority of candidates gave a full description of the enlargement, while many others gave a partially correct description. A few spoilt their answer by stating a second transformation.

Question 18

(a) Around half of the candidates gave the correct answer. Various incorrect words were offered such as diameter, radius, sector etc.

(b) Correct diagrams were drawn by a slight minority of candidates. The common errors were to draw a sector or two radii at right angles to each other to form an isosceles triangle with the right angle at KOM. Others drew a triangle in the circle with its vertices touching the circumference where none of the lengths were the diameter.

Question 19

(a) Nearly all candidates found the value 5 and the majority gave an accurate value 6.67 (with 6.66 or better also allowed). Those who gave the value 6.6 or 7 were not awarded this mark.

(b) Many fully correct curves were drawn. A common error was joining the points with straight line segments. Plotting the point (3, 6.67) caused a problem for those who had not read the vertical scale correctly and plotted at (3, 6). Similarly, a few plotted (5, 4) at (5, 2).

(c) A good majority gave a correct answer. Incorrect answers usually resulted from those who used an algebraic approach rather than reading from their graph; for example, $8 \times 20 = 160$ or $8 \div 20 = 0.4$.

Question 20

(a) Candidates had been well prepared for this topic and many of them understood that the sum of the values should be 1 and showed clear working to arrive at the correct relative frequency, 0.12. The less well-prepared candidates thought the required relative frequency ought to lie between 0.22 and 0.26 with 0.24, the midpoint, being a common choice. Others tried to find a sequence and so a few added 0.7 to get 0.29.

(b) The majority gave the correct answer. Incorrect answers were varied, often with no working.

Question 21

(a) (i) This part was answered very well with a very large majority writing the numbers in the correct order. Most other candidates were able to write 4 in the correct order.

(ii) This was a challenging question for the vast majority of candidates. Only the better candidates scored full marks here and amongst those there were several who only scored 1 method mark as they omitted to show the interim stage of 6.107…. Many varied incorrect calculations were shown, with attempts to calculate either the circumference, surface area or volume of the Earth. A significant number of candidates took a trial and error approach, using 6.11 in their working, which always scores 0, and a significant minority did not attempt this part.

(b) Around a third of candidates gave the correct answer and slightly less were awarded the method mark for using the formula Distance = Speed × Time. The most common incorrect answer was 27000×95. Others gave a slightly inaccurate answer from premature rounding $27000 \times 1.58(3)$. Common incorrect methods involved Speed ÷ Time.

(c) This conversion question was challenging for many candidates with few fully correct answers. There were many incorrect methods seen. The most common was to just convert the distance 25200×1000, although other answers with figures 252 from incorrect distance conversions were common. Some divided by 60 instead of 60×60. Some multiplied by 60. Those who divided figures 252 by a correct time conversion to seconds were able to score a part mark.

Question 22

(a) A slight minority of candidates gave the correct answer. Many started with the correct equation $\pi \times r^2 \times 10 = 478$ but were unable to rearrange it correctly. Errors such as $r^2 = \frac{478 - 10}{\pi}$ were seen as the next step. Some only got as far as $478 \div 10$ while a few stopped at $r^2 = 15.2$. It was fairly common for candidates to start with an incorrect formula such as $2\pi rh$ or $2\pi r^2$.

(b) The majority of candidates gave the correct answer. The most common error was $19.3 \div 478 = 0.04$ and slightly less common was $478 \div 19.3 = 24.76$.

Question 23

This question was answered well with the majority finding the correct hypotenuse. A few recognised the method as Pythagoras' theorem but only got as far as $35^2 + 22^2 = 1709$ or subtracted $35^2 - 22^2$ or gave the answer correct to only 2 significant figures. Other incorrect methods involved incorrect trigonometry or addition of the sides 35 + 22.

Question 24

A good number, but not a majority, of correct responses were seen. Although most candidates recognised the question required trigonometry, many errors in its application were seen. The most common were either selecting the wrong trigonometric ratio (using sine or cosine in place of tangent) or setting up the ratio incorrectly (usually with the fraction inverted). Incorrect notation caused problems when, for example, candidates who intended to do the correct calculation $18.4 \times \tan 52$ wrote this as 52tan18.4 and then evaluated $52 \times \tan (18.4)$.

MATHEMATICS

Paper 0580/41
Calculator (Extended)

Key messages

This paper tests a wide range of skills and mathematical understanding across the syllabus. Many candidates were able to demonstrate knowledge and competency across each of number, algebra, shape and space, and probability and statistics, achieving very good scores on this paper. Although candidates had enough time to complete the paper, weaker candidates did not attempt a number of the more challenging questions.

Candidates should spend time thinking about the suitability of the method they are going to use rather than trying lots of different methods and calculations. They should make it clear as to which part of their working they wish to be marked, and work in a logical order within the working space in order that their work can be followed, particularly in the longer, harder questions.

Questions should be read carefully to avoid misreads of numbers from the given information and from their calculators. Candidates should also ensure their writing is legible; slips were seen where candidates had misread their own writing, overlooked decimal points or missed out a digit, resulting in incorrect answers.

General comments

Candidates should choose efficient methods. Examples where inefficient methods were chosen included **Question 3**, **Question 12**, **Question 17** and **Question 20(a)** and, as a consequence, errors were made; premature approximation was seen and time was lost unnecessarily. In addition, if longer methods are used, clear working should evidence where numbers have come from so that the examiner can follow the approach taken.

Candidates should not, in general, be expecting to find answers using trials. It will often be possible to use a logical method or approach. Examples where trials were seen being used when they shouldn't have been included **Question 10(c), Question 16** and **Question 21**.

Candidates should draw diagrams accurately and with a pencil, using a ruler when appropriate. Lines that are not required should be rubbed out. Graphs, for example **Question 14**, should be drawn accurately through the plotted points and histograms, for example **Question 15(c)**, should be ruled at the exact heights.

Comments on specific questions

Question 1

Almost all candidates answered this part correctly. The most common errors included slips with arithmetic when finding 9 + 13 or a method error of subtracting rather than adding the 9.

Question 2

Some candidates answered this correctly. Others scored one mark for 7.999 but giving their answer as 8 or 8.00 rather than 8.0. Some prematurely rounded the denominator to either 7.8, 7.85 or 7.86 without realising how this could affect the accuracy of the final answer. A common misconception seen was to incorrectly simplify the denominator to $\sqrt{8.6^2 - 3.5^2} = 8.6 - 3.5$. Candidates who calculated incorrectly, but who were able to round their answer correctly to two significant figures, were awarded one mark.

Question 3

Some candidates answered this correctly. Others scored one or two marks for correctly finding the cost in dollars of one litre of fuel in the UK or in the USA. Common errors included finding the difference in cost of gallons rather than litres, or in pounds rather than dollars. Others gave the highest price, 1.97, but not the extra cost. Many candidates used incorrect operations of adding, subtracting, multiplying or dividing the given numbers in a wide variety of combinations and did not score.

Question 4

(a) (i) Some candidates described the translation correctly. Common errors included omitting the word 'translation' or using incorrect words such as 'move' or 'shift'. Others miscounted the squares, omitted or misplaced the negative sign, gave the vector upside down, included a fraction line within the vector, or gave a coordinate rather than a vector.

(ii) A minority of candidates gave a complete and accurate description of the transformation. Many others described a double transformation, both rotating the shape and then translating the shape, which did not score as a single transformation was required. Common errors included using an incorrect word such as 'turn' rather than rotate, omitting or giving an incorrect direction or angle, and omitting or giving an incorrect centre.

(b) A good proportion of candidates reflected shape *A* correctly. Common errors included reflecting the shape in an incorrect vertical line or reflecting in the line $y = -2$. However, some candidates drew the shape in positions which seemed to have no relevance to any of the parts.

Question 5

(a) Around half of all candidates were able to recognise the values in the sequence as cube numbers and write down the 10th cube number: that is, 1000. Some answered this correctly, but a common error was to give 216, the next term, rather than the 10th term. Many candidates did not recognise the sequence and attempted difference tables, often making arithmetic errors, or were unable to deduce that the sequence was a cubic with $1n^3$ from the common of difference of 6.

(b) Some candidates answered this correctly. Others found the second difference as 2 but frequently then had $2n + b$ or $2n^2 + bn + c$, rather than $n^2 + bn + c$. Many others did not use differences and tried to find the *n*th term by trials, but were rarely successful.

(c) (i) Just over half of all candidates answered this correctly. The most common errors were arithmetic slips, or candidates giving the answers 2, 9 or 11, not realising the given expression was the sum of the first *n* terms and not just the *n*th term.

(ii) Some candidates answered this correctly but more gave the answer 21, the sum of the first 3 terms. The most common other errors were arithmetic slips or using values for *n* other than 3. Around a fifth of candidates did not attempt this part.

Question 6

The majority of candidates scored full marks on this question. The few errors that were seen included omitting to multiply the –2 by $5x^2$, giving an answer of $15x^3 - 2$, or expanding $(5 + x^2)(3x - 2)$.

Question 7

Just under half of candidates answered this question correctly. Some candidates used the notation [–1.5, 4), which was accepted for full marks. Common errors included answers such as $-1.5 < y \leq 4$, $-1.5 \geq y > 4$ and $-1.5 \geq y < 4$, as well as answers such as $y < -1.5 \leq 4$ and $-1.5 \leq 4$. In addition, the scale was misread as +1.5 or –2.5 by a significant number of candidates, and some gave the length of the line, 5.5.

Question 8

(a) Many candidates answered this part correctly. The few errors that were seen came from candidates not setting up the correct calculations for both parts of the monthly plan correctly, for example finding 20% of both the \$980 and the monthly payments, or only finding the total of the monthly payments, or adding on an additional \$980. Other errors included slips in arithmetic or errors in calculating 20% of \$980.

(b) Less than half of all candidates answered this part correctly. The most common errors included finding the percentage of \$980 rather than the percentage increase (not deducting 100%), or not converting from a decimal to a percentage (not multiplying by 100). Other errors included finding the increase in cost rather than the percentage increase, having their part **(a)** in the denominator rather than \$980, or giving an insufficiently accurate answer such as 12, when an accuracy of at least 3 significant figures is required.

Question 9

Around half of all candidates answered this question correctly. Common incorrect methods included 38×1.08, 38×0.92, $\frac{38}{1.08}$, $\frac{38}{0.92}$, $\frac{38}{0.8}$ and $38 + 0.08$.

Question 10

(a) A large majority of candidates answered this part correctly. The most common errors seen were to miss out either or both of the factors 1 and 18. Some candidates also gave the negative factors –1, –2, –3, –6, –9 and –18, when only positive factors were required. Others gave the factors as products 1×18, 2×9 and 3×6, which scored one mark. A small number of candidates misunderstood the demand of the question and wrote 18 as a product of its prime factors, $2 \times 3 \times 3$, or gave multiples of 18.

(b) A good proportion of candidates factorised the expression correctly and many others scored one mark for getting as far as, for example, $y(3 - x) + 5(3 - x)$. Common errors included answers such as $y(3 - x)5(3 - x)$ or $y + 5(3 - x)$.

(c) A small number of candidates were able to answer this part correctly using the previous two parts. The best solutions recognised that from $(y + 5)(3 - x) = 18$ for $y > 0$, x could only be 1 or 2 and hence the possible solutions are either $x = 1$, $y = 4$ or $x = 2$, $y = 13$. However, many candidates did not use part **(b)** but used trial and error, choosing values of x (or y) and substituting into the given expression in this part to find y (or x). Often, however, these answers did not satisfy the condition of x and y needing to be positive integers. Others started with $(y + 5)(3 - x) = 18$ but often then solved $y + 5 = 18$ and $3 - x = 18$, or $y + 5 = 0$ and $3 - x = 0$. Some candidates did not consider the expression but just gave two positive integer values with a product of 18. Around a quarter of all candidates did not offer any response to this part.

Question 11

Only a very small minority of candidates answered this question correctly, with a wide range of errors seen. Candidates were unsure whether they should multiply or divide by 50, and even fewer used 50^2. Others added the parts of the ratio and multiplied or divided by 51. Some were able to convert 800m^2 to $8\,000\,000\text{cm}^2$, but many incorrectly used 800×100. The most common incorrect answers came from $\frac{800}{50} = 16$, $\frac{800 \times 100}{50} = 1600$ and $\frac{800 \times 100 \times 100}{50} = 160\,000$.

Question 12

Only a small minority of candidates answered this question correctly. Most candidates did not recognise that the shortest distance was found by using a perpendicular from side *PR* to the point *Q*. The most common two misconceptions were to either have a right angle at *Q* and find the length of the vertical line meeting *PR*, or to bisect angle *PQR* to give 57.5, find the remaining angle in the resulting triangle as $180 - 57.5 - 42 = 80.5$, and then use the sine rule as $\frac{d}{\sin 42} = \frac{12.5}{80.5}$. Other candidates gave their answer as the length of one of the other sides, *PR* or *QR*.

Question 13

Whilst some candidates rearranged the formula correctly, some did not realise that the best starting point was to work towards isolating the x^2 term. A number started by trying to take the square root of both sides, with the misconception of $\sqrt{w^2 + 5x^2} = w + 5x$ often seen. Others made errors when moving terms from one side of the equation to the other with slips in signs, or not dividing all terms on both sides by 5.

Question 14

(a) Most candidates completed the table correctly. The most common error occurred with the negative value $x = -1$, when its square was calculated as $-1^2 = -1$ rather than $(-1)^2 = +1$, to give $y = -8$.

(b) The majority of candidates plotted their points correctly. The most common plotting errors were the occasional misreading of the scale on the *y*-axis or inadvertently plotting the negative values of *y* as positive values. Candidates then produced graphs which were generally very well drawn, smooth, and with the correct curvature. A minority of candidates did not have a single curve, but feathered or very thick curves or ruled segments; none of these were accepted for full marks.

(c) It was rare for any candidate to score marks on this part, with few recognising that the equation needed to be first rearranged to $5x^2 - x^3 - 4 = 10 - x$, and then the *x*-intercepts of the curve and the line $y = 10 - x$ found. Although some candidates did manage to find the three correct solutions by using their calculator, they only partially scored, as a drawn line was required by the question. Common errors seen included drawing the line $y = 10$, reading off the x-intercepts from their graph in part **(b)**, or trying to solve the equation either by trying to use the quadratic formula or rearranging the equation. Around a fifth of all candidates did not attempt to answer this part.

Question 15

(a) The mean was calculated correctly by around half of all candidates, with most showing clear working which included midpoints, products, sum of the products and division by the total frequency. The errors that were seen were mainly from slips with the midpoints, with arithmetic, or division by 5 rather than 140. A minority of candidates were unable to demonstrate any knowledge of the method and attempted to add various combinations of the numbers together.

(b) Only a very small minority of candidates answered this part correctly. Whilst most candidates wrote down $\frac{70}{140}$, few also had $\frac{69}{139}$. Many either had no further fractions or a second fraction as either $\frac{70}{140}$ or $\frac{69}{140}$ or $\frac{70}{139}$. Of those with the correct two fractions, many went on to spoil their method by multiplying by 2 or by adding the fractions.

(c) Some candidates completed the histogram correctly, taking care to draw the heights and widths accurately. However, many candidates did not know how to find the heights of the bars. The most common incorrect response was for candidates to observe that the fifth bar was drawn at 10% of its frequency, 2, and thus draw the first four bars at 10% of their frequencies, 0.7, 1.2, 3.1 and 7, without recognising that the different widths of the bars affected the heights. Some candidates did have the correct heights for the bars but drew all the bars with equal widths.

Question 16

A fair number of candidates answered this part correctly. Others recognised that $1250 \times k^6 = 1484$, but there were various errors seen when trying to find *r* from this. Some subtracted rather than divided both sides by 1250. Others had *k* as $1 - \frac{r}{100}$ or $1 + r$. Those that reached a correct equation, namely $\left(1+\frac{r}{100}\right)^6 = \frac{1484}{1250}$, often could not solve this correctly for *r* as they performed the operations in an incorrect order. Some candidates reached $1 + \frac{r}{100} = 1.03$, but because of premature approximation, gave the answer as 3%.

Question 17

(a) A fair proportion of candidates answered this part correctly. The majority of candidates recognised that the cosine rule was required to find length *AD* and were able to substitute the correct values into the formula. However, a very common incorrect answer came from a misconception in calculating, where $9.6^2 + 12.1^2 - 2 \times 9.6 \times 12.1 \times \cos 56$ was incorrectly calculated as $(9.6^2 + 12.1^2 - 2 \times 9.6 \times 12.1) \times \cos 56 = 6.25\cos 56$. Some attempted to use the sine rule, and others right-angled trigonometry or Pythagoras, though there were no 90° angles in either triangle.

(b) Not many candidates answered this part completely correctly. Many candidates selected the sine rule and substituted correctly into it. From here, some struggled to rearrange, and others prematurely rounded, so 72.7 was not always seen. Only a minority went on from here to correctly give the obtuse value of 107.3. As in the previous part, some used right-angled trigonometry, and some instead added together angles with no use of any trigonometry.

(c) Only a small proportion of candidates worked out the correct area of the quadrilateral. Many others were able to evidence correct use of $\frac{1}{2}ab\sin C$ for at least one of the triangles. Some candidates did not use the formula directly but showed longer correct methods, finding other lengths and angles to use in the formula, but often candidates used premature approximations so did not reach a sufficiently accurate answer. Some candidates used $\frac{1}{2}ab$ for the area of a triangle, though there were no right angles in either triangle. More than a quarter of candidates did not attempt this part.

Question 18

A very small proportion of candidates answered this question correctly. Some scored 2 marks for finding *a* and *b* correctly. Other candidates tried to complete the square but could not handle the $2x^2$ successfully, with $(x + 12)^2$ and $(x + 6)^2$ often seen. A small number of candidates attempted to expand $a(x + b)^2 - c$ and compare coefficients, but few were successful. The most common incorrect answer was 2, 12, –2, with candidates copying the numbers from the given expression.

Question 19

Only a small proportion of candidates successfully found the complete perimeter of the sector. Others scored 3 marks for finding the curved length, but then omitted to add on the two radii. Others were awarded method marks for showing the calculations to find the perimeter, but then either evaluated using an inaccurate value for pi or made calculation slips. Other candidates who either used the wrong formula, commonly the area of a sector, or no formula, were frequently awarded one mark for finding the sector angle 234. Around a fifth of candidates did not attempt this question.

Question 20

(a) A minority of candidates produced correct, direct solutions to this question. Others used longer methods and often used premature approximation, which resulted in an inaccurate answer. Those without a complete method often used Pythagoras to correctly find the length of the diagonal of the base, *AC*, and hence *AM*. However, many candidates were not able to work out which angle was required, or that triangle *OAM* was a right-angled triangle such that trigonometry could be used. Some candidates found all the lengths in triangle *OAM* and used the cosine rule to show that the angle *AMO* was 90°.

(b) Few candidates were able to correctly find the volume of the frustrum. Few recognised that this question could be answered using the volumes of similar solids, and that the scale factor of the lengths in the whole pyramid to that of the smaller removed pyramid was $\frac{24-16}{24} = \frac{1}{3}$ and hence the base of the smaller pyramid was $10.5 \times \frac{1}{3} = 3.5$. From here, it was relatively more straightforward to find the volumes of the large and small pyramids and hence the volume of the frustrum. However, it was very common to see candidates either incorrectly trying to use the formula for the volume of a pyramid for the frustrum, with $\frac{1}{3} \times 10.5^2 \times 16 = 588$ often seen as the only working and final answer or, assuming that the base length of the removed pyramid was half of 10.5.

Question 21

This question was very rarely answered correctly. Very few candidates realised that the important first step was to write 16 as 4^2 and 64 as 4^3 (or 4 as 2^2, 16 as 2^4 and 64 as 2^6). The majority of candidates who attempted this question started with an incorrect step of dividing or multiplying without consideration of the powers, with either $\frac{16^{5m}}{4} = 4^{5m}$ or $4 \times 64^{2n} = 256^{2n}$ frequently seen. Others tried using logarithms, which are not in the syllabus, or attempted large calculations with trials. Around a third of all candidates did not attempt this question.

Question 22

This question was answered well by some candidates who evidenced the correct answer coming from the correct bounds. Other candidates were able to give the upper bound or lower bound of either 50 or 13, even if they did not select and divide the correct pair of bounds. Some candidates were unable to demonstrate knowledge of bounds and calculated $\frac{50}{13} = 3.846\ldots$, rounding this (often to the nearest integer) to 4. Around a fifth of all candidates did not attempt this question.

MATHEMATICS

Paper 0580/42
Calculator (Extended)

Key messages

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

Work should be clearly and concisely expressed and intermediate values within longer methods should not be rounded, with only the final answer rounded to the appropriate degree of accuracy.

Candidates should show full working in their responses to ensure that method marks are considered when full marks have not been given.

General comments

This was the first June series of the new syllabus for 2025. Candidates generally found the paper accessible and had enough time to complete the paper. There were many excellent scripts in which candidates demonstrated expertise with the content, with solutions that were well presented. A much smaller number of candidates were less familiar with aspects of the syllabus and struggled with large areas of the content.

Candidates are required to give non-exact answers correct to 3 significant figures but, in some cases, candidates gave answers with either 2 or 1 significant figures. Candidates should ensure that they retain sufficient accuracy in their working to give a final answer within the acceptable range.

The question paper includes a list of formulas which candidates should refer to where appropriate. Some candidates did not use this list and misquoted formulas such as the volume of a cone, the area of a triangle or the cosine rule.

In general, candidates were more successful in questions requiring direct application of mathematical processes, but had more problems accessing questions where they were required to interpret a context or form an equation to solve a problem such as **Questions 3**, **10**, **17(b)** and **24(a)**.

Where candidates make an error in their working, they should be encouraged to cross their work out and start again, rather than writing over their work, to make their method clear.

Comments on specific questions

Question 1

This proved to be a difficult first question for many. Candidates struggled to use the properties of quadrilaterals to correctly identify the rhombus. The most common incorrect answers included kite and parallelogram, but most other quadrilaterals and occasionally even a triangle or a solid were also given.

Question 2

Most candidates were able to give an acceptable answer of prism, and a large number gave a correct description of a triangular prism. The most common incorrect responses were ‘rectangular prism’ and ‘pyramid’.

Question 3

Many candidates were successful in this question and realised the first step needed was to divide the difference of 2.4 kg by 3. A common error was to try to divide 2.4 kg by 11 or 4 or 7. Other errors included $x + x + 2.4 = 11$ before multiplying by 4 and 7. A few showed a correct method but made arithmetic errors in the processing.

Question 4

A large majority of candidates used the correct formula for the area of a trapezium and gave a correct answer. Although it was possible to split the shape up into triangles to obtain the correct answer, many who tried this were unsuccessful. Some used incorrect formulae for the trapezium, including $\frac{1}{2} \times 12 \times 10 \times 8 = 480$ or $\frac{1}{2} \times 12 \times 8 = 48$.

Question 5

Almost all candidates gave the correct answer. The most common error seen was multiplying 300 by 1.2 to give 360 instead of dividing 300 by 1.2.

Question 6

Candidates were very well prepared for this question, and the majority were able to score full marks for a correct answer.

Many candidates either knew the correct formula for the volume of a cone or made use of the provided formula and then substituted correctly to find the required volume. Some candidates then worked with the accurate volume, 64π, while others used a decimal approximation in the subsequent mass calculation. Inaccurate answers usually came from approximations for π. Some candidates did not use the formula sheet provided and used an incorrect formula for the volume of a cone, and others rearranged the given formula for density incorrectly and divided volume by the density instead of multiplying.

Question 7

Almost all candidates were able to correctly rearrange this familiar formula. Errors were rare and most chose subtracting c as their first step.

Question 8

This question was answered very well. Only a small minority did not score. A few candidates did not give the exact answer and rounded to 5 or 5.0, which is not an acceptable answer when the value is exact.

Question 9

Candidates confidently solved the pair of simultaneous equations. The elimination method was more common and more successful for candidates. Of the candidates who used the substitution method, those who used $y = 11 - 3w$ were more successful than those who involved fractions by using $w = \frac{11 - y}{3}$.

Errors were sometimes made by failing to multiply all terms in the equation before elimination; sign errors were also made when adding or, more commonly, subtracting equations. Although candidates did show their working, as instructed, for some this was not always presented in a clear manner.

Question 10

Many candidates were able to set up the correct equation $12n + 9(n - 10) = 277.50$ and then solve it to reach the correct answer for an adult ticket of \$17.50. Some, after correctly setting up the equation, made an error in either multiplying the brackets or in rearranging; a common error was to subtract 90 instead of adding. A few, after finding 17.50, spoilt their answer by multiplying by 12 to give the total cost spent by adults as their final answer.

A significant number of candidates struggled to set up a correct equation, and errors included $12n + 9n - 10 = 277.50$, $n + (n - 10) = 277.50$ and $9n + 12(n - 10) = 277.50$. Some credit was given for a correct method shown to solve these equations. In other cases, candidates attempted several incorrect calculations without any attempt to set up an equation.

Question 11

This was a familiar question for most candidates. The most efficient method seen was for candidates to go straight to 23.63 ÷ 0.85 after recognising that 23.63 was 85% of the original price. An alternative approach was to recognize that 23.63 was 85% of the cost, then work out 1%, then 100%. Common errors included finding 115%, 15% or 85% of the sale price. In some other cases, the candidates divided the sale price by 0.15 rather than 0.85 to obtain their answer.

Question 12

The majority of candidates knew that the bounds needed to be found before the calculation of the perimeter. This question involved lengths with a straightforward degree of accuracy of the nearest centimetre and, as a consequence, many candidates were confident with the values for the bounds that they needed to work with. This usually led to the correct answer, although some just added the length and width rather than finding the perimeter. A common error was for candidates to calculate the perimeter using the original figures 16 and 14 to reach 60, then try to deal with the bounds, for example by giving 59.5 as a final answer. Some candidates correctly found the lower bounds for one (or both) of the sides but then calculated the area of the rectangle.

Question 13

(a) Almost all candidates were able to give the correct answer of 8 in this part. A small number found the length of *QR* instead of *PR* or did not demonstrate an understanding of how to apply proportion in this situation and gave the answer 9 from 9 – 6 = 3 then 12 – 3 = 9.

(b) This part was done less successfully, but a good proportion of candidates were able to give the correct answer. The most efficient method was to use $\left(\frac{9}{6}\right)^3 \times 1120$. The common errors included using the linear scale factor $\frac{9}{6} \times 1120$ or to use the area scale factor. A few made errors in setting up the relationship, for example by putting the smaller volume on the top of the fraction rather than the bottom, resulting in an answer of 331.8… These candidates did not appear to have considered whether the result was required to be bigger or smaller than the original value. A small number of candidates used a volume scale factor that did not involve the two given sides *AB* and *PQ*, and instead worked with 16 and *QR*. This sometimes led to the correct answer but more often accuracy was lost on the way.

Question 14

This was a well-answered question, with candidates demonstrating familiarity with the approach needed. The strategy to factorise to create a common bracket was carried out efficiently by many. The most common error was to factorise the first two terms and then factorise the final two terms without repeating the same bracket giving $5(x - 2) - a(x + 2)$.

Question 15

This was very well answered and was a familiar question to most candidates.

The most popular solution was to first find the exterior angle as 8, and then use this to calculate the number of sides. Others used the interior angle sum formula to set up an equation $\frac{180(n-2)}{n} = 172$ and then solved this to find n. This approach of using the interior angle sum formula was less successful, and the relationship was more frequently misquoted or contained errors.

Question 16

(a) This question part was almost invariably correct.

(b) This part was answered well by many, but for others caused issues. Many did not recognise that it was necessary to use the weather probabilities from the previous part, and so only 0.9 and 0.2 were considered. Many multiplied these together to give an answer of 0.18. Some attempted to add values, often resulting in an answer of a probability that was greater than 1. Candidates should recognise that this is not possible when calculating probabilities. Where correct answers were seen, in many cases a tree diagram had also been drawn to support the method.

Question 17

(a) This part was answered very well, with most candidates applying the simple interest formula correctly. Very occasionally, the interest of $46 was given as the final answer, rather than the total amount. A small number used compound interest in their calculations.

(b) Candidates found this part very challenging. Some were able to identify that the amount spent in April was 1.1 × the amount spent in March, which is $(1.1)^2$ × the amount spent in February. Those that understood this relationship usually set up a correct equation and solved it to find $x = 20$. Some candidates used a trial-and-error approach, starting with a trial amount for February and calculating corresponding amounts for March and April, and this approach sometimes led to the correct answer. The most common misconception was that the amount spent in April would be 120% of the amount spent in February, leading to the incorrect answer of $20.06. Another common error was to use amounts such as $0.1x$ and $0.01x$ for March and April.

(c) Many candidates were well prepared for this type of problem and reached the correct answer after setting up the correct equation $500 \times \left(1+\frac{r}{100}\right)^{17} = 700.13$. A common error was to round values too early, for example evaluating 700.13 ÷ 500 and rounding to 1.4 before taking the 17th root, which led to an inaccurate value for the interest rate. Some candidates reached the value 1.02 but used this as the interest rate in their final calculation rather than 2%. Some candidates set up a correct starting equation but subtracted 500 from 700.13 when rearranging, rather than dividing, and some equated to 1200.13 rather than 700.13. Others divided by 17 instead of taking the 17th root.

Question 18

Most candidates used the sum of angles in a triangle to find the correct value for angle x. Many also used angles in the same segment to find the correct value for angle y. Common errors in finding angle y were to assume angle AEC was a right angle, or to assume that AE and BC were parallel and attempt to use alternate angles for angle EBC. Candidates had more difficulty in finding angle z. Some found either angle EAC or angle EBC and then used opposite angles in a cyclic quadrilateral to find the correct value for angle z. Some candidates had an incorrect value for z but gained B1 for identifying angle EAC or angle EBC as 73° on the diagram. Common errors were to assume angle z was equal to 125°, to use $z = 180 – 125$, or to assume the 125° marked was at the centre of the circle and halve this to give angle $z = 62.5°$.

Question 19

(a) This was answered very well.

(b) Domain and range is a new topic for 2025; most candidates substituted the values in the domain into the function and gave the three correct values for the range as their answer. The most common wrong answer (4, 2.5, 1.5) came from equating the function to the given values rather than substituting them into the function. Another common misconception was around the meaning of the range of g(x), with some treating it as the range in a statistical calculation and giving the answer 10. A few candidates thought that the range could not be given as three distinct values and instead had to be an interval of values, so the other common incorrect answer was $1 \le g(x) \le 11$.

(c) This was answered very well, with candidates successfully obtaining the answer –5. A small number of candidates had an incorrect answer of 5, or 1.02 (3sf) from calculating $2^{\frac{1}{32}}$.

(d) This part was found to be challenging. Those candidates who understood that $h^{-1}(x) = 3$ means that $x = h(3)$ usually gave the correct answer. It was more common for candidates to give the answer as either 3^2 or $\sqrt{3}$. Some candidates attempted to use logs to answer the question, but these were often applied incorrectly.

Question 20

(a) Most candidates were able to use a correct method to find the length of *AB*, the most efficient being $\tan(34°) = \frac{AB}{12}$. Some used $\frac{\sin(34°)}{AB} = \frac{\sin(56°)}{12}$ or other longer methods. Some candidates made the error of giving their answer to 2 or fewer significant figures, i.e. 8.1 or 8, and not showing a more accurate value in their working, so could not be awarded the accuracy mark.

(b) Many candidates were able to use a correct method to find the area of the quadrilateral *ABCD*. Some candidates lost accuracy because they used 8 or 8.1 for the length of *AB* or because they used a rounded value for sin(56°) within the method. Some common incorrect methods seen were, for example, area of triangle $BDC = \frac{1}{2} \times 10 \times 12$ instead of $\frac{1}{2} \times 10 \times 12 \times \sin(56°)$, and area of triangle $ADB = \frac{1}{2} \times 12 \times$ *their AB* $\times \sin(34°)$ instead $\frac{1}{2} \times 12 \times$ *their AB*. Some candidates incorrectly assumed there was a right angle at *C*, and others treated the quadrilateral as a trapezium.

(c) To find the perimeter of the quadrilateral, candidates were required to find *AD* and *BC* in their method. Most used the cosine rule in triangle *BCD* to find *BC* and either right-angled trigonometry or Pythagoras' theorem in triangle *ABD* to find *AD*. Many candidates found both lengths correctly and often used them to find the correct perimeter. In some cases, candidates added *BD* on as part of the perimeter. Some final answers were out of range due to use of inaccurate values calculated earlier or, in a few cases, premature rounding of values.

(d) This part was much more challenging. Candidates who recognised that the shortest distance from *B* to *AD* is the length of the perpendicular line from *AD* to *B* and drew this line on the diagram were often successful. The candidates who used distance = $12 \times \sin(34°)$, where 12 and 34 are values given in the question, obtained an accurate answer. However, candidates who used distance = *their AB* $\times \cos(34°)$ often did not reach a sufficiently accurate answer. A common error was to draw a line from *AD* that bisected the angle *DBA,* then use the sine rule to calculate the length of their line. The other common error was to find the length of the line joining *B* to the midpoint of *AD*.

Question 21

(a) Almost all candidates answered this part correctly; the few who achieved no credit had omitted the variable from their response, writing 15^8. A common incorrect answer was $8t^8$.

(b) Candidates found the simplification involving a fractional power more challenging. Although many gave a correct answer, some applied the power to just the algebraic part of the term, giving the common partially correct answer of $64u^{30}$. Some weaker candidates attempted to cancel factors in the power.

Question 22

(a) (i) Almost all candidates gave a correct answer to this question. A few incorrectly gave the number of students rather than the probability, or gave an insufficiently accurate decimal answer of 0.15.

(ii) Almost all candidates gave the correct answer. Those who did not answer correctly in **(a)** tended to repeat their error here, with answers of 13 or 0.39 sometimes seen. Some gave an incorrect answer of $\frac{28}{33}$, with 28 being the total number of students in the Geography and History sets.

(b) This part proved to be more challenging and relatively few correct answers were seen. A common error was to select the required two students from all 33 students rather than from the 20 that studied History. If using the correct denominator, it was not uncommon to see answers using $\frac{7}{20} \times \frac{13}{20}$ because the candidates had not taken account of one student being chosen before the second. Of those who did select the correct probabilities, candidates sometimes forgot to multiply by 2 or add the product for selecting the students in the other order, leading to an answer of $\frac{91}{380}$.

Question 23

Most candidates answered this question correctly and both correct factorisations were often seen. Those who did factorise correctly usually proceeded to obtain the correct answer, but occasionally spoiled their answer by cancelling the h terms in the numerator and denominator, leading to an answer of $-\frac{1}{4}$.
Candidates fared better with the denominator than they did with the numerator. A small number incorrectly factorised the denominator as $(h-4)(h-4)$. Incorrect numerators such as $(h+4)(h+1)$ or $(h+4)(h+4)$ were sometimes seen.

A small minority did not attempt to factorise and instead cancelled the h^2 terms in the numerator and denominator, leading to an incorrect answer of $-\frac{h}{4}$.

Question 24

(a) Most candidates who successfully managed to set up the initial equation went on to score 4 or 5 marks. For many others, this question proved to be one of the more challenging on the paper. It was common to see candidates who started with the correct three-term equation make errors in their subsequent working, often due to poor notation such as missing brackets or applying a process to one side of the equation but not the other. Many candidates struggled to form the initial equation due to errors in the relationship between speed, distance and time in an algebraic context, sometimes forming a linear equation such as $2x + 3(x + 1) = \frac{5}{4}$. Others did not attempt to form an equation but instead solved the given quadratic equation. There were a number that omitted this part.

(b) As part **(a)** of the question required candidates to show a given result, it was possible for them to attempt part **(b)** even without a complete solution to the previous part, and many candidates did so. However, some candidates were unsure of the link between the two parts of the question and attempted to restart with a new equation in this part. Most candidates understood they were required to solve the quadratic equation from the previous part. The question required candidates to show their working, which the majority attempted to do. The use of the quadratic formula was far more common than completing the square; however, both methods were seen. In using the quadratic formula, some candidates made errors in the substitution, for instance substituting values in the wrong place, or making sign errors or bracketing errors with the $(-15)^2$ term in the discriminant. Some candidates used their calculators to solve the quadratic equation, which generally led to insufficient working being shown. Where candidates had correctly solved the quadratic equation, they were generally able to identify that the negative root should be rejected.

Question 25

This question differentiated well between candidates. The most successful responses showed a correct calculation for the gradient of the line joining the two points *P* and *Q*, used this to find the gradient of the perpendicular, identified the midpoint of the line segment joining the two given points and made the appropriate substitutions in order to determine the required equation of the perpendicular bisector. Where fully correct responses were not seen, candidates were often able to earn marks for a correct calculation for the gradient of the line segment *PQ* and/or for finding the perpendicular gradient from their gradient of *PQ* (whether correct or not). Many candidates did not recognise the need to find the midpoint of the line segment *PQ* and instead substituted the coordinates of either *P* or *Q* into their equation. Common errors included the calculation for gradient being inverted or the incorrect pairs being subtracted. Some candidates also incorrectly subtracted coordinates in order to find the midpoint. When finding the gradient of the line perpendicular to *PQ*, there were also a significant minority of learners who found the reciprocal but not the negative reciprocal.

Question 26

Many candidates were able to interpret the notation $\frac{dy}{dx}$ as requiring them to differentiate and this often resulted in some, if not all, of the unknown constants being found. Common errors included attempting to differentiate the given expression for $\frac{dy}{dx}$ rather than *y*, or instead comparing the two statements given in the question and incorrectly identifying the values *a*, *b* and *c* as some of the constants given within the question. A small minority of candidates did not answer this question.

Question 27

Candidates found this question challenging and relatively few correct answers were seen. Those who were successful usually decided to use a numerical value for the side length of the cube. Some candidates used a side length of *x* but then often made errors in the algebraic manipulation or were unable to proceed to a numerical trigonometric statement. These candidates sometimes made errors in finding the length of the diagonal of the base, with $\sqrt{2x^2}$ often simplified to $2x$. The majority of candidates who had a trigonometric statement used tan to find the correct angle, although sin and cos were also sometimes used. Occasionally, candidates lost accuracy when taking the square root of numeric values, leading to inaccurate answers outside of the required range. The biggest barrier for candidates in this question was identifying the correct angle. Some knew to draw the line *AP* on to the diagram but then identified angle *PAB* rather than angle *PAC*. Some understood the requirement to use Pythagoras and trigonometry but were unable to make the link between the sides of the cube, and as a result their workings were in terms of *AB*, *BC* and *AC*; these candidates were unable to make further progress.

MATHEMATICS

Paper 0580/43
Calculator (Extended)

Key messages

To do well in this paper, candidates need to be familiar with all aspects of the syllabus. The recall and application of formulae in varying situations is required as well as the ability to interpret situations mathematically and problem solve with unstructured questions. Work should be clearly and concisely expressed with intermediate values written to at least 4 significant figures, and only the final answer rounded to the appropriate level of accuracy. Candidates should show full working in their responses to ensure method marks are considered when final answers are incorrect.

General comments

There were some excellent scripts for this paper with a significant number of candidates demonstrating a clear understanding of the topics examined. However, there were a small number of candidates who struggled to access some of the questions and for whom extended tier may not have been the most appropriate choice. The standard of presentation varied considerably. On some scripts a lack of clear working made it difficult to award some method marks. There was no evidence that candidates were short of time, as most candidates attempted nearly all the later questions. Some candidates rounded or truncated intermediate values prematurely in their working, leading to inaccurate final answers and a loss of marks. This was particularly common in questions involving compound interest (**Question 14**), trigonometric ratios (**Question 18(c)**), Pythagoras' theorem (**Question 18(c)**), areas (**Question 21)** and volumes of composite solids (**Question 23**). Where answers are exact integer or decimal values, candidates should give this value as their answer rather than rounding to 3 significant figures, unless the context of the question requires a rounded value.

Comments on specific questions

Question 1

Most candidates were successful in finding the median for the set of numbers. The most common error was the answer 11 (the mode), with a few giving 13 as the answer.

Question 2

To be successful, candidates needed to draw an accurate triangle with the construction arcs clearly visible. In most responses, the triangle constructions were accurate and neatly presented. There were a few instances of candidates swapping the lengths of *AC* and *BC*. In some responses, a correct triangle was drawn without arcs. Some candidates attempted to draw freehand lines to resemble arcs, but these were not acceptable. A small number calculated the correct lengths but made no attempt to construct the triangle.

Question 3

(a) Almost all candidates responded correctly. Common errors usually involved the inclusion of numbers such as –2 or 0.8.

(b) Most candidates gave the correct irrational number. Common errors included $\frac{2}{5}$, 0.8 and $\sqrt{144}$.

Question 4

Most candidates chose to work with the area of one or two trapezia. Some chose to work with the area of a rectangle and an isosceles triangle, and a few used a large rectangle and subtracted the area of two small triangles. Many of these candidates were successful in finding the value of x. Less successful candidates made a variety of errors; forgetting to halve 130.2 when working with one trapezium, omitting brackets around the sum of the two parallel sides and using incorrect lengths for the parallel sides. Some weaker candidates made no attempt at a response.

Question 5

(a) Many correct answers were seen. Occasionally an answer was given in standard form and was usually correct. A common error was dividing 780 by 100 instead of 10 000.

(b) Candidates were slightly less successful with the volume conversion. Multiplication by 100 or 100^2 resulted in the two common incorrect answers of 3.7 and 370.

Question 6

Some candidates were unsure of the required method and whether to use division or multiplication. Most of those that chose division usually obtained the correct answer, but some divided in the wrong order or made errors with the power of 10. A large minority chose multiplication, resulting in an answer which was less than 1. In context questions such as this one, candidates need to consider whether their answers are realistic. In a small number of cases either the units of mass were not consistent, or 1 kg was taken as 100 g.

Question 7

(a) Many had no difficulty in giving the correct vale for n(M). A significant proportion of candidates did not demonstrate understanding of the notation for number of elements in a set, and 3, 6, 9, 12 was the most common incorrect answer.

(b) More candidates were successful with the intersection of two sets. A variety of incorrect answers was seen. Some listed the union of the two sets, some gave worded answers such as 'multiples of 6' or 'even multiples of 3' instead of listing the elements. A small number confused even and odd and gave the answer 3, 9.

(c) Many candidates were able to list at least one element from the given set with some listing all four elements. Some missed the notation for the complement and gave an incorrect answer. A higher-than-average number of candidates made no attempt at a response.

Question 8

(a) Most candidates gave a correct factorised expression with just a few giving a partial factorisation, usually with $2x$ as their common factor. Some weaker candidates attempted to subtract the terms, and answers such as $16xy$ were sometimes seen.

(b) Many candidates were able to separate out the pairs and factorise correctly. Some made errors at the first stage, either with incorrect factorisation or with an inconsistent factorisation of their pairs, such as $2x(y – 3) – 1(3 – y)$, and were unable to recover. A small number completed the first stage correctly as $2x(y – 3) + (y – 3)$ but could not deal with the factor of 1 for the second term, and this led to answers like $2x(y – 3)^2$.

Question 9

(a) Most candidates were successful in simplifying the multiplication. Dealing with the y terms sometimes resulted in an error and $35x^8y^2$ was a common incorrect answer. Occasionally some gave an answer with 12 in place of 35 but many of those that did not understand attempted a 'factorisation' giving answers such as $x^3y(5x^2 + 7y)$.

(b) Most candidates understood that the fifth root was represented by the power $\frac{1}{5}$. A small number worked it out by raising both sides to the power of 5, comparing the powers to give $5n = 1$ and then proceeding to the final answer. The most common errors usually involved one of the values 5, –5 and $-\frac{1}{5}$.

Question 10

(a) Many correct responses were seen. Some treated the $2x - x$ as if it was in a bracket and expanded $(2x - x)(5 - x^2)$. Some candidates factorised the final answer, which was not required.

(b) Many candidates had a good understanding of how to expand the three brackets, and the majority gave a correct expansion. After expanding two brackets, some chose to simplify to three terms before dealing with the final bracket. This sometimes led to errors such as $-5x + 4x = -9x$. However, those that did not simplify had more terms to deal with in the final expansion and were more likely to slip up, usually with an incorrect sign, an incorrect power or the occasional numerical slip. Having reached a correct answer, some miscopied this when transferring it to the answer line.

Question 11

With 8 marks on offer, this question discriminated well between the candidates of different abilities and a wide range of marks was seen. Very few candidates earned no credit at all, and a small majority obtained all the correct responses.

Sequence *A* proved more accessible for candidates and most gave a correct sixth term and *n*th term. Some did not simplify the *n*th term, but this was still acceptable.

Sequence *B* proved the most challenging, and fewer correct responses were seen both for the sixth term and the *n*th term. For many, the fifth term being written as $\frac{1}{2}$ rather than $\frac{5}{10}$ proved a hindrance in spotting $\frac{6}{11}$. Most candidates that identified the sixth term as $\frac{6}{11}$ usually went on to give a correct nth term.

Most candidates found the sixth term of Sequence *C*, but the *n*th term proved more of a problem. Some found a correct *n*th term and attempted to simplify but did so incorrectly, such as $\frac{1}{4} \times 2^{n-1}$ simplified to $\left(\frac{1}{2}\right)^{n-1}$ and in some cases as $\frac{1}{2}(n - 1)$.

Question 12

Some candidates had a good understanding of the rules of indices. There were a variety of ways that candidates could work through this problem. Most opted to simplify the denominator, then carry out the division and finally apply the square root, and a majority were successful. Common errors in this approach included cancelling the indices to obtain $\sqrt{\frac{10^4}{10^{22} \times 10^8}}$. Some of those that did reach $\sqrt{10^{100}} = 10^k$ took the square root of the power and gave the answer as 10 instead of 50. Another approach was to square both sides of the equation. Some were successful, some made the errors listed above and some squared 10^k as 10^{k^2} instead of 10^{2k} and sometimes as 100^k.

Question 13

(a) Many candidates had no difficulty in finding the correct point on the *y*-axis. Some assumed that on the *y*-axis the value of *y* would be 0, which led to a common error of (5, 0). Some gave points that did not lie on either axis.

(b) Candidates were more successful when finding this point. Rearranging $2x - 10 = 19$ led to a common error of $2x = 19 - 10$, and some ignored the brackets in the equation of the line and solved the equation $2x - 5 = 19$.

(c) Stronger candidates had no difficulty in finding the equation of the line and almost all obtained the correct equation. For the others, finding the gradient of the perpendicular line proved to be the stumbling block. Many did not show an awareness that the gradient was the coefficient of x, and some reverted to using the points in the previous two parts to calculate the gradient, and not always successfully. Once a value for the gradient was found, some were aware they needed to use (2, 3) and their gradient to find the constant term. A higher-than-average number of candidates made no attempt at a response.

Question 14

Most candidates started correctly by forming an equation such as $1523.15 = 1400 \times \left(1+\frac{r}{100}\right)^4$ and many rearranged this correctly to find the correct interest rate of 2.13%. Some got as far as $\sqrt[4]{\frac{1523.15}{1400}}$ and then gave its value as 1.02 or 1.021. After subtracting 1 in the next step, they were left with values with fewer than 3 significant figures and this led to an inaccurate answer. Candidates need to be aware that in this sort of question they may need to write down at least 5 significant figures for intermediate values in order to obtain a final answer that is accurate enough. Some errors were seen when rearranging the equation such as $1523.15 - 1400 = \left(1+\frac{r}{100}\right)^4$ and, in some responses $\frac{1523.15}{1400} - 1 = \left(\frac{r}{100}\right)^4$.

Question 15

In general, those that had a good understanding of inverse proportion usually obtained the correct answer, otherwise they tended to make little or no progress. A good majority did obtain the correct value of 0.25. Some did not demonstrate knowledge of inverse proportion and instead applied direct proportion, while others misinterpreted the square root and squared instead, and some just worked with $(t + 2)$.

Question 16

A large minority of candidates had a good understanding of regions, drew the lines in the correct positions and with the correct style and identified the region correctly as requested. Errors in drawing the boundary lines and/or errors in identifying the region were common. Boundary lines were usually correctly positioned but incorrect line styles, i.e. solid lines when they should be dashed, and vice versa, were frequently seen. When all lines were correct a correct region usually followed. Partial credit was gained if their region only satisfied two of the constraints. The question clearly required the shading of unwanted regions and for the final region to be labelled R. Some candidates shaded the wanted region, and this was accepted as their answer if it was labelled R; otherwise, the unshaded region was marked.

Question 17

In a majority of responses candidates were able to interpret the set notation and shade the correct subsets on the Venn diagram.

Question 18

(a) Nearly all candidates found this question straightforward and gave the correct volume. A few chose to write 475 but this was usually after seeing the correct answer in the working. When an answer is exact, the entire answer should be given. Only in the case of non-exact numerical answers should they be given correct to 3 significant figures.

(b) Almost all candidates calculated the correct surface area of the cuboid. Some wrongly assumed that four of the faces were either 13.2×4.5 or 13.2×8. There were a few cases where the sum of the lengths of all the sides was given.

(c) A small majority of candidates were able to identify the required angle and use Pythagoras and trigonometry to reach the correct answer. The most efficient method was to calculate either the base diagonal or the body diagonal of the cuboid, and use these with tangent or sine ratio respectively. Others calculated both diagonals, and some resorted to using the sine or cosine rules. The most common error was premature rounding of values within the calculation before using trigonometry, resulting in slightly incorrect answers of 29.9° or 30.0°. Some used an incorrect trigonometric ratio while a few found the angle between *AB* and the vertical.

Question 19

(a) Many of the responses had a well-drawn cumulative frequency diagram, with the points usually connected by a smooth curve and a few joined by ruled line segments. Any errors in drawing a diagram usually involved an incorrect vertical placement for one or more points. A significant number of candidates drew a block graph, which was not acceptable.

(b) Many candidates with a cumulative frequency diagram understood that they needed to read off the height corresponding to a cumulative frequency of 150. Some did not realise and read off a height for a cumulative frequency of 75. Others gave incorrect answers such as 196 by reading off the cumulative frequency for a height of 75 or less.

Question 20

(a) Many candidates realised that the probability of $\frac{2}{15}$ was the product of $\frac{3}{5}$ and the probability of a red sweet from bag *B*. Most then started with $\frac{3}{5} \times p = \frac{2}{15}$ and rearranged this to find the required probability. Some did not understand how to start and some subtracted or multiplied the given probabilities, while others tried $1 - \frac{3}{5}$ or $1 - \frac{2}{15}$.

(b) Most of the candidates with a correct answer in the previous part were able to find the probability of picking two yellows. Some others were able to reach a correct follow-through answer from an incorrect answer in the previous part. Some attempted to draw trees to represent the probabilities. A common error was multiplying the correct probability by 2. Some of those not reaching the final answer were able to earn some credit for finding the probability of picking a yellow from either one of the two bags. A higher-than-average number of candidates made no attempt at a response.

Question 21

Correct areas for the shaded region were seen in many responses. For the area of the triangle, some used $\frac{1}{2}ab\sin C$ successfully. Some opted to use Pythagoras to find the height of the triangle. This was often rounded to 3 significant figures, which tended to lead to inaccurate answers later. Some misquoted Pythagoras, using $\sqrt{12^2 + 6^2}$. When attempting to find the area of the sector, some used the wrong radius, sometimes 12 or 6. Premature rounding often resulted in answers just outside of the acceptable range. A higher-than-average number of candidates made no attempt at a response.

Question 22

(a) Nearly all candidates gave the correct lower bound for the mass of the cube. The most common error was giving the answer 13.7 from 14.2 – 0.5 rather than 14.2 – 0.05.

(b) Results were very mixed on this question, and fully correct answers were in the minority. There were candidates who were able to choose the correct upper and lower bound values and give the correct answer, but a variety of errors prevented many others gaining full marks. A common error was rounding the answer to 3 significant figures after showing correct working instead of giving the exact answer of 7.296. Others rounded 1.25^3 excessively within their working. Some candidates used 14.24 as the upper bound for the mass but still earned some credit by dividing this by the cube of 1.25. Some weaker candidates gave an incorrect calculation but manged to show an upper or lower bound value within their working. There were many who were not able to demonstrate an understanding of this topic. Common errors regularly involved the addition and/or subtraction of 0.5

to both 14.2 and 1.3 and using 13.7, 14.7, 0.8 or 1.8 in their working. Some simply used 14.2 and 1.3 in the calculation of $\frac{14.2}{1.3^3}$.

Question 23

Roughly half of all candidates were able to calculate the volume of the frustum. Many candidates had no difficulty in calculating the volume of the large cone. Finding the volume of the smaller cone proved more of a challenge, with a significant number not realising that the radius of the smaller cone was not 4.2 cm. Those that did realise often attempted to use similar triangle work such as $\frac{r}{4.2} = \frac{7.5}{12}$, which usually led to the correct radius. Some mistakenly used the height of the frustum instead of the height of the small cone in this ratio. When the correct radius was found, the candidate usually found the correct volume of the small cone. A correct method was completed by subtracting the two volumes, but premature approximation and use of inaccurate values for pi resulted in some answers being outside of the acceptable range. A small number attempted to solve the problem by using the ratio of volumes. A few were successful but incorrect ratios and forgetting to take the cube root of the volume ratio led to incorrect answers.

Question 24

(a) Roughly half of all candidates completed the table correctly. Some mistakenly gave a running total so 14, 51, 75 was sometimes seen. Where answers were incorrect and working was seen, errors resulted from misreading the scale or simple mistakes with the number work. For questions in context, candidates need to be thinking about whether their answer seems reasonable. In some cases, answers were decimal values.

(b) Many responses gave the correct number of people with a car allowance. In a few cases, candidates gave their working as 15×0.4. In many other cases the correct answer was given without any working. A higher-than-average number of candidates made no attempt at a response.

Question 25

(a) Candidates had a good understanding of the sine curve and many correct responses were seen. Some lacked accuracy with the amplitude but still maintained the shape of a sine curve. A higher proportion of the weaker candidates made no attempt at a response. Those that did usually drew a sine curve shape with incorrect amplitude and frequency, with some not starting at the origin. A higher-than-average number of candidates made no attempt at a response.

(b) Candidates were less successful in this part, with only a small majority solving the equation correctly. For some, errors occurred with the rearrangement of the given equation and values such as $\sin(x) = \frac{1}{5}$ and $\sin(x) = \frac{1}{7}$ were seen. With a correct rearrangement many gave one or two correct answers. However, some identified the wrong quadrant and 168.5 was a common incorrect answer. Referring to a correct sine curve in the previous part could have helped some candidates avoid angles in the wrong quadrant. A higher-than-average number of candidates made no attempt at a response.

Question 26

(a) Many correct answers were seen. The common wrong answers were 3**a** + 12**b** or 3**a** – 12**b**.

(b) The key to success in this part was identifying any two of the three key vectors for $\overrightarrow{OP}$, $\overrightarrow{OT}$ and $\overrightarrow{TP}$ along with a correct answer to the previous part. Many candidates presented their work clearly and a small majority went on to obtain the correct ratio. For some that attempted the correct method, dealing with the directions of the vectors (sometimes reversed) resulted in one or more incorrect key vectors. Those that obtained correct vectors usually went on to obtain the correct ratio. A higher-than-average number of candidates made no attempt at a response.