MATHEMATICS

Paper 0980/12
Paper 1 (Core)

Key messages

- Build up a vocabulary of mathematical names of shapes and terms.
- Check that responses are sensible for what is asked in the question.

General comments

Most candidates presented clear scripts with none or few questions not attempted. There were numerous standard process questions that many candidates understood well, with clear logical steps and well laid out solutions. In contrast, other candidates scattered their calculations and values randomly, making their methods difficult to follow.

The majority found questions involving trigonometry, expanding and simplifying algebraic expressions and general terms of sequences particularly challenging.

There were a significant number who did not make figures clear or worked in pencil before overwriting their working and answers.

Comments on specific questions

Question 1

Most candidates tackled this question successfully but it was surprising that nearly one fifth did not attempt it and a small number put 72 instead of seventy-two. Otherwise, the main confusion was between billions and millions while thousands for both was seen at times.

Question 2

(a) While the question was done well by most candidates, it was clear that some did not have a protractor. Cases of using the wrong scale were common with answers around 135° or reading the angle in the wrong side of 50°.

(b) Nearly all candidates could measure the line, provided they had a ruler. However, a significant number gave the answer in centimetres, 8.4, or felt they had to multiply by 10 to give 840.

(c) Again, the marking of a mid-point of the line was well done, but some did not mark a point with a line or a dot but just wrote the letter M. This made it difficult to define where they intended the point to be positioned.

(d) The majority of candidates understood the word 'perpendicular' although quite a number lacked accuracy of within 2° of 90°. Some vertical lines were seen and attempts at parallel lines showed a lack of understanding of the mathematical terms. A line bisecting the angle was seen a number of times while some lines were so short they were little more than a point making it difficult to award the mark.

Question 3

Many candidates knew that the reciprocal of 0.4 was $\frac{1}{0.4}$. However, the question asked for the value of the reciprocal and so this was not sufficient for the mark. Writing 0.4 as a fraction and inverting it led to $\frac{10}{4}$ but, if left as an improper fraction, it had to be in its lowest terms.

Question 4

This question was well done by the majority of candidates. A mark was sometimes lost by switching 8.6×10^{-1} and 86.5%. While many left the % sign off the final item this was not penalised provided all the rest was correct but candidates should be reminded that in these questions that they need to be careful to copy items fully.

Question 5

(a) A number of candidates lost a mark by drawing just 2 lines, but most did achieve the 2 marks. There were some poor-quality freehand lines and accuracy on positioning was not always carefully considered.

(b) The majority of candidates gave one of the three correct quadrilaterals, but the incorrect square was often seen.

Question 6

Some candidates showed working for the difference in temperature with 25 – (–4) or –4 –25 resulting in either acceptable answer. While the numbers were easy enough for a mental calculation a significant minority found the incorrect answer of 21 or –21.

Question 7

The majority of candidates showed understanding of this type of regularly set question. The main error was from adding $6.55 and $15.50 and then multiplying by 4.

Question 8

This question was one of the more demanding on the paper but was quite well done by many high scoring candidates, at least up to the point of finding the correct amount spent on food. A small proportion of these did read the question fully and progressed to a correct fraction. Many did find a quarter of 750 but did not know how to proceed then. Subtracting $187.50 from 437.50, leading to a fraction of $\frac{1}{3}$ was seen in many scripts.

Question 9

(a) Most candidates seem to be understanding stem-and-leaf diagrams and there was a high proportion completely correct. Only a few did not order the leaves correctly while the main error was omitting one of the entries. This was most common with the 7 for 57 where there were two items of data for that number.

(b) Those who realised that the median could be found from the middle value in the table (or between the middle two in this case) generally found the correct answer. Others went back to the original values and after a longer process some found the correct value but often errors were made. Some candidates still confuse mean and median and attempted to find the mean. Unfortunately, quite a number using the table to identify the middle of the leaf numbers gave the answer as 6, ignoring the stem value.

Question 10

The subtraction of vectors was well done with most candidates managing the subtraction of negative numbers. The second component as 14 or –14 was the main error. Fraction lines between components were seen at times even though the vectors in the question clearly show nothing between the components.

Question 11

(a) Finding the next two terms was very well done and just getting one of the two was rare.

(b) Finding the *n*th term was more demanding for a decreasing sequence. $6n$ was more often seen as part of the answer than $-6n$ while 17, the first term, was often seen as part of the solution. Starting from an un-simplified form was often seen and occasionally left for full marks. However, poor attempts to simplify that lost a mark.

Question 12

Many candidates who realised that the first two zeros were not significant figures then drew a line between the 6 and the 2 in order to check the second significant figure. Unfortunately, quite a few added zeros after the correct answer which lost the mark. 0.05 was a common wrong answer as that was 2 decimal places.

Question 13

While there were a lot of correct shadings, many shaded $A \cap B$, perhaps due to the intersection being the one most easily remembered.

Question 14

With 5 possible ways of getting a partial factorisation, one mark was very common. While some did not understand how to factorise, many did achieve the correct answer, even though this was quite involved due to 2, 5 or 10, as well as x, being factors that could be taken outside the bracket.

Question 15

While it was understandable that an incorrect response of positive was seen very often, it was clear that many candidates did not understand correlation.

Question 16

(a) While this was a very challenging question some did make a good attempt and succeeded in finding the fully correct answer. Answers in terms of π have rarely been asked at core level but are likely to become more common in a non-calculator paper from 2025. Those working out a numerical value for the given 36π often used non-exact values such as 113.1.

(b) Unfortunately, very few candidates related this part of the question to the stem giving the area as 36π. Those who did see the connection and realised that height was volume divided by area often gained the marks.

Question 17

For those understanding standard form this question was very straightforward and consequently was done well. A major misconception was to have 2 figures before the decimal point leading to 17.4×10^4.

Question 18

This trigonometry question was a straightforward example of basic bookwork so those who understood the topic generally succeeded in finding the answer from a correct use of cosine.

Question 19

The division of mixed numbers was quite well done but many lost a mark by leaving the answer as an improper fraction rather than the required mixed number. Nearly all candidates started with at least one of the mixed numbers changed to a correct improper fraction Most realised that inverting the second fraction was needed but some inverted the first one or even both. Cancelling was generally more successful than simply multiplying numerators and denominators before simplifying.

Question 20

The majority of candidates understood that they had to multiply the appropriate terms in the brackets to give four terms, two of which would combine leaving three terms in the answer. However, multiplying directed numbers caused many errors to be made, resulting in at least one mark being lost. The most common error was –28, instead of + 28 when the number term was calculated.

Question 21

A high proportion of candidates understood the rules of indices and applied them successfully.

Question 22

The question of bounds was complicated since the length, *l,* was in metres while the accuracy was in centimetres, resulting in the question being found challenging. Working in centimetres, but not reverting back to metres for the answer did gain 1 mark, as did the often seen correct values but the wrong way round.

Question 23

While there were a good number of fully correct responses, even those who seemed to understand what was required rarely scored more than 1 of the 2 marks. The most significant reason was missing the number 6 since it did not come in either of the sets but was in the universal set as defined. Some included 12 in the diagram even though ‘less than 12’ was stated in the question. Each digit should only be present in one section of the diagram but there were quite a lot of answers where numbers were in two sections.

Question 24

For a question towards the end of the paper this probability question was well answered. However, some did lose a mark by converting the probability to a decimal without sufficient figures for accuracy when multiplied by 570. Just looking at the figures in the question candidates should have realised the answer was going to be in the hundreds.

Question 25

(a) In ‘show that’ questions all steps should be made clear and when the answer is given in the question proof of the calculation performed means an answer to at least one more decimal place should be recorded. For this reason, most candidates who clearly understood how to do the question only scored 2 of the 3 marks. In applying Pythagoras’ theorem, adding the squares instead of subtracting them produced answers which defied the given one, as did answers from not squaring the sides at all.

(b) Many did not realise that the given value of 13.3 for *BD* in part (a) would lead to a basic trigonometry calculation to find the hypotenuse, *CD*. While many made the correct start with $\sin 48 = \frac{13.3}{CD}$ transforming this to a correct expression for *CD* was rare to see. Most often it was $CD = 13.3 \times \sin 48$.

MATHEMATICS

Paper 0980/22
Paper 22 (Extended)

Key messages

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

General comments

Candidates generally attempted the majority of the questions on the paper and it did not appear that time was an issue. Although there was a high level of non-response in the very last question on the paper this was a comparable amount of non-response with similar questions on previous papers when it was not the last question on the paper. Candidates showed particular success in the skills assessed in **Question 1**, **3(a)** and **11**. With the most challenging questions being **Question 19(b)**, **23(a)** and **24(b)**. Candidates could have improved their checking in certain questions. For example in **Question 4** the question asked for a fractional answer and many did not give this. In **Question 9** the question asked for a single transformation and some gave more than one transformation. In **Question 13** and **21** the question asked for all working to be shown and some was often missing.

Candidates were very good at showing their working in most questions with very few just offering an answer only, this maximised opportunities to gain method marks in questions. Candidates should be encouraged to read the instructions on the front cover of the examination paper. A number of candidates ignored the instruction to give non-exact answers to 3 significant figures or 1 decimal place for angles. Candidates should be encouraged to work with simple fractions or in their working, perhaps ensuring they can type them in to their calculator. Many candidates try to avoid working with fractions when they arise and convert them to decimals which often leads to loss of the final accuracy mark in a question.

Comments on specific questions

Question 1

It was unusual to see an incorrect answer to this question. Approximately half of the answers were –29 and most of the rest were 29. In nearly all cases, there was no working shown. The most common incorrect answer was 21 from taking the difference between 4 and 25. Some less able candidates benefited from drawing a number line to help with the calculation.

Question 2

Candidates tended to score 2 or 0 marks on this question with the majority scoring 2. The most common error was to add the fixed charge to the hourly rate before multiplying by 4 leading to the answer $88.20. Another error seen was to multiply the fixed charge by 4 and then add to the hourly rate leading to the answer $68.55. There were also some addition errors seen suggesting some candidates may not have had a calculator or were choosing to not use it.

Question 3

(a) Candidates generally understood how to complete an ordered stem and leaf diagram nearly all scored 2 or 1 marks with most scoring 2. Some candidates scored 1 mark due to recording eleven of the twelve values in their diagram with those in the final two rows having most of the errors seen. Candidates that crossed through the values in the list as they recorded them were the most successful as they were less likely to omit any. A small minority scored just 1 mark as they did not write the leaves in numerical order, this was not as common as missing a value out.

(b) This was answered correctly by about two-thirds of candidates. Some candidates used their diagram to locate the median, others re-wrote the list. Most candidates found the median by crossing off the highest and lowest values until they came to the middle. Very few used $\frac{n+1}{2}$ to find the position of the median, some wrongly used $\frac{n}{2}$ so it was common to see the 6^{th} value chosen and a common incorrect answer was 44. The candidates using the diagram were able to locate the median on the third row between the 4 and 8, but many gave their answer as 6 rather than 46, missing out the 'tens' in the stem. Those re-writing the original list tended to be more successful as they gave the 46 rather than just the 6. Not all candidates appreciated the need to use an ordered list to find the median so in a few cases the median was sought from the list in the order given in the question rather than one that was rearranged into numerical order first. A small minority found the mean of the values instead of the median.

Question 4

This question early on in the paper saw a variety of answers and approaches. The most successful candidates worked methodically starting by finding 187.50 as a quarter of 750, and then subtracting this and the 437.50 from 750 to leave $125. Approximately a fifth of candidates stopped here and scored 2 marks and did not carefully follow the instruction to give the answer as a fraction of the total amount. Just over half of candidates found the correct fraction of $\frac{1}{6}$. For those not obtaining 2 or 3 marks a few obtained 1 for calculating 750 – 187.5 = 562.5, but then did not follow up by subtracting the 437.50. Those candidates scoring 0 generally found the 187.50, but then subtracted this from 437.50 leading to a fraction of $\frac{1}{3}$. Another common error, also scoring 0, was to subtract $437.50 from $750 and then find a quarter of this amount so a common incorrect amount spent on food was found as $78.125.

Question 5

Many candidates answered this question correctly or scored at least one mark. Successful candidates often showed working of 30 minutes and 17 minutes, going up to the next hour and then adding on the 17 minutes past the hour. Many candidates did not gain the accuracy mark for the answer as they did not write the time correctly in the 24-hour clock form, with 13 5 being very common, along with 01 05 and 1 05. A common misconception was to simply subtract 1030 from 1117 to give 87 as the length of the journey, not considering that there are 60 minutes in an hour. Less able candidates continued what they considered to be a pattern and gave an answer of 12 17 or 13 17.

Question 6

Just over half of the candidates answered this correctly with the most common incorrect answer being 0.05 suggesting that many confused significant figures with decimal places. Some candidates decided to change to standard form, often correctly but sometimes giving answers with an index error. Common incorrect answers included 0.04, 46, 4.6, 4.628×10^{-2}, 4.63 and 46.28×10^{-3}. Some candidates gave answers with 4 significant figures such as 0.04600 which scored 0. Candidates are advised that trailing zeroes such as in 0.046**00** are considered significant unlike in whole numbers where the zeros are just place holders.

Question 7

This question was generally well answered by candidates with many able to shade the correct region and gain the mark. The most common errors were to shade $A \cap B$ or $A' \cap B'$. Another error seen less often was to shade $A \cup B - A \cap B$.

Question 8

In this question there was almost an even split between those scoring 0, 1 and 3. 2 marks was less commonly awarded. Most were familiar with the formula for simple interest of $I = \frac{PRT}{100}$ and about a third of candidates substituted the appropriate values into it but very often $\frac{PRT}{100}$ was equated to \$5700 rather than \$700, which usually resulted in an answer of 14.25 which scored the special case mark. A significant number of candidates attempted to find the rate for compound interest and consequently 1.65 was a very common incorrect answer that didn't score any marks. Some candidates had missing zeros or resulting in the wrong solution being obtained, for example a very common incorrect starting point was $700 = \frac{500 \times 8 \times R}{100}$ instead of $700 = \frac{5000 \times 8 \times R}{100}$. Some attempted to use the starting point $5700 = 5000\left(1 + \frac{8 \times R}{100}\right)$ but were often less successful than those using $I = \frac{PRT}{100}$ when they tried to rearrange. A few began with just dividing 700 by 8 to find the increase per year in dollars but then stopped at 87.5 forgetting to then divide this by 5000 and times by 100. A few used $I = PRT$ and forgot the 100 so 0.0175 was another common incorrect answer which scored 2 marks.

Question 9

(a) This part was generally well attempted, with most candidates correctly obtaining 1 mark for enlargement. Many scored 1 more mark for the scale factor 2, although 0 was sometimes scored as the scale factor was often $\frac{1}{2}$ or written using words such as 'double' or a ratio such as 1 : 2.

More than half of the candidates also scored the third mark however the centre of enlargement was found to be more challenging with this sometimes being missed out, or it was given as a column vector, or candidates reverses the x and y coordinates. (5, 3) was also often seen as this was the coordinate of the lower left corner in the enlarged shape. The most successful candidates joined corresponding vertices on shape A and shape B, i.e., the rays of enlargement which led to the correct centre of enlargement. A small minority did this inaccurately and gave non-integer coordinates. For those scoring 0 they generally combined an enlargement with a translation which is not a single transformation.

(b) This part was very well answered with most candidates scoring 2 marks. 1 mark was not so often seen, but generally led to shape being within 1 square either horizontally or vertically of the correct position. For those scoring 0 this was generally with a shape drawn at (6, –3) (6, –2) and (8, –3) from using the top of the column vector as the vertical translation and the bottom of the column vector as the horizontal translation. In some cases, a shape which was not congruent to the original shape was drawn.

Question 10

The correct standard form was given by the majority of candidates. Common errors were to give the power as –5 or use an incorrect form such as 174×10^3 and less commonly 17.4×10^4. Candidates should also be aware that it is incorrect to round or truncate the given digits as this does not result in an equivalent value, it was common to see the incorrect answer 1.7×10^5.

Question 11

This question was generally completed correctly for 2 marks with working shown in the majority of cases. Most candidates showed competency in finding the expected number using the relative frequency. Errors involved subtracting the sample in the survey from the total population size using 1200 or 37 in subsequent calculations. Some gave the answer as $\frac{93}{1240}$ instead of just 93. Some just gave the proportional answer of 0.075 (from a correct starting point of dividing 3 by 40 but then forgetting to multiply by 1240) or just gave 31 as the answer (from a correct starting point of dividing 1240 by 40 but then forgetting to multiply by 3.

Question 12

Most candidates identified that the angle could be found using $\cos x = \frac{8.5}{14}$. Answers were usually given to at least 3 significant figure accuracy. Some candidates tried the longer method of using Pythagoras' theorem to find the missing side and then using the sine ratio or tangent ratio instead of the simpler cosine ratio. Some made it even more complicated and applied the sine rule or the cosine rule not realising all that was required was right-angled triangle trigonometry. These methods, although often successful, also saw a few losing accuracy marks due to prematurely rounding the vertical side length to 11.1. Consequently a common incorrect answer was 52.5 or 52.58 to 52.59 if they rounded the vertical side to 11.12. A few candidates used a long route to get to the answer. They first found the height of the triangle and used it to find the area of the triangle then equated it to $0.5 \times 8.5 \times 14 \times \sin \times$. Although a valid method the number of stages used normally led to early rounding or truncating. Candidates are advised to look at how many marks are available for a question. This might give them an idea of the number of likely processes involved and therefore lead to less accuracy marks being lost. It was not uncommon for candidates to find the top angle correctly but not completing this method by then subtracting from 90.

Question 13

Almost everyone could convert the mixed numbers correctly into improper fractions although there were a small minority who treated e.g., $2\frac{1}{4}$ as $2 \times \frac{1}{4}$ instead of as a mixed number. The question asked for candidates to show all their working and some did not show sufficient working and only showed $\frac{9}{4} \div \frac{15}{8}$. Even if they reached the correct answer the maximum they could score was 1 mark. The most successful candidates inverted the $\frac{15}{8}$ and used the method $\frac{9}{4} \times$, the more able candidates cancelled before multiplying and usually $\frac{6}{5}$ was the result. About a fifth of candidates stopped here and missed the requirement in the question to give the answer as a mixed number. Some did give their answer as a mixed number but it was not always in its simplest form e.g., $1\frac{3}{15}$ was a common unsimplified answer from those who did not cancel before multiplying or who only partially cancelled before multiplying. Candidates are advised that following the calculation $\frac{9}{4} \div \frac{15}{8}$ with arrows drawn between numbers to imply multiplication is not acceptable for method. Some candidates chose to work with a common denominator i.e., $\frac{18}{8} \div \frac{15}{8}$ to reach $\frac{18}{15}$. This was a less successful method as a few of the less able candidates incorrectly wrote $\frac{18 \div 15}{8}$. Some made things more difficult by converting the fractions to the same denominator even though they still intended to multiply, e.g., $\frac{135}{60} \times \frac{32}{60} = \frac{4320}{3600}$. A few candidates spoilt a correct answer by giving a decimal answer of 1.2 as their final answer.

Question 14

This was very well answered, the majority of candidates correctly worked out the gradient and then either read the intercept off the graph, or calculated it. A common error was to find the correct gradient of $\frac{1}{2}$ and then find the negative reciprocal of that to give a gradient of –2 in their final equation, this led to one mark for the intercept if it was read off the graph, or 0 for them calculating the intercept from this incorrect gradient. A gradient of 2 was seen from dividing change in x by change in y, and again this either led to 1 or 0 as above.

Question 15

Approximately a third of candidates scored 0 marks on this question with a few more scoring 3 marks and many scoring 1. There were many routes to reaching the correct answer in this question, with the most common being to draw a north line at *C*, and find the co-interior angle of 76, identify the 60 in the equilateral triangle and then subtract both from 360. A common error candidates made was assuming that the co-interior angle of 76 to the left of the North line at *C* was in fact 104°. Another popular method was to extend the north line down at *C* and subtract 60 from the alternate angle of 104 to reach 44 and then add this to 180. The key to this question was to understand that it was an equilateral triangle and therefore the angles within it are 60. Many did not make this connection but still gained a mark for a correct relevant angle, usually the co-interior angle of 76 at *C*. Partial marks could be awarded where candidates had clearly marked a correct angle on the diagram which candidates are encouraged to do in this type of question. There were many values seen within the working which could not be awarded marks as they were not clearly identified either on the diagram or by using a letter reference of the vertices. Candidates should be encouraged to draw in north lines in a bearings question as a first step. Many candidates did not know which angle they were trying to find as the bearing of *B* from *C* and it was clear that a large proportion thought it was the bearing of *A* from *C* with 284 being a very common answer.

Question 16

(a) The correct answer of 0.2 or 1/5 was most commonly seen, with a few candidates writing their answer as a negative. Candidates are advised that -0.2 m/s^2 being negative is the value of the acceleration not the deceleration. Some candidates inverted their calculation to give an incorrect answer of 5 or –5. A small number, whilst focussed on the final triangle section of the graph, mistakenly attempted using Pythagoras' theorem to find the length of the sloping side or found the triangle's area. Also seen were candidates attempting to use various formulae not realising just a simple gradient was required.

(b) Many candidates found this question accessible, recognising the need to find the area under the graph, with fewer using the area of a trapezium than finding three separate areas (two triangles and a rectangle) to add. When attempting the trapezium formula a common error was in not using the correct top parallel side length of (240 – 30). Of those taking the second approach some candidates forgot the $\frac{1}{2}$ in their calculations for the triangles so usually gained 1 mark for the area of the rectangle. Common wrong working was to write the formula 'distance = speed × time' followed by 320 × 16 and the answer 5120 which scored 0 marks.

Question 17

Only the more able candidates scored 2 marks on this question. Most placed 3 and 2 correctly in the Venn diagram so 1 mark was commonly awarded. It was then more challenging to complete the final two values, and 8 was often used in place of 5 leading to 7 being used in place of 10 to give a total of 20 students. Another common error in an otherwise correct solution was to miss out the value 10. A minority of candidates placed several values in one or more regions of the Venn diagram. In some cases, 20 was placed in the diagram. Often an extra value was seen in the region with 2. A small minority of candidates used dots or rather than the required numbers.

Question 18

(a) Approximately two-thirds of candidates had a good understanding of this topic and there were many examples seen of accurately drawn tangents. Rulers were nearly always used, but there were some instances of very thick lines being drawn. A minority left a small gap between their attempt at a tangent and the curve. A common error was to see a vertical line drawn at $x = 3$ and/or a horizontal line at 5.2 .

(b) This question had one of the highest omission rates on the paper with just under 10 per cent offering no response. Candidates who drew a correct tangent in part **(a)** generally scored 1 or two marks in this part of the question. Some who attempted a tangent showed that they knew how to work out the gradient of a line and were able to score 1 mark. Inaccurate answers often resulted from the misreading the scale on the graph which led to answers outside of the range, or from using one of the points off the curve and not from the tangent. For greater accuracy candidates are well advised to select 2 points a good distance apart on their tangent. Often points less than 0.5 apart horizontally were chosen leading to inaccurate gradients. It was fairly common to see candidates use their vertical and horizontal lines from part **(a)** to simply read 5.2 on the graph at $x = 3$ or the vertical reading of 5.2 was divided by the horizontal reading of 3. Some candidates divided the wrong way round and instead of $\frac{\text{difference in } y-\text{coordinates}}{\text{difference in } x-\text{coordinates}}$ they found $\frac{\text{difference in } x-\text{coordinates}}{\text{difference in } y-\text{coordinates}}$. Some used inconsistent subtraction e.g., $\frac{y_2 - y_1}{x_1 - x_2}$ instead of $\frac{y_2 - y_1}{x_2 - x_1}$ leading to a negative gradient.

Question 19

(a) This part of the question was well answered, with many candidates scoring all the marks. Those who were most successful set their work out clearly and used $k = \frac{1}{3}$ rather than a decimal, then working out $y = \frac{1}{3}(7-1)^2$. Of those not scoring 3 they often scored 2 from correctly showing $y = k(x-1)^2$ or better, and then substituting their value of k into $y = k(x-1)^2$. This is was generally where k was found to be 3 leading to a very common incorrect answer of 108, or as 0.3, 0.33 which led to less accurate values than the exact answer of 12. For those scoring 0, they either did not use an equation for direct proportion, often omitting k, with 36 as a common incorrect answer, or they tried to use inverse proportion as the first step. Some used $y = 4$ and $x = 3$ as their initial substitution instead of $x = 4$ and $y = 3$.

(b) This part of the question was the most challenging on the paper for candidates. Approximately a fifth of candidates scored the mark. Many vague answers were seen such as m decreases, m is reduced without specifying divided by 3 or multiplied by $\frac{1}{3}$. Many candidates wrote divide by 9, whilst others put that m would increase by 3 or 9 times as in direct proportion. Some candidates attempted to write this using notation rather than words also scoring 0 marks.

Question 20

Approximately half of the candidates understood the requirement to cube root the volume scale factor to find the length scale factor and gave the correct answer. Some lost the final accuracy mark because they rounded $\frac{4}{3}$ to a decimal in the working but the majority either left the scale factor in cube root form or as a fraction to reach the exact answer. Some candidates were confused as to whether they should be multiplying or dividing by the scale factor depending on which way round they had done the volume division. Incorrect methods often involved using square roots or a mixture of square roots and cube roots, 3.38 was a common incorrect answer from using square roots. For candidates attempting to use a volume scale factor, it was not uncommon to see candidates using $\frac{33.75^3}{80^3}$ instead of $\sqrt[3]{\frac{33.75}{80}}$ leading to a common incorrect answer of 0.39. Some set up the initial relationship incorrectly, cubing the scale factor rather than the heights. Some stated correct method but then seemed to use their calculator incorrectly, for example finding the square root rather than the cube root. The most common error from many candidates was to use a linear scale factor, reaching the common incorrect answer of 2.19. It was rare to award 1 or 2 marks in this question.

Question 21

Stronger candidates recognised that the equations were not both linear so managed a first stage of substitution to eliminate one variable. The most successful approach was the simplest approach of replacing y with $x^2 – 18$ in the first equation reaching $4(x^2 – 18) + 3x = 13$. Very occasionally this went wrong in the expansion of $4(x^2 – 18)$ which sometimes became just $4x^2 – 18$. Occasionally $4x^2 – 72 + 3x = 13$ was rearranged incorrectly. Sometimes the resulting quadratic was left as $4x^2 + 3x = 85$ instead of equating to 0. A less successful approach, attempted by some, was to multiply the second equation by 4 then attempt to subtract the two equations, in an elimination-type method more commonly seen in linear simultaneous equations, this very often resulted in sign errors. In this approach it was also common to see $4x^2 + 3x$ simplified to $7x^2$. Some rearranged both equations to make y the subject correctly reaching $x^2 – 18 = \frac{13-3x}{4}$ but this often went wrong when multiplying through by 4, often only one of the terms on the left was multiplied by 4. A few decided to make x the subject of the first equation and substitute it into the second often correctly reaching $y = \left(\frac{13-4y}{3}\right)^2 - 18$ but this usually went wrong when they attempted to square the bracket. Similarly a correct starting point of $4y + 3\sqrt{y+18} = 13$ usually went wrong and resulted in a non-quadratic equation. The middle M1 mark was quite often missed by candidates who did not show a method to solve their quadratic. Some quoted the formula correctly and stated values of a, b and c but did not show the substitution. This was required due to the demand in the question to show all working. Using the formula was used by more candidates than factorising. Those choosing to use the formula need to take care to show its correct use, quite often the fraction line was too short or the root sign was too short. Many did factorise correctly, although candidates need to be aware that ‘factorising’ $4x^2 + 3x – 85$ to $(x + 5)\left(x - \frac{17}{4}\right)$ is not acceptable. Those with incorrect solutions to their quadratic were often able to gain a mark by showing substitutions into one of the original equations to find the values of the other variable. A common error here was forgetting brackets when squaring a negative. It was common to see $x = –5$ followed by $–5^2 – 18$ and the incorrect value of $y = –43$ instead of $y = 7$. Some candidates with a correct quadratic did not score full marks due to losing accuracy, giving 0.0625 as 0.063 or 0.06. Many starting points, usually among the less able candidates, resulted in equations that still contained terms in both x and y. About a quarter of the candidates scored 0 marks.

Question 22

(a) (i) Approximately half of candidates identified the graph correctly as a cubic graph. It was clear that some candidates were unfamiliar with the shapes of graphs with the most common incorrect answer being quadratic.

(ii) Candidates were slightly more successful with the reciprocal graph with about three-fifths answering this correctly. Exponential was often selected in this part.

(b) (i) There were some excellent smooth graphs drawn by candidates with many able to produce a sketch of a sine curve passing through the points (0, 0), (180, 0) and (360, 0) with appropriate amplitude and curvature. Some sketches did not pass through the key points but were clearly an attempt at the correct shape and scored 1 mark. A common error was the amplitude being too high, much more so than the incorrect wavelength. A small number of candidates attempted to sketch a cosine curve and less frequently a tangent curve. Many curves were made up of straight sections that were too straight for 2 marks to be given. Incorrect curvature also often meant the loss of a mark. Quite a few candidates offered no response to this question.

(ii) In this question there was a high omission rate and an almost an even split between 0, 1 and 2 marks and with a about a third of candidates scoring 3 marks. Many candidates were able to find at least one of the correct solutions having solved sin $x = -0.4$. Some truncated their solutions rather than rounding which led to one answer outside the acceptable range e.g. 203.5 and 336.5. A very common incorrect solution was 23.6 and 156.4. However, this scored the special case mark for two non-reflex angles with a sum of 180 and usually sin x = –0.4 was seen in the working to gain 2 marks in total. A common error was to give one solution as 156.4, the result of 180 – 23.6 rather than 360 – 23.6. Also seen was 383.6 arising from adding 23.6 to 360. Candidates are advised to check the required range given in the question. Some candidates solved the equation incorrectly but were able to use the correct relationship between their two solutions to gain the special case mark. The most successful candidates used their sine curve drawn in part **(b)(i)**, some attempted a 'CAST' diagram (a sketch showing four quadrants of a graph labelled C, A, S, T representing cosine positive, all positive, sine positive, tangent positive) with varying degrees of success, the more able understood this type of diagram the less able did not and are advised to use the diagram found in part **(b)(i)**.

Question 23

(a) This was one of the most challenging questions on the paper. Whilst most candidates attempted a solution to this question about a quarter got the correct answer. The candidates that were most successful understood set notation and used shading to identify the regions specified in the question. These candidates could then find (EUF)' = 9 and were then able to complete the question by adding the rest of the elements of S. There were a variety of incorrect answers, 4, 9 and 10 being the most common.

(b) This question was also challenging for many but answered better than part **(a)** with just over half of the candidates scoring 2 marks. Many candidates were able to identify the regions on the diagram showing students that studied Spanish and one other language reaching the 2 and 3. The most common wrong methods seen were then to multiply $\frac{2}{10}$ and $\frac{3}{10}$ rather than adding them or working with a denominator of 30 i.e., the whole class, so an answer of $\frac{1}{6}$ coming from $\frac{2+3}{30}$ was common. Others had a numerator of 6 from all those studying Spanish and one or two other languages instead of Spanish and one other language. Some made both of these errors with another common incorrect answer of $\frac{1}{5}$ coming from $\frac{2+1+3}{30}$.

Question 24

(a) There were many good attempts at the first part of the final question on this paper with just under half of the candidates scoring 2 marks. Many gained one mark, usually for giving $\frac{1}{2}$ **b** + $\frac{2}{3}$ **a**, suggesting that they did not appreciate that vectors have a magnitude and a direction. Some candidates took the longer route of *MP* + *PO* +*OR* + *RN* which is equivalent to the more direct route *MQ* + *QN* but also highlighted the disregard of direction with answers involving $\frac{3}{2}$ **b**. Candidates should be careful with notation involving negative numbers as some who were possibly trying to show the multiplication **a**(– $\frac{2}{3}$) often omitted the brackets to give **a** – $\frac{2}{3}$ which could not score any marks as the result is not a vector. Candidates are also advised that the question asked for the simplest form and it was common to see final answers in a form such as $\frac{1}{2}\mathbf{b} + \left(-\frac{2}{3}\mathbf{a}\right)$ which is not the simplest form. It was also common to see $\overrightarrow{NM}$ given instead of $\overrightarrow{MN}$ as $\frac{2}{3}\mathbf{a} - \frac{1}{2}\mathbf{b}$ was one of the most common incorrect answers scoring 0. Some responses had a numerical answer rather than an algebraic one. There was quite a high rate of candidates offering no response to this question.

(b) This was less well attempted by most. The most able candidates were able to give the correct answer and over a fifth of candidates offered no response to this question. Candidates should be encouraged to show clear working in this type of question. Those who gave a correct route scored a mark even if they did not get the vector notation correct. Linking the parts of the route to the vectors also gained some candidates marks, for example stating that $\overrightarrow{RS} = \frac{1}{4}\mathbf{b}$ within the working was worth 2 marks even if the candidate did not know what a position vector was. Those who did not link $\frac{1}{4}\mathbf{b}$ with $\overrightarrow{RS}$ could not be awarded the marks and it should be emphasised that writing it on the diagram with no direction is also not sufficient. Those who showed a clear route linking the parts of the route to correct vectors scored method marks even if the final answer or parts of the route were incorrect. The key to answering this question was the use of similar triangles which many understood but made the error of using a scale factor of 3 or $\frac{1}{3}$ rather than 2 or $\frac{1}{2}$. This resulted in a large number of candidates thinking that $\overrightarrow{RS} = \frac{1}{3}\mathbf{b}$ or that $\overrightarrow{NS} = \frac{1}{3}\overrightarrow{MN}$. Some divided correct expressions for $\overrightarrow{RS}$, $\overrightarrow{MS}$ or $\overrightarrow{NS}$ by an algebraic term rather than a numerical scale factor. Less able candidates did not understand the term position vector and many seemed to think that it was $\overrightarrow{MS}$, perhaps because they had been asked to find $\overrightarrow{MN}$ in part **(a)**. Many candidates did not appreciate that $\overrightarrow{OS}$ should be a multiple of **b** as it was a straight line, giving their answer in terms of both **a** and **b**.

MATHEMATICS

Paper 0980/32
Paper 3 (Core)

Key messages

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

General comments

This paper gave all candidates an opportunity to demonstrate their knowledge and application of Mathematics. The paper was quite demanding although most candidates completed the paper making an attempt at most questions. The standard of presentation and amount of working shown continued to improve and was generally good. Candidates should realise that in a multi-level problem solving question the working needs to be clearly and comprehensively set out particularly when done in stages. Centres should also continue to encourage candidates to show formulae used, substitutions made, and calculations performed. Attention should be made to the degree of accuracy required, particularly in those questions involving money. Candidates should be encouraged to avoid premature rounding in workings as this often leads to an inaccurate answer and the loss of the accuracy mark. Candidates should also be encouraged to read questions again to ensure the answers they give are in the required format and answer the question set. Candidates should also be reminded to write digits clearly and distinctly and to use correct time notation for answers involving time or a time interval.

Comments on specific questions

Question 1

(a) (i) Most candidates answered this question correctly. The common error was 63.

(ii) Most candidates answered this question correctly.

(iii) Most candidates answered this question correctly. Common errors included 49 and 63.

(b) (i) Most candidates answered this question correctly. Common errors included 41.56 and $24\sqrt{3}$, both coming from the square root.

(ii) Most candidates answered this question correctly. Common errors included 16, 64 and 10 coming from 2×5.

(iii) Most candidates answered this question correctly. Common errors included 0 and 5.

(iv) This part was reasonably well answered. Common errors included 36.5 and 18 coming from $36 \times \frac{1}{2}$.

(c) Many correctly placed the pair of brackets, some incorrectly included the minus sign to the left of 6. Some responses added more than one pair of brackets, few showed any evidence of working to check their answer. A relatively high number of candidates did not attempt this part.

(d) If not scoring full marks, most gained a method mark for a correct factor tree or table, or for listing at least the first 3 multiples of both 30 and 68. A significant number of responses set out their table of prime factors comparing the numbers side by side rather than using separate tables for 30 and

68. For some candidates this approach caused arithmetic errors or confusion of which prime factors to pick. Prime factor trees were almost always completed successfully. The most common incorrect answers were 2040 from simply multiplying 30 × 68, 2 which was the HCF and 510.

Question 2

(a) (i) This question was answered correctly by most of the candidates. Some left their answer as $-1a + 3a$ without simplifying further. The most common error was an answer of $-4a$ from subtracting last two terms.

(ii) Most candidates gained partial credit simplifying the algebraic expression of $2x^2$ but some did not combine fully leaving $-6x - x$ in their final answer. Others worked out $-6x - x$ as $-5x$. A few did not appreciate that x^2 and x are different variables and tried to combine them. Some went on to introduce a bracket usually with a factor of x outside. Some found dealing with the squared terms difficult and added powers resulting in $2x^4$.

(b) The incorrect answer of 24 was more common than the correct answer of 74. This arose from wrongly calculating $(-5)^2$ as - (5^2). Those that showed their working generally gained a method mark for 49 whilst those showing no working mostly scored 0.

(c) (i) There were a significant number of candidates who knew how to deal with 35m once it was isolated, but the common error was to incorrectly deal with the first step. Instead of subtracting 20 from T, candidates stated 35m = T + 20 or 35m = –T + 20. Some candidates who gave a correct first step lost full credit by writing the final answer as m = T – 20 – 35 or m = $\frac{T}{35}$ – 20. A small number of candidates gave a numerical value as the final answer, commonly 15.

(ii) Those who gave a correct rearrangement in part **(i)** were often successful in getting to the answer of 1.8 here. A significant number of candidates returned to the original formula substituting T = 83, but then some did the same wrong first step of 83 = m + 20 or 83 + 20 = 35 m. A few gained marks for using their incorrect formula. Candidates not scoring in this part either did not have a suitable formula to follow through from in **part (i)** or ignored the previous answer entirely. A small number of candidates were unable to attempt this part.

(d) The vast majority started the question correctly by multiplying one or both equations to equalise coefficients and then use the elimination method, and many showed full and clear working for this. However, many struggled to add (or subtract) their two equations consistently and so were unable to gain the method mark and therefore the answer marks. A large number of these nevertheless gained a special case mark for substituting their value for the first variable into one of the equations to gain a pair of values that satisfied one equation. There were however some who did not achieve this, as they made mistakes with signs when manipulating the chosen equation in order to solve it. A small number of candidates were unable to attempt this part.

Question 3

(a) The vast majority gained this mark, with a correct spelling or close misspelling of the answer, though some answered trapezoid which is not an acceptable answer. The most common wrong answer was rhombus and some just put quadrilateral. A few other shapes and mathematical terms were seen including parallelogram and pentagon.

(b) (i) Many gained this mark, though the answers 7, 8 and 9 were also common and some answers were wildly inaccurate with some unrealistically large areas including 28.8, 36, 40.5 and 57.6. Many estimated part squares rather than using a triangle so were not exact. Area and perimeter were sometimes reversed.

(ii) Those that gave the perimeter in **part (i)** attempted the area here. A good number answered this within the allowed range however the answer 12 was seen often and others appeared to only measure one side. A small number of candidates did not attempt this part.

(c) (i) This transformation part of the paper was answered very well by some candidates. However, it was a topic where a significant number found difficulty in scoring high marks. Many identified this part as a translation though translocation, transition and transformation were common incorrect attempts along with those who chose an incorrect type of transformation. Vectors were commonly seen, often correct but some lost marks by using coordinates or a fraction line in their vector and others reversed either numbers or signs. A small number of candidates gave a double transformation.

(ii) This part proved challenging and although a good number were able to identify the given transformation as a reflection, the incorrect transformation rotation was common. The identification of the line of reflection proved more challenging with common errors including, –3, y – 3, –3 on the y–axis, y–axis = –3 and x = –3. A small number of candidates added a translation.

(iii) The majority identified a rotation though some added a translation and therefore scored 0. The angle of rotation was quite often correct if present, however, the direction was sometimes missed. A few stated 270 with or without anticlockwise. The identification of the centre of rotation proved more challenging with a significant number omitting this part. Errors included (0, 2), (–2, –4) and (3, 1).

(d) The majority of candidates were able to draw the shape with the scale factor 2 but using the centre of enlargement proved more challenging. Few used rays to help position the enlargement. Those that did were mostly successful whilst others positioned their shape around or touching the given centre of (–3, –3). A small number drew the shape with a scale factor –2. There were a significant number of candidates who did not attempt this part.

Question 4

(a) (i) This part was generally reasonably well answered, though a small but significant number did not appreciate the numbers and information given. Common errors included 3 and 6 reversed, 5 and 4, 16 and 10.

(ii) This part on using the table and completing the bar chart was generally very well answered with a good number of candidates scoring full marks, particularly with a follow-through allowed. Common errors included errors in reading the scale, inaccurate heights, inconsistent gaps and widths of the bars.

(iii) This part on finding the mode was generally answered very well. Common errors included 15, giving the median, the largest number, and calculating the mean value.

(iv) This part on finding the mean from a grouped frequency table caused more problems although some excellent answers with full working were seen. Common method errors included 50 ÷ 6, 108 ÷ 6 , 15 ÷ 6, finding the median and stating the range.

(b) (i) This part on completing the table was reasonably well answered with a good number finding the required angles of 171, 126 and 63. Common errors included the percentage values of 47.5, 35 and 17.5, and a variety of incorrect angles.

(ii) This part on completing the pie chart was generally well answered with a good number drawing their angles accurately. Common errors included inaccurate drawings, and incorrectly drawing an angle of 189°.

(iii) This part was generally well answered, with the majority of candidates correctly starting from 28/80 and a smaller number from 126/360.

Question 5

(a) (i) This part was generally answered very well, although a small number of errors such as acute, reflex, and very occasionally names of quadrilaterals, triangles or polygons were seen.

(ii) This part was mostly found more difficult with few candidates able to give the correct geometric reason of alternate angles. Although a number of candidates recognised that the parallel lines were important, many just referred to reasons of parallel, opposite or corresponding.

(b) The value of angle *y* as 52 was generally correctly worked out. The correct geometrical reason was less successfully stated. A small number just gave the numerical working out.

(c) (i) This part was generally answered well, although the common errors included chord, straight line, and circumference.

(ii) This part was generally poorly answered. Common errors included 180 – 74 = 106, 180 – 74 – 74 = 32 and 90 ÷ 2 = 45.

(iii) A small number were able to score the mark on follow-through basis. The correct geometrical reason was rarely correctly stated. Common errors included 'angle in a semi-circle is 90', 'alternate angles', 'corresponding angles' and 'half of 90'. Again, a small number just gave the numerical working out.

(d) This part proved demanding for many candidates though a number of fully correct answers were seen. The most commonly used method was to find the interior angle directly by using the formula. The most successful method however was to find the exterior angle first. Common errors included 2340, 24, and a variety of incorrect answers arising from incomplete or incorrect formulas.

Question 6

(a) (i) The table was generally completed very well with the majority of candidates giving 5 correct values. The common error was in substituting $x = 1$ into the given quadratic, usually resulting in a y value of 10.

(ii) Many curves were very well drawn with very little feathering or double lines seen. A few joined up some or all of their points with straight lines.

(iii) Identifying the equation of the line of symmetry was not generally well answered. Common errors included $y = 4$, $x + y = 4$, $y = \mathrm{m}x + \mathrm{c}$. 4 and (4, 17).

(b) (i) This part proved difficult and demanding for many candidates and proved to be a good discriminator, though a small number of fully correct lines were seen, and a number of lines were drawn passing through the point (2, 7) but with an incorrect gradient.

(ii) Writing down the equation of the line of this line was not generally well answered. Stating the correct gradient was more successful than stating the correct intercept.

(iii) This part on using the graph to solve the given equation was generally poorly answered with a significant number of candidates not appreciating how to read the required values off accurately from their curve. Common errors included misreading of the scale, inaccurate readings and incorrect values such as 8 and 1 from attempting to use the given equation. A small number were unable to attempt this part. A small yet significant number of candidates tried to solve the equation algebraically.

Question 7

(a) The majority of candidates did not score marks in this part. Most took the area 4620 to be the total area of the land rather than the area of the park and so divided it by 16 parts instead of 11. Another common error was to divide 4620 by the ratio parts 2 and by 3 as given in the question.

(b) (i) The majority of candidates knew how to find a percentage, but many did not show sufficient working in their calculations to gain the mark. Many candidates showed a complete method either by finding 18% and subtracting this from the total or by finding 82% directly. In their working, candidates were required to write 0.18 or 18/100 and not just 18% or alternately 0.82 or 82/100 and not just 82%.

Some candidates used the answer 3788.4 in a reverse method which did not score.

(ii) Candidates found this part difficult, and a minority found the correct answer. A common error was to misinterpret the question and use the park area of 4620 m^2 rather than the grassland 3788.4 m^2

Many started with the correct division 3788.4 ÷ 280 = 13.53 but did not round up to 14 bags, ignoring the fact that in reality you could not buy 13.53 bags of seed so would need to round up in the context of this question. Many of these candidates continued with a correct method using 13, 13.5 or 13.53 bags and were awarded partial marks.

A common error was made by those who only added 72 and not 5×72 resulting in the answer 584.

(c) The large majority recognised the question required the method to find compound interest and many candidates gave the correct answer rounded to the nearest dollar as requested. Many others gave the exact answer and were not awarded the final mark for rounding appropriately. Having found the correct answer some spoilt their method by subtracting or adding the principal amount from it, while some used the method for simple interest.

(d) Those candidates who chose to calculate the number of millilitres per dollar or the cost per millilitre for each of the three bottles usually gave accurate answers and chose the correct bottle giving the best value for money. Some misinterpreted their answers and chose C rather than A. Those who found the cost of 750 ml for each bottle were usually awarded full marks also.

Question 8

(a) (i) A large majority of candidates showed the correct calculation 5.5 – 3.6 and were awarded the mark. Candidates must not use a reverse method involving 1.9. The most frequent incorrect method was 3.6 – 1.7.

(ii) A very large majority gave the correct answer.

(b) Although stronger candidates were successful, this part on finding the area of the compound shape was found quite difficult and demanding by many and most only scored partial marks at best for a correct partial area. Common errors were adding all the given side lengths or multiplying them all, forgetting to multiply by half when finding the triangular area and only finding the area of the large rectangle 4.7 by 5.5. Another common error was to treat the whole shape as a trapezium $\frac{1}{2} \times (3.6 + 5.5) \times 4.7$.

(c) A lot of confusion was seen in this part with both the calculation for volume and with the units, and a significant minority did not attempt the question. Incorrect calculations were seen several times including $\frac{1}{2} \times 1.2 \times 2.3$, $1.2^2 \times 2.3$, division of 1.2 and 2.3 in either order and some attempts resembling a calculation for surface area. The units were often given incorrectly as cm^2, cm^3 or m^2.

(d) A very large majority of candidates gave the correct answer. A few incorrect methods, $275 \div 1.64$, were seen.

(e) The majority used the formula for the area of a circle, but many only scored a partial mark because they forgot to find half of $\pi \times 2.3^2$ since the shape was a semicircle. It was common for candidates to write their answer with 2 significant figures, 8.3, rather than the 3 figures required and again this could gain partial credit but only if the method was shown. Some incorrect formulas such as $2\pi r$ and $2\pi r^2$ were used.

Question 9

(a) Although some correct answers were seen, the majority were not able to convert 420 metres per minute to kilometres per hour. Many ignored the time aspect and just converted 420 m to km or made an incorrect attempt to do this, by dividing 420 by 100 or multiplying by 1000. Others divided their figures 420 by 60 rather than multiply by 60 to convert minutes to hours. Consequently, common incorrect answers were 0.42, 4.2, 7, or other answers with these digits.

(b) Some correct answers were seen but the majority only scored partial marks at best. Finding the correct interval of time from 11 55 to 14 41 proved too difficult for many candidates. Those who did manage to find the interval 2 hr 46 often forgot to subtract the rest period of 25 minutes. Many used incorrect notation such as 2 hr 21 mins written as 2.21, resulting in an incorrect final answer.

MATHEMATICS

Paper 0580/42
Paper 4 (Extended)

Key messages

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

General comments

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

Candidates performed well where questions were directly assessing a clearly identifiable area of the syllabus. Candidates found questions to be more challenging when they needed to identify the mathematics required or combine several topic areas.

In questions requiring candidates to show a result they need to show the individual steps of their working in a coherent order leading to the result they are being asked to show. Most candidates were unable to show a clear route to the result required in **Questions 5(e)** and **9(b)**.

Some candidates rounded or truncated values prematurely in their working, leading to inaccurate final answers and the loss of method marks. This was particularly common in questions involving trigonometric ratios and Pythagoras' theorem. Where answers are exact integer or decimal values, candidates should give this value as their answer rather than rounding to 3 significant figures unless the context of the question requires a rounded value.

There was an error on the question paper in **Question 11(b)(i)** where the coordinate (–2, 2) had an incorrect y – value for the function $y = 2x^3 - 6x + 8$. The coordinate should have been (–2, 4) and this has been corrected on the published version of the paper. This error had no impact on candidates as only the value $x = -2$ was needed to answer the question.

Comments on specific questions

Question 1

(a) This was generally answered well with most candidates correctly converting 1.5 litres to 1500 ml and then simplifying to the ratio 10:3. Some gave a final answer with decimals which did not earn the final mark as the ratio when simplified should have only integers.

(b) This was answered reasonably well with many candidates giving the correct three values. Errors, where they occurred were either with conversion of 1 litre to millilitres or because candidates attempted to share a quantity other than 1 litre, for example 1.5 litres or 1950 millilitres.

(c) Candidates answered this part well. Infrequent errors included correctly calculating the increase 0.48 but then subtracting it from \$3.20 or candidates treating the question as a reverse percentage problem giving an answer of \$2.78.

(d) Most candidates showed a good understanding of exponential growth and gave the correct answer. A small number attempted a year-by-year calculation but often did reach the correct answer either as a result of doing fewer or more than 5 steps or by prematurely approximation within the step by step calculation. The most common error was to treat the growth as 5 × 2.5 per cent.

(e) A number of candidates gave a correct answer. Many found this lower bound question to be challenging and did not select the correct combination of bounds for the subtraction to give the lower bound of the distance. Almost all candidates gained partial credit by showing one of the four correct bounds involved in the question. A small number did not consider bounds and gave the answer 4.5 from the lengths given in the question, 23 – 18.5.

Question 2

(a) This part involving angles in parallel lines was very well answered. Almost all candidates were able to use angles on a straight line to find angle a = 142° and alternate angles to find angle b = 142°. When an error was seen it was to state that angle a and/or angle b were equal to 38° even though the diagram showed that both were obtuse angles.

(b) This part was also answered very well. There were different approaches with some candidates divided 360 by 12 to find the exterior angle first before subtracting from 180 while others used the formula for the interior angle sum and then divided by 12. The latter approach led to the more errors as some gave the interior angle sum incorrectly, for example, (n – 1) × 180. Partial credit was given to those that showed the correct method to find the angle sum of the interior angles or the correct method to find an exterior angle.

(c) Many candidates were able to use the relevant circle theorems correctly to find angle f = 56° and angle g = 34°. Candidates who recognised the alternate segment theorem were able to find angle f first before using the angle at the centre is twice the angle at the circumference together with the angle sum in an isosceles triangle to find angle g. Many other candidates began by using tangent meets radius at 90° and the isosceles triangle to find angle g first and then angle sum of a triangle and angle at the circumference is half the angle at the centre to find angle f. Those making errors included the incorrect use of the alternate segment theorem or using alternate angles to state angle g = 56°, as well as numerical errors in otherwise correct methods.

(d) Most candidates answered this part well. Other candidates that clearly stated that the angle of 129 was opposite to angle k or indicated this c on the diagram gained partial credit. Common errors included answers of 129° or 64.5°.

Question 3

(a) (i) Most candidates were very confident with this topic and gave a correct answer supported by working. A small number incorrectly multiplied the class widths by the frequencies, and some multiplied either ends of each interval by the frequencies. Only a very small number of candidates added the midpoints together.

(ii) The majority of candidates drew a correct histogram. Some attempted freehand drawings and this sometimes led to inaccuracy with the heights of some bars. Candidates are advised to use a ruler when drawing histograms. Some made errors when attempting to calculate the frequency densities, for example dividing the frequency by the total frequency or by the corresponding midpoints.

(iii) Many candidates found this probability question challenging although there were a considerable number scoring either 2 or 3 marks. The most common misunderstanding was not to appreciate that the two candidates could be chosen in either order. The other common error was to not to treat the choices as dependent events i.e., $\frac{19}{40}\times\frac{3}{39}$ not $\frac{19}{40}\times\frac{3}{40}$. A few candidates added the two probabilities instead of finding the product.

(b) (i) This was answered well by the majority of candidates. The most common error was to give an answer of 8 which was the lower quartile.

(ii) Most candidates drew a correct box-and-whisker plot Some gave gave the lower quartile as the lowest value, others drew more than one line in their 'box' and so gave a choice for the median value. Some boxed the entire plot and had no 'whiskers'. A very small number were unfamiliar with the term 'box and whisker plot'.

(iii) A comprehensive reason was required in this part that stated the median was 22 and that made a correct reference to 100 or 101. A minority of candidates were able to give both of these elements in their answer with the majority making reference to one of the elements only.

Question 4

(a) (i) Many candidates were able to find the area of the semi-circular cross section. Some candidates then omitted to multiply by 100 to find the volume or did not convert 1 m to cm to achieve consistent units. Incorrect conversion of units was also an issue for some.

Some candidates having found a correct volume omitted the final step of rounding to the nearest 10 cm^3. Another common error was to use the area of a circle instead of the area of a semi-circle as the cross-sectional area.

(ii) This was the most challenging question on the paper. The lack of structure meant that candidates had to devise their own strategy to solve the problem. A very common misunderstanding was to deduce that as the level of the water below the top of the tank was half of the radius then the volume of the water was also half of the volume of the half cylinder.

If we consider the centre of the circle *O* and the ends of the chord *A* and *B*, candidates who created triangle AOB were often able to gain some credit for their approach. Some candidates used Pythagoras theorem to find $\frac{1}{2}AB$ and went on to find the area of triangle *AOB*. Further credit could be gained by using trigonometry to calculate angle *AOB* or another relevant angle to then find the area of sector *AOB* or another relevant sector. Some candidates made an assumption about the angle and values such as 90° and 45° were given no credit when finding a relevant sector area. Some candidates found the area of sector *AOB* and subtracted the area of triangle *AOB* to find the shaded area whilst others added the area of the two smaller unshaded sectors to the area of triangle *AOB* before subtracting this total from the area of the semi-circle. In both approaches it was necessary to set work out clearly. Confusion over whether the working was for the whole of triangle *AOB* or sector *AOB*, or for the smaller sectors or right-angled triangles, often led to inconsistent doubling or halving of values. Most candidates were unable to start to build a structured approach to the problem.

(b) Most found this part challenging. Candidates who understood Archimedes principle were able to calculate the volume of the stone 42 × 35 × 0.2 and then use the given formula to find the mass of the stone from the density and volume. However, the most common approach was to assign a value *d* to the depth and calculate the volume using 42 × 35 × *d* and then subtracting 0.2 from their *d* and calculating a new volume, before subtracting to find the volume of the stone. This approach was sometimes successful but the error of subtracting 0.2 from 42 or from 35 instead of from their value for *d* was common. The most common error was to use the area 42 × 35 instead of a volume in the formula mass = density × volume and calculate mass = 42 × 35 × 2.2, or for some calculate 2.2 × 0.2.

(c) Candidates appeared very well prepared for this part which was answered very well. Candidates used Pythagoras' theorem to find *AC* and/or *AG* and then almost always used a correct trig ratio to find angle *CAG*. The most common error for some candidates was to premature round a value before the final trig calculation for the angle, for example some gave an answer of 46.2 from rounding $\sqrt{208}$ to 14.4 and then used this within their method.

Question 5

(a) This was well answered. Almost all candidates scored at least 1 mark for a correct element in the answer. The common error was in applying the index $\frac{3}{2}$ to one of the elements 25 or x^6, for example as answer of $25x^9$ was given by some.

Some treated the index as a 'multiplier' and multiplied 25 by 1.5 rather leading $37.5x^9$.

(b) Many gave the correct answer for the nth term. Some others were familiar with the form of the expression needed for an exponential sequence and gained partial credit by giving an expression of the form 6^n.

The answer was most often written as $\frac{1}{6} \times 6^{n-1}$ and any correct equivalent to this was given full credit. A small number of candidates were able to give a correct expression in working but then simplified it incorrectly, for example $\frac{1}{6} \times 6^{n-1} = 1^{n-1}$. The most common misconception was to treat the sequence as an arithmetic progression and to give an answer of the form $6n$.

(c) Candidates were very well prepared for this part and there were many fully correct answers. Common errors included transcription errors of terms from line to line in working, as well as slips when multiplying and collecting negative terms. Some after multiplying a correct pair of brackets then omitted essential brackets when multiplying by the third bracket.

(d)(i) A number successfully manipulated the given expression to the required answer showing all working steps and no omissions. There were a number of approaches used.

Some attempted to simplify like terms before dealing with the fraction, others attempted to work with the left-hand side of the equation before removing the fraction. Both approaches were often successful but sign errors and omission of essential brackets were often seen.

Some attempted to remove the fraction but did not multiply all terms in the equation by $(x - 2)$.

Some did not keep an equation within their working and worked in isolation with expressions and so omitted the key element required in this type of question and although partial marks were awarded, the omission prevented full marks.

(ii) The majority of candidates were able to factorise the quadratic equation correctly and then write down the two solutions. Some did not follow the demand in the question and used the quadratic formula and could then only score one mark for correct solutions.

(e) As this was a 'show that', candidates were required to construct expressions in terms of x and y, for the total surface area of the cylinder and the total surface area of the hemisphere before forming an equation. A small number were able this concisely and successfully. The most common error was to exclude the flat circular surface area for the hemisphere and to give $\frac{4\pi(5y)^2}{2}$. A number of candidates also omitted essential brackets when substituting $5y$ for the radius. For the cylinder, some considered the curved surface area only.

The majority found forming the expressions for both surface areas challenging and were able to make only limited progress.

Question 6

(a) The majority of candidates recognised this as a cosine rule problem and many were able to demonstrate the method correctly. Candidates then needed to give an answer to sufficient accuracy e.g. 9.546… to demonstrate that this would round to 9.55 correct to 2 decimal places to score full marks. There were a large number that gave the answer 9.55 without greater accuracy.

(b)(i) This was very well answered. A few gave an incorrect statement such as 180 – 26 + 42 = 112.

(ii) The majority of candidates answered this very well. Almost all recognised it as a sine rule problem and were able to show the substitution and rearrangement of the sine rule leading to the answer. There were a number of candidates that gave an answer of 6.9 instead of to at least 3 significant figures. Candidates should note that Examiners will not imply method marks for values given to 2 significant figures unless the method is written down leading to those figures.

(c) Many were successful in this part**.** Most candidates understood that the shortest distance is the length of the perpendicular from point *D* to line *AB***.**

Some candidates lost accuracy within a correct method by prematurely rounding the value of sin64 or by giving their answer correct to only 2 significant figures.

A small number used an incorrect trigonometry ratio to find the length.

The most common method error was to assume incorrectly that the perpendicular would bisect side *AB*.

Question 7

(a) Most candidates solved the equation correctly. A small number of candidates rearranged correctly to $7x = 14$ and then gave the answer $x = 7$.

(b) Most candidates factorised the expression correctly. Some gave a partially factorised answer, either $5(2a^2 + a)$ or $a(10a + 5)$. A small number of candidates made an error in one of the terms in the bracket such as $5a(5a + 1)$ which gained no credit.

(c) Few candidates identified this expression as the difference of two squares. It was more common for candidates to expand the first bracket and simplify the result. This led to the result $4x^2 – 12x$ which was often given as the answer rather than factorising to give $4x(x – 3)$ as required. Errors in the first expansion were also seen, for example $2x^2 - 12x + 9$, $4x^2 - 12x - 9$ and $4x^2 - 6x + 6x + 9$. Those candidates who used the difference of two squares usually started correctly with $(2x - 3 + 3)(2x - 3 - 3)$ but some gave the answer $2x(2x - 6)$ rather than factorising fully as required.

(d)(i) Candidates usually gave the correct fraction as their answer. Some evaluated the result correctly but gave a decimal answer with fewer than 3 significant figures.

(ii) This part was usually answered correctly, although some candidates rounded the correct answer of 19683 to 3 significant figures. A small number of candidates showed either 3^{3^x} or 3^9 without reaching the correct answer. The most common errors were $3\left(3^2\right) = 27$, $3^2 \times 3^2 = 9$ and $3^{3\times 2} = 729$.

(iii) Many candidates correctly evaluated f(7) and wrote $3^k = \frac{1}{27}$ but they were not always able to use this to find $k = –3$. Answers of $k = 3$ and $k = \frac{1}{3}$ were also common. Some candidates evaluated f(7) but did not equate this with 3^k.

Question 8

(a) Many candidates stated the three correct inequalities. In some cases, candidates used $\leqslant$ in place of < or reversed the inequalities. Some candidates were unable to form the equation $x + y = 24$ required for the final inequality, with $xy \leqslant 24$ as a common error.

(b) Some candidates drew all four required lines accurately and identified the correct region. Many candidates were unable to distinguish between strict and inclusive inequalities. Strict inequalities, such as $y < 10$, should use broken lines and inclusive inequalities, such as $x \leqslant 16$, should use solid lines. Most candidates drew the lines $x = 16$ and $y = 10$ but some made errors in drawing one or both of $y = x$ and $x + y = 24$. Some candidates omitted one of the lines, often $x = 16$. Even when all four lines had been drawn correctly, some candidates were unable to identify the correct region, with many satisfying just three of the four inequalities. Some candidates who had made errors when drawing lines gained credit for identifying a region that satisfied three of the correct inequalities.

(c) Most candidates identified that the largest amount would be found by substituting values for x and y into $8x + 12y$. Many identified a point on the border of their region and substituted correctly into this expression to gain the method mark. Candidates who had identified the correct region rarely reached the correct answer of 228 as they used the point (14, 10) which does not satisfy the inequality $y < 10$. Some candidates used points from outside their region and gained no credit. Some candidates with an incorrect diagram found the correct answer by using the information given at the start of the question to identify the required values as 9 large cakes and 15 small cakes.

Question 9

(a) Some candidates were able to find a correct expression for the perimeter of the shape and identify the values of a and b. It was common for this expression to be evaluated as 42.3 rather than leaving the arc lengths in terms of π and candidates were then unable to find the required values. Some attempted to subtract multiples of π from 42.3 to give values of a and b. The most common error was to either subtract the two arc lengths or to subtract the perimeter of the small sector from the perimeter of the large sector. Some candidates found sector areas rather than arc lengths.

(b) (i) Most candidates found this part very challenging and were unable to make any meaningful attempt at the question. Many attempted some calculation with 127.3 and 6 sides without finding any angles. Some candidates identified the interior angle of the hexagon as 120° or divided into equilateral triangles and identified the 60° angle but made no further progress. The most successful solutions resulted from equating the area of one equilateral triangle with 127.3 ÷ 6, although some showed insufficient stages or accuracy in values to gain full credit. The value given in the question was 7.0, so candidates needed to show a value correct to at least 3 significant figures to gain the accuracy mark. Some candidates had learnt a formula for the area of an equilateral triangle, but use of this formula did not gain full credit without showing the 60° angle. Some candidates used the 7.0 cm in the question in their method which could not be awarded any method marks.

(ii)(a) Most candidates found the volume correctly. A small number found the surface area rather than the volume.

(b) Many candidates found the surface area correctly. Common errors were to use an incorrect number of rectangular faces or to add just one hexagonal face rather than two.

Question 10

(a) (i) The majority of candidates found the correct coordinates of the midpoint. A common error was to subtract the x and y values rather than adding them before halving the result and these values were subtracted in either order giving answers of (1.5, 3) or (–1.5, –3). Some candidates carried out the correct calculations but then gave (–1,4.5) as the answer. Occasionally the sum of x and y values for the two points were not halved.

(ii) Some candidates gave an answer of 6.7 following from the correct calculation. A surd answer was acceptable as the final answer but where a decimal answer is given it should be correct to at least three significant figures. There were only occasional surd answers. There were a few candidates who tried to find the gradient rather than the length of AB.

(b) (i) Many gave the correct gradient. Other candidates attempted to rearrange the equation some did this incorrectly and gave answers of, for example, 4, –4 or $\frac{4}{3}$. In a few cases the answer of $-\frac{4}{3}x$ was written or sometimes the rearranged equation. Finding, or attempting to find, the gradient of the line joining points A and B from **part (a)** was also attempted by some.

(ii) Many candidates gave the correct coordinates, but a number gave a coordinate with the x–coordinate not equal to zero. Some substituted $y = 0$ and arrived at the answer (3,0) or (0,3). Some gave the coordinates (0,12) as the rearrangement in **part (b)(i)** had not been divided by 3 previously.

(iii) The method to find the equation of a perpendicular line was understood by most candidates. Those with the correct answer to **part (b)(i)** usually found the correct equation in this part. Many with the incorrect gradient were able to find the equation of a line perpendicular and through the required point and earned the method marks for this..

Question 11

(a) There were a number of candidates that correctly substituted of $x = -1$ into the given derivative, showing that the result was equal to 0. In this part, it was not uncommon to see a variety of different attempts offered with no selection of the preferred method. In cases like this where a choice of method is offered, Examiners cannot award credit unless a choice is made by the candidate. Many did not know how to use the given derivative to justify a stationary point. A few candidates appeared to use their calculator to solve the given cubic expression, listed the three solutions, and then assumed that they had done what was required. Other attempted to involve the *y* coordinate 6 in the substitution. Other incorrect attempts involved either differentiating or attempting to integrate the derived function.

(b) (i) Many candidates obtained the correct gradient of 18, and often those who did not gave a correct derivative for partial credit. Errors were sometimes seen in attempts at the derivative, or in the evaluation of their derivative at $x = -2$.

(ii) A number of candidates were able to obtain the correct two values of *x* but not all of those who found the derivative correctly were able to solve $6x^2 - 6 = 0$. Many candidates did not appreciate that both sides of the equation could be divided by 6. Some candidates solved the equation to find only one of the two solutions, $x = 1$, and then often gave 0 or 6 for the second solution.