MATHEMATICS (WITHOUT COURSEWORK)

Paper 0980/12
Non-calculator (Core)

Key messages

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

General comments

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

Comments on specific questions

Question 1

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

Question 2

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

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

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

Question 3

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

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

Question 4

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

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

Question 5

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

Question 6

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

Question 7

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

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

Question 8

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

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

Question 9

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

Question 10

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

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

Question 11

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

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

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

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

Question 12

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

Question 13

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

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

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

Question 14

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

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

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

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

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

Question 15

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

Question 16

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

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

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

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

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

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

Question 17

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

Question 18

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

Question 19

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

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

Question 20

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

Question 21

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

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

Question 22

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

Question 23

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

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

Question 24

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

Question 25

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

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

MATHEMATICS (WITHOUT COURSEWORK)

Paper 0980/22
Non-calculator (Extended)

Key messages

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

General comments

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

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

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

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

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

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

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

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

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

Comments on specific questions

Question 1

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

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

Question 2

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

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

Question 3

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

Question 4

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

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

Question 5

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

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

Question 6

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

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

Question 7

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

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

Question 8

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

Question 9

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

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

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

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

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

Question 10

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

Question 11

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

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

Question 12

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

Question 13

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

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

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

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

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

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

Question 14

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

Question 15

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

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

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

Question 16

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

Question 17

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

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

Question 18

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

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

Question 19

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

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

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

Question 20

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

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

Question 21

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

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

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

Question 22

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

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

Question 23

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

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

Question 24

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

MATHEMATICS (WITHOUT COURSEWORK)

Paper 0980/32
Calculator (Core)

Key messages

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

General comments

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

Comments on specific questions

Question 1

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

Question 2

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

Question 3

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

Question 4

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

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

Question 5

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

Question 6

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

Question 7

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

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

Question 8

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

Question 9

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

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

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

Question 10

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

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

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

Question 11

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

Question 12

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

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

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

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

Question 13

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

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

Question 14

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

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

Question 15

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

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

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

Question 16

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

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

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

Question 17

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

Question 18

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

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

Question 19

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

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

Question 20

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

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

Question 21

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

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

Question 22

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

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

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

Question 23

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

Question 24

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

MATHEMATICS (WITHOUT COURSEWORK)

Paper 0980/42
Calculator (Extended)

Key messages

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

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

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

General comments

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

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

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

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

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

Comments on specific questions

Question 1

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

Question 2

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

Question 3

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

Question 4

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

Question 5

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

Question 6

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

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

Question 7

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

Question 8

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

Question 9

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

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

Question 10

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

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

Question 11

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

Question 12

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

Question 13

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

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

Question 14

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

Question 15

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

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

Question 16

(a) This question part was almost invariably correct.

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

Question 17

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

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

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

Question 18

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

Question 19

(a) This was answered very well.

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

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

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

Question 20

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

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

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

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

Question 21

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

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

Question 22

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

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

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

Question 23

Most candidates answered this question correctly and both correct factorisations were often seen. Those who did factorise correctly usually proceeded to obtain the correct answer, but occasionally spoiled their answer by cancelling the h terms in the numerator and denominator, leading to an answer of $-\frac{1}{4}$.

Candidates fared better with the denominator than they did with the numerator. A small number incorrectly factorised the denominator as $(h - 4)(h - 4)$. Incorrect numerators such as $(h + 4)(h + 1)$ or $(h + 4)(h + 4)$ were sometimes seen.

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

Question 24

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

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

Question 25

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

Question 26

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

Question 27

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