MATHEMATICS (WITHOUT COURSEWORK)

Paper 0580/11
Non-calculator (Core)

Key messages

To succeed with this paper, candidates
- need to have completed the full Core syllabus
- are reminded of the need to read the questions carefully, focussing on instructions and key words
- need to develop non-calculator strategies
- only round calculations at the end of a question
- need to check that their answers are accurate, are in the correct form and make sense in the context.

General comments

Strategies to make working without a calculator easier such as cancelling and estimating, need to be embedded for all areas of the syllabus as some candidates' working showed that they made errors with basic number skills and calculating with fractions.

The questions that presented least difficulty were **Questions 1**, **7(a)**, **10(a)**, **13(a)**, **16(a)**, **22(a)** and **23(a)**. The next parts of these questions were seen as more complex. Those that proved to be the most challenging were **Questions 13(b)** measure a bearing, **20** find the total number when given a fractional part, **22(b)** find whether Albie has enough cocoa for 18 biscuits, **24(b)** understand set notation for the number of elements and **27** find the perimeter of a semicircle in terms of π. The questions that were most likely to be left blank were **Questions 24(b)**, **24(c)**, **27** and **29**.

Comments on specific questions

Question 1

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

(a) Most candidates wrote the number correctly in figures. A significant number interpreted the words incorrectly. A few treated the word 'and' as 'plus', so gave 60 405 as their answer. Others seemed not to interpret the word 'thousand' correctly and gave answers such as 4605 or 46 005 or 40 605. Occasionally, the 5 was omitted.

(b) Common errors included rounding to the nearest thousand or to the nearest ten. Some did not round the given value and gave the given number, 52 149, as the final answer.

Question 2

(a) Many candidates gave a correct ruled line that did not go outside the circle. The most common error was to draw a radius. Some gave two answers of both a radius and a diameter so could not be awarded the mark.

(b) A lot of correct answers were seen for this question with most candidates clearly identifying a point on the circumference of the circle. Some indicated part of the circumference, i.e. an arc rather than just a single point. Some only wrote the letter *C* outside the circle and consequently were not awarded the mark. The most common wrong answer was to label a point on the line that they had previously drawn or to mark the centre of the circle as *C*.

Question 3

Many gave the correct mathematical name for the shape, hexagon, and some qualified this as an irregular hexagon. There were a variety of incorrect names given including rhombus, pentagon, octagon, hectagon, sixagon, prism and trapezoid as well as descriptions such as 'irregular polygon' and 'six-sided shape'. With questions on mathematical names or terminology, candidates must use the terms as specified in the syllabus.

Question 4

(a) Many candidates did well here, with the majority listing correct factors of 24 and no extra values. The most common error was to omit some factors, often 1 or 24. A few misunderstood factors of 24 and gave the prime factors instead.

(b) This part was handled even better than the previous part. Many understood what was required as some indicated that they needed to work out 1 divided by $\frac{3}{7}$ (this was not sufficient to be awarded the mark). Some were unable to evaluate this. Some reached the stage of writing $\frac{7}{3}$, so were awarded the mark, and then went on to attempt a conversion to a mixed number or decimal. A few gave the answer, $-\frac{7}{3}$, as perhaps they were thinking about the relationship between the gradient of a line and the normal.

Question 5

Correct equipment must be brought into the exam for diagram questions like this, **Questions 12**, **13** and **21**.

There were many accurate triangles with correct construction arcs drawn. Some candidates erased their arcs or drew a triangle without arcs and then drew some in by hand without compasses. Some drew correct length lines but did not start them from the end points of line *AC*.

Question 6

Many candidates answered this question correctly demonstrating a clear understanding of rotational symmetry of order 4. The most common incorrect answer was to shade a square to the side of the bottom right hand corner square, instead of above it. A few candidates added 5 extra squares so that the diagram had both rotational and line symmetry order 4.

Question 7

(a) Candidates almost invariably answered this part correctly. The most common incorrect answers included +7 (a sign error),1 (adding rather than subtracting 4), –4 (the common difference) and 13 (the term preceding the first term) as well as candidates giving an expression for the *n*th term.

(b) Many gave a correct response. Some explained in words and others showed calculations. A simple explanation such as 'subtract 4' was all that was required here. Many candidates gave equivalent answers such as 'each term is 4 less than the previous term' or 'the common difference is -4'. The most common error was to state a double negative, such as, subtract -4 or gave generic answers such as 'I followed the pattern' or 'I kept subtracting' without explicitly mentioning the number.

Question 8

Many candidates showed the values substituted correctly and had well-presented workings to reach $q = 20$. Some reversed the substitution so used 50 for r and 5 for p. Another common error occurred when rearranging, to subtract 10 from 50 instead of adding. Some who got as far as $3q = 60$, did not go on to divide by 3.

Question 9

(a) Most candidates correctly shaded 15 blocks. The most straight forward method was to shade 3 rows or to leave the last column unshaded with one unshaded in the penultimate column. Other candidates correctly left five random blocks unshaded; this method could be prone to mistakes in the counting of shaded blocks. Others miscounted the blocks to shade after correctly writing 15. Some calculated 3×4 so then shaded 12 blocks.

(b) The majority showed the correct method of $\frac{15}{100} \times 80$. After this statement, there were frequent errors when multiplying 15 by 80, with many using long multiplication methods and others having the correct figures in their answer but with the decimal point in the wrong place. Without a calculator, a partition method such 10% of 80 is 8 and 5% is 4 so 15% is 12 is simpler than multiplication with less chance of making arithmetic slips than long multiplication. Those who were most successful, first cancelled $\frac{15}{100} \times 80$ to $\frac{15}{5} \times 4$, or similar, before multiplying. A minority did not know how to set up the calculation as $\frac{15}{80} \times 100$ was commonly seen.

Question 10

(a) Almost all candidates gave the correct answer. A small number drew a bar with an incorrect height or width, and a tiny number drew the bar in the wrong position.

(b) This was well answered by candidates. Errors seen were with the arithmetic in the addition in the correct method or only adding 5 of the values and not including August. A few divided the total number of books by 12 instead of 6. A small number gave the range or median instead of the mean.

Question 11

(a) This part was well answered. A few candidates drew number lines which generally resulted in a correct answer; this strategy is useful when candidates do not have a calculator. A common error was to add the two values resulting in the answers of 3 or –3.

(b) Slightly fewer candidates were correct here. A common error was to write, –2 + 8 = 10 or –10 possibly due to a misconception about adding a positive and a negative number.

Question 12

There were a good number of fully correct nets seen which were generally well-presented and accurately drawn and many others drew at least one correct face. Candidates needed to remember that for a cuboid, the faces are in pairs. Sometimes the top and bottom face were 1 cm too deep, or the side faces were drawn as 3 cm × 3 cm instead of 4 cm × 3 cm. A few candidates only gave 5 faces, missing out the second 5 cm × 3 cm face. Some candidates drew a 3D diagram like the one given in the question. Candidates must remember that tabs for making a cuboid should not be drawn on a mathematical net.

Question 13

(a) Most candidates gave the correct answer. Some measured inaccurately, with measurements sometimes 1 cm out, suggesting these candidates did not know how to position their ruler correctly. A few showed the correct measurement for the distance on the diagram but did not multiply by the correct scale factor.

(b) Most candidates did not gain the mark here. A number gave the bearing of *A* from *B*. Others measured from *B* in an anticlockwise direction and gave answers of 328°. A wide variety of other incorrect answers were seen.

(c) This was handled slightly better than the previous part. A few candidates gained both marks here for a correct bearing and distance for town *C*. Most gained one mark for marking a point the correct distance from *A*. Only a minority were able to mark a point on the correct bearing from *A*.

Question 14

(a) Most candidates were able to organise the data, placing the values in order. A few gave an unordered diagram or made errors with one or two values. Some ignored the key provided to show the format of the diagram, so candidates wrote the complete numbers instead of just the leaf values.

(b) Most candidates identified the correct answer. Some miscounted and so gave the answer 4. Some gave the answer 12, suggesting they thought the question was asking for the number of children who were older than 2 months. A wide variety of other errors were seen, including answers such as 13, which was more than the total number of children.

(c) Only a few candidates used their stem-and-leaf diagram to find the position of the median. Most demonstrated how to find the median correctly by arranging the data in numerical order and calculating the middle value. Some showed how to find the position of the median (6.5th position) but did not go on to use this to find the median value. A few made errors because they missed out some data (often the second 12) or attempted to find the mean.

Question 15

Many candidates answered this correctly. Many others showed a correct starting step of 180 – 140 or evidencing $\angle DBC = 40^\circ$, or $\angle DAC = 40^\circ$. Many did not go on to make the final step to find the value of x. So, the most common errors included reaching 40 and giving that as the final answer, dividing 40 by 2 and having two base angles of 20 in the isosceles triangle, assuming angle x was 140 or errors with the arithmetic as mentioned before. More successful candidates wrote the angles onto the diagram, helping to understand the link between the angles. Some candidates gave the correct answer with no working and others produced many extra calculations, often starting with angles at a point are 360 and the calculation 360 – 180 – 140 = 40. Geometrical reasons were not required for this question.

Question 16

(a) Most gave two correct values. The most common errors were omitting the negative sign for the value −4.5 or writing the incorrect answer −4.1, suggesting an error in handling the remainder. There was no need to use division as there was a clear pattern in the numbers already in the table; the numbers on the left half were the negative of the values on the right.

(b) There were some very accurate, smooth curves. Most candidates were able to plot some or all of the points correctly. Some plotted the points correctly but could not draw the curve. Some candidates often made errors plotting points at the non-integer values. Some drew poor quality curves and others used ruled line segments. A few joined the two sections of the curve across the y-axis. A small but significant number plotted the bottom left quadrant correctly but then plotted a mirror image in the bottom right quadrant.

Question 17

(a) Most gave the prime number as 23 or 29 and some gave both. The most common incorrect response was 27 or 25. Sometimes the answer was a prime number but not in the given range.

(b) 9 was the value seen most often. Many candidates were not awarded the mark because the calculation was unfinished with, for example, 3^2 or $\sqrt{81}$ on the answer line or, quite often, the answer was given as 3.

Question 18

A reasonable number of candidates answered this correctly giving their answer as a fraction in its simplest form. Those candidates who used the lowest common denominator of 18 were more successful than those who used a higher common denominator such as 36, 72 or 162 (18×9) as frequently these latter candidates made arithmetic errors. A very common method error was to see candidates subtracting the numerators and denominators giving, $\frac{9}{9}$ or 1. Other errors included cancelling the 2 and the 18 over the minus sign and writing out the question and then changing the operation from subtraction to addition and arithmetic errors.

Question 19

This was a question that was often misunderstood. The instruction to round each number correct to 1 significant figure was frequently ignored, as candidates tried long multiplication and division of the original expression. Others scored one mark for rounding 2 of the numbers correctly. Other errors included rounding 19.5 to 2 or 10 or 19 and also rounding 2.49 to 2.5 and then to 3. The correct rounding and answer must be seen before both marks could be awarded.

Question 20

Some candidates used an efficient method and reached the correct answer. Most candidates thought they needed to find $\frac{3}{5}$ or $\frac{2}{5}$ of 75 (45 or 30), and some added their answer to 75, leading to the common incorrect answers of 120 or 105. Very few candidates were awarded just the method mark because, those who used a correct method, almost always went on to reach the correct final answer. Some candidates made arithmetic errors in their calculations as commented on before.

Question 21

(a) There were two different equally good answers to this question, but the majority attempted to describe the rotation as a 90° anticlockwise rotation about the origin with fewer candidates describing a 90° clockwise rotation about (0.5, 3.5). Although most candidates were able to recognise the transformation as a rotation fewer were able to give a complete description of the single transformation, with many missing out the centre or the angle. The word ‘rotation’ was required and words such as ‘turn’ or ‘revolve’ were not accepted. Only a few candidates attempted to describe two transformations.

(b) Some candidates were awarded full marks for correctly reflecting shape *A*. Others scored one mark for reflecting in a line parallel to the *x*-axis or in the line $y = -1$. A number of candidates drew the line $y = -1$ on the grid but did not attempt to draw the image. Other errors included reflecting shape *B*, rotating shape *A* or *B* about the origin or enlarging shape *A,* scale factor –1 with centre (0, –1).

Question 22

(a) Almost invariably the correct answer of 200g was given. The most common incorrect answer was 2400; this did not take into account that this recipe made 12 cookies not just one.

(b) This part was a challenge. There were many methods seen. This needed a statement that Albie does not have enough cocoa with sufficient calculations to show that 30g is required or that the 28g would only make about 16 cookies. A significant number did not realise that a calculation was needed along with a correct statement. A small number of candidates recognised the 18 cookies being 1.5 times 12 and they applied it to the amount of cocoa to reach 30g or 6 cookies require 10g so 20 + 10 gives 30g. Other common methods were more suited to the use of a calculator including showing $\frac{28}{20} \times 12 = 16.8$ and stating 28 g of cocoa only made about 16 cookies. Some candidates showed the correct method but made calculation or rounding errors. Others had the correct calculation but reached the wrong, or no, conclusion.

Question 23

Candidates did well with both parts of this question on the rules of indices considering this was not a completely straight forward question as the values required were part of the calculation and not the answer.

(a) The correct value of 7 was seen from the majority of candidates. A common error was an answer of 23 from adding 8 and 15 rather than subtracting. An answer of a^7 did not receive the mark as the form of answer required was just the value of *x*, the index.

(b) The most common wrong answer was 14 from subtracting 7 from 21. Again, the required answer was just the value of *y*.

Question 24

(a) A good number of candidates demonstrated a clear understanding of Venn diagrams and set notation, successfully completing the diagram. The starting point for this question was to find the number who studied both subjects and then use the total of the four regions adding to 80. Some candidates entered more than one number or an expression such as $55 - x$ into a region, and as this was not correct, they were awarded no marks.

(b) Only a minority of candidates answered this part correctly to demonstrate an understanding of the set notation used. Many did not recognise that n(G) represents the total number of candidates who study Geography, including those who study both subjects. Whilst some gave a correct answer of 55, or added their two values in set G correctly, many gave the number from only one region in G that is not the intersection, and some gave the answer 2 for there being two numbers (30 and 25) rather than the number of candidates.

(c) A good number of candidates answered this part correctly. Many went on to cancel correctly, but this cancelling was not required as the question did not ask for the probability to be a fraction in its simplest form unlike **Questions 18** and **28**. Incorrect answers included $\frac{15}{100}$, $\frac{15}{65}$ and 15.

Question 25

Many were able to expand the brackets correctly with a few making errors when multiplying 3 and −2, instead choosing to try and add them to make 5, −5, 1 or −1 for this term. When collecting terms, some made errors in dealing with the minus sign, mistakenly concluding that $-2x + 3x$ was $-5x$. Candidates did not always take care when copying their last line to the answer line with sign or numbers changed. A minority of candidates were unable to make any progress with this question.

Question 26

This was correctly answered by about half the candidates. Many had problems about the correct number of zeros to be added after the 3 digit or gave the correct number of zeros and did not delete a decimal point between the 1 and the 7 as given in the question. Some were unsure what an ordinary number meant and gave answers such as 1.700×10^8 or 1753. Some used two decimal points, one between the 1 and the 7, as well as another between their last two zeros. A small number tried to multiply 1.753 by 80.

Question 27

Often an incorrect formula was used with some using $2\pi \times 8$ but then either not dividing by 2 or multiplying by 2 and others using the area formula. This suggests that candidates did not understand that perimeter connects with circumference rather than area. Of those reaching 8π, some went on to calculate 8×3.142, possibly because they missed the instruction to leave their answer in terms of π or did not understand what it meant. Few candidates realised they had to add the diameter to find the perimeter of the semi-circle, with many candidates giving an answer of just the arc length, namely, 8π, or equivalent. Of those who found the correct perimeter as $8\pi + 16$, it was not uncommon for this to be spoilt by either writing, for example, 24π or converting to a decimal number.

Question 28

Some candidates worked logically and efficiently. Candidates who reached $\frac{26}{3} \times \frac{8}{13}$ and cancelled before multiplying were much more likely to reach the correct final answer than those who multiplied first. Some reached answers that were not fully simplified, such as $\frac{208}{39}$, $\frac{16}{3}$ or $5\frac{13}{39}$.

Most gained a mark for a correct conversion to a vulgar fraction. A significant number of candidates made basic calculation errors, both when converting to vulgar fractions and when calculating with their fractions. Some were unable to convert either of the given mixed numbers correctly and consequently made no progress. The most common mistakes were to invert the first rather than second fraction and make arithmetic errors with their cancelling or multiplication.

Question 29

This question needed candidates to set up their own equations from the given information for the first 2 marks. After this, solving simultaneous equations is a familiar exercise. This question was perceived as challenging by many. These equations must be multiplied and then subtracted to eliminate one of the variables. The simplest approach is to multiply one equation (for Li's fruit) to equate the number of pears. Other methods will work but might take longer and have more places for errors to be made, for example, to multiply both equations to equate the number of apples or to rearrange both and put them equal to each other. When one cost is found, candidates must still be careful with directed numbers when they substitute their cost to find the second – this was also a place where many errors were seen. Candidates should check their costs satisfy the conditions for both Jim and Li. Answers had to be given as the correct money form and not fractions for all 3 marks to be awarded.

MATHEMATICS (WITHOUT COURSEWORK)

Paper 0580/12
Non-calculator (Core)

Key messages

Prioritise mental arithmetic skills in order to improve non-calculator working.
Ensure all topics in the syllabus are covered.

General comments

There were a lot of no responses this session and also attempts at questions which showed lack of familiarity with the topic involved. Basic knowledge of mathematical language such as equation and expression was often lacking and prevented many candidates from making a positive start on questions.

Concern should be given to presentation and clarity of working with clear, identifiable figures in particular to avoid confusion between 4's and 9's as well as 1's and 7's. Overwriting figures and working makes it difficult at times to assess solutions. Candidates should delete any work they do not wish to be considered.

Comments on specific questions

Question 1

While the great majority of candidates understood the value of the position of the 3 in the number, many only gave the column heading rather than the specific value of the 3.

Question 2

This basic buying and change question was well done but there were two common errors seen. Careless reading of the first line meant only the cost of one book was subtracted from \$20. Of those tackling the question correctly, many had the subtraction resulting in the answer \$4.60.

Question 3

(a) The question was correctly answered by the majority of candidates with 17 500, 17 480 and 17 460 being common errors. Some did not understand rounding which resulted in responses of 16 and 69 occasionally.

(b) Rounding to one decimal place was not as well done. Many wrong answers had more than one figure after the decimal point whereas others moved the decimal point, 50.73 and 50.3 being examples. Others were closer to being correct with 5.0 or even 5.1 with trailing zeros.

Question 4

(a) While the question was correctly answered by the majority of candidates there was a significant number who did not understand the square root notation. Some simply divided by 2 while others understood that 12^2 was equal to 144 but left 12^2 as their answer.

(b) There was a better response to this part with the vast majority understanding that $5 \times 5 \times 5$ had to be worked out. Unfortunately, some thought that was enough for the answer even though the question asked for the value. Some thought the exponent meant multiplication resulting in them working out 5×3.

Question 5

(a) Most candidates understood the concept of lines of symmetry, but the question was not well answered overall. Many simply gave one vertical line and were unable to visualise the other two lines. Where three lines were seen, the accuracy was often beyond tolerance, so they did not score. A small percentage simply had incorrect lines.

(b) Those who had **part (a)** correct were more likely to gain the mark for the order of symmetry. However, many did not appear familiar with the idea of 'order of rotational symmetry' with many candidates giving one as their answer.

Question 6

(a) Those who knew the conversion of a simple fraction to a decimal were relatively few. Some tried to work it out by division, but this often resulted in incorrect answers such as 3.4, 0.3 or 0.25.

(b) Knowing that a fraction with denominator 100 meant the numerator was a percentage was quite well done. However, there were a significant number of candidates with answers of 0.09, 0.9 or 90.

(c) A similar percentage to **part (b)** were successful in changing a percentage to a decimal number, probably mostly the same as those gaining the previous mark. 0.143 was the most common incorrect answer.

Question 7

The major difficulty on this question was indicating the probabilities on the scale rather than finding the probabilities. Often the probability scale has 10 divisions, but the 8-division scale was more appropriate, particularly for **part (c)**. **Parts (a)** and **(b)** were understandably better done than **part (c)** but, even for these simple parts, the arrows were usually far from the correct place. In particular, the arrow for B was often seen to show a probability of 1. **Part (c)** was understandably the least well done part as there was some working out of the probability first, quite often arrows were shown but not labelled or the same label was placed on several arrows. There was a high proportion of no responses on all parts.

Question 8

If this question had been in three parts, asking for all the factors of 144 and multiples of 9 before asking for those in common, it would probably have been answered better. However, some questions expect a higher level of interpretation and organisation of working to reach the solution. Only a very small number of candidates managed to work out all five numbers in the answer. While often 1 or 2 marks were gained from finding some of the five numbers or from a list of factors of 144 or more commonly multiples of 9. Incorrect numbers included meant these part marks could not score. Added to these difficulties many confused factors and multiples.

Question 9

(a) The difference between two temperatures was quite well done, although arithmetic errors were quite common. Otherwise, some added the temperatures to find −18.

(b) While not so well done as **part (a)**, again there was a good response to finding the value of the temperature. The common error was to get 38 or −38 from various combinations of the numbers −15 and 23. Having to relate the question to the data at the start was also an evident problem for quite a number of candidates. Even the time, 10 pm, was seen in some calculations.

Question 10

This question assessed candidates' understanding of probability based on a ratio and many simply wrote down the correct answer. However, a very common wrong answer was $\frac{2}{3}$ from using the numbers in the ratio while some wrote the answer as a ratio. Once again, a lack of understanding that probability had to be between 0 and 1 was evident with answers often greater than 1.

Question 11

Weakness in understanding stem-and-leaf diagrams reduced the success in this question. Also, some confused range, mode and median.

(a) While some candidates gave the range 72–30 rather than an actual value from a subtraction, there was quite a good response for this part. Unfortunately for some they got the answer to the calculation, 72−30, incorrect.

(b) Those who understood mode usually had this correct but again the diagram added to the problem as 4 was often seen. Otherwise, this part was quite well understood.

(c) Only those getting high marks overall had some success with this part, and many did not attempt it. An answer of 11% from $\frac{55}{100}\times 20$ was very common and $\frac{20}{55}\times 100$ was also seen.

(d) (i) Again the difficulty with stem-and-leaf meant an answer of 2 was common. While many did realise the median was between two values in the table, answers of 51 and 53 were seen quite often.

(ii) Very few candidates gained the mark for this part as it depended on understanding the effect on the median of an entry to the shop which was less than the median in the previous part. The common answer of less customers was not enough as it had to relate directly to the median. Some were successful when they found what the median would become.

Question 12

(a) While there were some clear, correct responses to forming and solving an equation based on the parallelogram, these were mainly from those scoring high marks on the paper as a whole. Many candidates did not seem to understand the difference between an expression and an equation. Those who did have an equation often had the sum of the two angles equal to 360°, 90° or even 0°, rather than 180°. Once a correct equation had been seen most either found the correct value for x or gained a further mark if they made just one error. Those who had an incorrect equation often gained 1 or 2 marks for resolving their equation.

(b) Most realised that $3x + 10$ was the largest angle, or at least observed that on the diagram, so that mark could be gained from their answer to **part (a)**. Some had a negative angle which could not be awarded a mark. Many simply left the answer as $3x + 10$.

Question 13

The vast majority of candidates made some progress on the net of the prism by gaining at least a mark for one of the rectangles correct. Since all dimensions of the triangle were given, it was only a few who did not have the correct lengths. Some 3D attempts were seen, and many did not attempt the question.

Question 14

Finding the angle x required the application of the angle properties of a straight line and angles in a triangle. There were two routes to the solution and most first found the remaining unknown angle at point F. Then either the two angles at D or the two angles at E would lead to the final step to find angle x. Many candidates were reluctant to write on the diagram. Without identifying values of angles on the diagram, many did not make it clear in their working which angle they were finding. Also, errors were very common in calculations such as 180 – (50 + 45). Many candidates did not realise that only two basic properties of angles were needed, leading to assumptions that there were parallel lines involved as well as congruent triangles.

Question 15

Having one share given and asked to find the total amount rather than being given the total and asked to find one share has become quite common in questions. This question was not done well as many did not realise they had to find the value of 1 part having been given 2 parts. Adding the ratio shares and dividing 120 by that total was a very common error. Some did find the one part and multiplied it by 15 while others found how much each received and added those together. However, again arithmetic errors were common, meaning of those following a correct method, some still failed to reach the correct answer.

Question 16

There was quite a good response to the ordering question which was rather unfamiliar by having all the data in standard form. A natural starting point of changing all the numbers to ordinary form was not very common which resulted in many errors being made. Common errors were having the first two values the wrong way round or starting with the numbers greater than 1. Some were not familiar with standard form and simply put the order from just the decimal part of the item.

Question 17

Although the formula for the area of a trapezium is not listed in the formula page, it should have been better known than was evident in the response to this question. Even if not remembered, the shape could have been split and the areas added. An answer of 28 from simply adding the three values was seen frequently. Other errors were from regarding it as a single triangle or a rectangle (14×6). Even those knowing the formula often had errors in applying it such as 14 + 6 instead of 14 + 8.

Question 18

Changing to an improper fraction gave a promising start for the vast majority of candidates but some tried to deal with the whole numbers and the fractions as separate parts. While most knew they had to invert the second fraction and multiply, a significant number inverted the first one or both of them. Those who then cancelled the 17's usually ended up with the correct answer but multiplying numerators and denominators resulted in larger numbers that many struggled to deal with correctly. The alternative method of a common denominator, most often 24, again seemed to produce errors or an unsimplified answer.

Question 19

(a) Many candidates did have a correct shape flag for reflection which was parallel to the object. Although candidates were not asked to draw the line on the grid, those that did usually drew the correct image position. Reflecting in $y = -1$ for 1 mark was rare since that line was mostly not correct.

(b) There was a better response to the rotation of 180° and many did find the correct place on the grid. Quite a significant number of candidates rotated through 90°.

(c) Having experienced reflection and rotation in the first two parts, many did recognise this as a translation as long as they knew the name. Many did not know it as evidenced by the large number of no responses. Some described the transformation in words while others used a column vector. Some had that correct but both the number or signs were often incorrect.

Question 20

(a) The Venn diagram was usually populated correctly but a significant number did not fill in the part of the universal set outside the circles. Some missed one or two of the elements from the universal set in their diagram. The other error seen often was to repeat certain elements according to how many times they appeared in the lists. Usually, it was a repetition of 1 and 3 but at times all numbers that appeared more than once in all three lists were repeated.

(b) Nearly all recognised that intersection was the part in the middle and either the correct answer or a follow through of an incorrect **part (a)** was listed correctly.

(c) In contrast, many did not know the notation n(B') so did not attempt an answer. Those who tried often listed the numbers 6 and 10 thinking that it meant just those only in set B.

Question 21

Many showed a clear understanding of the rules of indices and found the correct index for the x term but an index of 4 was seen quite often from dividing instead of subtracting. Unfortunately, a significant number thought they had to do 18 – 9 instead of 18 ÷ 9 to deal with the coefficients.

Question 22

Nearly one-quarter of the candidates did not appear to know what a hexagon was so did not attempt the question. Others attempted a formula with the number of sides not equal to 6. Some did reach the total for the angles of a hexagon but few of them divided by 6 to find the answer for the interior angle.

Question 23

The straightforward start to the question was done well provided candidates knew that the equations needed two terms added and an equals sign followed by an amount of money. The vast majority did gain the first 2 marks. The elimination method was sensibly most often applied to solving the equations, but again arithmetic errors resulted in very unlikely decimal solutions. Only small multipliers were needed to eliminate either variable, but often extremely large calculations were attempted. The substitution method was not suitable and although this resulted in one or two method marks the algebraic manipulation was beyond all but the very able candidates. A final mark was often unable to be awarded since a fractional answer, $2\frac{1}{2}$ or $\frac{5}{2}$ was not acceptable for an amount of money.

Question 24

Many did not attempt this question. However, the diagram suggests that the angle at B was 90° even if the circle theorem was not known, which meant there was a reasonably good response. Some ignored that angle and just subtracted 36 from 180 while 72 from 2 × 36 was also seen.

Question 25

(a) While many were unable to begin this question, those who did understand performed well, at least to the extent of gaining 1 mark for three terms out of the four correct. Addition and multiplication of directed numbers resulted in many errors.

(b) The factorising question was slightly more successful than the expansion in **part (a)**. Again, partial success from taking out 5 or x was quite common but most who did take $5x$ outside the bracket got a fully correct answer. Some left + 10 inside the bracket which was probably carelessness, and a few thought they had more to do once the correct answer was found, so spoilt their answer.

Question 26

This was quite a difficult example of a common straightforward topic. Requiring a third decimal place for the bounds seemed to be too much for most candidates. Rarely were answers given that did have three figures after the decimal point, but when they were seen it was usually 2 marks.

Question 27

(a) Most candidates that attempted this question managed to find the nth term correctly, but others reversed the 6 and the 4 in their expression. A few gave the unsimplified form and often gained 1 or 2 marks for their response. Some did not understand that it required a general term, instead choosing to extend the sequence to the next term.

(b) This was a friendly end to the paper, but too many candidates had given up at this stage. Those who realised that they had to substitute 1, 2 and 3 into the expression often made some progress and there were a reasonable number of correct answers. Unfortunately, $1^2 = 2$ spoilt a number of answers while others were sure the terms increased by the same amount each time.

MATHEMATICS (WITHOUT COURSEWORK)

Paper 0580/13
Non-calculator (Core)

Key messages

Read questions carefully, when a question states 'give your answer in its simplest form' check the answer is in the simplest form.

Show all working.

Check answers are reasonable in the context of the question.

General comments

The majority of candidates attempted all the questions, with many setting out their working in a clear and logical way. Candidates generally did well on number questions however, as this is a non-calculator paper there were some arithmetic errors. Topics which candidates found challenging were finding a reverse bearing and some set notation. The majority of candidates has sufficient time to complete the paper.

Comments on specific questions

Question 1

(a) Many correct answers were seen, a small number rounded to 6 which was outside the acceptable tolerance.

(b) The majority of candidates drew an acceptable line. A small number drew a perpendicular line.

Question 2

(a) Almost all candidates gave the correct answer.

(b) Most knew the 7 was in the hundreds column but failed to include the value in their response.

(c) (i) The majority of candidates gave the correct answer.

(ii) The majority of candidates gave the correct answer.

Question 3

Almost all candidates gave an answer in the required range. A small number wrote 120.

Question 4

Most had clearly counted each sport correctly and most wrote the frequencies in the correct place. A significant number wrote fractions or probabilities in the frequency column.

Question 5

(a) The majority of candidates gave the correct answer, a very small number reversed the coordinates.

(b) This part of the question was the least well done with trapezoid, rhombus and polygon named.

(c) Several were able to give the answer of 16. 20 and 30 were often seen. Only a small number of candidates showed working on the diagram.

(d) Most had correctly plotted the point, common errors were plots at (2, – 3) and (–3,–2).

Question 6

This was well attempted by most candidates however many made arithmetic errors when working out 12×12 or when halving their answer.

Question 7

This was generally correct, the most common incorrect answers were 5:45, 6:05, 6:15, 6:45 and 7:15.

Question 8

(a) Most candidates correctly completed the stem-and-leaf diagram.

(b) Many candidates had not seen the link between the completed diagram and finding the median, so had rewritten the list in order at the top of the page, which led to some errors.

Question 9

(a) This part was usually correct; the common incorrect answers were 64, multiplying by two too many times and 10, multiplying by the index.

(b) Although many gave the correct answer, this part was less well answered than **part (a)** with 6 and 0 the most common incorrect answers.

Question 10

(a) Many candidates gave the correct answer. Others had only written 70° in the base angles of the isosceles triangle. Some made arithmetic errors, 180 – 40 = 120 was seen quite often.

(b) The value of y was often correct, but many gave an incomplete reason, e.g. a line adds up to 180°. Candidates should use the wording of geometric reasons provided in the syllabus.

Question 11

(a) Many correct answers were seen. Some candidates worked in dollars throughout and so scored 2 marks. Others made arithmetic errors.

(b) Many gave the correct expression. Common errors were writing an equation or not writing the plus sign between $55x$ and $36y$.

Question 12

(a) This was generally well answered, although some candidates seemed reluctant to write just y. Common incorrect answers were $3y$ or $3y - 2y$.

(b) (i) Almost all candidates gave the correct answer to this part.

(ii) The majority of candidates who understood how to solve the equation scored at least 1 mark. Some made an arithmetic error writing $6x = 13$.

Question 13

Candidates found this question challenging, while many had a basic idea of what was required, common errors were writing the signs the wrong way round or not using inequality signs.

Question 14

Many candidates made an attempt at this question showing $2000 \times 0.05 \times 4$ but were unable to correctly work out the answer. A common error was to multiply 2000 by 4 as well as 100 and give the answer as 8400. Only a small number attempted to find compound interest.

Question 15

(a) Very few candidates were able to give the correct answer, many had put more than one zero after the decimal point.

(b) More candidates were able to give the correct answer to this part. The most common incorrect answer was 85, dividing by 100 instead of 1000.

Question 16

Many candidates used 1400 as the total amount of money shared rather than Jo's share and divided 1400 in the ratio 4 : 7 : 13. Those who realised that 1400 was Jo's share usually correctly divided 1400 by 7 to find one part and then used this to find the other parts. However, when summing the values to find the total, several candidates used 200 rather than 1400 for Jo's share.

Question 17

(a) Many correct answers were seen, a small number gave the answer 4 by dividing rather than subtracting the indices.

(b) Candidates who understood this question usually gained 2 marks. The most common error was a sign error on $4x$ or $5x$.

(c) About half the candidates were able to factorise correctly. The most common error was to just factorise out the r from both terms. A small number of candidates did not know how to attempt this question.

Question 18

Many candidates knew how to find the area of a circle using the diameter and scored 1 mark for 8^2. Some then did not evaluate 8 squared to 64.

Question 19

Very few candidates knew how to answer this question, with a significant number not making any attempt.

Question 20

Although the majority of candidates attempted this question, few earned any marks. There were several incorrect answers including 179 and 181, 175 and 185, 179.9 and 180.1. More scored 1 mark for the first value than the second. Some wrote 180.49 instead of 180.5 as the second value.

Question 21

(a) The majority of candidates gave the correct answer of 22.

(b) Many candidates were able to state plus 7, a small number wrote the nth term, $n + 7$, rather than the term to term rule.

(c) (i) Many candidates were able to give the correct nth term.

(ii) This was the least successful part of the question, only a small number of candidates were able to show that 688 was not a term in the sequence.

Question 22

This was well attempted, and several candidates scored 3 marks for a fully correct description. Some tried to describe movements using coordinates.

Question 23

(a) Some candidates were able to use the correct symbol; others used the union symbol. A small number of candidates used words rather than set notation.

(b) (i) This part was well answered with many scoring both marks. The most common error was to write 20 rather than 14 in the T only section.

(ii) Many candidates did not understand the compliment symbol as 14 was a common incorrect answer.

Question 24

(a) The correct answer was rarely seen; many did not realise the units were different and just wrote 12 as the answer. Those who did realise they needed to convert from kilometres were rarely able to do so correctly.

(b) Few candidates scored marks on this part, most subtracted 70 from 360, a smaller number subtracted 70 from 110.

Question 25

Many candidates were able to give the correct answer and scored 3 marks. Others had arrived at $\frac{15}{12}$ or $1\frac{3}{12}$ but did not then simplify their fraction. Others had no idea how to multiply fractions with mixed numbers.

Question 26

(a) Many were able to complete the tree diagram correctly, occasionally the 0.7 and 0.3 were the wrong way round on one or both of the second branches. A common error was to have 0.4 and 0.7 on all three pairs of branches.

(b) This part was not well done. Most could identify the correct probabilities from their trees, but these were often added rather than multiplied. Some had difficulty calculating 0.6×0.3.

Question 27

Many candidates made an attempt at this final question, with varying degrees of success. Many knew the limits for the value. Although the question stated ‘explain why’, several candidates simply wrote the number in standard form without any explanation.

MATHEMATICS (WITHOUT COURSEWORK)

Paper 0580/21
Non-calculator (Extended)

Key messages

In some questions there were two calculations, one a multiplication and the other a division. It is usually easier to do the division before the multiplication. For example, in **Question 3** candidates needed to calculate $\frac{18 \times 180}{20}$. Many candidates attempted to do 18×180 first before dividing by 20. Many made errors in the multiplication. It is easier and more efficient to do $180 \div 20$, which gives a result of 9, and then attempt 18×9.

General comments

There were many errors made in doing the calculations, partly because many candidates did not use an efficient method, as explained in the key message. In **Question 6(b)** they had to calculate $125^{\frac{2}{3}}$ and many attempted 125^2 first, which should be 15 625, then $\sqrt[3]{15625}$, which is quite difficult. It is more efficient to find $\sqrt[3]{125}$, which they should know is 5, then 5^2, which is 25. There were also many errors in subtraction, so centres should adopt strategies to improve this process.

In algebra, candidates need to take care when expanding a bracket with a negative sign outside, such as in **Question 7(b)**. Here they usually had to expand $-2(x - 1)$ which is $-2x + 2$, and not $-2x - 2$ as many wrote. In rearranging equations to change the subject, candidates should perform one operation at each stage and perform the operations in the reverse order to how the expression is calculated. Many candidates are performing multiple steps in one stage of working and making one error. In **Question 17(b)**, one correct order is to take $I = M(k^2 + c^2)$ and divide by M to get $\frac{I}{M} = k^2 + c^2$. The next step is to isolate the term in k by subtracting c^2, not taking the square root as many did. From $\frac{I}{M} - c^2 = k^2$ we then take the square root to find the expression for k. We do one step at each stage.

In geometry when finding angles, candidates are often required to give a reason for each angle found, and these reasons need to be learned. Candidates are also advised to take care in calculating angles, as subtraction is often used. In **Question 14(a)**, in calculating angle *CDB*, the calculation 180 – 55 – 88 was often performed incorrectly, even in responses that provided a correct reason.

Comments on specific questions

Question 1

This was answered well with most candidates using the method of $\frac{90}{5}$ followed by multiplying their result by 2 and 3. Most errors were arithmetic rather than a misunderstanding of the method. The most common method error was $90 \div 2$ and $90 \div 3$ to obtain 30 and 45, which were the most common incorrect answers. A few candidates chose to multiply first before dividing by 5, and this often resulted in incorrect answers.

Question 2

Most candidates were able to work out angle *ACB* by subtracting 148° and 82° from 360°. It is probably easier to add those two angles then subtract the sum from 360°. Moving forward, many candidates made the error of dividing this sum of 130° by 2, having recognised that triangle *ABC* was isosceles and that this meant that two of the angles were equal. Extra calculations needed to be done to find the correct values. The correct method was to divide the result of 180° − 130° by 2.

Question 3

Most candidates seemed to understand the need to use $(20 - 2) \times 180$ in their calculations but often failed to appreciate that this gave the sum of the interior angles of the polygon, and that they subsequently needed to divide by 20 to find the size of just one interior angle. Many of those who did use the correct formula often performed the calculations inaccurately. It would have been more efficient to divide 180 by 20 to get 9 then perform 18×9. There were some who used a wrong formula, with $\frac{(n-1)\times 180}{n}$ being seen on several occasions. Alternatively, those that found the size of one exterior angle by doing 360° ÷ 20 and then subtracting the answer from 180° were more successful, though a few gave the 18° as the answer.

Question 4

This question required the ability to manipulate the formula for the area of a triangle to find the height given the area and the base. Many candidates answered this question correctly. The main errors were the omission of the $\frac{1}{2}$ in the area formula or, in some cases, using the 8 and 12 given in the question as the base and height of the triangle and calculating its area.

Question 5

(a) There were, overall, many good attempts at describing the single transformation that mapped triangle *T* onto triangle *P*. Most candidates gave the correct answer of translation. Some candidates gave the answer as rotation. Many candidates gave the vector in the correct format but had the *x* and *y* movements interchanged, or made errors with the signs. Some candidates wrote the vector as a fraction or as a coordinate. Other candidates wrote the movement in words such as three to the left and one up, that description was condoned.

(b) Many candidates gave a correctly sized triangle, though many of these were not in the correct position. The best method was to draw lines from the centre of enlargement to each of the vertices and beyond. The image will also lie on these lines but further away from the centre of enlargement, as determined by the scale factor.

Question 6

(a) The most common method was to add the indices and obtain 5^0 and hence 1. A few used $\frac{5^5}{5^5}$ to again obtain 1. A common error was to obtain 5^0 and then write this without simplification, or give 0 as the answer. Another common error was $5^{-5} \times 5^5 = 25$.

(b) Many candidates showed sound knowledge of indices and attempted $\sqrt[3]{125} = 5$ and then $5^2 = 25$. The most common problem was to attempt to find 125^2 first, then the cube root of the result. In that final method, many candidates made errors or did not complete the method.

Question 7

(a) Most candidates realised that the expression had to be rewritten as $\frac{p}{t} \times \frac{t}{2}$ but many of those gave the answer as $\frac{pt}{2t}$. Some did not invert the second fraction, or wrongly inverted the first fraction.

(b) The majority of candidates were able to complete the first step by setting up the two terms with a common denominator, such as $\frac{3x}{4} - \frac{2(x-1)}{4}$. A number of candidates were unable to combine these fractions correctly into a single fraction. The most common error was in expanding the bracket, so we would see $\frac{3x-2x-2}{4}$ with a final answer of $\frac{x-2}{4}$. Those attempting to combine the two fractions in one step often made this mistake. Other errors occurred when the candidates tried to cancel the 2 with the 4, giving the answer $\frac{x-1}{2}$ or $\frac{x+1}{2}$. When the common denominator used was a multiple of 4, the candidate often did not reduce the answer to its simplest form.

Question 8

The initial step should be to put the information into two simultaneous equations. Most candidates who did this then managed to solve their equations. The variables t and w were given in the question; however, many candidates chose their own variables and were then confused about which variable represented which cost. Where candidates rearranged one equation and substituted it into the other one, they were usually successful. Those that applied a multiplier to one or both equations sometimes made errors in the subsequent subtraction or addition of their amended equations, with some making an error when they failed to apply their multiplier to all terms in the original equation(s). In all methods, many went wrong with the simple arithmetic and with rearrangements of their equations. Those who failed to produce an integer solution might have considered their solutions in the context of the problem, as the answers were in cents.

Question 9

Many candidates correctly recognised the need to use the lower bound of 4.5 and, of these, the vast majority then answered the problem correctly. However, others were unable to complete the speed and time calculation. Those candidates who were unsuccessful either tended not to recognise the need for a lower bound at all, or performed the speed and time calculation first and then found the lower bound as if that value had been rounded to the nearest kilometre. A number of candidates also did not appreciate that the question stated the time was exact, so they also found a lower bound for the time; hence 4.5×1.5 was seen.

Question 10

(a) Most candidates knew that $A \cap B$ was the intersection of both sets. The correct subset of {1,3} was given by the majority of candidates. However, there were quite a number of candidates who just gave the answer of {3}, having missed that 1 was also factor of 12. Candidates might have found the use of a Venn diagram helpful.

(b) The introduction of the two symbols representing the number of elements in a set and the complement of a set clearly showed that these symbols proved to be more challenging than those commonly used to represent the union and the intersection of two sets. Few candidates gave the correct answer, with the majority showing they did not know what the ‘n’ represented. Many candidates therefore listed elements they thought were in this set or gave the answer 2 or 3.

Question 11

Several candidates just wrote down the answer $\frac{24}{99}$ and then cancelled it down. Most candidates used the standard method of $100x - x = 24.24... - 0.24...$ and showed clear stages of calculation. A common error was to use $100x - 10x = 24.24... - 2.42...$ or other incorrect pairings in which the recurring digits do not line up. Many candidates did not simplify their answer. Other errors included giving $\frac{24}{100}$ or the number 0.2444… as answers.

Question 12

Many candidates did not appreciate that the first step was to find the angle at *O*, while many who did set about finding this angle wrote down incorrect equations like $\frac{\theta}{360} \times 2\pi 9 = 18 + 2\pi$, treating $18 + 2\pi$ as the arc length rather than the perimeter. Most candidates realised they needed to calculate $\frac{\theta}{360} \times \pi \times 9^2$ but could not find a value for θ. A few candidates guessed the value of θ or measured it from the diagram.

Question 13

In order to accurately calculate the interquartile range of the scores, it was essential to first find the value of the unknown *x*. A few candidates appeared to think that the two *x*-values could be different, but most realised that they were the same. As the mean of the 10 test scores was given as 8, it was clear that the scores need to sum to 80; therefore, candidates had to subtract the eight values from 80 and divide by 2. The next step was to rearrange the 10 scores in numerical order so that the quartiles and hence the IQR could be calculated. Some offered a range rather than a single value as their solution, whilst others gave positional results, e.g. $\frac{3 \times 11}{4}$, rather than the scores corresponding to those positions.

Question 14

(a) Candidates were usually able to find the correct angles, but they found it challenging to provide the correct geometrical reasons. Many candidates understood the reasons that were required but were not sufficiently detailed in the responses they gave, omitting key words such as 'angles', or using vague terminology such as 'quadrilateral in a circle' when 'cyclic quadrilateral' was required. It is important that candidates memorise the terminology required in explaining the circle theorems. The vast majority of candidates did at least appreciate the need for a geometrical reason written in words; there were relatively few responses in which the reasons given were calculations only.

(b) (i) This question was answered successfully by many candidates. Of those who were unsuccessful, most used incorrect pairs of corresponding sides or inverted one of the fractions in their equation. Some candidates wrote the correct equation but were then unable to solve it, particularly if *CX* appeared in the denominator. There were also a number of arithmetic errors when attempting to calculate 2×2.7, with a number of candidates thinking this was equal to 4.14.

(ii) This part proved challenging for a lot of candidates, as many did not apply the correct ratio of areas for similar triangles. The most common error was 2 : 1, from candidates who failed to appreciate the need to square the length scale factor to find the area scale factor. A few candidates attempted to find the area of both triangles, which was not possible on a non-calculator paper, but did sometimes lead to the correct answer if candidates then appreciated that they could cancel the sine of the common angle along with other common factors in the ratio.

Question 15

(a) A very high proportion of candidates showed that they could convert the given number into standard form. The two most common errors were giving the power of 10 as 10^{-4} or giving the answer as 66×10^3, which is not in standard form.

(b) The successful candidates generally were the ones who converted one of the given numbers to the same power as the remaining one, such as $3.7 \times 10^8 + 0.37 \times 10^8$ or $37 \times 10^7 + 3.7 \times 10^7$. A small number of candidates who rewrote the numbers using powers of 10^7 often gave the answer as 40.7×10^7. A number of candidates wrote out both numbers in full and then added them together. This was successful in some cases, but many candidates made errors either in writing the numbers in full or incorrectly aligning the two numbers in order to add them up in columns.

Question 16

This question proved to be very challenging to most of the candidates; only a few were able to give a fully correct answer. There was some confusion between equations of straight lines and inequalities. Most candidates wrote down the correct equations of the lines, but many could not write down the equation of the line $y = 2x$. The equations $y = x$ and $x = 2y$ were the most common incorrect equations. Many candidates then had problems inserting the correct inequality symbol. Many candidates used double inequalities such as $3 < y \leqslant 4$ and $1 < x \leqslant 2.5$, the latter being incorrect. Candidates often gave the x and y variables the wrong way round for their equations and/or inequalities.

Question 17

(a) This question was answered correctly by most candidates. After writing down $7(3^2 + 2^2)$, the most common errors occurred in multiplication and addition while trying to reach the answer.

(b) This part required rearranging the formula by correctly performing these operations: dividing by M, isolating k^2 and taking the square root. A number of candidates attempted to do more than one step at a time and made an error in one of these steps. Often, candidates attempted to perform the square root of $k^2 + c^2$ in the wrong order. At this stage, they needed to isolate the term k^2 before taking the square root.

Question 18

Due to an error in **Question 18**, full marks were awarded to all candidates for this question to make sure that no candidates were disadvantaged. The error has been corrected in the published version of the paper.

Question 19

The majority of candidates did not recognise the need to use a common base. Successful candidates generally rewrote the equation using powers of 3. Those who attempted to convert the left-hand side to a power of 9 were generally less successful. For those who tried to use a base of 3, many errors were present, often from poor manipulation of the negative power or of the brackets, e.g. a power of $2x + 4$ rather than $2x + 8$ on the right-hand side. A number of candidates also thought that 9 was equal to 3^3, confusing powers with multiplication. Equating powers on each side was the most common approach. Some candidates took the alternative approach of $3^x \times 3^{2(x+4)} = 1$, but failed to progress because 1 was not written as 3^0. Candidates who correctly obtained the linear equation of $-x = 2x + 8$ usually went on to give the correct answer; a few made a sign error when rearranging this equation to move the terms in x to the right-hand side.

Question 20

(a) Most candidates correctly identified that the probability of both balls being black was impossible and gave the correct answer of 0. The most common errors were either assuming the ball was replaced, or recognising that the ball was not replaced but instead not remembering that there was only one black ball.

(b) (i) Most candidates gave the correct probability of $\frac{3}{8}$ for picking a black ball from Bag A. Candidates had more difficulties filling in the second half of the tree diagram. In the second part of the tree diagram the probabilities often had denominators of 7. These candidates probably assumed the second ball also came from the first Bag A without replacement.

(ii) Many candidates managed to write down the correct expression from their diagram, even if they had made mistakes in the last branch of their tree diagram. Many candidates made errors in multiplying out the fractions, especially with 8×4 in the denominators, which was often worked out as 24.

(c) A few candidates gave the correct answer for this question. Many candidates did not take into account that Bag B had gone from having 4 balls in it to 5, as one ball had been added to it from Bag A. Often when a candidate had multiplied two probabilities together, the first had a correct denominator of 8 but the second an incorrect denominator of 4. Many candidates did not realise that a second option existed whereby a black could be obtained. This was when a white is first picked from Bag A followed by a black from bag B. Few candidates produced revised tree diagrams for the new situation, which would have helped them to find the correct answer.

Question 21

(a) Most candidates only gave one correct value because they could not simplify the expression $-\sqrt{5} \times 3\sqrt{5}$ correctly. Those that were successful in giving correct answers showed clear stages of calculation in expanding the brackets and simplifying. Some carried out a correct step but did not reach a correct final answer due to errors in their arithmetic.

(b) Several candidates wrote the correct answer with no working out. Some left the answer as $\frac{6\sqrt{2}}{2}$. Many used the correct method of multiplying by $\frac{\sqrt{2}}{\sqrt{2}}$. The alternative method of multiplying by $\frac{-\sqrt{2}}{-\sqrt{2}}$ often led to sign errors.

Question 22

It was pleasing to see so many correct solutions to this question, which occurred at a late stage in the paper. Candidates generally demonstrated good understanding of algebraic manipulation and an understanding of how to solve quadratic equations. The vast majority approached this problem by eliminating the denominators before successfully equating to zero and solving. For those candidates who chose to gather the fractions to one side of the equation before combining by subtracting, the apparent difficulty of negatives when subtracting algebraic fractions caused several to go wrong, usually resulting in a sign error when trying to do many steps at once. Even though the factorisation was simple, there were a lot of candidates who chose to solve using the quadratic formula, and a small number by completing the square. Use of the quadratic formula and factorisation were the more successful methods.

Question 23

The majority of attempts involved differentiating the equation, though often there was a sign error. Not all candidates equated their resulting expression to 0, which was essential to finding the x-value at the turning point. There were also many that reached $-2-2x=0$ but gave the answer $x=1$. Next, the result for x should have been substituted into the original equation in order to find the corresponding value for y. It was not unusual for candidates to obtain $x=-1$ but fail to find the correct value for y. It was possible to find the coordinates by completing the square to reach $-((x+1)^2-8)$ and extracting $(-1, 8)$ from this expression, though not everyone who attempted this route seemed to know how to obtain the turning point from their resulting expression. The method using $\frac{-b}{2a}$ was sometimes used to find x, and as long as the signs were not confused, this proved successful. Quite often, candidates tried to find the roots of the original equation, which could have led to a correct answer if they had known how to extract the information from that result, but those that started this way generally seemed to be doing so because they did not appreciate the requirements of the question.

Question 24

Most candidates struggled with this question. Some candidates did not make any meaningful attempt, while others filled the answer space with some correct statements and many wrong statements. A good starting point was to write out a route from O to M, for example $\overrightarrow{OM}=\overrightarrow{OB}+\overrightarrow{BC}+\overrightarrow{CM}$, and there were a number of different routes to accomplish the equivalent of this statement. A few used $\overrightarrow{OD}$ in their route but failed to recognise $\overrightarrow{BD}=\frac{1}{2}\mathbf{b}$, instead stating $\overrightarrow{BD}=\frac{1}{3}\mathbf{b}$. Candidates also need to be very clear of direction, for example recognizing $\overrightarrow{DM}=-\overrightarrow{MD}$.

Question 25

Many candidates provided elegant solutions showing clear stages of working and displaying sound skills in algebra. These candidates were aware that they were factorising to allow them to then cancel common factors and simplify their answer. Factorising the numerator was normally done well. However, there was a lot less success with the denominator as many failed to see that it was a difference of two squares. A common mistake was writing the denominator as $4(x-5)(x+5)$ or $(2x-5)(2x-5)$ or $(4x-5)(4x+5)$. There was evidence of many errors in algebraic manipulation. Many candidates cancelled just part of a bracket in the numerator with something in the denominator. Even those who had factorised both numerator and denominator correctly sometimes failed to give the correct final answer because they either did not cancel or they cancelled incorrectly. There were lots of sign errors in factorising, particularly when using partial factorisation; a common error seen was $2x(5a+3b)-5(5a-3b)$.

Question 26

Those candidates who were most successful knew that $\tan 30° = \frac{1}{\sqrt{3}}$. A few of these candidates showed they got this value from using half an equilateral triangle of side length 2 and working out the perpendicular height of $\sqrt{3}$, or were able to replicate a correct sketch of the tan graph. They used their knowledge that the value of a tan x is negative between 90° and 180° as well as 270° to 360° and achieved the correct answers of 150° and 330°. Most commonly, many gave an incorrect answer of 60° for the inverse tangent of $\sqrt{3}$ which would produce final answers of 120° and 300°. Credit was given for recognition of the difference of 180° between solutions.

MATHEMATICS (WITHOUT COURSEWORK)

Paper 0580/22
Non-calculator (Extended)

Key messages

To succeed in this paper, candidates need to complete 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, written in the correct form, and make sense within the context of the question.

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, candidates are usually unable to score any method marks. There was evidence that some candidates did not adapt well to the change to a non-calculator paper. There were far more arithmetic errors, and so candidates need to be more fluent with non-calculator methods and check their work carefully. It is even more important for them to show all their working, no matter how basic they think it is, so that marks can be awarded even if arithmetic errors are made.

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 examination paper, they should clearly indicate which question the working is related to or cross out anything they do not wish to be marked.

There was little evidence that candidates were short of time as most candidates 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-responses were more common in **Questions 13(b)** and **17(c)** than in **Question 24**.

Most basic number and algebraic questions were well attempted, but dealing with negative numbers remains an area to be improved, as well as more complex indices. Some shape and space questions were not answered well, for example those on similar triangles, 3D Pythagoras and converting a major sector into a cone. **Question 13(b)** was the most notable question that candidates struggled with, as many did not know how to tackle this. Many candidates did not seem to be familiar with questions asked using probability notation, giving integer answers to **Question 12(b)**.

Candidates who did less well on this paper showed 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 to be marked.

Comments on specific questions

Question 1

The vast majority of candidates gave the correct answer to this question. The most common incorrect answer was 9, from 21 – 12. Some candidates gave the answer –33 which was not acceptable as the question asked for the increase in temperature. Other errors generally came from arithmetic slips.

Question 2

This question not well answered, with less than half of the candidates gaining the mark. Successful candidates listed the three common factors of 8 and 12 as 1, 2 and 4. A small number of candidates included incorrect values such as 8 or 12 or omitted one or more of the correct factors, usually 1. Occasionally some candidates found the LCM or HCF of 12. Candidates are advised to read the question carefully and underline important phrases so that they do not miss the requirements of the question. For example, 'all' was already given in bold so this should have been a clue that just one answer would not be acceptable.

Question 3

Candidates commonly scored full marks here in finding the volume of the cuboid. Generally working was shown, so even with arithmetic slips the method mark was generally gained. A common error leading to no marks was to attempt to find the surface area of the cuboid instead of its volume.

Question 4

The majority of candidates scored full marks. For those candidates that did not, partial marks were scored for getting 112 or for writing the correct method. Of the few errors seen, the more common were increasing by 20 per cent or assuming that 560 represented 80 per cent. Establishing at the start what percentage the 560 represented would improve candidates' approaches.

Question 5

(a) The majority of candidates gave the correct answer to this question. The most successful candidates simplified the fraction $\frac{90}{360}$ to $\frac{1}{4}$ before multiplying by 600, even if they did not simply recognise that a right angle represents a quarter of a circle. Some candidates gained a mark for writing the correct calculation but then made errors with the arithmetic, often dividing all the values by 10 to give an answer of 15. Some candidates did recognise the need for a proportion calculation, but wrongly calculated $90 \times 360 \div 600$ rather than $90 \div 360 \times 600$.

(b) Most candidates scored all 3 marks, drawing a correct, fully labelled diagram. Candidates need to be reminded to label a pie chart, as some lost a mark for omitting these labels. Some candidates perhaps did not have an angle measurer, as they calculated the angles correctly but did not draw them correctly. Incorrect pie charts often had no stated angle, and so could not gain any marks. Those who had 72 or 138 stated, either in the working or on the chart, were awarded 2 marks. Candidates who clearly showed the angle they were drawing were able to gain a follow through mark for drawing their incorrectly calculated angle correctly. Less successful candidates struggled to recognise the difference between angles and the number of students.

Question 6

(a) This question was accurately answered by just under two thirds of the candidates, but some candidates missed the fact that angle *ABC* and the angle labelled 75° were co-interior angles, and gave answers such as 80 or 100 from wrongly using angle *BCE*. A small minority used a less efficient method, i.e. angles in a quadrilateral add up to 360, and found angle *AEC* first.

(b) Candidates needed to identify the corresponding angles in order to successfully answer this part of the question. Again, just under two thirds of the candidates answered this correctly. Where incorrect answers were seen, these were often based upon assuming that the angle was 90° based on the diagram. Candidates are advised that when a diagram says 'NOT TO SCALE' they should not measure or assume what the size of an angle. A few candidates wrote 80° in the correct place on the diagram for angle *AED*, and 100° in the correct place on the diagram for angle *AEC*, but then wrote 100° on the answer line, demonstrating a lack of understanding of angle notation.

(c) A similar number of candidates were able to find that angle *DAB* was 125° based on identifying the isosceles triangle *ADE* and using this to find angle *EAD*. Some candidates were able to gain full marks for correctly following through from *their* angle *AED* from **part (b)** of the question.

Only a minority of the candidates who did not find angle *DAB* were able to gain partial marks for identifying *EAD* or *EDA* as 50°. Although it was common to see working leading to either 50°, or the correct follow through value for their answer to **part (b)**, this was not generally identified and was often given as the final answer rather than one of the base angles in the isosceles triangle.

Candidates did not often utilise the diagram to label angles that they had found. Some may have benefitted from this as it would have enabled clarity on which angles were being worked with during intermediate steps of working.

Question 7

The correct use of open and closed circles to indicate strict and non-strict inequalities was realised by a majority of candidates. Many, however, were unaware that a single straight line either on or preferably parallel to the number line was the most appropriate way to show the range between these circles. Some drew a rectangle, either clear or shaded, between the two limits. A common error was to draw the two parts of the double inequality separately, leading to two separate lines. Other candidates scored 1 mark by drawing a correct length line but without appropriate circles at either end. A small number of candidates were not aware that the use of arrows on number lines is not appropriate for bounded inequalities.

Question 8

It was difficult for most candidates to gain 2 marks on this question, with only the more able achieving this. Candidates were often able to gain 1 mark on this question for $40p$ or less often for $0.4p$, but forming a correct expression proved more difficult. Incomplete answers often involved giving a mixture of cents and dollars, such as $20 - 40p$, or giving 1960 and not using p at all. A number of candidates produced an equation that they proceeded to solve. In the question, the word '**cents**' was in bold, which was the key piece of information needed for a correct answer and the clue that there was a change of units to consider.

Question 9

This was a well-attempted question with the majority giving the correct answer. Incorrect answers came from performing the wrong calculations much more often than making mistakes in the calculations with fractions. The question was worded clearly to state that $\frac{1}{3}$ of a **full** bottle and $\frac{3}{7}$ of a **full** bottle should be subtracted from a full bottle, so $1-\frac{1}{3}-\frac{3}{7}$. However, incorrect answers often subtracted $\frac{1}{3}$ to give $\frac{2}{3}$ of a full bottle, and then subtracted $\frac{3}{7}$ of the remaining $\frac{2}{3}$, usually by calculating $\frac{4}{7} \times \frac{2}{3}$. Candidates should be encouraged to make sure that their answers are sensible; for example, some answers given were greater than 1, or negative. Of the candidates attempting to add or subtract fractions, most did correctly use a common denominator and gained a method mark for demonstrating this skill. Some less able candidates added numerators and denominators without finding a common denominator. The most common error was $\frac{1}{3}+\frac{3}{7}=\frac{4}{10.}$.

Question 10

(a) This question was very well answered by candidates. Working was generally very clear and showed the substitution of 3, 8 and 10 into the given formula, which leads to the answer of 184. Of the candidates not rounding to one significant figure initially, many then used significant time carrying out far more complex multiplication, and then only gained the method mark for demonstrating they could substitute into an equation. This is an instance where candidates need to remember to read the full question.

(b) This was also well answered by many; generally the method shown was clear, with candidates factorising with a m outside the brackets to give $b = m(d + 2k)$ before dividing. It was unusual for candidates to obtain the method mark without then continuing through to gain full marks; however, where seen this came from the correct factorisation and then incorrectly rearranging to give $m=\frac{d+2k}{b}$. Where candidates did not obtain any marks, this was the result of an incorrect first step which could not be recovered from, for example dividing by d to give the incorrect equation $\frac{b}{d}=m+2mk$, then similarly dividing by k unsuccessfully and attempting to combine m and $2m$.

Question 11

(a) Whilst most candidates seemed to understand the concept of similar triangles and recognised which angles were equal, the demand for geometrical reasoning to support each statement meant that most found this a challenging question, with only a minority scoring full marks. Those that did commonly stated three pairs of equal angles with geometrical reasons. Fewer scored full marks by giving two pairs and a correct similarity condition. Most commonly omitted, or incorrect, was the recognition of corresponding angles, without which the maximum possible mark was 1. Sometimes candidates simply stated 'due to the parallel lines' as an inadequate attempt at geometrical reasoning. Some stated pairs of angles were corresponding without stating that this meant that they were equal, which was also insufficient. For those scoring 1 mark only, this was most often for stating the common angle at P. However, some candidates used the incorrect terminology, referring to P as a 'point' rather than an angle, so could not gain the mark.

Commonly seen from those scoring no marks were correct pairs of equal angles but no geometrical reasoning, or simply making reference to the parallel lines. Some focused on describing one triangle being an enlargement of the other, but again without geometrical reasoning.

(b) A correct ratio approach was usually shown, with many candidates reaching the correct answer of 15. A noticeable number of candidates spoilt their initially correct method by adding on 5 (or sometimes subtracting 5). This was the most common reason for scoring no marks. Few scored just 1 mark with arithmetic errors in their working, and only a small number scored no marks by taking an inappropriate approach such as adding on the same difference in length to give an incorrect answer of 11.

(c) Approximately two fifths of candidates correctly realised they needed to use an area scale factor (or ratio) based on the length scale factor of 3. Hence many reached the correct answer of 16k, but it was not uncommon to see the answer 18k, as the area of the larger triangle, forgetting to subtract the area of the smaller triangle to give the area of the quadrilateral. A number of candidates did not square the scale factor, reaching the incorrect answer of 4k (or 6k if they also forgot to subtract 2k). Those who attempted to use $\frac{1}{2}\times\text{base}\times\text{height}$ were not usually successful. The small number who were seen attempting the area of a trapezium formula were unable to make progress due to not knowing the height of the quadrilateral.

Question 12

(a) This part was answered well by many candidates with fully correct responses often seen. Almost all incorrect responses gained partial marks, usually for the correct placement of 25 in the outer region of the Venn diagram. This was sometimes accompanied by a total of 60 for S and 70 for C to gain a method mark also. Some candidates did have 55 correctly placed but errors elsewhere. Some incorrect answers included a blank intersection.

(b) (i) Less than half of candidates were able to answer this correctly. A common error was where candidates did not recognize that the notation P(C) represents probability rather than the number of elements in set C, i.e. n(C). Consequently, they gave 70 as their answer instead of calculating the probability correctly. A few less able candidates gave $\frac{1}{70}$ as their probability.

(ii) Approximately half of candidates were able to answer this correctly. The most common error was to give the answer as a frequency and not a probability, usually 55 in this case, or whatever value they had in the intersection of their Venn diagram. A few less able candidates gave $\frac{1}{55}$ as their probability, or similar. There were a few candidates who did not have a value in the intersection of their Venn diagram so could not achieve the follow through mark that was available here.

(iii) This was found to be challenging by many candidates, with less than a quarter answering this correctly. Often candidates could not identify the region represented by $S \cup C'$ and could therefore not calculate the correct probability. Again, the most common error was to give the answer as a frequency and not a probability. Some of these incorrect answers were 85, but many other totals were seen here also due to issues in identifying the required region. For example, some candidates did not correctly identify the three required sections of the Venn diagram and just used the total of their ‘only S’ section and their ‘25’, perhaps from confusing $S \cup C'$ with $(S \cup C)'$.

Question 13

(a) This part of the question proved challenging for many candidates. The best responses correctly expressed 14 as a product of its prime factors in index form, i.e. $2^1\times7^1$, and used this to write the index form of 14M for their final answer. Some candidates scored 1 mark for showing clearly that $14 = 2\times7$ (by calculation or in a factor tree) but did not reach the required index form. Incorrect answers included evaluating 14M or multiplying each of the base values by 14. There were also instances of candidates attempting to combine indices with different bases or multiplying the indices each by 14.

(b) This part of the question was the least well answered question on the paper, with correct answers being rare. A small minority gained full marks by showing a clear, structured method and dividing *M* by the largest possible cube number by selecting for each prime factor the largest power that was divisible by 3 (i.e. $2^6 \times 3^3$), and arriving at the correct final answer of 50. Very occasionally, an alternative correct answer of -86400 was seen on the basis that $\frac{M}{R}$ could be interpreted as a negative cube number. A small number of candidates were able to gain the method mark by reaching a valid intermediate stage, such as dividing by $2^3 \times 3^3$, giving the answer 2×5^2 without evaluating it to 50, or not completing the evaluation accurately. Some candidates whose final answers were incorrect still received special case marks for values of *R* that gave a cube number, but not the smallest. A significant number of candidates scored no marks, often giving small positive answers such as 1, 2 or 3 with little or no working shown. About a fifth of candidates offered no response, with this question having the highest omission rate on the paper.

Question 14

(a) This question on simplifying indices was answered well by just under two thirds of candidates. A common error was to give the answer in index form (3^4) rather than to evaluate the calculation to find the correct value (which the question asked for). Candidates need to be able to identify what format the answer should be in. A common incorrect response was 1 which was the result of issues in dealing with directed numbers (thinking that $2 - -2 = 0$) leading to 3^0.

(b) A similar number of correct responses were seen for this part too. There were a variety of correct approaches seen, with the best of these showing clear, well-organised layout in working with indices. Common correct approaches were:

$$16^{-\frac{3}{2}} = \left(16^{\frac{1}{2}}\right)^{-3} = 4^{-3} = \frac{1}{64}$$

$$16^{-\frac{3}{2}} = \left(\sqrt{\frac{1}{16}}\right)^{3} = \left(\frac{1}{4}\right)^{3} = \frac{1}{64}$$

$$16^{-\frac{3}{2}} = \left(4^2\right)^{-\frac{3}{2}} = 4^{-3} = \frac{1}{4^3} = \frac{1}{64}$$

$$16^{-\frac{3}{2}} = \frac{1}{16^{\frac{3}{2}}} = \frac{1}{\left(\sqrt{16}\right)^3} = \frac{1}{4^3} = \frac{1}{64}$$

There were also candidates that worked using a base of 2 and those that chose to start by cubing 16, leading to larger numbers to manipulate. Where fully correct responses were not seen, some candidates were able to gain partial credit for a start to a method which dealt with two of the three elements of the index (the negative, the numerator of 3 or the denominator of 2). Incorrect responses took a variety of different forms, which included misinterpreting the index as a multiplier, or methods that interpreted parts of the index correctly but then made other parts into a multiplier.

Question 15

(a) Most candidates recognised and were able to factorise the difference of two squares. Incorrect answers seen included $(x-8)^2$ or $x(x-64)$.

(b) Approximately two fifths of candidates recognised the bracket $(x-2y)$ as a common factor and were able to reach the correct answer; some did not simplify the second bracket, so scored only 1 mark, leaving their answer as $(x-2y)(5x+6(x-2y))$. Those not spotting the bracket as a common factor typically expanded all terms which, if simplified correctly, gave a commonly awarded SC1 mark, but a number made slips expanding and simplifying, and so did not score any marks. A small number inappropriately either cancelled (or divided by) the common bracket, or mistakenly thought there was a common factor $(5x+6)$ with a second factor of $(x-2y)^2$ or $(x-2y)^3$.

Question 16

Approximately three fifths of candidates were successful in this question, reaching the correct answer of 36°. The most successful candidates used the simplest method of finding the exterior angle of the original polygon (24°), subtracting the given 14° and dividing 360° by the new exterior angle of 10°. Many took a longer approach, using the interior angle formula for the first and/or second stage of their solution. Whilst this approach often worked, it was more prone to error at some stage, especially after finding the original interior angle of 156°. Some making algebraic errors in this latter approach seemed unaware that their non-integer answer could not be correct. A common error seen by candidates who did not score marks was treating the given 14° alone as an interior or exterior angle. They were perhaps unfamiliar with working with incomplete diagrams of polygons; candidates may therefore benefit from practice in this area. Approximately 10 per cent of candidates offered no response to this question.

Question 17

(a) Just over half of candidates understood how to answer this question, and able candidates almost always reached $3\sqrt{17}$ without any problems. Most preferred to deal with the ratio after finding the distance *BD*. Some scored 4 marks because they did not appreciate that they needed to simplify; the most common answers scoring 4 marks were $\frac{3\sqrt{68}}{2}$, $\frac{6\sqrt{17}}{2}$ and $\sqrt{153}$. A significant number got as far as $\sqrt{68}$ and then stopped, or could not deal appropriately with the square root; $\sqrt{68}$ sometimes became $17\sqrt{4}$ and $\frac{\sqrt{68}}{2}$ often became $\sqrt{34}$ instead of $\sqrt{17}$. Many interpreted the ratio incorrectly and multiplied by $\frac{2}{3}$ or $\frac{3}{5}$. A large proportion of candidates showed an understanding of what was needed and used Pythagoras, but found dealing with the negative numbers difficult, both subtracting and squaring. It was common to see the incorrect method of adding the coordinates instead of subtracting. Some thought that they needed to find the gradient of the line at this point. Less able candidates often did not know how to get started; sometimes drawing a kite with the coordinates labelled, which was a good idea, but could proceed no further.

(b) The vast majority of candidates calculated the correct midpoint. There were some arithmetic errors when dealing with the negative numbers, and occasionally the coordinates were reversed.

(c) There was a very high omission rate on this question, and only around half of candidates gained full marks. The candidates who realised that they needed to find the equation of the perpendicular to *BD* demonstrated a good understanding of the steps required to do this, with the more able candidates usually reaching the correct answer. Some errors were made in finding the gradient of *BD*; again, the negative numbers involved caused problems, with $\frac{-8}{8}$ commonly seen. Those showing clear working were able to gain method marks before or following mistakes. Some candidates continued to use the initial gradient of *BD* and so could gain no further marks. The other common error in the method was to use either point *B* or point *D* for the substitution, rather than the midpoint.

Question 18

Just under two thirds of candidates obtained full marks in this question. Successful responses correctly multiplied the numerator and denominator by the conjugate $4-\sqrt{6}$, showed the denominator simplifying to 10 (or an equivalent single number), and arrived at a fully simplified final answer such as $2(4-\sqrt{6})$ or $8-2\sqrt{6}$. Candidates who did not gain full marks frequently scored two marks for reaching the intermediate step $\frac{80-20\sqrt{6}}{10}$ or an equivalent unsimplified fraction. One mark was commonly awarded when candidates correctly formed the conjugate fraction $\frac{20}{4+\sqrt{6}}\times\frac{4-\sqrt{6}}{4-\sqrt{6}}$ even if later steps contained errors in expanding, which was often the case. Common errors included multiplying by an expression containing the same sign $(4+\sqrt{6})$ instead of the conjugate, not including brackets around the conjugate, or attempting incorrect cancellation, often following $\frac{80-20\sqrt{6}}{10}$ with $8-20\sqrt{6}$, i.e. only cancelling one term in the numerator with the denominator. Another incorrect approach that gained no marks was to multiply the numerator and the denominator by $\sqrt{6}$.

Question 19

Approximately half of candidates scored full marks in this question. The quality of responses varied greatly. Some candidates calculated the diagonal of the cuboid as $\sqrt{99}$ but did not compare this figure with 10, including a small number who stated that $\sqrt{99} \neq 10$, which did not answer the question. Some only worked in two dimensions, and weaker responses calculated the surface area or volume of the cuboid. For those struggling, an approach including sketches of the relevant right-angled triangles could have helped visualise the problem. A significant number of less able candidates thought the rod could only be placed horizontally or vertically, and compared the length of 10 with the dimensions of the box (5 and 7).

Question 20

(a) (i) This initial part of question 20 was very well answered. There was an equal mix of candidates who showed working to obtain 10, and those who just gave the answer. In the rare instances when this part was answered incorrectly, this was usually by substituting into the wrong function or thinking that (g)2 meant multiplying g(x) by 2 to reach the answer $6x+8$. Other errors included replacing the g with 2 i.e. $2(x)=3x+4$ and then attempting to solve for x.

(ii) Around three quarters of candidates had a sound understanding of the composite functions involved in this question. Most candidates were able to correctly substitute f(x) into g(x). Candidates who processed this numerically tended to have greater success than those who followed an algebraic approach and then substituted. Most candidates who found f(–1) = –7 then correctly found $3\times-7+4=-17$, although there were sometimes numerical errors in processing this, often following –21 + 4 with something other than –17 (often 25 or –25) due to arithmetic errors when adding positive and negative numbers.

Those who followed the algebraic approach had less success because the manipulation of the fractions created challenges. Some candidates found gf(x) first as: $3\left(\frac{21}{2x-1}\right)+4$, then substituted −1 into this. When candidates only obtained part marks, this was usually down to a miscalculation with the negatives in $\frac{21}{2(-1)-1}$. or from correctly evaluating the fractional part but then multiplying both the numerator and denominator by 3. Those candidates who were able to clearly show their working were awarded method marks. Very occasionally, candidates instead found an expression for fg(x), i.e. $\frac{21}{2(3x+4)-1}$.

(iii) This was a more challenging inverse functions question than previous ones set, as candidates struggled at times to correctly process the final step of dividing by 2. This question, therefore, did differentiate well between candidates who were aiming to achieve the top grades. The more able candidates were able to obtain full marks; it was usually due to unfinished processing that prevented full marks being awarded. The most successful candidates were able to follow the method of substituting *x* and *y* into the function. The most common mark of M1 was for the starting point of $x = \frac{21}{2y-1}$. However, not all candidates did this, and some continued to use function notation, either $f^{-1}(x)$ or f(x), which made the manipulation much more untidy and therefore more challenging. Of those who were only awarded M1, it was usually because there were mistakes in the processing of the –1, with $2y - 1 = \frac{21}{x}$ often followed by $2y = \frac{21}{x} - 1$ instead of $2y = \frac{21}{x} + 1$. The most common misconception was around the processing of algebraic fractions and candidates not being able to process two-tiered fractions. As a result, $\frac{\frac{21}{x}+1}{2}$ was often left as the final answer, as candidates were not able to complete the processing. This was awarded M2. $2y = \frac{21}{x} + 1$ was often followed by $y = \frac{21}{x} + \frac{1}{2}$, i.e. not dividing the $\frac{21}{x}$ by 2, or by $y = \frac{42}{x} + \frac{1}{2}$, i.e. realising that $\frac{21}{x}$ also needed to be divided by 2 but evaluating this incorrectly. Candidates would also benefit from understanding that $\left(\frac{21}{x} + 1\right) \div 2$ is not considered suitable as a final answer as it has not been processed fully. Other errors including leaving *y* in their final answer. Or finding $(f(x))^{-1}$.

(b) This question was very well answered, with many candidates obtaining the full 5 marks coming from very clear working and most often using the quadratic formula to obtain the roots. A smaller number of candidates obtained 4 marks, losing a mark due to a mistake in calculating the values after a correct quadratic formula, or from obtaining $(3x - 5)(2x + 5)$ and then giving incorrect signs in their solution.

For candidates scoring lower marks, the M1 mark for $21 = (2x-1)(3x+4)$ was not always awarded, as candidates sometimes did not show the brackets and as a result processed their work incorrectly. Often this resulted in no marks being awarded, since multiplying out $21 = 2x - 1(3x+4)$ resulted in a linear equation that did not require the same techniques as a quadratic. Some candidates did not show working at this stage, which did result in a loss of marks if they did not go on to obtain a correct quadratic equation. A small number had the correct brackets, but ignored or did not use the 21. It was common to see sign errors when simplifying, often resulting in $6x^2 - 5x - 4$ instead of the correct $6x^2 + 5x - 4$. However, some candidates did then process this correctly, scoring both of the available method marks. More able candidates used factorising as their method for solving the quadratic. Candidates using the formula tended to make more arithmetic errors. Some candidates incorrectly factorised, which resulted in their answers being the wrong way around, e.g. $\frac{5}{2}$ and $-\frac{5}{3}$. Candidates are advised, on a non-calculator paper, to leave their answers in exact form, i.e. not to follow a correct $\frac{5}{3}$ with a rounded answer of 1.67.

Question 21

(a) Just under two thirds of candidates demonstrated the correct shape, period and y-intercept of the graph, and produced a good sketch. Of the incorrect answers, many gained a mark for an attempt at the correct general shape starting at (0, 1), but with an incorrect or inconsistent period and/or amplitude. Candidates should be reminded that there are no straight sections in trigonometric curves. Those who did not gain any marks were usually confused with the sine curve and started their curve at the origin.

(b) Approximately 10 per cent of candidates offered no response to this question. From those that did make an attempt, responses were seen at all levels of the marking range. The majority of candidates gained the first method mark by showing the rearrangement of the equation to $\cos x = -\frac{\sqrt{3}}{2}$, and the value of 30 or –30 was often reached. Candidates had various methods of finding the correct solutions from here, but they should always be encouraged to use the symmetry of the trigonometric curve if they are unsure, and to check their answers. When writing their answers, candidates should remember to read the question again, since –30° is not a valid solution in the range $0 \leqslant x \leqslant 360°$. Where candidates did not remember the angle value from the ratio, it was common to still award 2 marks out of the 3 for the correct rearrangement and two answers in range that added to 360. 30 and 330 was a common answer that gained 2 marks.

Question 22

Approximately 10 per cent of candidates offered no response to this question. Usually only the more able candidates scored full marks. Candidates used various methods, such as differentiation and completing the square, to solve for b and c. Some candidates attempted to differentiate the given equation, but they did not equate the derivative to zero hence they could not find the solution. Some candidates simply substituted the given coordinate into the equation and did not make any progress after that since their resulting equation, $12 = (-5)^2 + b \times (-5) + c$, still contained two unknowns. Where candidates chose to use differentiation, attempts either did not go far enough or contained errors, which meant that the mark for the correct method for b was not awarded. For example, some candidates differentiated $y = x^2 + bx + c$ successfully to get $\frac{dy}{dx} = 2x + b$ but failed to equate this to 0 and/or substitute $x = -5$ into their derivative. There were a few candidates who did substitute $x = -5$ into their derivative but set $\frac{dy}{dx}$ equal to 12 and not 0 here. Some candidates who had an incorrect value for b then showed the correct working for $12 = (-5)^2 + \textit{their}\ b \times -5 + c$ to gain a method mark for finding c.

Question 23

(a) Many candidates were able to give a correct calculation for the given answer, usually stating $\frac{240}{360} \times 2 \times \pi \times 12$, with some working in stages. Fewer used a radian conversion, multiplying the angle 240° by $\frac{\pi}{180}$ before using $r \times \theta$. A small number unnecessarily worked with the minor arc. Some incorrectly attempted to use circle area rather than circumference, whilst only a small number appeared completely unsure how to approach the question.

(b) This part had one of the highest omission rates on the paper with only about a third of candidates scoring multiple marks. More able candidates were quick to visualise that the arc length from the sector would be the circumference of the cone base, deducing that the radius was 8 cm. Commonly accompanied by a sketch, they were then able to use Pythagoras to determine the cone height and thus the volume, with many correct answers seen once the correct first step was established. For some, their only error was in simplifying the surd answer for cone height. Many less able candidates did not manage to identify the correct cone radius, often using the given arc radius as the radius in the cone volume formula. Some of those with an incorrect cone radius were able to gain method marks if they attempted Pythagoras to find the cone height, although incorrect attempts at Pythagoras were seen, with terms added when they should have been subtracted. In unstructured questions such as this, candidates must be clear what they are doing (e.g. indicating the radius they are using). Some candidates tried to use trigonometry to find cone height, making incorrect assumptions about the slope angle (often seen as 60°). Those candidates who did not score had generally missed the need for Pythagoras to find the cone height and did not make the connection with **part (a)** to find the cone radius before attempting to use the cone volume formula.

Question 24

Here, the rules of indices needed to be applied correctly, using a common base of 3 on both sides, which just under two thirds of candidates attempted to do. One important point candidates need to remember is that it is better to convert all composite numbers into their prime factors using index notation. A common mistake observed was that some candidates tried to convert 27 into 9^k, which led to an incorrect power. Some candidates correctly equated the powers but did not to cancel the variable 'x' on both sides and were unable to solve $3nx = 4x$.

MATHEMATICS (WITHOUT COURSEWORK)

Paper 0580/23
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 terms of π in its simplest form in **Question 19** or to give the answer as a fraction in its simplest form in **Question 26**).

This examination provided candidates with many opportunities to demonstrate their skills. It differentiated well between candidates, with a full range of marks being seen. There were a good number of high-scoring scripts, 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 award of part marks when the correct answer is not seen. Structuring of working was particularly important when candidates were asked to show a result or to show their working, or in questions where more steps were required in their method (for example **Questions 13**, **21**, **22**, **27**, **28** or **29**).

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 **Questions 19** and **29**. 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 find the value of a missing angle in an isosceles triangle. The majority of answers were fully correct. Where incorrect answers were seen, these covered a range of different misconceptions – with assumptions of all three angles being equal, addition of three angles of equal size and what appeared to be guesses all seen.

Question 2

This question asked for the largest odd number that is a common factor of 90 and 120. This discriminated well between candidates. Slightly more than half of the responses correctly identified 15 as the answer. Common incorrect responses were 5 (the largest prime factor of both) and 30 (the largest common factor of 90 and 120). Some responses also worked with multiples and attempted to find the lowest common multiple of the two numbers.

Question 3

Here candidates were expected to use their understanding of nets together with the given information that the sum of the opposite faces on a dice are 7 in order to complete the labelling of the net. The majority of responses seen were fully correct. Where incorrect responses were seen, these generally involved values between 1 and 6 being placed on the unlabelled sides which appeared to be due to difficulty in identifying which faces of the net were opposite one another in the corresponding three-dimensional solid.

Question 4

Finding the perimeter of the compound shape made from two rectangles was answered correctly by about three quarters of candidates. It was common to see candidates making use of the diagram to help them to identify the lengths that they needed to work with. Where incorrect responses were seen, these often included the overlapping section of the two rectangles either once (leading to an answer of 91) or twice – once for each rectangle (leading to an answer of 96). In other cases, one or more of the lengths included in the perimeter were omitted.

Question 5

This question on finding missing angles was well answered, with many candidates able to find both of the required angles. To find angle *x*, candidates needed to know that equilateral triangles have 60° angles and use the sum of angles on a straight line. Most candidates were able to find angle *x* using this knowledge. Where incorrect responses were seen, a significant proportion appeared to be guesses; those where a method could be identified tended to be working with 90° (from the rectangle) and 12°. To find angle *y* candidates needed to know about angles in a quadrilateral (*FCDG*) or angles formed by a pair of parallel lines and a transversal. Finding angle *y* proved more challenging than finding angle *x*. Where candidates were successful in finding angle *y*, many had used the angle sum of a quadrilateral, but use of alternate angles being equal and co-interior angles adding to 180° were also seen. A common error was to assume that angle *x* and angle *y* were equal.

Question 6

Candidates generally answered these question parts on use of the scatter diagram correctly.

(a) The vast majority of candidates were able to identify the point which represented a painting with a much lower value than expected. Some candidates omitted this question part and it appeared that they perhaps had not read it due to the requirement to respond on the graph rather than to provide working or an answer on a line. Where incorrect answers were seen, these included circling a variety of different points on the graph including the lowest valued painting for both years.

(b) The vast majority of candidates were able to correctly plot the required point based upon the information provided. Where the point plotted was not correct, this was often due to inaccurate plotting with the point being in the correct region of the graph but not at the correct point.

(c) This was well answered with most responses correctly identifying that there were 5 of the paintings with a value of less than \$53 000 in 2005. Incorrect answers, where seen, included 4 (due to miscounting), 6 (due to miscounting, misinterpretation of the horizontal scale or adding the number of paintings below \$53 000 in 2005 and the number of paintings below \$53 000 in 2025) or 1 (the number of paintings with a value of \$53 000 in 2025).

(d) The majority of responses correctly identified the correlation shown on the scatter graph as positive. Where incorrect responses were seen, these included direct proportion, increase and scattered.

Question 7

This question on the sum of prime numbers was answered well by the majority of candidates.

(a) Most candidates were able to identify prime numbers less than 16 and many went on to correctly add these to find the required sum, either using the information about the sum of the primes less than 10 or by adding all of the relevant prime numbers. Some responses included additional incorrect numbers in the attempted list of primes less than 16 – either including numbers which were not prime or including numbers which were greater than 16. These responses were often awarded 1 mark for sight of 11 or 13 with no more than one incorrect value.

(b) This part of the question was also well answered, with many candidates listing out prime numbers greater than 6 (or using a list from **(a)**) and finding a correct value for the upper limit x. Incorrect responses took a variety of values, but one which was seen a few times was 3, which was the result of $18 \div 6$, from performing a calculation with the two values given in the question.

Question 8

This question on vectors differentiated well between candidates.

(a) The majority of candidates were able to find $5\overrightarrow{DE}$ from $\overrightarrow{DE}$. Responses which were not awarded marks included $5\begin{pmatrix} 3 \\ -4 \end{pmatrix}$, those which incorrectly included a fraction line within the vector and responses where candidates sought to reduce this to a single value.

(b) This part of the question differentiated well between candidates. The best responses showed clear working that led to $\left|\overrightarrow{DE}\right|$ being evaluated as 5. Some incorrect responses had errors in the attempt at using Pythagoras' theorem and used subtraction rather than an addition; others used Pythagoras' theorem correctly, but did not put the -4 in brackets when squaring it, which was sometimes recovered in subsequent working. Some of the incorrect responses made no attempt at Pythagoras' theorem and gave a vector or a coordinate as the answer; in some cases both components had been made positive.

(c) In the final part of this question, candidates were given the coordinates of the point D and asked to find the coordinates of the point E. This differentiated well between candidates. The strongest responses showed working and obtained the correct coordinate pair. There were also a significant number of candidates who were able to perform the required calculation in their head and gave the correct answer with no working shown. Where incorrect responses were seen, there were a significant minority that gave the answer (1, 7) having omitted the negative from the 7 in the coordinate. In some cases it appears that this was because there were two negative numbers being added together in the calculation for the y-coordinate, which led to candidates mistakenly believing that the answer should be positive. Some responses left the answer as a vector and were awarded 1 mark.

Question 9

Candidates were presented with $n^{15} \div n^{x} = n^{5}$ and were asked to find the value of x. This was answered correctly by the majority of candidates. In some cases candidates showed working and in others they were just able to identify the missing value by inspection. The most common incorrect answer was 3 which appeared to be from candidates calculating $15 \div 5$.

Question 10

(a) This part of the question asked candidates to find the exact length of one of the shorter sides in a right-angled triangle. This differentiated well between candidates. The strongest responses showed clear working to find the shorter side by using Pythagoras' theorem and obtained the correct exact answer of $\sqrt{57}$. In some cases, responses had the correct method shown, $\sqrt{11^2 - 8^2}$, but made errors in arithmetic leading to an incorrect final answer, or found the correct exact value but attempted to give a decimal equivalent rather than the exact surd. Occasionally responses were seen which showed $11^2 = AC^2 + 8^2$ but where subsequent attempts at rearrangement to find AC were incorrect; however, this was not common. Where candidates did not attempt Pythagoras, it was common to see attempts involving trigonometry which did not gain marks.

(b) In this part of the question candidates needed to use the right-angled triangle to write down the value of $\cos x$. This was less well answered than **part (a)**, but there were still a good proportion of correct answers. Where incorrect responses were seen, a common error was an answer of $\cos\frac{8}{11}$, and in other cases candidates used the wrong ratio of sides and their fraction involved their answer from **(a)**. Some responses showed evidence of deciding that angle x was 30° and then stating the value of cosine for this angle.

Question 11

Many candidates were able to identify that rolling a number greater than 4 on a fair 6-sided dice has a probability of $\frac{2}{6}$ and could go on to find the probability of this occurring on two rolls of the dice by calculating $\frac{2}{6}\times\frac{2}{6}$. Some responses initially worked correctly reaching $\frac{1}{9}$ or equivalent, but then incorrectly added $\frac{1}{9}+\frac{1}{9}$ which meant no marks were awarded. Another common error was to add, rather than multiply, the two probabilities leading to either $\frac{4}{6}$ or $\frac{4}{12}$ (from incorrect evaluation of the addition or from reasoning that in two dice rolls there were 4 numbers that were greater than 4 available and 12 numbers that could be rolled); this did not gain marks.

Question 12

(a) The majority of candidates were able to correctly identify that $73^0 = 1$. Where incorrect answers were seen, those which were most common were 0 and 73.

(b) This question differentiated well between candidates. The best responses showed clear working leading from $\frac{7}{3^{-2}}$ to 63. Incorrect answers often included working showing or implying that $3^{-2} = \frac{1}{9}$ but then not combining this correctly with the 7, leading to answers of $\frac{9}{7}$ or similar. In some cases, the responses did not show correct working with the rules of indices and instead combined the figures within the question in a variety of incorrect manners.

(c) Responses to this part of the question were more successful overall than those to **part (b)**. A good proportion of candidates were able to reach the correct final answer of 3^{11}, often following on from clear working utilising rules of indices. Where responses were not fully correct, it was often possible to award 1 mark where 27 was written as 3^3 or, less commonly, for expressing 81^2 as $\left(3^4\right)^2$. Incorrect responses often had errors in manipulating the 81^2 with 3^6 (from 3^{4+2}) and 3^{16} (from 3^{4^2}) both seen. Some responses multiplied the bases and combined the indices leading to an incorrect answer not in the required form where others had attempts to multiply out the given calculation, sometimes followed by an attempt to match the result to a power of 3.

Question 13

This question required candidates to use knowledge of angles between a tangent and a radius; angle sum in a triangle or angle sum in a quadrilateral; alternate angles formed by parallel lines and a transversal or similar triangles. Around half of the candidates were able to correctly find that x was 23. Where responses were seen that were not fully correct, it was not common to see a correct equation formed using either the triangle or a quadrilateral. Many of the incorrect responses seen were awarded 1 mark for ODE or OBE or BOA = 90° or for $AOE = x$ or $OED = x$, or two marks where both a 90° angle and one of the angles equal to x were identified.

Question 14

(a) This part of the question required candidates to write the equation of the line of symmetry of a quadratic curve from the coordinates of the minimum point. This was answered correctly by less than half of candidates. The strongest responses identified $x = -3$; however, there were a significant proportion of incorrect responses. Common incorrect responses included equations of lines parallel to the x-axis (for example $y = -3$), equations of straight lines with a gradient formed using the values found in the coordinates of the minimum point, and substitution of $x = -3$ and $y = -5$ into the general equation of a quadratic $y = ax^2 + bx + c$.

(b) Using the coordinates of the minimum point to write the equation of the curve in the form $y = (x + \mathrm{a})^2 + b$ proved challenging. When an attempt to use the given form was seen, a common incorrect answer was $y = (x - 3)^2 - 5$. In other incorrect responses, candidates expanded the given form or substituted $x = -3$ and $y = -5$ into the given form.

Question 15

(a) The majority of candidates were able to correctly factorise the given quadratic. Where incorrect answers were seen, these often included sign errors such as $(x + 4)(x + 3)$ which was awarded 1 mark as it had the correct constant term when expanded, or $(x - 4)(x + 3)$ which did not gain marks as neither the coefficient of x nor the constant term were correct when expanded. Other incorrect responses involved incorrect algebraic manipulation or attempts leading to a numerical answer.

(b) The factorisation in this part of the question was answered less well than that in **part (a)**; however, the majority of answers were still fully correct. Fully correct responses often followed from a correct partial factorisation as intermediate working. There were also some responses where partial factorisations were seen but which were followed by no further work or by incorrect final answers. This appeared to be because the two brackets that had been obtained were not written in the same order – for example $5(x + 2y) + 3n(2y + x)$. A common error was to collect together terms which could not be simplified in this way.

Question 16

There were three sequences which candidates were asked to give an nth term for – a linear sequence, a sequence with nth term $\frac{n+2}{n+1}$ and a sequence with nth term 2^{n-3}. A minority of answers were fully correct. A common incorrect response was to give the next term in all three sequences.

Most candidates were able to identify the correct nth term for sequence A, the linear sequence, with some giving this in its simplest form but others giving $8+5(n-1)$ from use of $a+(\mathrm{n}-1)d$. Some recognised that the common difference was 5 and reached $5n$ but either did not include a constant term or included the wrong constant term. A common incorrect response was to give the term-to-term rule of $+5$ or as $n+5$, or to give an algebraic expression that made use of the 3 and the 5 in an incorrect way, for example $3n+5$.

Responses with the correct nth term for sequence B, $\frac{n+2}{n+1}$ or $1+\frac{1}{n+1}$ were less frequent than those with the correct nth term for sequence A. Where incorrect responses were seen, some just gave the next term in the sequence; where there was an attempt at an algebraic nth term, some recognised that this should be a fractional expression similar to the correct one, but were not able to correctly identify the required nth term.

Sequence C proved to be the most challenging of the three to identify the nth term for; nevertheless there were a good number of fully correct responses using a variety of alternatives for the nth term, for example $2^{n-3}, \frac{1}{8}\times 2^{n}$ or $\frac{1}{4}\times 2^{n-1}$. The answer $\frac{1}{4}-2^{n-1}$ was generally the result of candidates using $a\times \mathrm{r}^{n-1}$. Some candidates identified that the answer used powers of 2 but did not ensure that the correct first term would be obtained; this led to answers such as 2^{n} which was awarded 1 mark. Incorrect answers took a range of different forms – a common error was an answer of $2n$ due to the terms being multiplied by 2 each time; this also led to some candidates giving the term-to-term rule of $\times 2$. Other incorrect responses gave powers of $\frac{1}{4}$, for example $\left(\frac{1}{4}\right)^{n-1}$, or identified that the sequence was non-linear and gave a quadratic expression, a cubic expression or powers of n as their nth term.

Question 17

(a) The sketch of the graph of $y=\cos x$ was drawn sufficiently accurately in around half of responses. Where fully correct responses were not seen, these often had a correct cosine curve shape through (0, 1) but with an incorrect period and were awarded 1 mark. In other cases, cosine curves were presented that were broadly correct, with one section of incorrect curvature. A few candidates produced almost correct sketches that were fully within tolerance but with an omission at either end. Incorrect responses were most commonly an attempt at a sine curve.

(b) This part of the question was found to be relatively challenging by candidates. In the strongest responses, candidates recognised that an angle of 45° would give $\cos x° = \frac{1}{\sqrt{2}}$ and then went on to identify that the reflex angle that would give this value for the cosine was 315°. In some cases, candidates were able to identify the angle of 45° but did not know how to work from this to find the reflex angle. Incorrect responses included working with a range of angles, most commonly those for which the exact trigonometric values are required knowledge in the syllabus (30°, 60°, 90°) but also answers which appeared to be guesses.

Question 18

(a) This question differentiated well between candidates. There were a good proportion of correctly shaded Venn diagrams. Incorrect responses included examples from all of the potential shadings of the Venn diagram, with $A \cap B$, $A \cup B$ and $(A \cup B)'$ being common incorrect regions shaded.

(b) This part of the question was answered better than **part (a)**. Similarly to **part (a)**, there were a good proportion of correctly shaded Venn diagrams. Common errors were to shade the correct sections but also the area surrounding the three circles, which resulted in the shading of E', to omit $C \cap D$ from an otherwise correct response, to shade $(C \cup D) \cap E'$ or to shade $C \cap D \cap E'$. Many of the incorrect responses resulted from confusing union for intersection or not including 'or both' when considering the union of two regions.

Question 19

(a) More than half of candidates were able to find the area of the minor sector in terms of π. A few responses were seen that did not give the answer in its simplest form, as was required, which meant that only one mark was awarded. The most common incorrect approach was working with $2\pi r$ rather than πr^2 i.e. finding the length of the minor sector *AOB* rather than its area. Whether the method used was correct or incorrect, the majority of candidates were able to work in terms of π and did not attempt to multiply by a fractional or decimal approximation.

(b) **Part (b)** of this question was answered less well than **part (a)**. The best responses showed a clear process to find the major arc as a fraction of the circumference and then multiplied by πd, working clearly in terms of π. A common error was to find the length of the minor arc *AB*, which gained 1 mark. Some responses incorrectly worked with area rather than circumference.

Question 20

There were a good proportion of fully correct responses to this question. It was more common for correct responses to come from converting $0.1\dot{1}\dot{4}$ to a fraction and then adding 0.2 than from adding the two decimals together and then converting to a fraction. Where successful responses were seen, these generally showed clear working to convert the recurring decimal to a fraction often by multiplying by 10 and 1000 leading to $990x = 113$, followed by writing the 0.2 as $\frac{1}{5}$ and then $\frac{198}{990}$. Some responses showed a correct method but made errors in arithmetic.

In some cases, candidates recognised the recurring nature of the decimal but struggled to write this as a fraction. These responses sometimes did not find two multiples that were suitable to eliminate the recurring part of the fraction, attempted to use known facts about recurring decimals and fractions or simply made no progress. A common error was to treat the fraction as though there was no recurrence leading to 0.314, which was sometimes followed by $\frac{314}{1000}$. This did not gain marks.

Question 21

Around half of the responses to this question were fully correct. The best responses worked with the ratio of $p : m$ and the sum of opposite angles in a cyclic quadrilateral in order to find $p = 72$ and $q = 108$ before working with the sum of opposite angles in a cyclic quadrilateral or sum of angles in a quadrilateral to find the value of y. Where the correct value of y was not found, there were a small proportion of responses that gained partial marks. Occasionally candidates carried out a fully correct process but made an error in arithmetic leading to an inaccurate final answer. Very occasionally, candidates worked correctly with the ratio and the sum of opposite angles in a cyclic quadrilateral but made an error when selecting the value to substitute into $m + 10$. A slightly more common error was to work correctly with the ratio but with p and m reversed in the calculation; this generally led to 2 marks being awarded for the correct method to find 108°, or 1 mark being awarded if the method shown was sufficient to find the 72° but not the 108°. There were also a small proportion of responses where candidates showed working that demonstrated knowledge that the opposite angles of a cyclic quadrilateral added to 180°, for example $p + m = 180$ but did not go further and so gained 1 mark. In a significant proportion of incorrect responses, candidates appeared to assume that 2 and 3 were the values of p and m rather than parts in the ratio $p : m$.

Question 22

This question was answered correctly by the majority of candidates with working often being shown clearly – identification of the gradient of the original line, the perpendicular gradient and then substitution into $y = mx + c$, or less commonly $y - y_1 = m(x - x_1)$, to find the y-intercept. Errors in working included those in attempts to find the perpendicular gradient where the reciprocal rather than the negative reciprocal was used, or use of the gradient of the original line as though attempting to find the equation of a parallel line. A small number of responses showed errors in substitution, for example $3 = 2(5) + c$ or $y = 2(3) + 5$. There were a variety of completely incorrect responses seen, including $y = 3x + 5$, where the given coordinate pair was used for the coefficient of x and the y-intercept.

Question 23

Finding the area of the given triangle was generally answered well, with many fully correct answers seen following on from working with $\text{Area} = \frac{1}{2}ab\sin C$. In a small proportion of responses, candidates reached $\frac{1}{2} \times 6 \times 10 \times sin30$ but then did not know the value of sin 30 and either stopped or substituted in an incorrect exact value. Common incorrect responses included attempts at trigonometry calculations using sine or cosine, or attempts at use of Pythagoras' theorem which were not appropriate as there was not a right-angled triangle.

Question 24

(a) Simplifying $\sqrt{125} - \sqrt{20}$ was done correctly by most candidates. In most cases candidates showed accurate working, often writing the surds as $\sqrt{5 \times 5 \times 5} - \sqrt{2 \times 2 \times 5} = 5\sqrt{5} - 2\sqrt{5} = 3\sqrt{5}$. Some responses showed correct initial working but then made slips such as $\sqrt{2 \times 2 \times 5}$ becoming $4\sqrt{5}$. This often gained 1 mark as one of the two surds was correct. A common incorrect answer was $\sqrt{105}$ which came from the incorrect working of $\sqrt{125 - 20}$.

(b) To find the value of k candidates needed a calculation for the area of the rectangle and then to work with the surds in order to obtain an integer. A good proportion of candidates were able to manipulate the surds in the calculation in order to find that k was 24. Incorrect responses were generally due to errors in manipulating the surds in attempts to multiply them.

(c) Around half of the candidates were able to correctly rationalise the denominator of the given fraction. Most of the correct responses showed clear working following the method shown in the mark scheme rather than multiplying numerator and denominator by $2 - \sqrt{7}$. In a small proportion of responses, the fraction line was omitted in the multiplier and brackets were not shown; this made the intended method ambiguous. This could be recovered by a correct next step in working or answer; however, in some cases the poor notation led to subsequent errors and no marks could be awarded in this case. A common incorrect approach was to attempt to rationalise by multiplying the numerator and denominator of the fraction by $\sqrt{7}$.

Question 25

(a) The sample space diagram was completed correctly by almost all candidates.

(b) Slightly less than half of candidates were able to answer this question correctly. Where they did, they were generally able to write this down from the sample space diagram without any additional working being shown.

A common partially correct answer was $\frac{1}{5}$ where candidates had identified that there were five odd outcomes, but then incorrectly worked with one of the outcomes being 15 rather than considering the numbers that had been added; this scored 1 mark. Another common partially correct response was $\frac{2}{9}$ where the two odd outcomes from adding 15 were identified but given as a probability out of the nine outcomes overall rather than the five odd outcomes.

Incorrect responses included calculating $\frac{1}{6} \times \frac{5}{9}$ as there was one 15 out of the six available numbers and five odd outcomes out of the nine possible, or $\frac{5}{9} \times \frac{2}{15}$ from five odd outcomes out of the nine possible and two 15s out of fifteen values in all the cells in the table. There were also a number of attempts using tree diagrams rather than the sample space diagram from **part (a)**. Some candidates gave answers with a probability greater than 1 but did not appear to recognise that this was an issue.

Question 26

(a) This question was answered well with many candidates being able to multiply the fractions and simplify correctly. In a small number of cases candidates were able to multiply the two fractions and begin to simplify but did not reach the most simplified answer, with answers of $\frac{15p}{25y}$ or $\frac{3mp}{5my}$ being reached. Incorrect answers included those where the process for multiplication of fractions was confused with that for division and the second fraction was inverted before multiplication was attempted. There were also some cases where attempts were made using common denominators.

(b) This question was also answered well with many responses reaching the correct final answer. Successful responses generally showed a clear process for writing the two fractions over a common denominator, for example $\frac{3(x - -3) + 4(2x - 5)}{(2x-5)(x-3)}$, before simplifying this to $\frac{11x - 29}{(2x-5)(x-3)}$ or $\frac{11 - -29}{2x^2 - 11x + 15}$. In some cases, candidates started with the correct process, but then subsequently cancelled the brackets in an incorrect manner or reached a correct answer in their working but then cancelled x's from the numerator and denominator in an incorrect manner.

Incorrect responses which gained no credit generally did not show understanding of how to write the two algebraic fractions with a common denominator before adding. In these responses candidates sometimes merely added the numerators and denominators leading to $\frac{3+4}{2x-5+x-3}$.

Question 27

This question on solving a pair of simultaneous equations where one was linear and one was quadratic was generally well answered. There were many candidates who were able to find both pairs of solutions to the given equations. These responses showed substitution of the linear equation into the quadratic equation followed by rearrangement to obtain a quadratic equation equal to 0 which was solved by use of factorisation (more commonly) or use of the formula (less commonly). This was then followed by substitution of the two x-values into the linear equation to find the corresponding y-values.

Where the two pairs of solutions were not obtained, this was sometimes due to arithmetic errors in an otherwise correct process – for example an error in substituting and solving for the y-values – or for errors in arithmetic rearrangements in an otherwise correct process.

Some responses reached $x^2 - 11x + 24 = 0$ but made errors in the attempts at factorisation or in attempts to use the quadratic formula to solve, due to sign errors, substitution of the wrong value in the wrong place in the formula, or use of an incorrect formula. Other responses did not have a correct quadratic, but did have the correct process to solve and so gained partial credit for this.

In a significant minority of responses candidates had not been able to make progress towards the solutions. In these responses a variety of incorrect approaches were seen which did not show knowledge of how to deal with the simultaneous equations presented or how to solve any quadratic that might have been obtained.

Question 28

There were a good proportion of completely correct simplifications of $\frac{2x^2 - 11x - 21}{x^2 - 49}$. In these responses the factorisation of the numerator and the denominator was shown followed by cancellation to the final answer of $\frac{2x+3}{x+7}$. Where responses were not completely correct it was common to award partial marks for a correct factorisation of the denominator as $(x+7)(x-7)$, which was awarded 1 mark. Responses with partially correct working also sometimes had a correct factorisation of the numerator as $(2x+3)(x-7)$, which was awarded 2 marks or, commonly, an attempt at factorising the numerator which would give the correct coefficient of x or more commonly the correct constant term, for example $(2x-3)(x+7)$, which was awarded 1 mark.

Common errors included attempts to simplify the numerator by incorrectly collecting the x^2 term and the x term and incorrect cancellation of the x^2 term in the numerator with the x^2 term in the denominator.

Question 29

This question proved challenging for candidates, with only a minority of fully correct answers. The most successful responses showed clear working for the surface area of solid A and the surface area of solid B in terms of R and x, equated these and then solved for x. Where responses were not fully correct, then partial marks were often awarded for the correct surface area of the hemisphere and/or the correct curved surface area cylinder and/or the correct area of the circular base of solid A. A common error when trying to find the area of the circular base was to omit the brackets around $2R$ which gave $\pi \times 2R^2$ which was often not recovered in subsequent working. Another error was to work with R rather than $2R$ when working with the surface areas in solid A.

MATHEMATICS (WITHOUT COURSEWORK)

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 and premature rounding should be avoided. 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. Candidates should be encouraged to use correct terminology, as defined in the syllabus, when asked to explain or give a reason for their answer.

Comments on specific questions

Question 1

(a) This part was answered well with most candidates correctly measuring the length of line AB in centimetres. Common errors were measurements given in mm, misuse of the ruler with common errors of 5.7, 4.2 or 5.2 or rounding to 5 cm.

(b) Candidates found drawing a perpendicular line to AB challenging with less than half of the candidates drawing a perpendicular line accurately. A common error was to draw a parallel or diagonal line. A significant number of candidates did not respond to the question.

Question 2

Completing the shopping list was generally answered well, although little working out was seen by most candidates. Common errors included rounding 15.64 to 15.6 for the cost of the flour, multiplying or subtracting instead of dividing for the cost per kg of sugar and adding their 15.64 to the unit price 3.60 instead of the total 9.90.

Question 3

Calculating the total cost of the journey, using the given formula, was mostly answered correctly. A few candidates rounded 194.6 to 195 or truncated 194.5 to 194, which did not score. A few candidates divided rather than multiplying, giving 84.21. A few candidates spent time showing the full multiplication working instead of using a calculator.

Question 4

Most candidates were able to identify the fractions that were not equivalent to $\frac{2}{5}$, with those that did not find all three often selecting at least two correct options. The fraction $\frac{1}{10}$ was identified the most, whilst $\frac{16}{80}$ was the option most often omitted.

Question 5

(a) (i) Nearly all candidates were able to use their calculator correctly to identify 1.4 as the square root of 1.96. The most frequent error was omitting the decimal point and giving 14 instead of 1.4.

(ii) An equal number of candidates demonstrated accurate use of their calculators to calculate the cube of 17.

(iii) The vast majority of candidates gave the correct answer of 0.96. Only a small number of responses gave a negative result, indicating confusion about the sign rule when multiplying two negative numbers.

(b) Many candidates ordered the numbers correctly. Good responses converted all values to comparable forms (most commonly decimals), maintained sufficient accuracy when rounding, and checked the order carefully before giving the final answer. Errors often arose from rounding $\frac{27}{47}$ or $\frac{11}{19}$ to too few decimal places because 4 decimal places were required for comparison with 0.574.

Question 6

(a) The majority of candidates correctly identified 18 as the mode. Common errors saw an attempt to list the values in ascending order to find the median or concluding that the data had no mode. Calculating the mean was seen in both parts of this question.

(b) Candidates were less successful at finding the range of the data. Errors included working out 25 – 3 incorrectly or using the first and last value from the list (17 – 12 = 5). As in part (a) some candidates found the median, mean or mode.

Question 7

(a) Candidates found using a probability scale harder than stating the probabilities with many candidates giving the correct probabilities instead of letters. Those candidates who gave correct numeric answers to all three parts could gain a Special Case mark and a number did so, often giving answers as fractions. Those that gave answers in decimal form often did not gain the Special Case mark due to not giving their answers to a sufficient degree of accuracy (3 significant figures). The most common wrong answer for part (a) was D with a probability of $\frac{1}{2}$.

(b) Candidates were more successful at identifying A as the arrow for probability of 0. The most common error was writing 0 instead of arrow A.

(c) A full range of answers were seen, especially A, E and G, with few candidates giving the correct answer of F.

Question 8

(a) Solving the one-step equation was answered very well. A small number of candidates incorrectly solved by subtracting 8 (answer 24) or multiplying instead of dividing (answer 256).

(b) Solving the two-step equation was again answered well with few errors seen. Most candidates demonstrated the ‘balance method’ to solve the equation correctly. Answers of $\frac{5}{2}$ was accepted for full marks however answers of $\frac{15}{6}$ showed incomplete processing, so only scored one mark. Common errors were 1.5 from (12 – 3) ÷ 6 and 5 from (12 ÷ 6) + 5.

(c) Over half of the candidates were able to represent the inequality on the number line correctly. A variety of responses were seen, with many candidates gaining 1 mark for a partially correct representation. Common errors were, using the full or empty circles in the wrong place or not joining the circles with a line, use of an arrow at the upper limit (instead of a circle), and lines or brackets instead of circles.

Question 9

(a) Around a third of candidates correctly named the angle as reflex. The most common incorrect response was obtuse. Other less common errors were reflective, reflected or reflect as well as acute, external and other angle related words.

(b) Giving a geometrical reason was challenging for around half of the candidates with many candidates demonstrating that the given numbers did not add up to 180, instead of giving the geometrical reason of ‘angles in a triangle add up to 180’. Others gave various other wrong reasons such as ‘angles on a straight line’ or ‘equal angles in isosceles triangles.’ Many understood the reason needed but did not gain the mark because they did not give correct terminology as defined in the syllabus. Key words such as angle or triangle were often omitted.

(c) Again, around half of the candidates were able to correctly calculate the value of x as 69. A common misconception was to assume AB and CD were parallel and then to refer to Z or alternate angles giving an answer of $x = 75$. Another common misconception was that 126 and x added to 180 because they were on the same straight line. Successful candidates used the sum of angles of a quadrilateral to find the angle of DCB and then used angles on a straight line to correctly find the size of the angle x. Many candidates gave a partial solution, which was 360 – 249 = 111, but did not then go on to complete the solution by showing 180 – 111 = 69, giving a final incorrect answer of $x = 111$.

Question 10

Only the strongest candidates were able to correctly calculate the total amount of money shared between Anna and Bruno. Successful candidates recognised that the difference in the ratio represented $36 and were able to reach the correct answer. A small number of candidates were able to use algebra to solve the problem, often using and solving the equation $\frac{7}{10}x = \frac{3}{10}x + 36$. However, most did not read the question accurately and shared 36 in the ratio 3:7. Other common incorrect approaches were to calculate $\frac{3}{7}$ and $\frac{5}{7}$ of 36 or to divide 36 by 3, 7 or 10 as a first step. Calculating $\frac{3}{10} \times 36 + \frac{7}{10} \times 36 = 46.8$ was also commonly seen as an incorrect method. Partial marks were only occasionally awarded, usually for calculating Anna’s share (27) or Bruno’s share (63) but not giving the total amount of money.

Question 11

(a) Most candidates gave the correct total of $679.75. Errors included adding $76.25 and $146 before multiplying, misplacing decimals when adding $533.75 and $146, or rounding the final answer to $680.

(b) Most candidates also correctly calculated the insurance as a percentage of $1400. The most common error was subtracting $364 from $1400 before dividing, resulting in 74%, instead of the correct value.

Question 12

(a) It is vital that in 'show that' questions, all stages of working are included, and the required answer (75) is the result and not used in the calculation. The most common errors were starting with or using 75 to get 90 or introducing $\frac{1}{4}$ without showing where it came from. A significant proportion of candidates did not attempt this question.

(b) Candidates were more successful at completing the pie chart with most calculating the angles correctly but not all drawing the pie chart or drawing it inaccurately. Another common error was to assume that the angles in the pie chart would be 45 and 120, the number of students.

Question 13

(a) Calculating the length of the side of the cube proved to be one of the most challenging questions on the whole exam paper. Few candidates gained full marks. A partial method mark was often awarded for dividing by 6 because a cube has 6 faces, with 20.25 a common wrong final answer. Many candidates started by 'square rooting' or dividing by π or 2π. Many candidates divided by 6 but then divided 20.25 by 4 instead of square rooting. Many only divided by 2, with 60.75 seen often. Many candidates did not attempt this question.

(b) (i) Candidates were significantly more successful at calculating the height of the trapezium with around a third of the candidates correctly calculating the height as 8.5 cm. 4.25 was seen frequently from 106.25 ÷ (10 + 15), omitting the $\frac{1}{2}$. Many candidates attempted calculations without using the 106.25, whilst others divided 106.25 by 15 or 25 or 150 or 75. Candidates were often unable to recall the area of a trapezium formula. The common errors with the formula regularly seen were, using the triangle formula, multiplying the sides rather than adding them, or omitting the $\frac{1}{2}$ from the formula. Some used the $\frac{1}{2}$ to halve the only the 10 to 5, so $\frac{1}{2}(10 + 15)$ became 20 instead of 12.5.

(ii) Converting the area to m² was the most challenging question on the whole paper and very few correct answers were seen. The most common wrong answer was 1.0625, where candidates had divided by 100. Also frequently seen was 106 250 by multiplying by 100.

Question 14

Candidates found completing the probability table challenging and the question was a good discriminator. Many candidates started by subtracting the given probabilities from one to get 0.28 but then did not know how to split the probability. Many divided by 2 to give 0.14 for blue and green. Many candidates incorrectly found the decimal equivalent of the two fractions, $\frac{2}{7}$ and $\frac{5}{7}$, and gave these as answers or multiplied them by 0.72 (the sum of the two given probabilities). Those candidates that made better progress sometimes went on to make a slip with the decimal point leading to 0.2 and 0.8 being a common incorrect response or 0.2 and 0.08 reversed in the table.

Question 15

(a) Most candidates recognised the transformation as an enlargement although there were a variety of incorrect words used such as reduction, de-enlargement and shrinking. The centre of enlargement was often identified correctly but identifying the scale factor was less successful with 2 or –2 being the most common wrong answers. A small number of candidates gave other transformations or more than one transformation such as enlargement and translation.

(b) A similar number of candidates gained full marks for this part. However, a significant number of candidates did not attempt it. A common error was to translate the object 7 units in the *x* direction and 6 units in the *y* direction (reversing the vector) or to translate only two vertices correctly, which resulted in an image that was not congruent to triangle A. Other errors included drawing reflections or enlargements. Some candidates gained a partial mark for either translating correctly in the *x* direction by 6 units or the *y* direction by 7 units.

Question 16

(a) Most candidates correctly identified when Bob stopped for a rest. Some errors occurred due to misreading the time scale. Explaining how they knew this proved much more challenging. Common inaccurate responses did not include key vocabulary or describing how the graph shows this. Some candidates explained how they used the scale to calculate the times rather than describe the shape of the graph. Successful answers used the words 'horizontal' or 'distance did not change'. A common error was to describe speed or acceleration.

(b) Calculating Bob's average speed was very challenging to all candidates and proved to be a good discriminator. Candidates often misread the journey times, using 6:15 without converting to hours, or used the total distance as 615 or 600 instead of 625. Some candidates calculated the speed of each part of the journey and then found the average of these – an incorrect method for the average speed of the whole journey.

Question 17

Most candidates were able to partially or fully factorise the expression. Common errors included, subtracting the terms (answer of $14y$), $7x(14 – y)$ by removing $7x$ from the 2 terms, or $14x$ by ignoring the y. A small number incorrectly attempted to factorise into two brackets.

Question 18

(a) Around half of the candidates obtained full marks in this part. Many did not understand that they needed to substitute $n = 1$, 2 and 3 into the given nth term. Common errors were to substitute $n = 1$, 3 and 5 giving –3, 5, 21 or $n = 3$, 4 and 5 giving 5, 12 and 21.

(b) Candidates found writing the nth term of the given sequence more challenging. Candidates generally showed that they understood that the common difference was –3 but were unable to find the nth term. Common wrong answers were $8n – 3$, $3n + 8$ and $n – 3$. Many candidates attempted to use the formula a + (n – 1)d but could not substitute the –3 correctly or made errors when simplifying, e.g. –3(n – 1) + 5 but then simplified to –3n – 3 + 5 = –3n + 2.

Question 19

Successful candidates applied the compound interest formula correctly, subtracted the principal and showed accurate calculations with clear working. Common errors included not subtracting the principal value, using simple interest, or incorrectly using $1 - \frac{2}{100}$ rather than $1 + \frac{2}{100}$. Some candidates rounded too early and got 74 as their answer.

Question 20

(a) Many candidates completed only part of the working, such as calculating $(8 - 2) \times 180$ but not dividing by 8 or finding the exterior angle but not subtracting it from 180 to determine the interior angle.

(b) Many candidates were successful in finding the value of x however giving the geometrical reason again proved very challenging for all candidates. The most common incorrect answer was 109° (from 180 – 71). Various wrong reasons were given and many attempted a correct reason but did not include key vocabulary (tangent, radius or diameter and 90 degrees). Common incorrect reasons included 'angles in a triangle add up to 180', 'angles on a straight line add up to 180', 'the angle between the tangent and circumference is 90', 'The tangent makes 180 degree with the diameter', 'subtracting from 90 gives 19' and 'I used the protractor'. A large number did not provide a reason.

Question 21

Writing the equation of the line L was challenging for all candidates and proved to be a good discriminator. Few fully correct answers were seen but many did gain part marks for either a correct gradient or *y*-intercept. The *y*-axis scale gave the most difficulties. Many candidates read the *y*-intercept as 4.5 as it is halfway between 4 and 6. Others made errors in the gradient calculation. Many knew the 'rise/run' method to find the gradient but found it difficult to apply. Some candidates used coordinates that were not on the line, e.g. (0,0), whilst some calculated change in *x* over change in *y*. Several candidates drew a right-angled triangle on the graph but were unable to read the height correctly using the scale or did not know what to do next. Some used the *x* intercept as the gradient, i.e. $-1.7x$.

Question 22

(a) The most successful method to find the next time both trains left together was listing the times of the two trains. However, many candidates made errors in their lists. Some candidates did not continue their lists far enough or had difficulty adding 35 minutes. Some candidates used factor tables of both 20 and 35 and found the LCM of 140 but often were not able to correctly change this to hours and minutes. The most common wrong method was adding 20 and 35 together and then adding this on to 09:30.

(b) This part was well answered by most candidates. Common errors included giving the correct values but reversed, 97.4 instead of 97.5, $96 \leqslant d < 98$, and $97 \leqslant d < 100$. Some gave only one correct value, often 96.5. A few candidates showed little understanding of the question and gave answers using the letters P and Q.

Question 23

Most candidates were able to use their calculators to evaluate the fraction as 0.025, but errors occurred in converting this to standard form. Common wrong answers were 2.5×10^{8}, 2.5×10^{-3}, 25×10^{-3}, 2.5×10^{2} and $\frac{1}{40}$.

Question 24

Calculating the length of BC was challenging to most candidates with few candidates reaching the correct final answer. Most candidates recognised that the question required trigonometry, but few were able to rearrange a correct initial trig ratio. Many used tan or used sine or cosine incorrectly, e.g. cos 27 rather than sin 27. Candidates who correctly wrote $\sin(27) = \frac{32}{BC}$ often rearranged incorrectly, with the most common error multiplying sin(27) by 32 instead of dividing 32 by sin(27). Some candidates attempted to use Pythagoras, with 27 and 32. Some candidates attempted a longer method and found AB before either using Pythagoras or trigonometry to find BC. Unfortunately, this often led to inaccurate answers due to rounding their value for AB prematurely.

MATHEMATICS (WITHOUT COURSEWORK)

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. Most 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 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 generally very well answered with the majority able to state the correct mathematical name of radius, although other names were seen.

(b) This part was generally well answered with the majority able to state the correct mathematical name of chord although, other names were seen, including diameter, vertical and straight.

Question 2

Many candidates were awarded 2 marks for listing all of the factors. Just as many were awarded 1 mark for listing at least four factors, with the most common omissions being 1 and 32. Candidates should be aware that listing factor pairs as multiplications is not sufficient for a list of factors. Some candidates confused factors with products of prime factors and gave their answer as multiplications of 2.

Question 3

This part was generally well answered with a good number able to give the three correct symbols. The first statement proved the most difficult with the common error being $\frac{2}{3} = 0.667$.

Question 4

(a) The vast majority of candidates were able to give the correct coordinate. There was the occasional reversing of coordinates leading to the incorrect answer (3, –2). A rare error was to include x and y within the coordinate, for example (x = –2, y = 3) or (-2x, 3y).

(b) Few were successful at drawing $y = x$ correctly and many made no attempt to draw this line at all. There were a significant number of vertical and horizontal lines that were labelled $y = x$. Often the line was drawn over either of the axes. Some drawing the correct graph gave a line that was too short or became too inaccurate.

(c) There were many attempts to draw a line, usually starting from P even if $y = x$ had not been drawn, occasionally this resulted in the correct line. Candidates who drew $y = x$ correctly in **(b)** also often drew the perpendicular line correctly. Some demonstrated correct understanding by drawing two lines starting at P that were perpendicular. Others drew a line passing through P that crossed a vertical or horizontal line that had been labelled $y = x$. Many incorrect lines started from P and passed through (0, 0).

Question 5

(a) This part was generally well answered with equal numbers of candidates giving the answer as a fraction or a decimal. Common errors included $5 - 8$, 5×8 and $\frac{8}{5}$.

(b) This part was generally well answered, although common errors included $8 - 5$ and $\frac{5}{8}$.

Question 6

(a) The majority of candidates gave a correct value, often 81. The most common incorrect values were the cube numbers, 8 and 27.

(b) The vast majority gave the correct answer here, with the most common incorrect answers being 39 or 0.

(c) Candidates had the least success with this part of the question. 51 was a very common incorrect value, along with all the other odd numbers.

Question 7

This part was generally very well answered although a common error was to calculate $\sqrt{362}$.

Question 8

Around half of candidates gained both marks in this question. It was common to award 1 mark for one of the correct values. Common errors involved multiplying and/or dividing by varying incorrect powers of 10. Candidates sometimes indicated that they were multiplying 3.25 by 1000 but just added a 0 on to give 3.250 as the answer.

Question 9

Both parts of this question proved to be difficult and demanding for many candidates, although a small but significant number of fully correct answers were seen, often accompanied by sketches or diagrams which helped to identify the correct mathematical name for the two shapes.

Question 10

This question proved to be difficult and demanding for many candidates and proved to be a good discriminator. A numerical scale on both axes left many candidates uncertain about which values to use to calculate both the total score of all spins and the total number of spins. It was common to see the sum of 7, 5, 8, 9, and 6 used to represent the total score. The total frequency was often given as 5 or, in some cases, the sum of 1, 2, 3, 4, and 5. A small minority were awarded 1 mark for multiplying the score by the frequency to find the sum of the total scores but this was then usually divided by 5 or 15. Occasionally, some with a correct method made arithmetic errors when calculating one of the totals or provided an answer rounded to fewer than three significant figures. Candidates who did not understand the term ‘mean’ often gave an answer of 3 from the middle value of the numbers on the spinner or 7 from the middle value of the frequencies when listed in order.

Question 11

This question was answered very well with a large majority working out the correct answer. Clear calculations were often shown. Those who did not find the correct answer were often awarded a method mark for showing the correct substitution. The most common error was to calculate 3×62 as 182. Less common was $2 \times -3 = -1$ from adding the numbers.

Question 12

(a) Finding the angles for the pie chart did not appear to be attempted as well as in previous sessions, although a good number of fully correct tables were seen. There was very little working shown but there were a few very common misconceptions. Some calculated percentages rather than degrees. It was common to see values of 74, 56 and 50 from 90 minus each frequency and less often, some added 90 to each frequency. Values of 22.5, 10.59 and 9 came from 360 divided by each frequency.

(b) Those who found the correct angles generally went on to draw a correct and accurate pie chart. There were some inaccuracies drawing the sectors and some who were clearly using the wrong scale. Some candidates gained a mark by following through one of their sector angles and drawing it accurately. There were also a significant number of candidates who did not attempt to draw the pie chart, whether they had values in the table or not.

Question 13

In a two-step question like this, candidates need to show the evaluation and then show the required rounding. Few candidates gave the correct answer rounded to three significant figures. Most were able to calculate $8^5 = 32\,768$ but often rounded this to 328. Other incorrect answers that were seen regularly included 327, 33 000, 32 700, 330 and 327.68.

Question 14

(a) Time differences continue to be a difficult concept for candidates. The vast majority of candidates were attempting the most efficient strategy of calculating the number of hours worked each day and then multiplying by 5, rather than taking the mornings and afternoons separately. 1 mark was often awarded to those with an answer of 45, taking the total number of hours in the day without the lunch hour. The half hours caused problems with much confusion between 0.5 and 0.3.

(b) Those who answered **part (a)** correctly most often went on to reach the correct answer and many follow through marks were also awarded from their **part (a)**. A significant proportion did not relate **part (a)** and **(b)** and tried to recalculate, often getting to a different number of hours to that found in **part (a)**. A common incorrect calculation was to simply multiply 15.20 by 5 days, giving an answer of 76.

(c) Many found this to be a difficult concept. It was common to see the number of hours or the total pay for the week multiplied by 1.5 rather than the hourly rate of pay. Some candidates simply gave an answer of $\frac{3}{2}$ or 1.5 as a conversion of $\frac{11}{2}$.

(d) The responses were typically split between the correct answer and those who multiplied by the conversion rate rather than dividing.

Question 15

This part was answered very well with a majority plotting the correct location of ship B. Others usually plotted B either with a correct bearing or with a correct distance and were awarded a partial mark. The best solutions had a clear, ruled, solid line drawn from A and then B clearly indicated by having either B written next to a clear dot on the line, or B marked next to the end of their line.

Question 16

This question on finding a percentage of a given quantity was generally very well answered.

Question 17

This question was not generally answered well, with only a minority of candidates able to indicate $x \geqslant 3$ on the number line using correct arrow notation. Many different types of responses were seen with incorrect circles used and, in some cases, no line drawn.

Question 18

(a) Many candidates correctly identified the type of correlation. However, a wide range of incorrect answers were seen, including responses such as inclined, straight line, ascending, and negative.

(b) There were many good attempts at the line of best fit which were awarded the mark. Others did not look at the data carefully enough to provide an acceptable line. Many drew a line from the origin to the top right corner of the grid or from the lowest data point to the highest on the y-axis. Others did not draw a straight line, often joining each point together.

(c) This was a better attempted part of the question and candidates usually gave a value in the acceptable range or followed through from their line accurately. Some got the two papers the wrong way round and so were reading from the incorrect axis. 40 and 48 were common responses; the data values plotted the closest to 35.

Question 19

This two-stage question proved both difficult and demanding for many candidates and proved to be a good discriminator. A minority of candidates gave the correct answer. Many calculated the volume of the cylinder, showing clear working, but either did no further work or divided by 3 rather than finding the cube root. Common errors also included dividing by 6 or 12 or using the surface area of the cube as $6x^2 = 942.5$. A significant number of candidates could not find the correct volume; either using an incorrect formula usually $2\pi rh$, $\frac{\pi r^2}{3}$ or simply 5×12.

Question 20

(a) Candidates who were awarded the mark made a statement correctly identifying the mean and the important comparison that it was higher. Statements which did not score the mark included those not identifying the mean such as, ‘it has a higher average’ or ‘it has higher audience numbers’, or a comparison was not made, such as ‘mean is high’ or ‘mean is 105’. Although some gave a correct statement involving the mean, they also made reference to the range so the mark could not be awarded. A significant number incorrectly chose ‘Movie Scene’ rather than ‘Flix’.

(b) Non scoring statements referred to ‘greater variation’ but did not mention the range and some correctly stated range but did not make a comparison. Although some gave a correct statement involving the range, they also made reference to the mean so the mark could not be awarded. A significant number incorrectly chose ‘Flix ‘rather than ‘Movie Scene’.

There was a significant rate of no response in both parts of the question.

Question 21

Many candidates were able to use a calculator correctly to reach 233.33... but few candidates converted this to standard form with 3 significant figures. The answers 2.3×10^2, 2.3×10^{-2} and 2.3×10^{-8} were frequently seen. Other common errors were adding/subtracting/multiplying the numbers 5.6 and 2.4 from the question.

Question 22

Candidates found this question very demanding, and it proved to be a good discriminator. Many candidates did not appreciate the connections between the different parts of the question. Many candidates did not attempt either all or parts of the question, notably **parts (b)** and **(c)**.

(a) This part of the question was the best attempted part. Candidates often confused the area and circumference of a circle and so used the incorrect formula. Centres should remind candidates to use the formula sheet provided at the start of the paper. Those using the correct formula often used 10 as the radius rather than 5 and sometimes the length of the rectangle, 16, was used.

(b) The common incorrect answer was 160 from calculating 10×16, having seen the area of the garden as a complete rectangle 10 by 16 or not knowing how to proceed from here. Some candidates did realise the need for further working but sometimes subtracted the whole circle rather than half which was covering the rectangle.

(c) Only a small minority gained any marks in this part of the question with very few correct answers or following through with a correct method from their values in the previous parts. Many candidates were finding percentages but very few had the value for grass as a numerator. It was common to see the area of the pond as the numerator, either divided by the value of **part (b)** or by 160, which may or may not have been their answer in **(b)**. Weaker candidates often simply divided their area for grass, which was often 160, by 100.

Question 23

This two-stage question was found to be both difficult and demanding for many candidates and proved to be a good discriminator. A number of candidates did not appreciate that Pythagoras was required to find the missing length. Common errors included using $15^2 + 14^2$ leading to a length of 20.5, simply adding the 3 given lengths and using a base length of 14 cm when splitting into a triangle and rectangle.

Question 24

Candidates who wrote down the relationship $\frac{42}{AB} = \frac{28}{12}$ or equivalent first, usually went on to rearrange correctly and score 2 marks for the answer of 18. Others who did not state this relationship, started by calculating $28 \div 12$ followed by 42 divided by the result. There was a lot of premature rounding with this, stating $28 \div 12 = 2.3$ and so $42 \div 2.3 = 18.26$. This earned a method mark but could not gain the accuracy mark. A less common correct start was $42 \div 28 = 1.5$, however few were successful with the next step. Most incorrect methods used subtraction rather than division.

Question 25

(a) Few candidates were able to state the correct equation of the line. A common error was to find the gradient as $\frac{1}{2}$ from counting the squares on the grid and ignoring the different scales on the axes. Some candidates were able to gain a mark for an equation with the correct intercept, $y = mx + 2$ while others gave the answer $y = 2$, which did not score. A small number used the points (4, 3) and (8, 4) but calculated the gradient upside down, giving the answer 4. Many varied incorrect methods and answers were also seen.

(b) Candidates found this part even more difficult and only a small number of correct answers were seen. Many candidates incorrectly substituted 1 and 5; usually $y = -3 \times 1 + 5$ or $5 = -3 \times 1 + 5$. A small number did appreciate that the parallel gradient was –3. A significant number of candidates were unable to attempt this part.

Question 26

High ability candidates who recognised that a trigonometric ratio was required often went on to obtain the correct answer. Premature rounding was an issue again in this question with many writing the interim value of tan 37 as 0.75, leading to an answer of 9. Some wrote down a correct ratio but were then unable to rearrange this correctly and others used an incorrect ratio, usually cosine. A significant number of candidates did not appreciate that the method required a trigonometric ratio and used the values on the triangle in a multitude of incorrect ways. A significant number were unable to attempt the question.

Question 27

(a) Nearly all candidates completed the table correctly, though occasionally a sign was missed off one or both of the negative values.

(b) The large majority of candidates scored either 4 marks or 3 marks in this part. Many good curves were drawn. Those who scored 3 marks usually had either plotted the point (4, 3) or (–4, –3) inaccurately or did not join the plotted points with a curve, or had joined (–1, –12) to (1, 12).

(c) Most candidates gave the correct answer 1.2 or an answer in the accepted range. Common errors included answers of 120 and $\frac{10}{12}$ usually from an incorrect rearrangement of the given equation rather than using the graph.

Question 28

Successful candidates gained full marks for using the correct formulae for compound interest and simple interest, leading to the correct values for both investments. It was very common for mistakes to be made in the simple interest calculation due to candidates only stating interest of \$1080, rather than adding the principal and giving the total value of Bob’s investment after 3 years. Some giving the correct value of \$4144.54 for Ali’s investment then subtracted the principal and compared just the interest for both accounts. It was common for candidates to use simple interest for both Ali and Bob with some just calculating the interest for 1 year, so comparing \$354 with \$360. Others used compound interest for both accounts and occasionally the type of interest was confused, with simple interest used with \$2950 and compound interest used with \$3000. Many candidates did not attempt this final question which may have indicated issues with time management or a lack of the skills required to attempt the problem.

MATHEMATICS (WITHOUT COURSEWORK)

Paper 0580/33
Calculator (Core)

Key messages

This paper tests a wide range of skills and mathematical understanding across the syllabus. More successful candidates demonstrated excellent understanding and knowledge across the breadth of the syllabus. Candidates had enough time to complete the paper with very few questions left unanswered.

Candidates should ensure that they show the method that they are using so they can be rewarded for making progress through the longer questions, even if they do not reach the correct answer. Candidates should make sure they give answers to enough accuracy and avoid premature approximation midway through a question.

General comments

Poor recognition of key mathematical vocabulary was evident throughout the paper with such words as radius and reciprocal not being understood. Candidates need to make sure they read their written explanations through when giving reasons, making sure their answer is clear and unambiguous; **Questions 7** and **14**. Candidates should take care when drawing diagrams and graphs, ensuring that they are clear, especially when making corrections to their answers. If an answer is exact, candidates should give the exact answer rather than a rounded answer, for example, 6859 and not 6860 in **Question 6(b)**. Also, 0.015625 and not 0.016 in **Question 18(b)**. If the answer is not exact, candidates should be careful to give answers that are accurate to at least three significant figures, as directed in the instructions on the front cover. For example, 5.39 and not 5.4 in **Question 16(a)**, 1.74 and not 1.73 in **Question 18(a)**, 10.4 and not 10.3 in **Question 23(b)** and 4.26 and not 4.25 in **Question 29(b)**.

Comments on specific questions

Question 1

A good proportion of candidates answered this correctly. The errors seen usually included missing one or more of the factors.

Question 2

(a) Around half of all candidates answered this correctly. Common incorrect responses usually included one of the words segment, sector, radius, diameter, tangent or straight line.

(b) Most candidates drew a radius on the circle. The most common error was to draw a diameter, and some candidates did not give any response.

Question 3

(a) Almost all candidates wrote 0.25 correctly as a fraction. The most common incorrect answers were $\frac{0.25}{1}$ or $\frac{1}{0.25}$.

(b) Almost all candidates wrote $\frac{1}{2}$ correctly as a percentage. The most common incorrect answer was 0.5.

(c) Most candidates wrote 7% correctly as a decimal. The most common incorrect answers were 0.7 and $\frac{7}{100}$.

Question 4

(a) Most candidates gave the correct mathematical name of the solid. Common errors included circle, cuboid and cone. Descriptions of the solid, such as ‘circular-based prism’ or prism, did not score.

(b) A majority of candidates gave the correct mathematical name of the triangle. The most common incorrect response was isosceles but scalene and triangle were also seen. Again, descriptions such as ‘an equal angle triangle’ were not accepted.

Question 5

(a) Almost all candidates gave the correct colour, namely blue. A small, but noticeable number, of candidates gave an answer that said they were ‘‘all equally likely’’, not taking the labelling of the spinner into consideration.

(b) Almost all candidates gave the correct probability, either $\frac{2}{5}$, 0.4 or 40%. Answers given in words, such as 2 out of 5 were not accepted. The other most common incorrect responses included $\frac{1}{5}$, $\frac{5}{2}$, and the ratio, 2:5.

(c) Almost all candidates gave the correct probability, either $\frac{3}{5}$, 0.6 or 60%. Answers given in words, such as 3 out of 5 were not accepted. The other most common incorrect responses included $\frac{4}{5}$, $\frac{5}{3}$ and 3:5.

Question 6

(a) Around half of all candidates answered this part correctly. However, many did not understand the meaning of the word reciprocal. There were a variety of incorrect answers including $-\frac{8}{1}$, 0.8, $-\frac{1}{8}$ and $\sqrt{8}$.

(b) Almost all candidates were able to use their calculator to work out the answer. Because the answer was exactly 6859, the answer 6860, without seeing 6859, did not score. A few candidates worked out $3 \times 19 = 57$.

Question 7

Many candidates were able to give two clear reasons as to why the bar chart was incorrect. Many recognised that the scale on the vertical axis was not linear. However, candidates who used the word ‘even’ ambiguously, such as writing ‘the numbers are not even’ did not score. Many recognised the bar widths were not equal. But candidates who used phrases such as ‘the bars are different sizes’ or ‘the number of squares is not the same’ did not score as they were not specifically clear that the width needed to b e the same. Candidates who gave the reason ‘the title is missing’ or the ‘names of the months should be written out in full’, were also not rewarded.

Question 8

A good number of candidates answered this part correctly. Common errors came from misreading the question and finding the number of seconds in either 6 hours (21 600), half an hour (1800) or in six and a half minutes (390). Other errors included writing 6 hours 30 minutes as 6.3 × 3600 = 22 680. In addition, a common error was to calculate $60 \times 60 \times 6\frac{1}{2}$ as $60 \times 60 \times 6 \times \frac{1}{2}$ = 10 800.

Question 9

A good proportion of candidates answered this correctly. Common errors included adding all the numbers together to find the perimeter (70), finding the product of the six numbers as 1 159 200 or just working out the base × height as 23 × 12.

Question 10

(a) (i) A majority of candidates found the mode correctly.

(ii) A majority of candidates worked out the range correctly. The most common errors were arithmetic errors or writing down 3 to 21 but not completing the subtraction.

(b) A fair proportion of candidates answered this part correctly. Others showed the correct method but made slips with the arithmetic. Others worked out either one, or both, of $5 \times 28 = 140$ and $6 \times 26 = 156$ but got no further. The most common incorrect methods included the answer 2 (from $28 - 26$), the answer 24 (from $26 - 2$) and the answer 4.33 (from $26 \div 6$).

Question 11

Most candidates were able to show the correct method, namely $\frac{19}{100} \times 46.25$. However, not all candidates evaluated this correctly, or evaluated it to enough accuracy. Others evaluated it correctly but did not go on to give their answer correct to the nearest cent. A number of candidates who gave an answer such 8.8, but with no evidence of a correct method, did not score. Some candidates, who used an incorrect method, were rewarded for rounding their answer correctly to the nearest cent.

Question 12

(a) The majority of candidates answered this part correctly or managed to score one mark for having $7b$ or $-11c$ in their final answer. The most common errors included sign errors and slips with arithmetic.

(b) The majority of candidates also answered this part correctly. The most common errors included slips with arithmetic. In addition, misconceptions included writing 3 + 4 or 34 when substituting *r* for 4.

Question 13

The majority of candidates answered this part correctly. The most common errors seen included dividing by the 3 and 5 separately as $\frac{136}{3}$ and $\frac{136}{5}$, or slips with the arithmetic, for example using 3 + 5 = 7.

Question 14

Most candidates were able to give 'no' and a well-worded reason with a supporting calculation to show that Carl did not have enough boxes to pack all the pens. There were a variety of equally successful approaches seen. The most common included:

No because….-

$980 \div 68 = 14.4..$ so, he would need 15 boxes.

or $14 \times 68 = 952$ so he would have $980 - 952 = 28$ pens that will not be able to be packed into the boxes.

or $980 \div 14 = 70$ so he would need to put 70 pens into each box, but the boxes only hold 68 pens.

Common statements that did not score included:

$70 - 68 = 2$ so, he has 2 pens too many, (rather than either 2 pens too many per box or 28 pens too many).

14.4 is a decimal number (rather than he needs more than 14 boxes).

A minority of candidates gave either a correct calculation or a correct reason and scored one mark.

Question 15

Almost all candidates answered this part correctly. The most common errors seen were calculation slips or the answer 135, assuming *x* was vertically opposite to 135.

Question 16

(a) Around half of all candidates answered this correctly. A few reached $5^2 + 2^2$ = 29 but either did not square root or square rooted inaccurately, with answers such as 5.3, 5.4 or 5.38 often seen. Incorrect methods, with candidates recognising that Pythagoras needed to be used, included $5^2 - 2^2$, $5^2 - 4^2$ and $5^2 + 4^2$. Other misconceptions included $x = 4$ (because it is an equilateral triangle) or guesses such as 5 or 6. A noticeable number of candidates did not read the question carefully and found the area of the triangle.

(b) A fair number of candidates drew a correct net for the pyramid. Some candidates constructed a correct net with compasses using the length 5.39 cm from the previous part, although this was not necessary as the triangles had perpendicular height 5 cm. Others drew a square with four triangles around it but had errors such as the wrong size square, the wrong size triangles or 4 non-identical triangles around the square. Other candidates drew pictures of a pyramid, rather than a net. Some candidates did not make any attempt at drawing a net.

Question 17

A good proportion of candidates answered this correctly. However, a wide variety of errors were seen, such as 46.17, 46.27, 46.28 and 4618.

Question 18

(a) Many candidates answered this question correctly and to at least 3 significant figure accuracy. Common incorrect answers included 1.7 and 1.73. The most common misconception was to use the order of operations incorrectly with an answer of 8.42 coming from evaluating $\sqrt{8.4^2 + \dfrac{9.3}{26.5}}$.

(b) Less than half of all candidates answered this question correctly. The answer to this question was the exact answer of 0.015625 or $\dfrac{1}{64}$. Candidates who did not evidence the exact answer and only evidenced rounded answers such as 0.01, 0.02, 0.015 or 0.0156 did not score. Incorrect answers included -64 and -12.

Question 19

Around half of all candidates answered this part correctly. The most common errors came when expanding with, $3(5x + 2)$ expanded as $15x + 2$ and/or $-4(x + 1)$ expanded as either $-4x + 1$, $-4x - 1$ or $-4x + 4$. Other errors included slips with arithmetic when expanding or slips with signs when collecting like terms or multiplying the two brackets together.

Question 20

Due to an error in **Question 20**, full marks were awarded to all candidates for this question to make sure that no candidates were disadvantaged. The question has been removed from the published version of the paper.

Question 21

(a) There were two different, equally good, answers to this question, but the majority attempted to describe the rotation as a 90° clockwise rotation about the origin with fewer describing a 90° anticlockwise rotation about (0,5). Although most candidates were able to recognise the transformation as a rotation, less than half were able to give a complete description of the single transformation. The word ‘rotation’ was required with substitute wording such as ‘turn’ or ‘revolve’ not accepted. Candidates who attempted to describe a double transformation, often as rotate and translate, did not score.

(b) A good proportion of candidates scored full marks by correctly reflecting shape *A*. Others scored one mark for reflecting in a line parallel to the *x*-axis or reflecting in the *y*-axis.

Question 22

(a) The majority of candidates completed the table correctly. The most common error was to give two correct values at $x = 0$ and $x = 3$ but evaluate the $x = -3$ incorrectly as $-3^2 - 4 = -13$. Other candidates completed the table by trying to spot patterns with the values. However, without any values that could be found by symmetry, the only way the values could be found was by substitution. Some candidates chose to fill in the table with three random values.

(b) This was a difficult curve to draw well as the distance between some of the points was large, but despite this, there were some accurate and clearly drawn curves. Candidates should recognise the given equation as a quadratic and should therefore be expecting to draw a graph that is parabolic in shape. The most common errors included the mis-plotting of the occasional point, not drawing the curve accurately through the plotted points, joining the points with a ruler, feathering of the curve and plotting but not joining the points. In addition, candidates should use a sharp pencil for drawing graphs so that, if they wish to improve the shape of their curve, they can rub it out and redraw it. A small minority of candidates did not attempt to answer this part.

Question 23

(a) Around half of all candidates answered this part correctly. Some answered the question partially, with incomplete methods leading to 145, 1.45 or 0.45. The most common errors included giving the answer as the amount of profit, $1.44, or dividing the profit by the selling price rather than the buying price.

(b) Relatively few candidates scored full marks on this question. The most successful candidates used the correct formula, which could be found on the formula sheet, substituted the values in and rearranged correctly to find the radius to at least 3 significant figure accuracy. Common errors included not starting with a correct formula, rearranging incorrectly, rounding within the stages with loss of accuracy or just dividing the volume by the height, namely $900 \div 8$.

Question 24

This question was answered well by a fair number of candidates. Common errors included sign errors when moving terms from one side of the equation to the other or omitting to divide all terms by 9. Conceptual errors included $9p + 32 = 41p$ and treating $9p$ as $9 + p$.

Question 25

A good number of candidates answered this part correctly and most used factor trees as their method. Others wrote out lists of multiples of the two numbers, although this is not generally the most efficient method. Common errors included finding common factors with answers such as 2 and 4 often seen, or giving a multiple of 180 as the answer, usually 360 or 720, or making arithmetic errors in factor trees. Some candidates obtained correct factor trees but did not know how to proceed further and sometimes addition of the factors was seen, for example, $5+9=14$.

Question 26

A minority of candidates answered this part correctly. Some found a correct equation but did not simplify the coefficient of x to 3. Many others were unable to correctly find the gradient because they did not take into account that the axes had different scales, with the incorrect answer $y=1.5x+9$ seen. Others made errors with the gradient calculation, giving it as -3 or either having it upside down, or making slips with the arithmetic. Others misread the scale and had the y intercept as 8.5. Frequently, answers contained several numbers without the x variable, for example, $y=\frac{9}{3}+9$. This question had the largest number of no responses over the whole paper.

Question 27

Due to an error in **Question 27**, full marks were awarded to all candidates for this question to make sure that no candidates were disadvantaged. The question has been removed in the published version of the paper.

Question 28

There were many things to think about when answering this question, and as a result only a minority of candidates answered it correctly. Candidates needed to ensure they used the correct formula, namely speed$=\frac{\text{total distance}}{\text{total time}}$; which candidates could deduce from the units of speed which were given on the answer line. Incorrect formula using distance $\times$ time and $\frac{\text{time}}{\text{distance}}$ were seen. Candidates also needed to read off the correct total time for the **whole** journey, namely 36 minutes and convert this into hours. Incorrect times such as 0836 and 0.36 hours were frequently used. In addition, the distance of 5.4 km was often misread as 5.2 km. Some candidates tried to find the average speed by finding the mean of the speeds of the three parts of the journey, but this method would only work if the times of the three different parts were equal.

Question 29

(a) A good proportion of all candidates answered this correctly. Others were able to show a correct method, but by working out their answer in two steps, and prematurely rounding midway through, they sometimes gave an inaccurate answer. Others showed $\frac{20.8}{x}=\frac{9.1}{1.4}$ but rearranged this incorrectly. However, an extremely common incorrect answer was 13.1, which came from candidates wrongly assuming that $9.1-1.4=20.8-x$.

(b) A fair proportion answered this part correctly, but answers were frequently not accurate to 3 significant figures. Those who showed working could score one mark even if their answer was inaccurate. But those candidates who showed no working and gave a common inaccurate answer of 4.25 were not rewarded. The most common errors included choosing the wrong trigonometrical function, rearranging for y incorrectly, calculating $38\times\cos 5.4$ or $\cos(38\times 5.4)$ or performing calculations that involved no trigonometrical function.

MATHEMATICS (WITHOUT COURSEWORK)

Paper 0580/41
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 with their answers to ensure that method marks are considered when full marks have not been given.

The question paper includes a list of formulae which candidates should refer to where appropriate.

General comments

There were many excellent scripts that demonstrated a wide-ranging knowledge of the syllabus, however there were also some candidates for whom this extended paper was not appropriate.

Candidates appeared to have enough time to complete the paper.

Most candidates presented their work well and therefore had the opportunity to gain some method marks when solutions were not entirely correct. There was good communication in calculations and in algebraic manipulation as well as clear diagrams in the construction of a triangle and completion of the histogram. Candidates should, however, be reminded to reference angles clearly and to annotate diagrams.

Attention should be paid to the key message regarding intermediate values within longer calculations as premature rounding is an issue for some candidates.

The topics that were most accessible included linear equations, simple angle facts, construction of a triangle and accurate angle measuring, multiplying out brackets, percentage change and estimating the mean from a grouped frequency table.

The more challenging topics were within those questions that required some interpretation and reasoning, e.g. **Questions 14(d)**, **27**, **28(b)** and **29(b)**. In **Question 13**, although the mathematics involved only simple trigonometry, many candidates did not understand the angle of elevation. Set notation, angles in circles when having to draw in extra lines, exponential decrease, the formula for the *n*th term in a power series and functions were also challenging for many.

On a few occasions it was difficult to see which method the candidate wanted to be marked; in situations like this it is important that candidates make a choice.

Comments on specific questions

Question 1

There was a mixed response to this question on symmetry, with all other quadrilaterals seen as well as the correct answer rhombus. Rectangle was a common wrong answer. Some candidates used sketches to confirm their answer, but this did not always help as incorrect names were attached to the correct shape and incorrect lines of symmetry were drawn on some shapes e.g. diagonals on rectangles.

Question 2

Most candidates completed this solution of a linear equation correctly. Occasionally the mistakes $2x = 11 + 4$ leading to $x = 7.5$ or $2x = 4 – 11$ leading to $x = –3.5$ were seen.

Question 3

Most candidates answered this question correctly and were able to obtain the final answer of 125. A small number of candidates, however, placed 55 correctly on the diagram, often as vertically opposite or corresponding angles, but gave 55 as their answer.

Question 4

Most candidates were able to add the given time duration correctly and arrived at the expected finishing time of 04 08. A few candidates, however, gave the unacceptable answer 28 08 or made an arithmetic error, giving for example the answer 3 08.

Question 5

(a) Candidates were usually successful with this construction question. Many of the candidates were able to accurately construct the triangle using compasses and a ruler, and scored both marks. A few candidates drew an accurate triangle but without showing correct construction arcs so did not score full marks. Only a small number of candidates were unable to access the question at all.

(b) Most candidates that drew a triangle in **part (a)** were able to accurately measure the required angle with acceptable accuracy. Errors seen included giving the obtuse value from the protractor rather than the acute value.

(c) (i) Candidates were much less successful with this part of the question. The majority used the scale to multiply 8 by 10 000 to arrive at 80 000; however, many students were then unable to convert this into km to arrive at 0.8. Many did not try to convert at all, giving their answer as 80 000 km, while others gave the answer 80, presumably believing 80 000 was in metres not centimetres.

(ii) Many candidates did not appear to understand what was meant by the bearing and a full range of alternatives to 270 was seen.

Question 6

This question on expanding algebraic brackets was in almost all cases answered correctly. A very small proportion of candidates removed the brackets correctly but then did an incorrect further step.

Question 7

(a) This was done well by many candidates. Most showed an understanding of the notation for strict and unstrict inequalities and were able to write the correct inequality. Some candidates had the symbols the wrong way round.

(b) Many candidates were able to divide by 2 and give the correct six integers. The value 0 was sometimes missing from their list and some did not understand the requirement for integer values after writing $-2 < x \leq 4$.

Question 8

Many candidates were able to use their calculator correctly and most used the correct accuracy, with just a few giving an answer to 2 significant figures or an incorrect answer of 1.12. Some candidates omitted the step of raising to the power of $\frac{1}{4}$ or raised to the power of 4 instead.

Question 9

Most candidates attempted this question and showed clear working. The strongest candidates combined the conversion factors and multiplied by 3.6. Most worked in stages and commonly divided by 1000 to convert the distance, then multiplied by 60×60 for the time. The most common error was to do these the wrong way round, dividing by 60×60 and multiplying by 1000. It was rare to see errors in the conversion factors, e.g. 100 instead of 1000 used, but sometimes candidates multiplied by only 60.

Question 10

Many candidates used addition correctly to reach the correct answer (4, 5) understanding that $\overrightarrow{OB} = \overrightarrow{OA} + \overrightarrow{AB}$. A common incorrect answer given was (0, 3) from candidates using $\overrightarrow{OB} = \overrightarrow{AB} - \overrightarrow{OA}$ in error.

Question 11

(a) This was a straightforward question for candidates and most gained 2 marks for the answer 51. In a few cases the reduction of 9 was calculated but not subtracted from 60 to give the sale price, or was instead added to 60.

(b) This reverse percentage question was found to be more challenging but was attempted well by candidates, and many gave the correct answer 68.40 for the original price. The most common wrong methods included finding 85% of 58.14 to get 49.42 or finding 15% of 58.14 and then adding this to 58.14 to get 66.86. A few candidates calculated $58.14 \div 0.75$, presumably making an arithmetical error when subtracting 15 from 100, but without showing this subtraction they could not earn the method mark.

Question 12

(a) Candidates correctly interpreted the diagram to identify the region that represented the students who did not like rugby. This usually led to the correct answer, although some did not include the 4 students who liked neither.

(b) Many candidates were unable to use the correct set notation here. It was common for candidates to incorrectly use the union symbol to describe the region. There were a few more complex versions of the simplest correct response.

Question 13

This proved to be a challenging question for some candidates, with many having difficulty identifying the correct angle as the angle of elevation. The most common error was to see the angle *TAP* indicated. Candidates who knew the correct angle chose a variety of methods to calculate this angle correctly, although accuracy was sometimes lost by candidates prematurely rounding in a method using the length *ET*.

Question 14

The four parts in this question tested candidates' ability to perform calculations with three-dimensional shapes.

(a) Most candidates scored this single mark by correctly showing the substitution of $r = 4$ into the formula for volume of a sphere which was provided on the formula sheet. Some candidates incorrectly identified the radius of the sphere as 8 cm, which was the side length of the cube and therefore the diameter not the radius. Other candidates did not show the step $4^3 = 64$ and, unless they stated $r = 4$ somewhere within their response, were unable to achieve the mark due to lack of evidence in a 'show that' style question.

(b) This part combined finding volumes of three-dimensional shapes with calculating percentages. A large number of candidates illustrated excellent understanding for this problem and showed a fully correct method for how to solve it; however, many lost accuracy due to premature rounding, most noticeably in using a rounded value for the given volume of the sphere; candidates should be encouraged to input values in their exact form into their calculators so as to avoid inaccuracies in their final results.

Some candidates found the volume that was occupied by the sphere as opposed to the space left over. Weaker candidates were able to find the difference between the volume of the cube and the volume of the sphere but were unable to identify how to convert this into a percentage; some of these chose to divide by 100 instead of 512 but others just stopped at 244, not knowing how to progress further.

(c) This part involved finding the mass of the sphere using the given formula for density. A large percentage of candidates understood how to substitute the given values into the formula and rearrange it to ascertain the mass by multiplying the density and the volume. A small number of candidates did this incorrectly and divided. Other errors that resulted in not scoring both marks were nearly always because of premature rounding of the volume again, or for failing to convert the result in grams into kilograms.

(d) This was the most challenging part in the question. The initial step of equating the volume of the sphere to the volume of the cylinder to find the value for the height of the cylinder was missed by many and severely impacted any further progress that could be made in the question. Many candidates assumed the height was the same as the side length of the cube and used $h = 8$ throughout. For those that did recognise the need for this first step, many again either prematurely rounded the value of the volume of the sphere or rounded or truncated their resulting value of h to 2 significant figures (8.8 or 8.9) which then impacted the accuracy of their final answer. Many candidates illustrated understanding of how to find the surface area of a cylinder; the formula for the curved surface was given on the formula page, and they recognised the need to add the two circles that formed the top and bottom. A minority though only added one circle.

Question 15

Most candidates attempted this question, but many struggled to reach the correct answer. Candidates had difficulty selecting appropriate angle theorems. Candidates who added the lines *BO* and *OA* or alternatively the line *AB* to the diagram had most success although some of these still chose to use the common incorrect assumption that angle *ACB* and angle *ATB* should add to 180. There were three different approaches to this question, and it is important that candidates use correct three-letter notation for angles to gain method marks, e.g. angle $OBT = 90$ will score whereas angle $B = 90$ is not sufficient.

Question 16

Finding an estimate for the mean from a grouped frequency table was generally well answered, with most candidates showing well-organised working. There were a few errors with use of interval widths instead of midpoints. Candidates should realise that the mean value must lie somewhere within the given values in the table.

Question 17

Finding the equation of a line passing through two given points was generally well answered. Errors seen included using change in x divided by change in y for the gradient or giving the gradient as 2 instead of −2. Some candidates did not use the y-intercept (0, 4) given in the question for the value of c in the final $y = mx + c$ equation. Other candidates misinterpreted the question and used properties of perpendicular lines and midpoints.

Question 18

(a) Most candidates attempted to find an area and the correct answer was attained usually by using the area of a triangle and a rectangle. Far fewer candidates used the area of a trapezium. The most common error was for candidates to disregard the fact that the athlete was accelerating in the first two seconds and simply calculated $8 \times 10 = 80$.

(b) In very many solutions candidates calculated the time to run 100 m at 8 m/s, ignoring the second line of this question and the words 'after 10 seconds'. Hence, their answer to **part (a)** played no role in answering this question. Of the candidates who correctly subtracted their answer in **part (a)** from 100 before dividing by 8, a significant number then forgot to add on the 10 seconds to find the total time.

Question 19

There were mixed responses to this question. If candidates understood **exponential** decrease, then they usually set up a correct equation or inequality of either $20(0.9)^n < 1$ or less often $(0.9)^n < 0.05$. Candidates mainly used trial and improvement to find n. Some showed excessive amounts of working and it is only necessary to show their 2 or 3 closest attempts leading to their solution. Although not on the syllabus, a few candidates used logarithms to solve the equation, but $n = 28.4$ often resulted in an incorrect final answer from simply rounding rather that interpreting the value correctly in the context of the question. A very common error was to find the mass lost after one day, 2 g, and to assume that 2 g was then lost each subsequent day and give the answer 9 or 10.

Question 20

This question tested candidates' ability to recognise and describe a geometric sequence.

(a) Most candidates gave the correct answer of 1.5. Incorrect answers were rare but when seen were either 0, possibly just from looking at the difference between the last two numbers and assuming it was linear, or 96, presumably from incorrectly working from right to left.

(b) This was a challenging question. Any equivalent expression to $96 \times \left(\frac{1}{2}\right)^n$ was acceptable, and $48 \times 0.5^{n-1}$ was the most common. Some candidates unfortunately wrote this as $48 \times \frac{1}{2}^{n-1}$ which, without including brackets around the fraction, is incorrect. Many chose to write the expression as a division, e.g. $\frac{96}{2^n}$, which was also acceptable. Some were able to find the correct expression, but further incorrect simplification resulted in an incorrect answer, e.g. $48 \times 0.5^{n-1} = 24^{n-1}$.

Some candidates wrote the formula for geometric progression ar^{n-1} but were unable to successfully substitute in the required values. There was evidence that most recognised the term-to-term rule as 'divide by 2' which was tested in **part (a)**, and $n/2$ was a common error seen in this part. Other candidates were seen to find the difference between the values in the sequence, looking for a common difference to be ascertained, but after 3 or 4 lines of differences, gave up and abandoned the question.

Question 21

Most candidates correctly used the formula from the formula sheet and efficiently achieved a correct result. Some candidates drew a sketch to visualise the problem, and this often resulted in the correct method. Some, however, mislabelled their diagram and used other trigonometric calculations to find the size of the other angles or sides and then used the correct formula for the area but with the wrong values. Some candidates found the perpendicular height of the triangle and then used $\frac{1}{2}bh$. They did not appear to be aware that their $h = 8\sin50$ and therefore their final calculation is still $\frac{1}{2} \times 9 \times (8\sin50)$. It is beneficial for centres to teach this formula from first principles so that candidates understand why it works in non-right-angled triangles. The weakest candidates only used $\frac{1}{2}bh$ and gave an answer of 36.

Question 22

This demanding question was often well answered with many candidates, clearly well prepared, setting up the equation $301.10 = 200[\ldots]^{25}$ for the first mark. Whilst many candidates knew that a 25th root was going to be necessary, incorrect algebraic steps were quite frequently seen, the most common being $301.10 - 200 = [...]^{25}$. Premature approximation was also quite common, and some candidates earned method marks but could not reach the correct 3 significant figure answer. Some candidates attempted to use simple interest methods.

Question 23

This question proved to be more demanding than anticipated. The stronger candidates clearly reached the correct final answer from a fully correct method. Many candidates did not introduce a constant and so ended up with $3 = \frac{1}{3}$ or $3 \propto \frac{1}{3}$. Other errors included substituting x and y the wrong way round or giving a numerical answer.

Question 24

(a) Many candidates used $T = D \div S$ and wrote the correct expression of $\frac{10}{x}$. The main error was to write an expression for walking and running or the full equation for the journey.

A small number of candidates found a more complicated but still correct expression by subtracting the time spent running from the total time taken for the journey. A variety of incorrect answers were given; generally these were algebraic expressions which did not involve division. Candidates should be reminded that units such as km should not be included in an algebraic expression.

(b) This question part proved challenging for many candidates with many unclear as to what was being asked of them. Candidates who started with the correct equation made good attempts to manipulate it. Most recognised the need to eliminate fractions, expand brackets and rearrange so that the right-hand side was equal to 0. Working was not always easy to follow. The best solutions were those where the manipulation of the equation was done in clear stages, rather than applying multiple steps at the same time. This allowed the candidate to keep track of the balance of the equation, ensuring variables and coefficients did not go missing, and allowed a better opportunity for part marks to be awarded when there were errors. Candidates do need to be careful when choosing to manipulate only one side of their equation to ensure this 'working out' does not become part of the main chain of reasoning. The main error was that many candidates attempted to solve the equation in this part, and this was not required until **part (c)**. Even after they realised that this was what they needed to do in **part (c)**, it was rare to see a candidate go back and reconsider their approach to this part of the question.

(c) This was the most successful part of the question, with most students correctly recognising the need to use the quadratic formula given on the formula sheet. When instructed to show all their working it is not possible for candidates to score full marks if they simply write down a solution that can be generated by their calculator such as $x = \frac{1 \pm \sqrt{561}}{7}$.The best solutions included the quadratic formula shown with each value correctly substituted prior to any processing. This allowed the candidates to gain the method marks for working out. Candidates lost working out marks most commonly for omitting brackets around negative values, for example writing $(-2)^2$ as -2^2, or for 'short' division lines and square root signs. Care should be taken to show the fraction line extending all the way under the numerator and for the square root sign to fully enclose $b^2 - 4ac$. Care needs to be taken in general when the coefficients a, b or c are negative. Most candidates gained the final mark for giving accurate solutions correctly rounded to 2 decimal places, but a minority lost marks due to incorrect or premature rounding, most commonly after rounding $\sqrt{2244}$ prior to processing the rest of the formula, or for failing to correctly round 3.5264 to 3.53.

(d) This part proved most challenging, and there were very few fully correct answers seen. Candidates needed to use their positive answer from **part (c)** and substitute this into the expressions for running and walking and then find the difference between their answers. Only the strongest candidates were able to do this and even those sometimes struggled to convert their answers correctly into hours and minutes, for example, 2.18 hours was often written as 2 h 18 mins. It is essential that candidates do not round prematurely here and to show all working out so that method marks can be awarded if their answer is outside the acceptable range of accuracy.

Question 25

This question was generally well answered, with most candidates showing a good understanding of histograms, the key property being that of frequency density.

(a) Many candidates successfully answered this part. A few gave the height of the column as the answer, and a few divided the height of the column by the interval width instead of multiplying.

(b) This part required the same property, so the success rate was similar to **part (a)**. Most solutions were correct and accurately drawn, although a few candidates drew the bar height at 24 or 32 after showing the correct calculation 102/3 = 34. Some candidates did not read the question carefully enough and assumed there was a total of 102 parcels so subtracted the 40 light parcels, leaving 62 ÷ 3 = 20.7 as their frequency density.

Question 26

This question proved to be straightforward for more able candidates, with many fully correct responses seen. The most common approach was to equate the given equations to eliminate y. This approach was the most successful, giving $2x^2 - 5x = 0$. There were some errors seen in rearranging the resulting equation in one variable, arriving at e.g. $2x^2 - x = 0$. It was rare to see a fully correct solution which attempted to eliminate x and arrive at an equation in y only. Some candidates attempted to use the quadratic formula to find the solutions but because their equation only contained two terms they were not always successful, struggling to deal correctly with the value of c being 0. Other incorrect approaches seen included trial and error and/or using incorrect substitution methods or solving the given quadratic expression in x equated to 0. Most candidates followed the instruction to show all working; it was very unusual to see values given without working to support them.

Question 27

This was one of the most discriminating questions on the paper particularly because of the challenging 3D situation. There were some good answers, usually aided by adding correct lines to the given diagram. The candidates who drew the vertical line from *G* to the line *EF* and the line from the foot of this perpendicular (*N*) to *A* usually gained at least two marks from using Pythagoras correctly for an appropriate line. The most direct approach to finding the correct angle *GAN* was to use $\tan^{-1}(5 \div AN)$, but some candidates calculated *AG* and used sine or cosine instead. This sometimes led to a loss of accuracy due to premature rounding of the two side lengths involved.

The very common misunderstanding was to attempt to find the angle between *AG* and *AF*, with many candidates thinking that triangle *AFG* was right-angled.

Question 28

This function question was found to be challenging by many, and it was not uncommon to see the answer to **part (b)** in **(a)** and vice versa.

(a) This part required recognising the need to solve $7^{x-4} = 1$ and drawing on knowledge of the index law $a^0 = 1$. Those that did this reached the correct answer of 4. However, many just substituted x = 1 into the expression resulting in the answer 1/343.

(b) The simple way to solve this question was to recognise that if $f^{-1}(x) = 1$ then $x = f(1)$; those that understood this relationship answered with ease often with no working shown. But many candidates were confused as they had already performed this substitution in **part (a)**. Although logarithms are not on the syllabus, some candidates set about trying to use logarithms to solve an exponential equation, having attempted to find the inverse function with varying amounts of success.

Question 29

The final question tested candidates' ability to apply trigonometry in non-right-angled triangles. Both the sine and cosine rule were provided on the formula sheet, and candidates are reminded to look at them to check rather than relying on memory; there were a few occasions where the sine ratio was used within the cosine rule, leading to an unnecessary loss of marks.

(a) The first part was generally done well, with most candidates correctly substituting the values into the cosine rule and reaching a correct answer. Some candidates found the rearrangement of the cosine rule challenging and often there were sign errors or the use of imaginary brackets in the implicit version, leading to $\cos y = 13^2 / (10^2 + 14^2 - 2 \times 10 \times 14)$.

Some candidates substituted the wrong lengths for *a*, *b* and *c* in the formula, leading to the wrong angle; a number tried to use the sine rule, even though they did not have any angles given to them in the question; these usually made some assumptions about angles on the opposite side of the quadrilateral being equal. These errors were all reasonably rare, and a good number of correct responses were seen.

(b) This part was more challenging; candidates were required to draw in the line *BD* and re-visualise a triangle that had not previously been identified (*ABD*). Many drew line *BD* but then chose to work with triangle *CBD* which involved two unknowns to be found, making the question more demanding than it was intended. Other candidates drew in the line *BD* and showed angle *DAC* = 45, but could not see how to progress further.

Several incorrect assumptions were seen; often that angle *BDA* was half of 97, or that angle *BAD* = 90; candidates then went on to incorrectly use right-angled trigonometry or Pythagoras. Candidates trying to find *CD* quite often incorrectly labelled angle *ABC* as 83, thinking they could the opposite angles added to 180. Premature rounding in intermediate stages also caused candidates to lose accuracy in this question, especially if they chose the *CBD* route as they were then working with a rounded value for *CD* and angle *BCA*. There were some candidates that correctly calculated *AD* using the sine rule in triangle *ACD* and showed correct use of the cosine rule in triangle *ABD* to find *BD* but, having made an error in **part (a)**, were unable to achieve the final correct result.

MATHEMATICS (WITHOUT COURSEWORK)

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 with their answers to ensure that method marks are considered when full marks have not been awarded.

General comments

Many candidates were well prepared for the paper and their solutions were often well presented.

Candidates are required to give non-exact answers correct to 3 significant figures but, in some cases, candidates gave answers with only 2 significant figures. Candidates should ensure that they retain sufficient accuracy in their working to give a final answer within the acceptable range. In questions that specify the required degree of accuracy, such as **Question 5**, candidates must give a final answer with this accuracy. In questions where candidates are required to show a value to a particular degree of accuracy, for example **Question 7(a)**, they should give an answer with at least one more significant figure than is given in the question to demonstrate the accuracy of their method. Candidates should note that they are expected to give answers in their simplest form: this applies to algebraic expressions and formulas as well as to numerical values.

The question paper includes a list of formulas, which candidates should refer to where appropriate.

Many candidates were familiar with applying standard processes such as use of the cosine rule, expanding brackets and solving simultaneous equations involving a quadratic. Candidates found questions requiring some interpretation or the combination of several skills more difficult to access, such as **Questions 9**, **13(b)**, **15(c)** and **18**.

Comments on specific questions

Question 1

Candidates answered this question well, with many realising they must convert 3 kg to 3000 g before simplifying the ratio. The most common error was to divide 60 by 3 to give an answer of 1 : 20 or, sometimes, 1 : 0.05. Candidates should note that units should not be included within a final answer in the form 1 : *n*.

Question 2

This question was very well answered, with the majority of candidates scoring full marks; answers were accepted in decimal or simplified fraction form. The most common error was to rearrange the equation to give $8x = 27 - 17$.

Question 3

This proved to be more challenging to many candidates. Some candidates did not know what was meant by order of rotational symmetry and gave answers that involved the sum of interior angles in a polygon, or used terms such as clockwise. A number did not know that a decagon has 10 sides and answers of 9 and 12 were common errors. A minority of candidates gave the correct answer.

Question 4

(a) This question was very well answered by candidates, with the majority giving the correct answer 216. Most candidates used a methodical approach e.g. $9 \times 3 = 27$ cards made in one hour and then scaling this up to 8 hours. Errors included dividing 20 by 9 and then either not knowing how to proceed from there or approximating this to 2.2 which led to an incorrect answer.

(b) This part was less well answered. Those who were successful found the actual profit first and then gave the correct fraction $\frac{50-12}{12}$ before converting to a percentage. The most common error was to use the selling price rather than the original price as the denominator in the fraction, leading to the answer 76%.

Question 5

Most candidates demonstrated a correct method to answer this question and showed 953×0.152 or the difference of \$3.856 in their working to gain partial credit. The majority of candidates, however, were unable to give the answer to the nearest cent, \$3.86, with many giving an unrounded answer or \$3.9 as the answer.

Question 6

The majority of candidates gave the correct values for P and Q. The most common error was to give the waiting time for patient P as 26 minutes, but in those cases method marks were often earned for setting up an equation involving the mean time of 16 minutes, to show that the values of P and Q had a sum of 43. A few candidates were unable to correctly use the information given in the question about the mean waiting time correctly and struggled to make any progress.

Question 7

(a) The majority of candidates showed a correct method to find the missing length, x, of the parallelogram. A minority gained full marks, however, as most did not give a more accurate decimal answer to the one given in the question to show that 6.06 cm was correct to 2 decimal places. Candidates should note that in a 'show that' question such as this, they should give an answer with greater accuracy than that given in the question.

(b) Many candidates were successful and gave a correct answer for the total cost of the floor.

The most concise method was to use trigonometry to find the vertical height of the parallelogram before finding the area and multiplying this by \$18. Many candidates used longer methods for this area, often dividing the parallelogram into triangles and/or rectangles. In both cases this added a layer of difficulty to the method and this was a less successful strategy. Those that did find the area by this method often gave an inaccurate final answer by premature approximation of some of the lengths required for the area.

Question 8

(a) The translation was very well answered, with just a few errors from some in counting the squares of the translation.

(b) The reflection was more challenging but was drawn accurately by the majority of candidates.

For those not drawing the correct image, partial credit was sometimes earned by having an image in the correct orientation but an incorrect position or for drawing the line of reflection $y = x + 1$.

(c) The vast majority of candidates earned at least partial credit for giving 'rotation' and one of the properties of the rotation, which was usually either the angle and direction of the rotation. Fewer gave the correct centre of rotation. An error made by some candidates was to describe the transformation as a reflection or, having correctly described is as a rotation, then to give a second transformation such as 'translation'. In cases where a second transformation is given, marks are not awarded to candidates.

Question 9

A minority of candidates gave the correct distance in kilometres, but the vast majority did make an attempt to find the area under the graph to calculate the distance travelled. Most worked in minutes combined with km/h and many gave an answer of 1450, which was given partial credit. For most candidates, the biggest issue was dealing with the units in the question when finding the partial areas required.

Question 10

(a) This was very well answered.

(b) Many gave a correct expression for the *n*th term. The majority worked with second differences of the sequence and were able to earn partial credit for either giving the common second difference as 6 or recognising that the expression for the *n*th term was a quadratic.

Question 11

(a) Almost all candidates completed the table correctly, with most giving their answers to two decimal places. Answers with three decimal places were accepted.

(b) Many candidates drew an accurate graph. A small number plotted the point (–2, –1) at (–2, 1) and some others had a curve or one or two plots that were not within tolerance, being more than half a small square away from the correct position.

(c) This part was more challenging, and many were unable to find the equation of the straight line required to solve the given equation by rearranging $x^3 - 2.5x + 1 = 0$ into the form $x^3 - 2x + 3 = 0.5x + 2$ to obtain the line $y = 0.5x + 2$. Those who were able to obtain the correct equation usually drew the line correctly and gave answers within the required range.

A small number of candidates with a correctly drawn line were unable to interpret the scale of the x-axis for their readings.

A small number also clearly used the equation solver on their calculator to obtain three correct values without considering the demand of the question to draw a suitable line on the grid. In these cases, credit is not given.

Question 12

(a) The majority of candidates found the correct value of x, but a minority gave the required geometrical reason for their answer. Candidates need to use the correct language within their reasons, and centres are advised to teach the wording given in the syllabus for such reasons to ensure candidates use the correct terminology. Terms such as edge, perimeter and circle, for example, are not acceptable alternatives for circumference when giving geometrical reasons.

(b) Many candidates gave a correct answer, with almost all using the angles in the isosceles triangle *AOC* and the alternate segment theorem. The most common error was to assume that triangle *ABC* was isosceles and having correctly found that the base angles of triangle *AOC* were 38°, to then subtract 38° from 64° to get an answer of 26°.

Question 13

Many candidates identified an appropriate common denominator and added the fractions correctly. Most gave a simplified final answer, although some gave a fraction such as $\frac{62}{16m}$ which was not acceptable for full credit as it is not fully simplified. Common errors were to attempt to use a common denominator of $8m \times 2m$, but to multiply the terms incorrectly to give $16m$ leading to a final answer of $\frac{31}{8}$. A small number of candidates simply added the numerators and denominators, leading to the answer $\frac{10}{10m}$. Candidates should take care to write their final answer in the correct form: an answer of $31/8m$ is ambiguous, while $\frac{31}{8}m$ is incorrect.

Question 14

(a) Most candidates were familiar with the formula for compound interest and applied it to reach the correct answer. Some candidates showed the correct calculation but then either subtracted or added 24 000 to their answer, which demonstrated that they did not understand what was required by the value of the investment. A small number of candidates applied simple interest in place of compound interest or did not convert the interest rate of 3.2% correctly for use in the compound interest formula.

(b) The application of reverse percentage in this question was found to be challenging, and only a small proportion of candidates reached the correct answer of \$10 370. It was more common for candidates to give the answer \$30 500, which is the cost price of the painting rather than the value of the profit that the question required. Some candidates set up a correct equation such as $\frac{40870 - x}{x} = \frac{34}{100}$ but made errors in the rearrangement. It was common to see an incorrect starting equation such as $\frac{40870 - x}{40870} = \frac{34}{100}$. The most common misconceptions were to find either 34% or 66% of the selling price of \$40 870.

(c) Some candidates gave a correct simplified formula for their answer. Candidates should be familiar with the difference between an expression and a formula, but it was common to see an expression rather than a formula on the answer line. The most common errors were the omission of $V =$, the use of $\left(1 - \frac{23}{100}\right)$ in place of 0.77 or $\frac{77}{100}$, or the inclusion of a % symbol in the formula such as $V = 32500(1 - 23\%)^n$. Some candidates added 23% rather than subtracting, and others were unfamiliar with the formula for exponential decay.

Question 15

(a) Most candidates recognised that the cosine rule was required and applied it accurately to reach the correct answer. Some showed correct substitution but made calculator errors when evaluating the result. A small proportion of candidates used sine in place of cosine in the cosine rule or attempted to use an inappropriate method such as Pythagoras' theorem or right-angled trigonometry.

(b) Most candidates recognised that the sine rule was required and applied it accurately to reach the correct answer. Some candidates gave an inaccurate answer due to premature rounding in their working, for example evaluating $\sin DBC$ as 0.18 and using this value – rounded to 2 significant figures – to find the angle, rather than retaining the calculator value. It should be noted that the full method requires an explicit expression for $\sin DBC$: some candidates stated the implicit sine rule $\frac{\sin DBC}{112} = \frac{\sin 140}{392.5}$ but did not show the rearranged form, earning M1 rather than M2 if the final answer was incorrect.

(c) This part was more challenging, but many candidates were able to use the information to find the area of triangle *BCD* and subtract from the given area to find the area of triangle *ABD*. The most efficient method to find the shortest distance was to equate $\frac{1}{2} \times 180 \times h$ with their calculated area of *ABD*, leading to the correct shortest distance. Many candidates used a longer method that involved finding angle *ABD* using $\frac{1}{2} \times 180 \times 300 \times \sin ABD$ and then finding the shortest distance using $300 \times \sin ABD$. This method often led to an inaccurate final answer due to premature rounding of angle *ABD*. Some candidates identified the shortest distance required on the diagram but were unable to make further progress. A small proportion of candidates treated *ABD* as a right-angled triangle and used Pythagoras' theorem to find the length *AD* as the shortest distance.

Question 16

(a) Many candidates showed a correct calculation leading to the required frequency of 10. This was usually shown as $40 \times 0.25 = 10$ or $40 \times (1.6 - 1.35) = 10$, either of which were acceptable. Some candidates showed an equation such as $\frac{F}{1.6 - 1.35} = 40$, $F = 10$ without showing the required product explicitly; this is unacceptable when the question requires candidates to show a result. A small proportion of candidates read the frequency density as 41 and were given credit if they showed an appropriate product.

(b) In order to find the required probability, candidates first had to interpret the histogram to find the frequency for category *C*. Many found this value correctly as 17 and some used it to form a correct product and reach the correct answer. Common errors included giving the answer $\frac{10}{27}$, showing a product with replacement rather than without replacement, reducing the numerator by 1 but not the denominator, or multiplying the correct product by two. Some candidates gained M1 for understanding that the required product had numerators of 10 and 9 but used incorrect numerators such as 48 and 47.

(c) Many candidates were able to extract the necessary information from the histogram to give the frequencies and midpoints of the intervals and showed a correct calculation for the estimated mean. Some made an error in one of the frequencies or midpoints but gained partial credit for showing their method. Some candidates used frequency densities rather than frequencies, or class widths rather than midpoints in their calculation of the mean.

Question 17

In general, candidates were well rehearsed in the expansion of brackets, and many expanded and simplified to reach the correct answer. Candidates who simplified the expansion of the first pair of brackets to three terms were generally more successful than those who attempted the second product using a four-term expression. Incorrect answers often resulted from sign errors when collecting terms for the final answer, or for incorrect powers of *x* when carrying out the second expansion. A small minority of candidates attempted to multiply all three brackets in a single step.

Question 18

(a) The majority of candidates gave the correct expression for $\overrightarrow{AB}$.

(b) Candidates found this question challenging. Some applied the ratio $OA : CB = 4 : 3$ correctly to find $\overrightarrow{CB}$ and hence $\overrightarrow{OC}$ and $\overrightarrow{OM}$. These candidates usually reached the correct simplified expression for $\overrightarrow{AM}$. A common error was to find $\overrightarrow{CB} = \frac{3}{7}\mathbf{a}$ rather than $\overrightarrow{CB} = \frac{3}{4}\mathbf{a}$. These candidates were only able to gain partial credit for stating a correct vector route for $\overrightarrow{AM}$, which was usually given as $\overrightarrow{AM} = \overrightarrow{AO} + \overrightarrow{OM}$. A small number of candidates positioned *M* incorrectly on *BC* rather than *OC*.

Question 19

Many candidates were well prepared for this question and showed a full method leading to the correct solutions. The most efficient method was to equate the given equations to eliminate *y*. Candidates using this method usually reached a correct three-term quadratic equation. The few candidates who rearranged the first equation and substituted in the second to eliminate *x* usually made errors in the expansion and rearrangement. Many candidates showed correct substitution into the quadratic formula, although some omitted required brackets in $(-5)^2$. Candidates should be advised that they must show the substitution of individual values into the quadratic formula to gain full credit; showing $\frac{5 \pm \sqrt{157}}{6}$ without a correct previous substitution stage indicates calculator use to solve the equation, which is not acceptable. The question required answers given to two decimal places, so answers left in exact form were not acceptable. Those candidates who did not reach the correct quadratic equation often gained some method marks for showing correct substitution into the quadratic formula for their equation.

Question 20

Some candidates identified that to find the lower bound for a division they needed to use the lower bound of the numerator value and the upper bound of the denominator value. These candidates often reached the correct answer. It was common for candidates to divide the two lower bounds. Candidates were usually able to identify the bounds of the mass as 4805 and 4815. They had more difficulty in applying the 1 decimal place accuracy to reach the bounds of the density as 7.65 and 7.75, with values such as 7.2 and 8.2 often seen. Some candidates divided the given values and attempted to apply bounds to the result, while others applied the formula incorrectly and multiplied the volume by the density.

Question 21

Many candidates were able to apply the inverse proportion relationship between *y* and *x* correctly to reach $y = \frac{242}{(x+2)^2}$ or to show correct working leading to $k = 242$. Many also used the relationship between *w* and *x* to find a constant of proportionality $k = \frac{1}{6}$ although they did not always use this correctly to show $w = \frac{x}{6}$. Some candidates were able to combine the two relationships to give a formula for *y* in terms of *w*. A final answer of $y = \frac{242}{(6w+2)^2}$ is acceptable; some candidates reached this but attempted further simplification, which sometimes included errors leading to an incorrect final answer. It is preferable to use a different letter for the two constants of proportionality as candidates who used *k* for both were often confused about how the two could be combined. Candidates are advised to leave values as exact fractions such as $\frac{1}{6}$ in their working rather than writing this as a rounded decimal value such as 0.167 which leads to an inaccurate final answer.

MATHEMATICS (WITHOUT COURSEWORK)

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 four significant figures with only the final answer rounded to the appropriate level of accuracy. Candidates should show full working with their answers to ensure method marks are considered when final answers are incorrect.

General comments

Several excellent scripts were submitted with a significant number of candidates demonstrating a clear understanding of the topics examined. However, a small number of candidates struggled to access certain questions and would have better suited to taking papers 1 and 3. The standard of presentation varied considerably. For some candidates, their working exhibited a lack of organisation, was difficult to follow and often appeared untidy, making it difficult to award some method marks, especially when the answer was incorrect. Some candidates rounded or truncated intermediate values prematurely in their working, leading to inaccurate final answers and a loss of marks. There was no evidence to suggest that candidates were short of time, as most candidates attempted nearly all the later questions and any omissions were due to difficulty rather than a lack of time.

The areas that proved to be most accessible were:

- mode and median;
- simple percentages;
- substitution;
- expanding brackets;
- scale drawing;
- simultaneous equations;
- sine rule.

The more challenging areas were:

- reverse bearings;
- changing the subject of a formula;
- cosine rule to find an angle;
- finding the gradient of a curve using a derivative;
- areas and volumes of similar solids;
- upper and lower bounds;
- vector geometry.

Comments on specific questions

Question 1

(a) Almost all candidates found the sixth term. Most errors were the result of arithmetic slips.

(b) Candidates were less successful in this part of the question. The most common error, 5, resulted from candidates substituting $n = 0$ rather than $n = 1$. The answer infinity was also a common error.

Question 2

(a) Many candidates had no difficulty in quoting the mode. Incorrect answers involved attempts at calculating the mean, as well as incorrect answers such as 3 or 1.

(b) Although candidates were less successful in this part of the question, many correct responses were given. The most common error was an answer of 41. Responses such as 42, 45 and attempts at finding the mean were also seen.

(c) Many candidates successfully answered this question. Some obtained the correct fraction, sometimes cancelling it, but did not go on to convert it to a percentage. Others miscounted the number of adults with an age less than 38 years. A few rounded the answer to 38 without showing a more accurate value.

Question 3

Almost all candidates provided the correct value of G. Most errors were due to arithmetic slips.

Question 4

(a) Many candidates were able to determine the correct position of town B without any difficulty. However, there were instances where errors were observed, usually in the bearing. Some measurements incorrectly indicated the bearing as anticlockwise from the north line, while others drew it 80 degrees from the south in either direction.

(b) This proved to be more challenging, with only a small majority giving the correct reverse bearing. Common errors included incorrect answers such as 360 – 130 = 230 and, to a lesser extent, 180 – 130 = 50. Drawing a sketch may well have helped some candidates to find the correct bearing.

Question 5

(a) The most common approach involved calculating the sum of the interior angles. Candidates were generally successful in obtaining the answer of 72. However, some candidates neglected to divide the 144 by 2. Some found the exterior angle but often applied the method incorrectly, resulting in answers of 36 or 18. Other errors included using an incorrect formula for the sum of the interior angles and applying regular polygon methods to either a 5-sided or 6-sided shape.

(b) Most candidates divided 360 by the exterior angle, resulting in many correct answers. In some instances, candidates took the sum of the exterior angles to be 180, leading to a common incorrect answer of 4. Some candidates attempted to find the interior angle and then apply the formula for the sum of the interior angles. While some were successful, errors were seen either in rearranging the formula or using an incorrect formula.

Question 6

(a) The overwhelming majority of candidates gave the correct answer.

(b) Once more, the overwhelming majority of candidates gave the correct answer. Common errors included $15x^{15}$ and, less frequently, $8x^8$. Other errors usually involved incorrect evaluation of 3×5.

Question 7

(a) Most candidates recognised the transformation as a translation. Describing the movement proved more difficult, and only a small majority achieved a fully correct answer. Some candidates used a coordinate format instead of a column vector, some had the components reversed and some omitted the negative sign.

(b) This proved more challenging than **part (a)** and fully correct responses were in the minority. Many candidates recognised enlargement, and some were able to identify its centre correctly. The scale factor was more of a problem, with $\frac{1}{3}$ and -3 being common errors. A significant number of candidates gave a combination of transformations, typically enlargement and rotation, with translation sometimes included.

Question 8

Many fully correct responses were seen. Some candidates expressed the multiples of *m* as percentages while others assigned a value to *m*, such as 10 or 100. The expression 320% of $\frac{\mathrm{m}}{10}$ was more likely to be misplaced than the other three expressions.

Question 9

Many candidates were familiar with division by a mixed number and had no difficulty in identifying the equivalent calculation. Some assigned a value to *n* and evaluated one or more of the options to determine the correct equivalent calculation.

Question 10

Many candidates had a sound understanding of solving simultaneous equations, with the majority opting to add the two equations to obtain the correct value of *x*. Although most went on to find the correct value of *y*, others made errors after their substitution of $x = 10$. After reaching $20 - 5y = 45$, incorrect steps such as $15y = 45$ and $20 - y = 9$ were seen. A smaller number of candidates chose to rearrange one of the equations to isolate *x* or *y*. This less efficient method was more prone to errors.

Question 11

A small majority of candidates correctly identified all three numbers. Many of the others were able to identify two of the numbers correctly. More errors were observed in identifying the number not written in standard form. Candidates frequently forgot that, for a number in standard form, i.e. $A \times 10^n$, the coefficient *A* would satisfy the inequality $1 \leqslant A < 10$. A common error for the largest number was 9×10^{11}, which is the number with the largest coefficient.

Question 12

A majority of candidates had no difficulty in recognising that P(pink) = 1 – P(red) – P(white) and that the probabilities P(red) and P(white) could be determined from the information provided in the question. Common errors included P(red) – P(white) and P(red) × P(white).

Question 13

This question posed a greater challenge, resulting in fewer fully correct responses. Candidates who recognised that $1024 = c^5$ almost always calculated the correct value of *c*. Those who found $c = 4$ almost always proceeded to give the correct answer of $y = \frac{1}{16}$. Weaker candidates often failed to substitute the given coordinates correctly. Many began with $1024 = c^{-2}$, from which there was no possibility of recovery. A higher-than-average number of candidates made no attempt at a response.

Question 14

Successful candidates usually equated the first two expressions, solved the resulting linear equation to find x and then substituted this value to find y. Others equated the first and the third expressions, as well as the second and the third expressions to form two simultaneous equations. These were usually solved correctly. Most incorrect solutions came from attempts to equate all three expressions as the first step. With this approach, candidates were unable to eliminate one variable correctly.

Question 15

(a) Many candidates had a good understanding of exponential decrease and had no difficulty in calculating the decrease in the population at the end of 4 years. Just as many candidates calculated the population at the end of 4 years, forgetting that they needed to find the decrease. In a few instances, some candidates used a multiplier of 1.02^4. It was common for weaker candidates to calculate a 2% decrease for the first year and then multiply this by 4. A small number of candidates misread the population as 5400.

(b) Many candidates were able to resume their calculations from the previous part and determine the number of complete years required for the population to fall below 44 000. Some used year-on-year calculations, while others successfully used trial and improvement. Those using a constant annual decrease of 2% of 54 000 = 1080 also arrived at the answer of 11 years. This was not allowed, as the method used is incorrect.

Question 16

(a) Many candidates demonstrated proficiency in expanding the brackets and simplifying the resulting expression. Any errors were due to minor slips or arithmetic errors.

(b) Candidates were slightly less successful with this expansion. Errors occurred in either omitting the power from one or both of the x^2 terms, or occasionally making a sign error. A small number reached a correct answer but then incorrectly transferred it to the answer line or partially refactorised the correct answer.

Question 17

Candidates were evenly divided between those who correctly initiated the problem and subsequently provided the correct answer, and those who made an error in the initial step and failed to progress further. Once the equation $5x - tx = 7t$ was obtained, the subsequent steps were generally executed effectively, including the factorisation and division. It is possible that some candidates encountered difficulty in distinguishing between the t and + signs, which may have been influenced by their handwriting. Consequently, some candidates opted to replace the t with a different variable to alleviate confusion.

Question 18

(a) Many candidates recognised that the sine rule was required, resulting in a significant number of correct answers. However, several candidates prematurely rounded intermediate values, others made errors in rearranging the formula, others used their calculators incorrectly and some attempted to apply the sine rule solely with the angles but without the sine ratio. Other responses included attempts to use the cosine rule, some assumed a right angle and used basic trigonometric functions, and a few assumed the triangle to be isosceles.

(b) This posed a greater challenge to candidates and fully correct responses were in the minority. Those who started with the explicit form of the cosine rule were more likely to obtain the correct answer, although some made errors when using a calculator. Those who started with the implicit form of the cosine rule were generally less successful as some made errors in the rearrangement. A small number applied the cosine rule to the wrong angle. Incorrect attempts included attempts to use the sine rule and basic trigonometric methods. A higher-than-average number of candidates made no attempt at a response.

Question 19

(a) The overwhelming majority of candidates gave the correct response, with only a few giving the incorrect answer of 25.

(b) Although the number of correct responses was lower compared to the previous part, a significant number of candidates did provide correct responses. Common errors included the expansion of $3(8x – 2)$ or $8(3x – 2)$.

(c) Most candidates had no difficulty in obtaining the correct inverse function. However, common errors included leaving the answer in terms of y, incorrect signs when rearranging and reciprocal answers such as $\frac{1}{3x-2}$.

(d) Many good attempts were made to solve the equation, with most resulting in a correct answer. Candidates usually substituted the functions correctly, obtaining $3(x^2 + 1) – 2 = 364$. While many were able to solve this correctly, errors in expanding the brackets and in rearranging the equation led to incorrect answers. Errors such as $3(x^2 + 1) = 3x^2 + 1$, sign errors and $3x^2 = 363$ followed by $3x = \sqrt{363}$ were quite common. Few candidates included $–11$ as a possible answer. Weaker candidates treated $gh(x)$ as $(3x – 2)(x^2 + 1)$.

(e) Few candidates were able to interpret ff^{-1} correctly and only a small minority obtained an answer of 12. Many complicated calculations were seen, leading to answers ranging from 0 to extremely large numbers. A higher-than-average number of candidates made no attempt at a response.

Question 20

(a) Many candidates demonstrated a good understanding of differentiation, resulting in many correct responses. However, a significant number of candidates had a partial understanding. In some cases, the powers of x in the original function were reduced by 1, but some or all of the coefficients remained unchanged while others omitted the constant term of –13. A higher-than-average number of candidates made no attempt at a response.

(b) Only a minority of candidates recognised that the derivative function represents the gradient of the curve. Those who did substituted $x = 3$ into their derivative, often obtaining correct values, although occasional arithmetic errors resulted in incorrect gradients. The most common error involved substituting $x = 3$ into the equation of the curve and giving the corresponding value of y as their gradient. Other errors involved finding the gradient of a chord from (3, 15) to another point on the curve.

Question 21

This posed a significant challenge for many candidates and fully correct responses were in the minority. Those who made any significant progress used one of two equivalent approaches. The most successful approach involved calculating the two distinct hourly rates and expressing the increase as a percentage of the rate in the first week. Others attempted to calculate the percentage decrease in the time spent on a dress in the second week compared to the first. This approach proved less successful as many candidates compared the decrease with the time spent in week 1 rather than the second week, as required by this approach. Some candidates successfully reached the value of 135 but neglected to subtract 100 to find the increase. Several candidates were able to find one or both of the appropriate rates necessary for either of the two acceptable approaches but then made errors in their percentage calculations. A significant number were unable to make any progress at all.

Question 22

(a) The overwhelming majority of candidates gave the correct response. Most errors resulted from rearranging the ratios of sides incorrectly or starting with the incorrect ratios.

(b) This posed a significant challenge for many candidates and fully correct responses were in the minority. The question relied on candidates recognising that they needed to work with the area and the volume scale factors. Those who used the area scale factor to calculate the volume scale factor usually obtained the correct answer. Premature rounding of some values and arithmetic slips were the most common errors when using this method. Many others incorrectly used the area scale factor to calculate the volume, resulting in the incorrect answer of 126. Others used the area scale factor to find the length scale factor but forgot to cube this, which led to another common incorrect answer of 84. Others forgot to take the square root of the area scale factor prior to cubing it.

Question 23

(a) Most candidates were able to set out their calculations clearly and went on to obtain the correct value for the mean. Occasionally some candidates made slips, either with a midpoint or with the numeracy work. Some candidates mistakenly used the class boundaries or the class widths in an otherwise correct method. Although the total number of oranges was given in the question, some candidates preferred to sum the given frequencies. This was acceptable but in some cases candidates made an error in the addition which led to an incorrect answer. In some responses candidates gave their answer without showing all the steps in their working. These candidates risk losing all the marks if their answer is incorrect.

(b) Candidates found this challenging and fully correct responses were in the minority. Many candidates realised that the frequency for the third interval divided by 10 gave the height of the bar. This process was repeated for the remaining intervals, resulting in common incorrect answers of 3.2, 6.4 and 3. Some recognised that frequency density was required for a histogram and calculated the values for the three remaining intervals, obtaining 1.6, 6.4 and 2. Had they repeated the calculation for the third interval they would have obtained 14.8 which may have helped them realise that the heights of the bars had a scale factor of $\frac{1}{2}$ in relation to the frequency densities.

Question 24

(a) Many candidates provided correct responses when applying Pythagoras' theorem in either two separate calculations or as one complete calculation. Those who attempted a single calculation were more likely to obtain the correct length. Premature rounding was common with those working in stages. Some candidates misinterpreted the situation and applied a single 2D Pythagoras calculation, such as $13^2 - 6.4^2$ or $13^2 - 5.1^2$, resulting in 11.3 or 11.95 as their answer for *EF*. A few candidates attempted to use trigonometry, but this led nowhere.

(b) Many candidates correctly applied trigonometry, resulting in numerous correct responses. Most candidates applied the sine ratio, while other attempts used cosine and tangent. In a few instances, candidates used the cosine rule. As in the previous part, premature rounding, such as rounding $\sin^{-1}\left(\frac{6.4}{13}\right)$ to $\sin^{-1}(0.49)$, led to several incorrect final answers. A higher-than-average number of candidates made no attempt at a response.

Question 25

Results were very mixed on this question, and fully correct answers were in the minority. There were candidates who were able to correctly identify the upper and lower bound values for the length of the wire as well as the two shorter lengths and apply the correct combination to obtain the correct answer. However, a variety of errors prevented many others obtaining the correct answer. These errors included incorrectly combining correct lengths, using some incorrect lengths and incorrectly using the given figures to determine the remaining length before attempting to apply bounds to the answer.

Question 26

(a) Candidates who correctly applied the information about the parallel lines with a correct route almost always obtained a correct answer. Incorrect answers usually resulted from simplifying the fractions incorrectly rather than a misunderstanding of the vector geometry. However, many struggled to give the correct answer. One of the common reasons was an incorrect interpretation of the vectors for $\overrightarrow{BF}$ and $\overrightarrow{FC}$, often quoting $\overrightarrow{FC} = \frac{1}{4}\mathbf{p}$ instead of $\frac{1}{5}\mathbf{p}$. Many simply quoted incorrect expressions for $\overrightarrow{EF}$ and it was not always possible to link these with a correct route. Candidates would be well advised to quote their route, such as $\overrightarrow{EF} = \overrightarrow{ED} + \overrightarrow{DC} + \overrightarrow{CF}$, before replacing these in terms of the given vectors.

(b) Success in this part was dependent on recognising that triangles *GFC* and *GED* were similar, and that the ratio *FC* : *ED* would equate to the ratio *GC* : *GD*. However, many candidates did not make this link and fully correct responses were rare. Incorrect answers often involved multiples of both **m** and **p**. Many of the candidates with this form of answer did not recognise that $\overrightarrow{CG}$ had to be a multiple of **m** only. A very high proportion of candidates made no attempt at a response.