MATHEMATICS

Paper 0580/11
Paper 1 (Core)

Key messages

To succeed with this paper candidates

- Need to have completed the full Core syllabus.
- Are reminded of the need to read the questions carefully, focusing on instructions and key words.
- Must not round figures in the middle of a calculation but only at the end.
- Need to check that their answers are accurate, are in the correct form and make sense in the context.

General comments

There were a considerable number of questions proved to be generally well understood and, in most cases, there did not seem to be confusion about what was being asked.

When two or more steps are needed in a calculation, it is best if each step is shown separately. This is particularly important with problem solving questions and vital for those that explicitly say to show all your working, for example, with **Questions 14** and **22**.

The questions that presented least difficulty were **Questions 1**, **3**, **6(a)**, **7** and **20(a)**. Those that proved to be the most challenging were **Questions 10** a problem-solving question to find height of cuboid, **13** find coordinates of a point on a line given the equation, **20(b)** use laws of indices, **23** change km/h into m/s and **25(b)** find the perimeter of a compound shape. The questions that were most likely to be left blank were **Questions 12**, **13**, **17(b)**, and **25(b)**.

Comments on specific questions

Question 1

This question was accessible to a large majority of candidates.

(a) Many gave $\frac{8}{10}$ or cancelled this down to $\frac{4}{5}$. All equivalent fractions were awarded the mark.

(b) This question was the second best well answered on the paper with virtually all candidates giving a correct answer.

(c) Many were correct here. Some gave their answer as 4800 (truncation to the hundred below) or 5000 (correct to the nearest thousand. A few gave 48 without the necessary zeros or 800, the value of hundreds in the original number. 4976 was seen occasionally.

Question 2

Some candidates have given their answer in centimetres (10.7) instead of millimetres.

Question 3

(a) Many got this correct. Some gave their answer as 12 km. This is the distance after 1 hour when the bus stopped rather than at 50 minutes.

(b) This question was slight less well answered with wrong answers of 15 40 (when the bus set off again), 30, 35, 45 or 60.

Question 4

The most common wrong answer was 4 instead of 2. Also seen were 1, 5, 7, 12, 16, 180, 360 or a string of 4 or 5 numbers.

Question 5

There was often no working here, so it is not possible to determine what candidates were trying to do. Some clearly were working out the perimeter as some calculations involving Pythagoras' theorem were shown. Some only gave the area of the rectangle or counted the number of sides.

Question 6

(a) **T**his part was answered well. The correct use of BIDMAS or PENDMAS gives 28 – 8 = 20 so many were correct. A few gave their answer as –20 putting the subtraction sign at the front of their answer. Those who worked left to right ignoring the order of operations, in effect, worked out (28 – 8) ÷ 2 which equals 6.

(b) This question was slight less well answered with answers of 0.8, $\frac{8}{10}$, $-\frac{5}{4}$ or $\frac{10}{8}$ seen. This last did not get the mark as the fraction must be simplified.

Question 7

This was the best answered question on the paper. Some candidates gave the answers –12 or –42 showing misunderstanding of directed numbers.

Question 8

Some correct, well drawn ruled lines. Others only drew one line (the vertical) or included incorrect diagonals as some did not appreciate that the arms were not all the same length. Some drew a box in the central area.

Question 9

This was done reasonably well with many gaining one mark if not the two. Some found the correct *D* by counting, other did it by estimation the position and were often one or two units, horizontally or vertically, away from the correct position.

Question 10

This question candidates found the second most challenging. Many worked out the area of the base (or top). Sometimes these candidates went on to treat the total surface area as if it was the volume, giving h as 4.1 instead of 4.5 Occasionally a hybrid method between total surface area and volume was seen. Sometimes Pythagoras' theorem calculations were given.

Question 11

(a) Many candidates did not understand that the calculation needed was 1 – 0.6 = 0.4 for the probability of picking a toy that was not wooden. Some candidates did try subtraction but took 0.6 away from 100 as if it was a percentage.

(b) Here, many candidates who were successful with **part (a)**, realised that the probability of a picking a toy made of plastic, or one made of metal was the same as half of their previous answer. Some got this correct even though they had not got the previous part correct.

Question 12

Some gave the correct answer and some correctly went as far as 60 – 4 × 5 and 5^2 – 300 but did not give the final values – this was not enough for any marks to be awarded. Some treated this as simplification of an algebraic expression rather than noting the heading says 5th term. During their algebraic manipulation, many misconceptions of algebra were made, for example answers of $56n$ and $-299n^2$ or $55 - n$ and $n - 295$. A few solved for n giving $n = 15$ and n = $10\sqrt{3}$ or 17.3.

Question 13

Some knew that the point where a line crosses the y-axis means that $x = 0$ and the coefficient, the c in $y = mx + c$, gives the y-value. Others used combinations of 3s and 5s in their answers. Very few diagrams were seen or in fact any workings.

Question 14

Only few candidates were able to do this question. The instruction to round each number correct to 1 significant figure was frequently ignored, as candidates put the given numbers into their calculators and rounded the answer to 1 significant figure.

Question 15

There were some totally correct answers, and more candidates were awarded a single mark for a partial factorisation. Candidates had to correctly factorise out the full $4x$. Factorising out the 2 by itself is not sufficient as that is not the complete number but using $2x$ correctly was given a mark. Common wrong answers that did not attempt any factorisation were $76x^2$ or $76x^3$. A small minority thought the x^2 meant a quadratic and attempted to factorise into two brackets.

Question 16

Not many candidates were awarded full marks. Many were awarded 1 or 2 marks for various correct lines of working. Some only used the two different sides of the rectangle or used all four but then divided by 2. Occasionally, the correct answer was spoilt by being written as $x = 8x - 10$. There were some with various ways of forming an equation and then attempting to solve it e.g. $x + 7 + 3x - 12 = 0$ or $x + 7 = 3x - 12$. Others tried to find the area by multiplying the two lengths.

Question 17

(a) Various words were given as the answer such as centre point, circumference, chord, segment, tangent and ratio. This last word was not accepted as a poor spelling of radius as it is a mathematical word nothing to do with circle terminology. Also seen were non-circle words such as rhombus, parallel, vertical and perpendicular as well as non-English words. Radii was not given the mark as there was only one radius drawn.

(b) Very few **c**andidates were successful here. There some tangents drawn in the wrong place which could not obtain the mark. Others drew arcs, chords or diameters.

Question 18

The HCF of 70 did gain a mark but did not fulfil all the requirements of the question as it is an even number so the answer for full marks was 35. Others gave 5 or 7, both are odd factors so these were given a mark. Incorrect answers that did not gain any marks were 420 (the LCF), 10 and 14.

Question 19

(a) Many were correct here. Answers such as 12.12 came from working out the square root of 343 rather than the cube root, 302.04 from ignoring the root symbols completely. The most common wrong answer of 49.16… came from $3 \times \sqrt{343} - \sqrt{40.96} = 55.56.. - 6.4$

(b) This question was more likely to be correct showing good calculator skills. Wrong answers such as 320 came from ignoring the brackets and 3136 was $(192 + 4) \times 16$ and 3920 is 3136×1.25 and 256 came from ignoring the index.

Question 20

(a) A large majority were correct here. Some gave their answer as 137 or 0.

(b) This question was far less well answered with incorrect values seen of 5 (should have been –5) or 29 (12 + 17).

Question 21

Many candidates gave as the answer, 203, the value on the calculator display. This needs to be manually turned into a standard form number. Often this second stage was not attempted. Of those that did try to change the form, some had more than one figure before the decimal point. There was a mark for converting their wrong answer to standard form correctly, but this mark was very rarely given as candidates did not show the values prior to changing it to standard form.

Question 22

There are various methods to eliminate one variable and, in this case either equation can be multiplied by 2 to equate coefficients. Of those that got this far working showed that addition was used when the method is subtract or the other way around. Many showed little or no working. Some candidates gave solutions that fitted one equation only. In this case, candidates were awarded one mark for showing some understanding of the process. Quite a few candidates omitted this question.

Question 23

Often this was started but poorly answered with majority attempting converting kilometres to metres and relatively few attempting the conversion of hours to seconds. There were some who were close to the correct answer but as they did not show sufficient workings and rounded during the calculation or even truncated, they so did not get any marks.

Question 24

Expressions such as $n + 7$, $4n + 7$, $11 + 7n$ were seen. The next term is 46 and that was often given as the answer. As in previous years, a small number thought *n*th term meant 9th term so gave 67 as their answer. Some treated this as a data question so gave 125 is the sum of all the terms or 25 which is the mean as well as the median.

Question 25

In general, candidates found this question challenging.

(a) Only a small number of candidates scored full marks here. Some ignored the semicircle giving simply the area of the triangle. Others found the area of circle and did not divide by 2 to find the area of semicircle; this was credited with a method mark. Some remembered the circle area formula incorrectly as $r\pi^2$ or $2r^2\pi$ or used the circumference formula, $2\pi r$. There were some who used Pythagoras' theorem to find the length of *KL* but that is not needed until the next part.

(b) Few candidates got full marks here and this was the question of the paper that was most often left blank. A good number picked up some method marks for their use of Pythagoras' theorem or for the length of the arc of the semicircle. Some included the length of the dashed line, *JL*. Another error was to use 12.8 as the radius of the circle instead of 6.4.

MATHEMATICS

Paper 0580/12
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 0580/13
Paper 1 (Core)

Key messages

Read questions carefully and ensure answers are given appropriately for example in the simplest form.

Ensure full working is shown on 'show that' questions.

Check answers, especially for algebra questions.

General comments

The majority of candidates attempted all the questions, with many setting out their working in a clear and logical way. A small number did not show any logic in their working, especially on the longer questions.

Candidates generally did well on number questions, although some found standard form challenging. Other topics which candidates found challenging were Set Notation, Converting Scales and Bearings.

Partial rather than full factorisation led to marks being lost.

Most candidates appeared to have use of a calculator and sufficient time to complete the paper.

Comments on specific questions

Question 1

Many correct answers were seen. There were also many responses where the place values of the 2s were incorrect and had too many zeros.

Question 2

The majority of candidates gave the correct answer.

Question 3

Correct answers were seen regularly, but there were also a significant number of candidates who did not simplify both terms correctly and only had one of either $6x$ or $-9y$ in their answer. $6x-7y$ was a common incorrect answer scoring 1 mark. A small number of candidates wrote terms involving x^2 and y^2.

Question 4

(a) This was generally well answered, common errors included 164 000, 170 000, 1647, 164700 and attempts at standard form.

(b) This was often correct, with 17, 16.9, 17.000 being common errors.

(c) This part was less well answered compared to previous parts of question. The most common error Was 0.04 There was also confusion with the position of the decimal point leading to answers of 0.38, 3.8, 3.7665 or 36.665.

Question 5

(a) Generally answered well by all candidates. However, there were some candidates who thought the horizontal diagonal of the kite was also a line of symmetry.

(b) Generally, correct with 0,1,2 and 4 also seen.

Question 6

Generally, well answered with many converting to decimal form and correctly ordering the original values. There was some confusion with $\frac{2}{5}$ as 0.4 and where to place this – a number of candidates putting this first. A small number of candidates ordered from largest to smallest, but those that had shown decimal equivalents earned the method mark.

Question 7

This was generally correct.

Question 8

Well answered with most candidates giving the decimal form. Errors included $\frac{3}{20}$ as the answer or 1–0.0015 leading to 0.9985.

Question 9

(a) Generally, well answered. An incorrect answer that was seen often was 13 from calculating $18-5$ rather than the difference between –5 and 18.

(b) Generally, well answered.

Question 10

(a) (i) Many candidates gave the correct answer.

(ii) Generally well answered, common errors were 7, $n + 7$ or $7n - 4$.

(b) Generally, well answered.

Question 11

Incorrect answers included 144 from 180 – 36, 54 from correctly working out 108 but then dividing 108 by 2, or 72, from calculating 180 – 36 to get 144 and dividing by 2.

Question 12

Several fully correct nets were seen. Generally, the two 2 × 3 faces on the side of the given face were Correct. Some candidates drew four 2 × 6 faces. A small minority drew the 3D shape.

Question 13

This question was answered well by stronger candidates, but many incorrect responses were also seen. Some only removed the common factors xy and gave their final answer as $4x-5y$, others thought the x in $5xy^2$ was squared and gave their solution as $xy(4x-5xy)$. Some candidates combined the terms as like terms and gave the answer $-1xy$.

Some factorised the expression correctly with either x or y only in front of the bracket and earned 1 mark.

Question 14

Candidates struggled to change between cm and km. B1 was often awarded for answers 1480, 148 or 1,480,000 (with no attempt to change to km). 40,000 ÷ 37 or 37 ÷ 40,000 were common incorrect attempts.

Question 15

Generally answered well by most candidates. Many candidates found the equivalent fraction $\frac{6}{14}$ and calculated $\frac{6}{14}-\frac{1}{14}$ correctly, whilst some calculated $\frac{42}{98}-\frac{7}{98}$ and then simplified. Some candidates incorrectly tried to subtract 3 and 1 and 7 and 14 in some way without finding a common denominator.

Question 16

This was a challenging question for many candidates as they divided by 56.40 instead of 48. Some candidates simply subtracted 48 from 56.40 and gave the answer 8.4 as the final answer or 8.4 per cent. Some divided 48 by 56.40 leading to 85 per cent and some went on to subtract this from 100 per cent to perhaps make it seem like a more likely answer.

Question 17

Several correct answers were seen. Common errors were incorrect use of sin or tan with 8 cm and 37°, whilst some did use cos but incorrectly, such as trying to evaluate $\cos 37 = \frac{8}{AB}$.

Some candidates gave the answer 6.4 without a more accurate answer seen or truncated their answer to 6.38. Others had used either sin or the sine rule to work out AC first and then used Pythagoras theorem to find AB. There were a few candidates who just worked out the missing angle as 53 or tried to use Pythagoras theorem initially.

Question 18

Generally, well answered. Where the lower bound was correct, there were occasions of the upper bound being 83.4

Question 19

Many correct answers were seen to this straightforward simultaneous equation. Common incorrect answers were $t = 7$, $w = -8$ or $t = 7$, $w = 8$, from subtracting rather than adding the pair of simultaneous equations.

Question 20

Many candidates did not know where 48 should be on the diagram and this impacted their solution. Several candidates measured the bearing and gave an angle of 122 degrees as their answer. Some candidates managed to find and label 125 degrees but went on to find the 55 degrees angle and give that as their final answer.

Question 21

(a) (i) Some correct responses were seen but many earned 1 mark for 4 or more numbers correctly placed, many appeared not to know 1 is a square number, others confused with square and cube numbers. A significant number did not use 5 and or 12.

(ii) Set notation was not well understood, several wrote 1 and 64 or listed all the numbers on their Venn diagram.

(b) Generally answered well. The common error was to shade both full circles.

Question 22

(a) (i) Although many gave correct answers in **part (a).** Common incorrect answers were 7×10^3, $\frac{7}{1000}$, 7×10^{-2}, 0.7×10^{-2}.

(ii) Common incorrect answers were 0.7×10^9, 7×10^{-8}, 7×10^9.

(b) Several scored 1 mark for 36,000 but did not convert this to standard form. Common incorrect conversions to standard form were 36×10^3 and 3.6×10^{-4}.

Question 23

This question was generally not well answered. Some fully correct responses were seen, but these were rare. The most common mark awarded was for the correct use of the formula given in the question to find the volume of a sphere. Some realised the units were not consistent, but overall, very few candidates converted the units correctly. Candidates who knew that the volume of a cylinder was $\pi r^2 h$ often gained a method mark for working out this volume correctly, but many used the diameter instead of the radius. Others did not attempt to work out the volume of the cylinder out, or simply used the wrong formula.

Some candidates did achieve the SC for rounding their answer down.

MATHEMATICS

Paper 0580/21
Paper 2 (Extended)

General comments

To succeed in this paper, candidates need to have completed full syllabus coverage, remember necessary formulae, show all necessary working clearly and use a suitable level of accuracy. It is also important that candidates read the question carefully to establish the form, units and accuracy of the answer required and to identify key points which need to be considered in their solutions.

This examination provided candidates with many opportunities to demonstrate their skills. It differentiated well between candidates with a full range of marks being seen. Many high-scoring scripts were seen, and there was no evidence that the examination was too long. Some candidates omitted questions or parts of questions, but this was likely due to a lack of knowledge rather than time constraints. It would have been helpful if candidates had written their numbers more clearly, as some of them were difficult to distinguish, particularly 4s and 9s, and 1s and 7s. Some candidates' handwriting was not as legible as others, which may have contributed to the errors in their work. There were also instances where working was not shown or was not shown clearly, showing working allows for the award of part marks when the correct answer is not seen.

It is important to take care when manipulating algebraic expressions. Some errors were caused by poor writing and some by not applying the laws of algebra correctly. For example, in **Question 12** where they were solving simultaneous equations and working was required.

As in previous series, there were some questions where candidates rounded to an unsuitable level part way through calculations, this was particularly evident in **Questions 7**, **10**, **12**, **14** and **21**. Premature rounding or use of inaccurate approximations for π often lead to inaccurate final answers. Candidates should keep greater amounts of accuracy in intermediate steps than they required for their final answer. Candidates should also be mindful that completing working in one line when they should use several lines, particularly when performing two steps of algebraic rearrangement in one line, means that they can miss the opportunity for method marks.

Comments on specific questions

Question 1

In this question candidates were asked to find the coordinate that would complete the parallelogram. There were lots of correct answers seen, but there were also many responses seen with only one value in their coordinate correct. Some candidates could not identify the correct position for D on the diagram but were able to correctly give the coordinate for their point in the appropriate quadrant of the diagram. Common errors included drawing a triangle rather than a parallelogram or placing the coordinate in the 1st quadrant rather than the 2nd quadrant.

Question 2

(a) In the first part of this question candidates needed to find the probability of an event not occurring. The majority of candidates were able to give a fully correct answer.

(b) Candidates were generally able to complete the table giving the number of wooden toys and using the equal probability of plastic and metal toys to find their probabilities. If errors occurred it tended to be with the number of wooded toys, but these candidates still normally achieved a mark for the probability of plastic and metal evaluated correctly.

Question 3

(a) Candidates were required to use the nth term of sequences to find the 5th term of sequence A and of sequence B. This was generally well answered with the majority of candidates able to find the required terms. Where candidates were not able to find both terms, they were often able to find the 5th term of the linear sequence. A common error was to show a substitution into the nth term, but not to evaluate this to obtain the required terms.

(b) Candidates were asked to find the smallest positive integer in the quadratic sequence given by the nth term $n^2 - 300$. Many candidates were able to try at this question, either by forming an equation/inequality or by use of trial and improvement. A common incorrect answer was 18, the term number of the first positive value in the sequence, rather than 24 the term in the sequence, in most of these cases candidates had shown working and could be awarded partial credit.
There were a minority of candidates who did not know how to make a start with the question.

Question 4

Candidates were asked to find the greatest odd number that is a factor of 140 and a factor of 210. Whilst fully correct answers were seen regularly, so were the answers 7 (the greatest odd prime factor of 140 and 210) and 70 (the greatest factor of 140 and 210) gaining one mark only. Common approaches to the question were to find all factors of 140 and 210, often working with factor pairs, or to find the prime factorisation of 140 and of 210. On rare occasions candidates worked out the lowest common multiple instead and gave their answer as 840.

Question 5

(a) In this part of the question, candidates needed to work out $\sqrt[3]{343} - \sqrt{40.96}$. This was answered correctly by the majority of candidates who seemed to be confident at use of their calculators.

(b) In this part of the question, candidates were required to work out $(192 + 4 \times 16)^{1.25}$. Again, this was answered correctly by the majority of candidates.

Question 6

In this question candidates were presented with 6 congruent kites and asked to find the size of a missing angle. This involved application of the sum of angles on a straight line, sum of angles in a quadrilateral and properties of a kite. There were a reasonable proportion of fully correct answers. Where incorrect answers were seen a common error was working with 5 angles at C totalling 180 in total rather than 6. Some candidates drew in the diagonal DB and tried to calculate x from here using angles in a triangle, whilst some thought DCB = 40, the same as angle DAB. Another misconception was that angles in a kite added to 180 and having calculated 30 correctly, candidates then added 40, but subtracted from 180 instead of 360 before dividing by 2.

Question 7

(a) In this part of the question candidates were asked to find the area of a compound shape made up of a right-angled, isosceles triangle and a semi-circle. Fully correct solutions were seen regularly, as well as responses that gained part marks. Most candidates were able to calculate the area of triangle JKL correctly, and then a significant number were able to work out the area of the semicircle correctly from here. Some candidates forgot to divide the area of the full circle by 2 to get the area of a semicircle. Some candidates used 12.8 (the diameter) rather than 6.4 (the radius).

(b) Candidates were asked to find the perimeter of the compound shape. In order to do so they needed to find the arc length of the semi-circle and use either Pythagoras' theorem or trigonometry to find the hypotenuse of the triangle. Fully correct responses were seen, as well as responses that gained part marks. Common incorrect answers included 63.8 where the candidate included an extra 12.8, and 38.208 from adding 20.106 and 18.102 but omitting JK from the perimeter.

Many candidates who did not answer the question fully, did either use Pythagoras Theorem to find KL correctly, or calculated the length of the semicircle correctly. Some candidates did forget to divide their circumference by 2 but had often gained marks for using Pythagoras to get KL. There were also candidates who had the correct method but premature rounding for some of their answers meant their final answer was out of tolerance.

Question 8

Finding the nth term of the linear sequence in this question was well answered. Many candidates were able to give a fully correct nth term, often in the form $7n+4$, but $11+(n-1)7$ was also a common correct response. Common incorrect responses included n + 7, 4n + 7 from misunderstanding how to use the common difference in finding the nth term or the next term in the sequence 46.

Question 9

This question on exponential decrease was answered correctly by a significant proportion of candidates. Many were able to show clear working and obtain a correct answer. It was noted that the majority of candidates working with compound decrease did so by use of the multiplier approach, with only a minority attempting to do the longer stepwise process of working year by year. Common incorrect answers came from working with simple depreciation rather than a compound process, this led to answers of $2000 (3 years of depreciation at 25 per cent) or $6000 (one reduction of 25 per cent).

Question 10

In this question candidates needed to find the interest rate based on the initial amount in an account and the final amount in the account after 8 years. This was answered well by around half of candidates who were able to find the interest rate of 1.25 per cent generally working from the compound interest formula and rearranging this. Incorrect or incomplete methods were also seen regularly. A common incorrect approach was to subtract 1500 from 1656.73 and then divided by 8 to give 19.6 per cent, whilst others incorrectly divided 1656.73 by 8 and then by 1500 to get 0.138 before converting this to a percentage 13.8 per cent.

Question 11

Finding the inequalities that define the region was answered fully correctly by only a minority of candidates with many struggling with inequality notation or identifying the lines that made up the region. There were a range of errors seen in partially correct responses. Common errors included use of equals signs or the wrong inequality sign when attempting to express the inequalities, there were also others who included R in some manner in their attempted inequality statements. Some candidates had x and y reversed on the vertical and horizontal lines. Others were unable to find the equation of y = x correctly to use in their inequality for the diagonal line. In some cases, candidates seemed not to know how to express a region using inequalities, they either listed coordinates that they thought satisfied the region or were the vertices of the shape of R, whilst some tried to describe the region in words.

Question 12

This question on solving simultaneous equations was answered well by around half of candidates. The most common correct approach taken was to multiply both of the equations to equate coefficients and then add or subtract. Where candidates took this approach, they generally chose to multiply $\frac{3x}{2}+5y=5$ and $4x-3y=46$ to equate the coefficients of *x* before subtracting. It was common to see errors in arithmetic, particularly when dealing with the fractional coefficient of *x*, which often meant that candidates could gain partial credit for a correct method with arithmetic errors. There were also a number of candidates who had incorrect processes such as not multiplying all terms when attempting to equate coefficients, adding the equations when they should subtract to eliminate (or vice versa), inconsistent addition/subtraction when attempting to eliminate or incorrect algebraic processes.

It was less common to see candidates attempting to use rearrangement and substitution in their attempt to solve the simultaneous equations. Where this was seen there were often errors made in the rearrangement. It was noted that few candidates using either method seemed to check their answers to ensure that they had a solution that worked for both equations, checking in this way would have highlighted when errors had been made in the approaches attempted.

Where candidates were not successful in their attempts to solve the simultaneous equations due to errors in their method, they were often able to find a pair of values that worked for one of the two equations given. This was awarded the SC mark.

Question 13

This question was based on knowledge of angle facts in cyclic quadrilaterals. Candidates needed to work with the fact that opposite angles in a cyclic quadrilateral add to 180° to form and solve equations. This was answered well by many candidates, but errors were also common.

Many candidates thought the correct method was to add all 4 angles together and equate to 360 (angle sum of a quadrilateral). This approach nearly always led to no progress being made towards the answer. However, candidates who did realise that the opposite angles of a cyclic quadrilateral added to 180 and added 4m and 5m first to get 9m = 180 were able to solve the question. A few candidates just added 4m + 38 and p to get 4m + 30 + p = 180 and could not solve from here but did gain a mark.

Question 14

Here candidates were required to find the area of a shaded major sector. A reasonable proportion of candidates were able to find the required area successfully. However, some candidates just worked out the area of the whole circle and made no further progress. Others found the area of the circle and then realised they needed to take something off this answer but were not sure what to subtract. Some candidates worked out the area of the smaller sector using 48, gaining a mark, or had the angle of the major sector 312 seen.

Question 15

Candidates found writing the recurring decimal $0.1\dot{4}\dot{6}$ as a fraction relatively challenging with only a minority able to give a fully correct answer including working. A number of candidates misinterpreted the recurring decimal notation as 0.146146… which meant that they could not gain credit. Where candidates had a non-calculator approach for this type of question, they were generally relatively successful. Many set up a pair of equations such as $1000x = 146.4646\ldots$ and $10x = 1.4646\ldots.$ then subtracted to find that $990x = 145$ which often lead to a fully correct answer, although some struggled with the subtraction due to writing differing numbers of decimal places in their two equations and did not successfully eliminate the recurring part of the decimal. Common errors seen included methods such as $\frac{146}{1000} = \frac{73}{500}$ or 146/999. Some candidates had the correct answer seen but with no method shown gaining no marks.

Question 16

(a) Candidates were asked to shade region of the Venn diagram representing $M' \cap N'$. This was answered correctly by a slight majority of candidates. Incorrect answers included shading a range of differing regions in the diagram.

(b) In this question candidates were asked to find $n(B \cap (A' \cup C'))$. This proved to be challenging for candidates with only a small minority of correct answers seen. There were a range of incorrect answers seen, although 4 which is $n(B \cap A' \cap C)$ was common. There were many candidates who gave incorrect answers that indicated that they did not understand the meaning of the n( ) notation.

Question 17

This question asked candidates to find the area of a triangle which involved use of the formula area of triangle $= \frac{1}{2}ab\sin C$. This was answered well by many candidates. Common incorrect attempts included treating the triangle as right-angled and working out $\frac{1}{2} \times 6.7 \times 5.9$. There were a few candidates who did not know the area of a triangle formula correctly, using absinC for example instead. Others attempted to use Pythagoras' theorem or trigonometry in attempting to find the perpendicular height of the triangle, however this was not possible with the information present in the question without incorrect assumptions being made about how the length AC was divided by the perpendicular (generally the candidates attempting this incorrectly assumed that the length was bisected).

Question 18

Candidates were asked to draw a suitable line on the graph provided in order to solve an equation. There were very few fully correct answers seen and many candidates did not attempt to draw a line, but instead tried to solve the cubic equation algebraically. Where candidates did draw a straight line, this was often $y = 2$ rather than the necessary $y = 2x$. If a candidate did manage to draw the line y = 2x successfully they nearly always gained full marks.

Question 19

(a) In this part of the question candidates were asked to factorise $12m^2 - 75t^2$. This was only answered correctly by a minority of candidates; however, some were able to gain part marks for a correct partial factorisation. Many candidates were able to factorise out the 3 successfully, but from here failed to recognise the difference of two squares. Some tried to factorise into 2 brackets and had terms that gave $12m^2$ and/or $-75t^2$ but that also left *mt* terms if expanded.

(b) The majority of candidates were able to factorise $xy + 15 + 3y + 5x$ successfully. There were also a good number of candidates who were able to make a start and factorise to $x(y+5) + 3(y+5)$ or $y(x+3) + 5(x+3)$ but could not complete the process. Incorrect responses included a wide range of incorrect attempts at factorisation.

Question 20

Candidates were asked to solve $8\sin x + 6 = 1$ for $0° \leqslant x \leqslant 360°$. Only a minority of candidates were able to give the two required angles. There were also issues with premature rounding of figures leading to inaccurate final answers. Many candidates were able to rearrange the equation successfully to get $\sin x = -\frac{5}{8}$, but having got –38.7 simply used this and/or the positive value 38.7 as one of their answers. Some candidates were able to go on to find one of the required answers but struggled to find the second one. There were a reasonable number of candidates who, having found the incorrect 38.7 as one of their angles, went on to give this and 141.3 as their two solutions and were awarded the special case.

Question 21

This question requiring use of Pythagoras' theorem and trigonometry in three dimensions was, as would be expected for a question at this stage in the paper, found to be relatively challenging. There were some very good answers seen, however there were also many incomplete or incorrect responses. A significant number of candidates were not able to identify the required angle correctly and carried out calculations that were not worthy of any marks as a result, whilst several candidates did not use the most direct method to calculate angle ECH and lost accuracy as a result. If the correct angle was identified, many of these candidates were able to use Pythagoras theorem to calculate HC, but some of these candidates then calculated other lengths, like EC, before attempting to use trigonometry, and often lost accuracy. Candidates who identified the correct triangle sometimes worked out angle CEH instead of ECH. Other candidates thought they were calculating angle ECD rather than ECH.

Question 22

This question on probability required candidates to identify a method to find the probability that Jen picks red and then work with this to find the probability that both Stephan and Jen picked a blue counter. This was answered well by a minority of candidates, but many incomplete or wrong answers were also seen. A common error was 0.6 × 0.75 = 0.45, whilst some candidates added where they should have multiplied.

MATHEMATICS

Paper 0580/22

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 6th 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 $-0.2\ \mathrm{m/s^2}$ 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 0580/23
Paper 2 (Extended)

Key messages

The problem of truncating numbers during multiple calculations still exists. Candidates are advised to write down partial results to a lot more than the 3 significant figures required in the answer or to keep the full number in their calculator ready for the next calculation.

General comments

In geometry, candidates should always look for the most efficient method. For example, in finding an angle or a side in a triangle, establish whether it is a right-angled triangle, or not, because using the sine rule or even the cosine rule in a right-angled triangle can easily lead to errors.

In algebra, it is important to check on a minus sign immediately before a bracketed term as a minus sign will change the sign inside the bracket. It is also important to check each stage in algebra as a small error will lead to an incorrect answer. This occurs in solving equations or in changing the subject of a formula.

Comments on specific questions

Question 1

Some of the candidates did not know how to relate place values with the description in words and a sizeable minority gave the incorrect answer for this question. Some common mistakes were the following: 22 002, 20 002 000 and 202 000 so either more zeros or fewer place values than required. Some used the comma to indicate thousands and only a few chose to give the number in standard form.

Question 2

This question was not so well answered as it seems that the candidates looked at the calculation and failed to realise that they had to add one pair of brackets. The most common incorrect response was to change the –9 to +9. What was also seen was a bracket around the 9 and the –2 which gave $5 – 12 – 7 = –14$ when using the correct order of operations. Two pairs of brackets were seen less frequently, this was usually $5 – [\ 4 \times 3 – (9 –2)] = 0$.

Question 3

Most of the candidates did very well in this question but some had challenges in adding two negative numbers together. A common error is $6x – 7y$. The error came from the addition $–8y – y = –7y$ instead of $–8y – y = –9y$. Another common mistake was that some tried grouping the terms and gave the following as an answer: $x\ (7 – 1) – y\ (8 + 1)$ but did not simplify the values in the brackets.

Question 4

This was very well answered with the vast majority of candidates correctly dividing 280 by 10×7 to give the answer of 4. For those not obtaining the correct answer, this generally came from trying to work with surface area or trying to use the volume of a cylinder. Occasionally candidates tried to cube root the 280 from seeing the cm^3.

Question 5

The majority of the candidates performed well in this question. A few errors came from the subtraction. The correct answer was from 1 – 0.15 = 0.85. Some candidates used 100 – 0.15 = 99.85 but most students provided 0.85 or 85% as the correct answer or less frequently the fraction $\frac{17}{20}$.

Question 6

This was very well answered. Sometimes it was unanswered and very rarely 45 $(x^2 - x)(y^2 - y)$ was seen. Some responses gave a correct partial factorisation such as $y(4x^2 - 5xy)$.

Question 7

The majority of the candidates performed well in this question. The major error is from the conversion of centimetres to kilometres. Candidates are expected to understand that 100 000 cm = 1 km such that 0.4 km × 37 = 14.8 km. Several responses gave an answer with figures148 such as 148 or 1.48.

Question 8

This was extremely well completed, and there were very few candidates who did not answer this question correctly. Those who did not answer it correctly either showed no workings at all and gave the answer of $\frac{5}{14}$ or made errors in finding a common denominator, without showing all their working.

Question 9

This question was very well attempted by most candidates and there was a range of different answers. Some gave an answer 6.38 by truncating or 6.4 by rounding to fewer figures than required. Some candidates used sin 37 rather than cos 37. A small number did then follow sin 37 with Pythagoras, however these were more likely to get an inaccurate answer. There was an increase in candidates using the sine rule which was not necessary in this question.

Question 10

This was answered well with most candidates giving their answer as an improper fraction with small numbers converting to a mixed number or decimal. The biggest error was having their working the wrong way round, that is change in x divided by change in y, or not dealing with the double negatives correctly. Some gave the equation of a line instead of the gradient.

Question 11

This was answered well but common wrong answers included $w = 2$ and $t = 7$ with $w = -8$ coming from incorrectly calculating $5t - 3t$ and 19 – 5 to give $2t = 14$ and $t = 7$.

Question 12

(a) A common incorrect answer was $16g^8$, where they had incorrectly simplified $\frac{32}{16}$. Some responses omitted the g by cancelling it out and leaving 2^8. Another incorrect response was $2g^2$ where they incorrectly divided the powers 16 ÷ 8 = 2.

(b) Most responses answered correctly. The most common incorrect answers were $625k^6$, 5^3k^6 or 125^6. Some were seen to write 468.75 from $625 \times \frac{3}{4}$.

Question 13

(a) Most struggled on this part. The most common incorrect answer was *A* shaded without the overlap with *B* where *B*' was not understood to include the area outside of *B*. Another common error was to omit the shading of the overlap between *A* and *B* with the remaining shading correct.

(b) Candidates understanding of set notation at times was not well founded. Some used letters not in the Venn Diagram, others had + and – signs included, and some put letters together e.g., *RP*u*Q*. The biggest misunderstanding was around brackets and the need for them, many missed out brackets, other errors included only u being used. Common incorrect answers were *R*u(*P*u*Q*)' or *R*u*Q*'u*P*.'

Question 14

(a) This was answered well by a large number of candidates, giving 50° as the final answer and those candidates applied the alternate segment theorem correctly. The common incorrect answer was 48°. This was seemingly from assuming triangle *PRT* was an isosceles triangle. 82° was another common incorrect answer. This was from assuming angle *RPT* = 50° and seemingly trying to use alternate angles, although not correctly as no parallel lines are given.

(b) Those candidates who gave the correct answer applied the following properties correctly: the sum of opposite angles of a cyclic quadrilateral add to 180°, the angle sum of a triangle adds to 180° and an isosceles triangle has equal base angles. Some candidates gained credit for having 132° correctly shown on the diagram at *PQR* or labelled correctly in working.

Question 15

(a) Many candidates gave the correct answer using UQ = 27 and LQ = 16. A number of candidates only gave 11 as their answer without the working out shown. Some candidates gained credit for either 16 or 27 written down or they just stated 16 as their final answer, only giving the lower quartile. The most common incorrect answer was 40 obtained from 50 – 10 or 21 to 22 from looking up 100 calculated from 150 – 50.

(b) The acceptable answers of 5, 6 or 7 were given by subtracting a correct reading from 200. Some candidates gained credit from writing an answer of 193, 194 or 195. Some candidates made an incorrect reading from the graph and examples of this are 192, 187 or 198.

Question 16

This was answered well by the majority of candidates by giving a correct final answer of $h = \dfrac{A - \pi r^2}{\pi d}$ from $A - \pi r^2 = \pi dh$ and commonly also written as $h = \dfrac{A}{\pi d} - \dfrac{r^2}{d}$. A small number of candidates had the answer in the form $h = \dfrac{\pi r^2 - A}{-\pi d}$ or $h = -\dfrac{\pi r^2 - A}{\pi d}$ which are also correct. Some candidates did continue to try and simplify their answers even after they had written a correct answer. Some gave their final answer shown as a fraction in a fraction such as $h = \dfrac{\frac{A}{\pi} - r^2}{d}$ whilst others used the division sign but did not use brackets so incorrectly showing $h = \dfrac{A}{\pi} - r^2 \div d$. These often occurred when they factorised the right-hand side first. The first step was particularly important and some attempted to square root first which was an error from which they could not recover.

Question 17

(a) This was answered well by some candidates giving the fully correct answer 1.68×10^{203}. The first step was $16.8 \times 10^{101 + 101}$ followed by 16.8×10^{202} and finally 1.68×10^{203}. A small number of candidates received credit for a correct answer not in standard form 16.8×10^{202}. The most common incorrect answer was 1.68×10^{101}.Some candidates had misconceptions and were multiplying the indices, for example some incorrectly wrote 16.8×10^{10201} .

(b) Most candidates wrote 23.1×10^{100} followed by the correct standard form 2.31×10^{101}. Some wrote 23.1×10^{100} as their final answer therefore not writing the number in standard form. A considerable number made an error of incorrectly adding the indices, giving 4.2×10^{201} or 4.2×10^{202}.

Question 18

The most efficient method involved first solving the equation $11.5y + y = 180$ to get the solution $y = 14.4$ then to find the number of sides using $360 \div 14.4 = 25$. The most common reason for not getting the correct answer was showing 14.4 in the working but not having a simple method to find the number of sides and giving 14.4 as the final answer. A smaller number of candidates gained credit for the correct equation of $11.5y + y = 180$ oe but no further correct working was seen. Some candidates used the incorrect equation of $11.5y + y = 360$.

Question 19

(a) This was answered generally well with a substantial number of candidates giving the correct answer; however, many gave the transformation with just one correct property. The common errors included using an incorrect term for rotation such as 'turn' or incorrect properties such as (–2, 0) for the centre.

(b) Some drew the correct image. A small number of candidates drew the correct enlargement but drawn in a translated position, usually only out by 1 square. Many incorrect solutions had their images as very small triangles where the candidate had made the image a fraction of the original object, for example a small triangle with one side on the *y*-axis with coordinates (0, 1.5), (0, 3) and (0.5, 3).

Question 20

(a) The following correct method was usually seen, first $245 = 3^x + 2$ then $243 = 3^x$ and finally $x = 5$ with the additional line of $3^x = 3^5$. The main error was this method, first $f(x) = 3^x + 2$ then $f(245) = 3^{245} + 2 = 5^{245}$.

(b) This part was not answered as well as part **(a)**. The simplest solution is $x = f(7)$ then $x = 3^7 + 2$ finally $x = 2189$. Some attempted to use logarithms to base 10 with a mixed outcome or they did not write the equation correctly such as $\log_3 x - 2 = 7$ which does not have the appropriate brackets. Some did not attempt this part at all.

Question 21

There were a number of correct methods seen, the most common included the use of 4.111… − 0.4111… leading to $\frac{3.7}{9}$ or 41.111… − 0.4111… leading to $\frac{40.7}{99}$. Some candidates assumed knowledge of $\frac{1}{90}$ without any working, whilst others did not show the recurring 1's treating the decimals as terminating and a few thought the decimal was 0.4141… which was not the set question.

Question 22

This was answered well. Most gave two answers with some giving one answer which was usually 120°. Some could not rearrange the equation and felt the need to square it and they usually did that incorrectly. Some solved $\tan x = \sqrt{3}$ thus getting 60° and giving that as the answer with possibly 240°.

Question 23

Mostly candidates were able to find the common denominator correctly and have the correct numerators. The error was dealing correctly with the negative sign between the fractions and then dealing with the negative sign in the answer. Therefore, a common incorrect answer was $\frac{3-y}{y(y+1)}$. Incorrect subsequent work was relatively common after a correct answer was seen.

Question 24

This was another well answered question. Some rounded prematurely in the question and obtained an answer outside of the range. Those who were most successful clearly labelled the diagram, and followed on to work out *AC*, many worked out *AV* as well although this was not necessary as the angle could be found using $\tan^{-1}\left(\frac{4}{5\sqrt{10}}\right)$.

Many, having found *AC* or *AV*, then went on to find angle *VAB*. Some used triangles *VAB* or *VBC* rather than triangle *VAC*. A few candidates who did identify the correct angle did not recognise that triangle *VAC* was a right-angled triangle and opted to calculate using the sine rule, which, whilst correct, was not the most efficient approach and occasionally led to errors in rearranging, particularly if they had the angles in the denominator. A number of candidates kept their calculated length of *AC* in exact form for the second stage of the method, which was good to see, and there were relatively few of these solutions where marks were lost due to inaccuracy. In a few cases, premature approximations of $\sqrt{250}$ and $\sqrt{266}$ ended up leading to answers which were slightly inaccurate. Other candidates correctly identified the required angle as *VAC* but incorrectly calculated *AV* as $\sqrt{15^2+4^2}$ which was later used to incorrectly calculate angle *VAC*.

Question 25

Some candidates found it difficult to factorise $pt - p - t + 1$ correctly as $(p - 1)(t - 1)$. The reason comes from not dealing with the minus correctly from $-t + 1$ as $-(t - 1)$. In addition, many made an error in factorising $1 - t^2 = (1 - t)(1 + t)$ as most wrote $1 - t^2 = (t - 1)(t + 1)$. The most common mistake was in the numerator which was given $p(t - 1) + (t - 1)$ or $p(t - 1) - (t + 1)$ or $p(t - 1) + 1 - t$. Since there was no clear common factor to recognise, they did not group the last two terms. Some cancelled out terms without fully factorising and cancelled a single term in the numerator with a single term in the denominator.

Question 26

This question was more variable in response. Those who were most successful clearly identified a route from *O* to *S*. The main error was incorrectly identifying $\overrightarrow{PQ}$ as $\boldsymbol{p} + \boldsymbol{q}$ or $\boldsymbol{p} - \boldsymbol{q}$. Many were able to get a correct expression for $\overrightarrow{OR}$ and knew that they needed to double this for $\overrightarrow{OS}$, but made an error and only doubled the coefficient of $\boldsymbol{p}$, not that of $\boldsymbol{q}$. There were also some calculation errors with minus signs when simplifying the expression for $\overrightarrow{OR}$. Some candidates did not simplify their vector $\overrightarrow{OR} = \boldsymbol{p} + \frac{1}{3}\boldsymbol{q} - \frac{1}{3}\boldsymbol{p}$ which led to difficulty in obtaining a simplified final vector $\overrightarrow{OS}$. In some cases, candidates started off without identifying the correct route taken, very few of this approach led to success. Also, others were unable to correctly use the ratio 1 : 2 leading to the confusion of whether to use $\frac{1}{3}$ or $\frac{2}{3}$ appropriately.

MATHEMATICS

Paper 0580/31
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. Many candidates completed the paper however a significant number of candidates did not attempt all parts of the paper. The standard of presentation and amount of working shown was generally good. 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 encourage candidates to show formulae used, substitutions made, and calculations performed. Attention should be made to the degree of accuracy required. Candidates should avoid premature rounding as this often leads to an inaccurate answer and must write digits clearly and distinctly. Candidates need to read questions again to ensure the answers they give are in the required format and answer the question set.

Comments on specific questions

Question 1

(a) (i) Nearly all candidates correctly calculated the cost of 4 tickets. The few wrong answers were $6.30 or $25 (rounding to 2 sig fig.).

(ii) Most candidates successfully calculated how much each person paid as $5.67. The most common wrong answers were $6.30 (not using the offer of 10 tickets for the price of 9), $56.70 (not dividing between the 10 people) or 0.9 (not using the cost of the tickets).

(b) (i) Nearly all candidates worked out the number of rows to be 25. The few incorrect methods seen did not involve division, candidates multiplied (16900) the values given.

(ii) Fewer candidates were successful in finding how many seats were not occupied. The most common error was to simply give the percentage not occupied (16 per cent) rather than the number of seats. Other errors given were finding the number of seats occupied (546) or misreading the question as 84 seats were occupied, rather than 84 per cent, with the common wrong answer of 566 given. Many weaker candidates were unable to find a percentage correctly – doing $\frac{(100 \times 84)}{650}$ = 12.9 per cent.

(c) Around half of the candidates correctly worked out the cost of a bag of popcorn and a bottle of water. Nearly all candidates found the total cost as $6.45 but many then divided by 2 for the cost of the popcorn ($3.22 or $3.23) and then divided by 2 again for the cost of the bottle of water ($1.61 or $1.615). Weaker candidates often abandoned the question after subtracting to find the total cost.

(d) (i) The majority of candidates were able to write 155 minutes in hours and minutes. The most common mistakes were candidates dividing by 60 ($\frac{155}{60}$ = 2.58) and giving the answer as 2 hours and 58 minutes.

(ii) Around three quarters of the candidates correctly worked out the time that the film finished. The most common errors were to give the time as a 12-hour time but not including the pm (05:05 or 5:05) or add the times but not take into consideration that there are 60 minutes in an hour (14:45 + 2h20min = 16:65).

(e) Most candidates were able to gain some marks by calculating the correct pay for Sunday ($57.50), however many candidates found it difficult to use the correct number of hours for Friday or Saturday (used 5.3 hours instead of 5.5 hours) or calculate 30 per cent of £11.50 or 30 per cent of the total pay for Wednesday and/or Thursday. Candidates were good at showing their method used, very few candidates only gave an answer. Few candidates did not attempt the question.

Question 2

(a) (i) Successful candidates used the angles given in the pie chart to find the fraction of people who preferred mountain holidays as $\frac{120}{360}$ and then simplified to 1/3. Many candidates however did not read the question carefully and attempted to give their answers as a percentage (33 per cent or 33.3 per cent or 33.3… per cent). Some candidates attempted to then change their percentages to a fraction but were not accurate enough as $\frac{33}{100}$ or $\frac{33.3}{100}$ or $\frac{33.3\ldots}{100}$ is not equivalent to $\frac{1}{3}$ and gained no marks. Weaker candidates often did not attempt the question or wrote the fraction $\frac{360}{120}$ simplifying it to 3.

(ii) Around half of the candidates successfully found the percentage of people who prefer a beach holiday. Many candidates missed out on the mark by rounding to the nearest whole number (38) instead of giving the exact answer of 37.5.

(iii) Many candidates attempted to give a ratio in its simplest form, but most gave their answers as decimals or fractions not as a simplified ratio in integers. The correct answer was rarely seen however candidates were able to gain a part mark for an un-simplified ratio using the angles in the pie chart or as a simplified fraction or decimal to at least 2 sig fig. However, candidates often made errors when using the angles in the pie chart as a fraction (e.g. $\frac{135}{360}$) and then converting to a decimal (0.375) but not giving their answer to 3 sig fig. (0.38). A large proportion attempted to work in percentages but again did not gain marks because they rounded to 2 sig fig. Around a quarter of candidates did not attempt this question.

(iv) The correct probability was given by many candidates – most commonly as a fraction. However, many candidates attempted to give the probability as a percentage or decimal, without first showing the correct fraction, and lost marks due to not rounding correctly to 3 sig fig. – common wrong answer of 29 per cent or 0.29.

(v) A significant proportion of candidates did not attempt the question or scored no marks because they used the 1800 in their working to show that the total number of people asked was 1800 or that 675 preferred a beach holiday. Successful candidates showed all steps to their solution. Most used the 135 degrees from then pie chart to find the number of people per degree ($\frac{675}{135}$ = 5) and then multiplied by 360 to find 1800.

(vi) (a) Candidates were more successful at completing the table, with more than half of the candidates scoring full marks. Most candidates attempted the question however not all correctly. Candidates who went wrong often did not refer to the pie chart or the previous question where they would have seen that the angle in the pie chart needed to be multiplied by 5 to give the frequency. Common incorrect methods estimated by doubling 150 for Lake holidays.

(b) The majority of candidates were able to gain marks for completing the bar chart. Most candidates who were able to write a linear scale on the frequency axis were then able to draw the bars correctly. Candidates were more successful at drawing the bars the correct height (using their scale) with equal gaps and widths. A few candidates used the sector angles from the table instead of the frequency and another small number drew a line graph rather than a bar chart.

(b) Around half of the candidates were able to work out how much more Mr Shah paid for the holiday than Mr Gibbs, in Euros. The most successful method was to convert Mr Gibb's cost to Euros and then subtract from Mr Shah's cost. The most common error was attempting to convert $2208 to Euros by multiplying by 1.15 instead of dividing.

Question 3

(a) (i) This question was well answered with most candidates correctly completing the timetable. Common incorrect answers were 11:67, 12:09 or 11:07.

(ii) Candidates found drawing an accurate pair of hands on the clock challenging. Most candidates identified that the time required was 10 27 but most made an error drawing the hour hand pointing directly to 10 rather than clearly between 10 and 11. Most candidates did draw the minute hand longer than the hour hand.

(b) Around a third of candidates were able to correctly work out the number of buses each day. Two methods were most common, finding the time between 07 10 and 22 10 as 15 hours (900 minutes) and then divide by 45 or writing a list of times every 45 minutes from 07 10 till 22 10. Both methods generally led to answers of 20 rather than 21 because most candidates did not count the first bus at 07 10.

(c) About half of the candidates were able to calculate the cost of the bus pass on 1st January 2024. Most successful candidates did it in stages, calculating the cost on 1st January 2023 and then the cost on 1st January 2024. Few candidates used multipliers (× 1.10 × 1.05) with most calculating 10 per cent of $50 and then adding it on, and then 5 per cent of $55 and adding it on. The most common error was to calculate 15 per cent of $50 ($57.50 the most common wrong answer). Many candidates gained part marks for correctly calculating $55 but then added on $2.50 rather than $2.25.

(d) (i) This question was well answered with most candidates correctly working out the number of workers in the hotel.

(ii) Candidates found working out the number of workers in B U T more challenging as many found the number of workers in the intersection ($n(B \cap T) = 9$) instead of the union. A significant number of candidates did not attempt this question.

(iii) Explaining in words what the number 85 in the Venn diagram represents was challenging to all candidates. The most common error was not to include the word 'only' in their answer.

(iv) Candidates were more successful at finding the probability that the worker travelled to work by bus and train. Most candidates gave the answer as a fraction (often as a correct follow through from a previous wrong answer), many who attempted to give it as a decimal or percentage were less successful as they rounded to 2 sig fig. rather than 3 sig fig. or did not include the per cent sign.

(e) Working out the number of single rooms proved to be one of the most challenging questions of the whole paper. Most candidates did not use the fact that the 75 represented how many more double rooms there were than single rooms. Most used the 75 as the number of double rooms or the total number of rooms by error and divided by 8 or 11 instead of 5.

Question 4

(a) (i) This question was well answered with the majority of candidates correctly finding the range as 38. Common wrong answers were 9 (not including the stem part of the number), 61 – 23 (not completing the sum) or calculating the mean.

(ii) The majority of candidates were able to find the mode as 36. Common wrong answers were 6 or 7 (not including the stem part of the number) or calculating the median.

(iii) Around half of the candidates were able to calculate the median as 40. Common errors were 39 and 41 (not identifying the number between them) or calculating the mean.

(iv) Again, around half of the candidates were able to work out the percentage of workers that were older than 40 but younger than 60. The most common error was rounding to 43.8 or 44 rather than giving the exact answer of 43.75.

(b) Candidates were successful at writing the new range, mode and median. Successful candidates kept the range the same and added 1 year to their mode and median answers. The most common error was not adding one to the mode and median.

(c) Around a third of candidates correctly completed the stem and leaf diagram. Most candidates were able to gain part marks for a partially correct diagram or correctly calculating the age of the new worker as 53. Common errors were to find the new workers age as 54 (not considering the month of birth) or not adding 1 to each of the previous numbers.

(d) Successful candidates often wrote out lists for each of the criteria given and then identifying the number which appeared in all 3 lists. Candidates who answered with a number which satisfied two of the criteria scored one mark – this was more common than the correct answer of 47. Common wrong answers were 49, 11, 29, 7 or 79.

Question 5

(a) (i) This question was well answered with most candidates identifying the angle as obtuse. Common wrong answers were acute, reflex or transversal.

(ii) The majority of candidates were able to calculate the value of angle *e* as 23 however most found giving a geometrical reason more challenging. Many gave a numerical explanation of how they found the angle rather than giving the reason. Some candidates did not meet the requirements to gain full marks by often missing the word ‘angles’ or ‘triangle’.

(iii) Less candidates were able to find the value of angle *f* as 52, many mistakenly thought it was equal to angle *e* and gave the common wrong answer of 23. Again, giving the geometrical reason proved challenging, with many giving a numerical method.

(b) Only the strongest of candidates were successful in calculating the interior angle of a regular 7-sided polygon. The most common correct method used the formula ((n – 2) × 180)/n with fewer candidates using 180 – 360/n. Many candidates found the exterior angle (51.42…) but did not subtract from 360, therefore not gaining any marks. Candidates found rounding to 2 decimal places challenging with many answers given to 1 decimal place only. Around a third of candidates did not attempt this question.

(c) Most candidates were able to find $w = 7.5$ by solving the equation $2w = 15$, however finding x proved much more challenging. Many candidates were able to form the equation $5(x + 7) = 15$ but were unable to solve it correctly. Common wrong answers were $x = 8$ or 4. Having made an error in finding x, most candidates were still able to gain marks for correctly finding y using their w and x and solving $w + x + y = 15$. A significant number of candidates did not attempt this question.

Question 6

(a) Less than half of the candidates were able to plot the correct position for point P. Common wrong answers were points plotted at (13,0) or (0,0). Around a quarter of the candidates did not attempt this question.

(b) Few candidates were able to use trigonometry correctly to calculate angle *a.* Successful candidates used Tan correctly, however a few stronger candidates were able to find the hypotenuse and then use Sin or Cos to find the angle. Over a quarter of the candidates did not attempt this question.

(c) (i) In this question common errors were not giving the direction of the rotation (90 degrees only) or giving the wrong centre. Many candidates found using the correct mathematical terms difficult with ‘turn’ seen often instead of ‘rotation’. Many double transformations were seen which gained no marks.

(ii) This part was answered poorly with most candidates unable to identify the given transformation as a translation (common wrong answers were 'translocation'. 'movement', 'shifted'). However, stronger candidates were able to give the vector, either as a column vector or in words.

(d) (i) Nearly half of the candidates did not attempt this question. Many wrong answers were seen, with the most common being 3.25.

(ii) Candidates had to use their scale factor from **part (d)(i)** to find the coordinates of triangle D, therefore all candidates that did not attempt **part (d)(i)** also did not attempt this part. Very few correct answers were seen as very few candidates were able to identify the scale factor as 7.

Question 7

(a) Only the strongest candidates were able to draw a bearing of 236 accurately and calculate the required distance from C as 7.2 cm. More candidates were successful at drawing a bearing of 236 than those that calculated the correct distance, however few were able to do either.

(b) (i) Many candidates attempted to draw this on the diagram and measure the bearing, but this often led to an inaccurate answer. Very few used the calculation 83 + 180 to find the answer, with the most common wrong answers were 277 (360 – 83) or 97 (180 – 83). Around a third of the candidates did not attempt this question.

(ii) Completing the statement proved challenging to most candidates, with only the very strongest candidates gaining full marks. Around a third of all candidates did not attempt the question.

(c) Finding the scale of the model proved equally as challenging for all candidates. Few correct answers of 1800 were seen, however many candidates were able to gain a part mark with the answer of 18 ($\frac{90}{5}$). Common incorrect answers were 450 (90 × 5) or 18 m (scales given as a ratio should not include units).

(d) Successful candidates found the scale factor of the enlargement from 9.2/5.6 and then multiplied by 8.4. This method however did cause some problems when candidates prematurely rounded the scale factor to 1.6 or 1.64 (instead of keeping it as a fraction) and then multiplied 8.4 by 1.6 or 1.64 – which led to an inaccurate answer. Fewer candidates used the ratio 8.4/5.6 and then multiplied by 9.2.

(e) Calculating the curved surface area of the tower was challenging to all. Very few correct answers were seen, however candidates were more successful at identifying the units of the answer as m^2. The most common errors involved calculating the area of the circle, calculating the circumference but not multiplying by the height of the tower or calculating the volume of the tower.

Question 8

(a) The majority of candidates were able to complete the table correctly. The common errors involved calculating the y value for $x = –3$ and $–2$ (candidates squared incorrectly and got –15 or –9 for $x = –3$ and –9 or –5 for $x = –2$).

(b) A significant proportion of candidates did not attempt to draw the graph, despite completing the table in **part (a)**. Many candidates plotted the points but did not join with a smooth curve, either using straight lines or not joining them at all.

(c) Many candidates did not attempt this question. Of those that attempted the question, most gave the x coordinate as 0 or the y coordinate as –3, from their table.

(d) Nearly half of the candidates did not attempt this question. Successful candidates often drew the line $y = 7$ and then read off where the line and the curve intersected. The most common wrong answers came from candidates writing the x coordinates of the intersection of the curve with the x axis.

MATHEMATICS

Paper 0580/32
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 0580/33
Paper 3 (Core)

Key messages

To do well in this paper, candidates needed to demonstrate that they had a good understanding of all topics in the syllabus, remembered necessary formulae, and used a suitable level of accuracy. In addition, candidates needed to ensure that they read the questions carefully and ensured that they were answering the question asked.

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

General comments

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

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

In describing a transformation **Question 3(b)**, candidates must only give one single transformation for each part, as highlighted in the question. They should not use phrases such as ‘and then moves….’ which indicates a second transformation and scores no marks.

Comments on specific questions

Question 1

(a) (i) The majority completed the bar chart correctly. Some candidates were awarded a method mark for showing the missing bars added to 15, either in their working or by drawing bars whose heights added to 15.

(ii) This part was not as successful, with many giving the incorrect answer 11, rather than the correct term, red.

(b) (i) The majority of candidates drew accurate pie charts. Candidates needed to show their working in this question as partial marks were available for correct angle values stated even when the sectors were not drawn accurately. Also, follow through partial marks were available for sectors drawn to accurately match their stated angle values.

(ii) This part was answered correctly by the majority of candidates.

Question 2

(a) (i) Many candidates found the correct time of arrival, 11 45. The incorrect answers varied widely, often with no clear working shown.

(ii) This was found challenging, but there were still a pleasing proportion of fully correct responses. Some were awarded a partial method mark for 4 ÷ 6, however it was very common for candidates to calculate the inverse of this, 1.5, and subtract 1.5 hours from 09 24. A few multiplied 4×6 and then subtracted 24 from 09 24. Both cases did not score marks.

(iii) Around half the candidates scored full marks here. The very common incorrect answers resulted from candidates who had not interpreted the question correctly and who calculated $45 \times \frac{3}{5} = 27$, either leaving the answer as 27 or adding 45 to this, resulting in the answer 72.

(b) The majority were able to find the correct cost for 1 kg of potatoes. A small proportion found the correct cost of buying the onions, \$3, but used this figure in an incorrect method, (11.25 – 3) ÷ 4.5.

(c) (i) This part, on sharing in a given ratio, was answered correctly by a very large majority.

(ii) This part, on finding 37.5% of 624, was answered correctly by a very large majority.

(iii) Another successful part with the majority of candidates managing to increase \$420 by 12% correctly. A few candidates found the correct increase, but either forgot to add it on or decreased by 12%, were awarded a partial method mark if 50.4 was stated.

Question 3

(a) Around a third of candidates were able to draw a correct enlargement of the trapezium. Others gained partial credit, usually for drawing the parallel sides to the correct length. The sloping lines caused a problem for many.

(b) (i) This part was nearly always answered correctly.

(ii)(a) The large majority recognised the transformation was a reflection and were awarded at least one mark. Many were unable to write the property $x = -1$ correctly, and answers such as –1 or $y = -1$ were quite common. Others used descriptions such as ‘flipped’ or described how the shape had moved, earning no credit.

(ii)(b) Most candidates were awarded at least one mark in this part. The large majority of these recognised the transformation but some candidates did not use the correct term, ‘translation’ and instead described the movement in words 3 right, 5 down. This only gained partial credit. Candidates must not write the property using coordinates. Terms such as ‘transition’ and ‘translocation’ were seen regularly and these did not score.

(ii)(c) Candidates found this part challenging to score full marks, but many candidates were awarded partial credit in this part, often recognising the transformation was a rotation. Some omitted the angle or the centre or spoilt the answer by adding extra information such as a further movement.

Question 4

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

(b) Similarly, in this part, most candidates gave a fully correct answer. The rest were fairly evenly split between those who were awarded partial credit because they had omitted 1 or 2 factors and those who did not score. A few candidates had drawn prime factor trees which did not score.

(c) The majority of candidates showed a correct calculation involving 3, 19 and 57 and were awarded the mark for this question.

(d) The majority gave the correct answer. The common incorrect answer was 8.

(e) This part was found more challenging with many misunderstanding the instruction and gave the answer as 16 from 40 × *16* = 640.

(f) The majority of candidates gave the correct reciprocal of $\frac{2}{3}$. The most common incorrect answer was to convert this to its decimal equivalent, 0.66.

(g) Around a third of candidates gave a correct answer and these were usually one of $\frac{2}{9}, \frac{21}{100}, \frac{11}{50}, \frac{6}{25}$ or $\frac{9}{40}$. Common incorrect answers were $\frac{1}{20}$ from subtracting $\frac{1}{4} - \frac{1}{5}$, $\frac{9}{20}$ from adding $\frac{1}{4} + \frac{1}{5}$ or $\frac{1}{4.5}$ taking the middle value from the denominators, or the decimal answer 0.23.

(h) Candidates found this part particularly challenging. The large majority gave a decimal between 9 and 10, most commonly 9.5.

(i) This was found less challenging than the previous part, but it still proved difficult. Around a third of candidates were awarded a part mark for either giving a common factor as the answer or for a correct factor list or factor tree.

Question 5

(a) (i) Just over half of candidates gave the correct answer. Some answers were slightly inaccurate and some gave the acute angle 34°. It seemed apparent that some candidates probably did not have access to a protractor and estimated the angle.

(ii) Only a few candidates gave the correct answer, reflex. The most common incorrect answer was acute, then obtuse.

(b) The majority of candidates were awarded at least one mark in this part, with either angle correctly identified in roughly equal numbers.

(c) The majority of candidates gave the correct answer. Common incorrect answers were 42 and (180 – 42 – 42) ÷ 2 = 48.

(d) The majority of candidates gave the correct answer. Candidates who did not know the angle in the semicircle was 90° sometimes assumed the triangle was isosceles and calculated $\frac{180-17}{2} = 81.5$.

(e) Around a quarter of candidates gave fully correct responses. Common errors were 180 – 171 = 9 or setting up the equation 180(n – 2) = 171.

(f) This question on trigonometry was answered correctly by less than half of the candidates. Some errors involved using the wrong ratio, cosine or tangent, and a few thought the question involved Pythagoras' theorem.

Question 6

(a) Candidates answered this part very well, with nearly all giving the correct answer. A small number of errors were made with the order of operations such as $15 + (4 + 7) \times (2 + 6) = 1320$ or those who set out the correct calculation but evaluated it incorrectly.

(b) This part was answered correctly by a very large majority of the candidates.

(c) Another part successfully answered by a very large majority of candidates. A few errors were made by those who rearranged to get $4x = 18 + 12$ or those who solved $4x = 6$ as $\frac{4}{6}$.

(d) This part was also answered very well with a majority being awarded full marks. Most of the other candidates were awarded a method mark for expanding one of the brackets correctly. The common incorrect answer was $23x – 14$ from ignoring the minus sign in front of 24.

(e) Around half of the candidates were awarded full marks. The common error was $\frac{T-6}{5}$.

(f) This was found to be the most challenging question on the paper with a minority of candidates being awarded full marks. Many candidates were able to score a part mark for an expression $x + 6$, $5x$ or $5x + 6$. Most of these did not know how to proceed and made no further progress.

Question 7

(a) (i) Just under a third of candidates indicated the correct position for the probability of $\frac{1}{6}$ on the number line. The most common incorrect answer showed an arrow pointing to the second marker, likely reflecting the number 2 given in the question, but many other varied incorrect answers were also given.

(ii) Around a half of candidates gave the correct answer. The most common incorrect answer was $\frac{4}{6}$, likely from candidates who included 1 as a prime number.

(iii) This was answered well with the majority knowing the probability was 0.

(b) The majority of candidates gave the correct probability as a fraction in its simplest form. A few scored a partial mark if they left the answer unsimplified.

(c) (i) The majority gave the correct answer. A common misunderstanding was to write a fraction out of 24 rather than 16, from counting all the squares in the table containing numbers.

(ii) This part was found challenging with many varied incorrect answers being given, either fractions or integers.

(iii) Another challenging part, with only a minority of candidates being successful. Common errors were just 3 or $\frac{13}{16}$ from giving the probability of a number being less than 10 rather than at least 10.

(d) (i) About a half of candidates were able to complete the tree diagram correctly. Many others completed the first blue disc correctly as $\frac{4}{5}$ or they completed both second red discs as $\frac{1}{5}$ and so scored a part mark.

(ii) Around a third of candidates gave the correct probability. The most common incorrect answers were $\frac{4}{5}$ from taking the probability from the tree diagram that the second disc was blue or adding $\frac{4}{5}+\frac{4}{5}$ incorrectly to equal $\frac{8}{10}$.

Question 8

(a) Around half of the candidates gave the correct answer. A common error was to multiply the three numbers given on the diagram together.

(b) Over half of the candidates gave the correct answer. Those candidates who started by setting out the equation $\frac{1}{2} \times b \times 4.5 = 15.3$ nearly always reached the correct answer. The common incorrect answer was 3.4 from those who forgot to deal with the $\frac{1}{2}$ in the formula for the area of a triangle.

(c) Over a third of candidates gave the correct answer. A common error was to calculate the diameter or to give the answer correct to 2 significant figures instead of 3 and these candidates were given partial credit. Some candidates started with an incorrect formula for circumference of a circle $(2)\pi r^2$ or they only calculated 58.6 ÷ 2 neither of which scored.

(d) About half the candidates scored full marks in this question showing they were able to find the correct shaded area. Many others were able to make some progress by finding the area of the rectangle and/or the area of a circle or semicircle and hence many partial marks were awarded in this question.

Question 9

(a) Just under half of the candidates gave the correct equation of the line $y = 4x + 3$. Many varied incorrect answers were given. These included $y = 3$ and $y = 7$ appearing regularly.

(b) Candidates who set out clear working tended to be successful, but this was a minority. Many did not know how to approach this question, often giving an incorrect answer with little or no working. A very common error was made by those who started with the correct equation $5 = 2 - 6a$ but rearranged this incorrectly as 5 – 2 = 6a leading to the answer of 0.5.

(c) (i) The majority of candidates completed the table with the correct values.

(ii) The majority of candidates scored full marks for a correct curve and many others were able to draw a reasonably good curve or plot most points accurately. It was quite common for candidates to use a ruler to join some of the line segments on the graph rather than draw a good freehand curve. These candidates were not awarded full marks.

(iii) This part was found particularly challenging with the majority unable to write the equation for the line of symmetry.

(iv) Around a third of candidates gave the correct answer. It was common for candidates to include the value of x for the negative point of intersection along with the positive value. Incorrect answers varied although 0 and 6 appeared regularly.

MATHEMATICS

Paper 0580/41
Paper 4 (Extended)

Key messages

Candidates sitting this paper need to ensure that they have a good understanding and knowledge of all the topics on the Extended syllabus. A number of candidates did not offer any responses to many of the parts and some candidates missed out whole sections.

Candidates generally showed a good level of working but the importance of showing methods that are being used cannot be underestimated. Often candidates would have similar incorrect final answers but only those whose working could be seen and followed could be awarded method marks.

General comments

Candidates should be careful with accuracy. Many candidates are working to 2 significant figure accuracy, which is not sufficient. All calculations should be worked out to enough significant figures, so that final answers are accurate to at least 3 significant figures.

Many candidates show multiple attempts when answering questions, but it should be clear which of their attempts they require to be marked. If none of the methods lead to the answer line, all attempts will be marked and the attempt with the lowest mark will be the mark awarded. This can often have a detrimental effect on the candidate's score. Others routinely cross out their working throughout the paper and this sometimes leads to a possible correct solution being overlooked if several are offered. Candidates should also try to work down the page and from left to right. Some candidates write solutions which go all over the answer space, and this makes it difficult for examiners to follow their method.

The 'show that' questions on this paper are **5(a)(ii), 6(b)(i), 6(b)(ii)** and **7(b)(i)**. Questions that ask candidates to 'show' results require rigour within the solutions and no errors can be made. Candidates are expected to start with the given information and arrive at the value or result that is asked to be shown, ensuring that every step is explicitly shown.

Comments on specific questions

Question 1

(a) (i) Under half of all candidates answered this question correctly. Common errors included inaccuracies when copying the numbers, dividing the numbers the wrong way round, finding the answer as a fraction rather than a percentage and giving the answer inaccurately as 4.5 or 4.54.

(ii) A good number of candidates were able to gain one mark for evidencing some simplification of the ratio. The simplest starting point was to divide the three numbers by 1000 and simplify from there. Common errors included miscopying of the original numbers, not simplifying far enough or simplifying beyond the simplest form so that decimals, rather than integers, were seen in the ratio. A common approach that did not score was to divide each of the three given numbers by their total.

(iii) Whilst this question could be worked out by using the actual areas of the countries, and a considerable number attempted this, it was much easier to work out the answer using only percentages. The starting point was to find 30% and then calculate 30% of $43\frac{1}{3}$%. Some candidates used the correct method but approximated $43\frac{1}{3}$% to 0.433 and lost the accuracy mark.

Very common errors included merely adding together 60% + 10% + $43\frac{1}{3}$% or working out $43\frac{1}{3}$% as $43 \times \frac{1}{3} = 14\frac{1}{3}$%.

(iv) A fair number of candidates answered this part correctly. Common errors included multiplying the area of the rain forest by $\frac{27}{50}$ or $\frac{23}{50}$ or $\frac{50}{23}$ and a large number of candidates lost the final mark because they did not attempt to round to the accuracy required. Other errors included answers which used percentages and were either 100 times too big or too small and calculator errors or slips when copying numbers.

(v) There were a good number of correct answers seen. The most common errors usually had the omission of one of 60 or 24 in the calculation and others used 360 or 52×7 for the number of days. Whilst many were credited for 31 903 920, this was not always converted into standard form or was written either with an incorrect power or with less than 3 significant figure accuracy or for example as 31.9×10^6. Candidates using an incorrect method often scored one mark for converting *their* answer correctly into standard form.

(b) There were some correct answers to this part and most candidates showed at least one correct upper or lower bound for 6440 or 4400. Common errors included adding on or subtracting off 10 and 100, rather than half of these amounts, using both of the upper (or lower) bounds or dividing rather than subtracting the values. Some candidates found the difference of the original numbers and either gave this as their answer or attempted to apply bounds to this answer.

Question 2

(a) (i) Most candidates correctly reflected the triangle. The most common error was to reflect the triangle in the y-axis.

(ii) Most candidates translated the triangle correctly. The most common error was to translate the triangle by the wrong number of units in one of the x and y directions.

(iii) Fewer candidates answered this part correctly. Many recognised that the triangles dimensions should be halved but either drew the triangle in the wrong position or used a scale factor of $+\frac{1}{2}$ rather than $-\frac{1}{2}$.

(b) A minority of candidates answered this part correctly. The majority of candidates worked out $10 \times 3 \times \frac{2}{5} = 12$ taking no account that enlarging the area needed to use the square of the scale factor for each part of the enlargement.

Question 3

(a) (i) Most candidates correctly evaluated C. The most common incorrect answer was 400 from $\frac{1}{4} \times (5 \times 8)^2$.

(ii) This part was answered well by many candidates. However, there were a significant number of candidates who made errors when isolating y^2. These errors almost always saw candidates subtracting the $\frac{1}{4}$ and /or 2.4 from 15, rather than dividing them into 15. Less common errors included misreading 2.4 as 24 and forgetting to square root 25.

(b) Most candidates used the correct common denominator of $(x - 1)(2x + 5)$ and set up the numerator correctly as $4(2x + 5) - 3(x - 1)$. The most common errors arose from the $-3(x - 1)$ term, when candidates either did not have brackets or did not remove the brackets correctly, with the 3 frequently becoming -3 or -1. Other errors included having the numerator round the wrong way as $3(x - 1) - 4(2x + 5)$, reaching $\frac{4(2x+5)-3(x-1)}{(2x+5)(x-1)}$ but cancelling the brackets to give $4 - 3 = 1$, slips with arithmetic and slips when multiplying out the brackets in the denominator, which was not required. Candidates who did not score had often simply added the numerators and denominators.

(c) A fair proportion of candidates answered this part correctly. Most candidates knew they needed to multiply out a pair of brackets and then multiply that result by the third bracket. Candidates who first multiplied out $(2x + 3)(4 - x)$ were usually more successful than those starting with $(4 - x)^2$, the latter often forgetting the middle terms and having $16 - x^2$ or $16 + x^2$.The most common errors were slips with signs, arithmetic and powers of x. A minority of candidates did not use a correct process, and these tended to attempt to multiply out the three brackets in one go.

(d) A minority of candidates solved this efficiently using a variety of approaches. Some started by dealing with the negative power to get $\left(\frac{16x^{16}}{y8}\right)^{\frac{3}{4}}$ and then dealt with the power of $\frac{3}{4}$ whilst others were able to successfully deal with the power of $-\frac{3}{4}$ on each of the 3 terms in one go. To score full marks candidates were required to simplify answers such as $\frac{y^{-6}}{\frac{1}{8}\times x^{-12}}$ to $\frac{8x^{12}}{y^6}$ or $8x^{12}y^{-6}$.

Common misconceptions included changing the power of $-\frac{3}{4}$ to $\frac{4}{3}$ when dealing with the negative power, finding $16 \times \frac{3}{4} = 12$ rather than $16^{\frac{3}{4}} = 8$, cancelling $\frac{x^{12}}{y^6}$ to $\frac{x^2}{y^1}$, and not recognising that the power also operated on the 16.Those who started by cubing all the terms were usually not successful.

Question 4

(a) (i) Many candidates gave the correct value for the median. The most common incorrect answers were 9.25 from misreading the scale and 9.5 which was seen coming from calculations such as $\frac{6+13}{2}$.

(ii) Many candidates gave the correct interquartile range. The most common incorrect answer was to give the range 11.6–8.2 without evaluating it.

(iii) Some candidates answered this question correctly. Most were able to select the required times of 6 and 13 and many were able to go on and calculate the difference in speed, often first in m/s. However, candidates were not always able to then convert to km / h. Premature approximation and lack of a clear method were evident in many solutions. Those who converted from seconds to hours, before using speed, frequently gave statements such as 6 s =0.0017 h which was not sufficient without showing $\frac{6}{3600}$ or 0.00167 as a minimum level of rounding. A common misconception was to subtract the times before finding the speeds.

(b) (i) Many candidates gave the correct class interval for the median. The most common incorrect answer was $400 < d \le 420$, which was the middle of the three classes.

(ii) This part was answered well, with the majority of candidates working out the mean correctly, supported by clear working. A minority of candidate used the lower- or upper-class bounds, rather than the mid interval value, but with a method shown, they were often able to score some marks.

(iii) A small minority of candidates answered this part correctly. Many candidates gave the answers 5.2, 7.6 and 8.4, which were found by multiplying the frequencies by $\frac{2.8}{7}$ without taking into consideration that the class intervals were different size widths.

(iv) A minority of candidates answered this correctly. Others scored only two marks because they did not consider that the cars could be chosen in either order or did not multiply by 2. Other errors included calculating products using 'replacement' with denominators all being 80 and adding rather than multiplying the fractions. It was rare for a candidate not to score at least one mark for writing down $\frac{20}{80}$ or $\frac{7}{80}$.

Question 5

(a) (i) Many candidates gave the correct vector. Common errors included finding the vector in the opposite direction, namely $\overrightarrow{QP}$, adding the coordinates, slips with arithmetic and slips with signs. A few candidates including a fraction line within their vector which was not allowed.

(ii) Being a 'show that' question, solutions needed to have no errors to score full marks and a fair number of candidates achieved this. The most common error was writing $\sqrt{5^2 + -5^2}$, without brackets around the -5. Others made no progress with this part and were unable to score.

(iii) Some candidates answered this correctly but not all of these recognised that the radius was found in the previous part, with many starting again. However, most candidates were able to state the formula for the area of a circle but had either no value or an incorrect value for the radius, so did not score. Common incorrect values used for the radius came from the length, or half the length, of the chord *PQ*.

(iv) This part was well attempted with some correct answers given and evidence of $\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right)$ being used. Others scored one mark for one correct value. The most common incorrect answers were, for example, (2, –6) from $\left(\frac{x_1 - x_2}{2}, \frac{y_1 - y_2}{2}\right)$ and reversed answers, namely, (1, 3).

(v) A small proportion of candidates gave the correct equation of the line. Most candidates were able to find the gradient of *PQ* but not all went on to find the gradient of the perpendicular. Others reached $y = \frac{1}{3}x + c$ but did not recognise that the previous part gave them a coordinate on this perpendicular. A minority of candidates used previous parts and recognised that the perpendicular bisector passed though the origin and were able to give the line directly, but this method was not expected.

(b) A small minority answered this correctly and those that did, had usually drawn a clear diagram, used vector notation correctly and showed clear routes and methodology to find the position vector of *M*. Other made little or no progress with few being able to complete a full diagram, write down a route for $\overrightarrow{OM}$ or state $\overrightarrow{AB} = b - a$. A common incorrect answer was $\frac{2}{5}a + \frac{3}{5}b$ which came from the ratio of *AM:MB*.

Question 6

(a) Less than half of the candidates answered this correctly. Common incorrect answers included 235 which was found using the reverse bearing from *H* as 180 + 55, wrongly assuming that *HB* was north.

(b) (i) Most candidates showed angle *CBH* = 100 by clearly evidencing 180 – 25 – 55. To score the mark both of 25 and 55 needed to be seen together with a subtraction from 180.

(ii) The majority of candidates used the sine rule to set up an implicit equation to find *BH*. Many then successfully rearranged this to find an explicit calculation for *BH*. Some substituted the values for sin100 and sin25 before rearranging and these candidates were often at risk of premature approximation. The most efficient method was to use the calculator once to evaluate $3^3 x - 2 - 2$, to at least 2 decimal places in order to show that *BH* = 13.7 to 1 decimal place as required.

(c) Many candidates recognised that the cosine rule was needed to find an angle within triangle *ABH* although it was not always clear that candidates knew which angle they were finding. Some used unnecessarily longer methods such as the cosine rule for angle *BAH* and then the sine rule to find angle *ABH*. Having found angle *ABH*, not all candidates added 190 to it to find the bearing. Common errors included errors in stating the cosine formula, errors in substituting into the formula and errors in evaluation, with $A^2 + b^2 - 2abccosB$ being evaluated as $(a^2 + b^2 - 2ab)cosB$. Some candidates wrongly tried to use right angle trigonometry.

(d) (i) There were some good answers to this question. Marks were mainly lost due to lack of accuracy when calculating $\frac{32}{10 \times 1.852}$ = 1.727… with candidates often using 1.7 or 1.72. Other errors included not multiplying by 10, using an incorrect formula for time, such as distance × speed or $\frac{\text{speed}}{\text{distance}}$ or finding the correct time interval but not giving the arrival time. Others gave the time incorrectly, such as 2.44 when 2.44 pm was required.

(ii) A small minority of candidates answered this correctly. Others recognised the position of the boat but found its closest distance to *B* rather than its distance from *H* at that point of time. Incorrect answers included those that assumed the boat was at the midpoint of *CH* and others who found the distance *BC*.

Question 7

(a) (i) Most candidates were able to show the area of one side of the box but not all found the total surface area correctly as there were often errors with the numbers of each side. Some found the surface area of a closed box and others had more than 2 of some of the sides. Others had correct methods but made calculation errors with statements such as 40 × 30 = 120 frequently seen. A minority found the volume of the box.

(ii) Only a small proportion of candidates attempted to answer this question using the correct method of fitting whole cylinders into the box. Whilst some of these scored full marks, others scored one mark for answers such as 18 from $\frac{30}{15} \times \frac{40}{20} \times \frac{70}{15}$ = 18.6. The majority of candidates used calculations involving π, whether it be for surface areas or volumes. An extremely common incorrect answer was 23 which came from dividing the volume of the box by the volume of a cylinder.

(b) (i) This was a more challenging 'show that' question. Only a small minority of candidates scored full marks by showing rigorously that the radius was 2.993…and thus 2.99 correct to 3 significant figures. Most candidates scored one mark for showing volume = $\frac{750}{8.9}$ but few could get much further. Candidates needed to use the given ratio to replace *h* by 3*r* in the formula for the volume of a cone, which is $V = \frac{1}{3}\pi r^2(3r)$. Many simply replaced h with 3×2.99 and went onto find r thus using the 2.99 to find 2.99.

(ii) This was a complex part, but some candidates showed excellent solutions, with clearly set out calculations and retention of accuracy, to score full marks. Other candidates found the curved surface area but omitted to include the circular base and others were only able to find the area of the circular base. Candidates often attempted to use the given formula but with inaccurate figures for the slant length. Where no workings were shown these candidates could not score. However, if these candidates had shown use of Pythagoras, their method may have been rewarded despite the lack of accuracy. Others incorrectly used the height of the cone as the slant height.

Question 8

(a) This question expected candidates to substitute x=0 into the equation to find the y intercept and factorise $x^2 + 7x - 18 = 0$ to find the x intercepts, which some candidates did successfully. Often with these marked on the axes a smooth parabola was drawn though the symmetry was not always correct, and the minimum was frequently drawn at (0, –18), rather than to the left of the y axis. Other candidates completed a table to find coordinates, labelled all the axes and attempted to draw the curve by plotting points. This was not required and more often than not resulted in graphs that were not a smooth shape. Other candidates were able to draw a graph with a parabolic shape and score one mark, although candidates should be careful of the curvature at the ends and make sure the graph does not come back in on itself.

(b)(i) Many candidates were able to correctly give the derivative. Although candidates were not penalised in this question for poor notation, candidates should write $\frac{dy}{dx} = 3x - 2$ rather than $Y = 3x - 2$.

(ii) Fewer candidates knew to set their derivative to zero to find the correct turning point. Other candidates did not use their derivative but were successful in using the completing the square method, although this was less efficient in this case. Others tried to factorise the equation, and some completed a table of coordinates, neither of which was helpful.

(c) A minority of candidates answered this question with clear and detailed workings. Some scored most of the marks but did not evidence correct use of the quadratic formula for finding the x values, which was required for full marks as was accuracy to 2 decimal places as asked for in the question. Some candidates reached $x^2 - x - 33$ but could not recall accurately the quadratic formula and got no further. As in previous parts, some candidates attempted to accurately plot the two equations and made no real progress. Others never equated the two equations so, despite trying various methods with the two curves separately, were unable to score.

Question 9

(a)(i) It was extremely rare for a candidate not to find f(3) correctly.

(ii) Many candidates found gf(3) correctly.

(b) Many candidates were able to correctly find the inverse function. Most candidates started by swapping the x and y in the function to $x = 6 - 2y$ and then rearranging. Common errors were not dividing every term by 2 or sign errors when moving terms across the equal sign or forgetting to switch x and y. Other errors included just reversing the signs in g(x) giving $g^{-1}(x) = -6 + 2x$ or confusing the inverse function with reciprocal resulting in $g^{-1}(x) = \frac{1}{6 - 2x}$.

(c) A good number of candidates answered this part correctly**.** Errors that were seen included sign errors in the simplification of $6 - 2(2x - 7)$ and slips with signs and arithmetic when solving $4x + 1 = 6 - 4x + 14$. Some candidates were unable to set up the correct equation, some simply writing $4x = 1 = 2x - 7$ and others trying to rearrange $f(x) = g(2x - 7)$ to find x in terms of f and g. Also seen were $g(x) = 6 - 2x(2x - 7)$ and $g(x) = (6 - 2)(2x - 7)$.

(d) Many well answered this question. Some candidates showed excellent algebraic work in being able to write hh(x) = $3^{3^{x-2}-2}$, although this was not required as an easier approach was to first evaluate h(2) and then find hh(2). Errors included writing $3^{-1} = 0.3$ and the misconception that hh(2)=h(2)h(2).

(e) Unless candidates understood that $h^{-1}(x) = 10$ can be rewritten as $x = h(10)$ this part was almost impossible for candidates to solve. However, a number of candidates were successful and reached x = 6561.

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 *n*th 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 $3^{3\times2} = 729$.

(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.

MATHEMATICS

Paper 0580/43
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 with only the final answer rounded to the appropriate level of accuracy. Candidates should show full working with their answers to ensure method marks are considered when final answers are incorrect.

General comments

There were some very good scripts in which candidates demonstrated an expertise with the content and proficient mathematical skills. However, there were some poorer scripts in which a lack of expertise was clear and a lack of familiarity with some topics resulting in higher numbers of incorrect responses. The standard of presentation varied considerably. For many scripts it was generally good, however there were occasions when a lack of clear working made it difficult to award some method marks.

Some candidates changed answers by overwriting one digit with another making it difficult to determine the intended answer. There was no evidence that candidates were short of time, as most candidates attempted nearly all the later questions. Premature rounding resulted in some candidates losing a number of marks.

Comments on specific questions

Question 1

(a) (i) Almost all candidates calculated the correct total. Most errors involved numerical slips in calculating one of the two products.

(ii) Many correct answers were seen. Errors usually involved a lack of accuracy in the final percentage, often resulting from too few figures. Some candidates found the cost of running the club as a percentage of the sum of the running cost and the membership fees.

(iii) More able candidates had no difficulty in applying reverse percentages to find the correct number of members in 2022. The most common error involved increasing 120 by 4 per cent leading to 124.8, which was often rounded to 125, and this earned no marks.

(iv)(a) Those candidates that understood what was required almost always obtained the correct number of members in 2024. Most opted to set up an equation of the form $\frac{50+x}{70+x}=\frac{14}{19}$ and solved it correctly. Very few opted to scale up the ratio 14:19 until a common increase in adult members and child members was found. Weaker candidates used the fact that the numbers of members in 2023 had a factor of 10 and so scaled up 14:19 to give the common wrong answer of 330.

(b) Candidates were more successful in this part, and many calculated a correct percentage. When the previous part was incorrect some were able to follow through correctly from the previous answer. Following on from incorrect answers often involved percentages greater than 100. In the case of the common incorrect answer of 330, some found that this was 275 per cent of 120 and gave this rather than the increase of 175 per cent. Others would calculate the percentage increase as 175 and subtract 100 to give an increase of 75 per cent.

(b) (i) Many candidates had a good understanding of exponential increase and found the correct population at the end of 3 years. Weaker candidates often calculate the decrease after 1 year and multiplied this by three leading to a common wrong answer of 2275.

(ii) This was well answered by many candidates, usually using a trial and improvement method. Those with an incorrect method in the previous part almost always continued with the same method and did not obtain a correct answer.

Question 2

(a) (i) Almost all candidates used the nth term correctly to find the 4^{th} term of the sequence.

(ii) Many correct answers were seen. Weaker candidates tended to make more errors in this part, usually when rearranging their equation, often leading to $n^3 = 1091$.

(b) Most candidates found the fifth term of the exponential sequence with answers given as a decimal, fraction or in standard form.

(c) A majority of candidates provided correct solutions to all parts of the table. Sequence A had the highest success rate with some responses for the *n*th term left in non-simplified form. Candidates were just a little less successful with sequence B, especially when it came to finding the *n*th term. Rather than treat the fraction as two separate sequences, some worked with the fraction as a whole and attempted to find a pattern in the differences. Sequence C proved the most challenging with fewer correct answers for the *n*th term. Many attempted to use the difference method but were not always clear on how to proceed after finding the second differences of 2.

Question 3

(a) Many candidates had no difficulty in finding all three statistical measures. For the mode a value of 6 was a common error. The most common error for the median was 3.5, simply finding the median of the six possible scores. Errors with the mean sometimes resulted from slips with the numeracy and occasionally some gave the answer 10, the mean of the six frequencies.

(b) (i) Most candidates were able to set out their calculations clearly and went on to obtain the correct value of the mean. Occasionally some candidates made slips, either with a midpoint or with the numeracy work. Some candidates mistakenly use the interval boundaries or the interval widths in an otherwise correct method. Those that made errors in completing the table were able to earn credit for a correct method. In some responses candidates gave their answer without showing all or any working, risking losing some or all of the marks if their answer is incorrect.

(ii) Those candidates with a good understanding of histograms had no difficulty in calculating the height of each of the remaining bars. Almost as many were unsuccessful. Using a scale factor of 0.3, from the first bar, and finding the heights of 21.6 and 5.4 was the most common error. Others divided the upper or lower bound by the frequency and some gave random values without any method shown.

Question 4

(a) Most candidates made a good attempt at this question and a majority were able to show the desired result. In many cases, candidates showed clear algebraic manipulation from setting up the initial equation to reach the final form without any errors. Most opted to use the formula $\frac{1}{2}ab\sin C$ with a few using $\frac{1}{2} \times b \times h$ after using trigonometry to find the height. As this was a show questions candidates were expected to show the use of sin 30 before replacing it with $\frac{1}{2}$. Other errors included the omission of brackets and sign errors.

(b) Most candidates tackled this in the expected way by using the quadratic formula. Some chose to calculate the discriminant separately and substituting its value into the formula. There were occasional slips when substituting, especially with the value of $c = -6$. A less common approach involved completing the square, usually attempted by the stronger candidates. Some failed to fully evaluate their answers and only gave a surd form while others failed to show any working, losing all the method marks in the process.

(c) Nearly all candidates made use of their positive answer to **part (b)** and attempted a perimeter calculation, and many correct answers were seen. Some were unable to link their answer to the previous part to this part and only gave an answer of $4r + 4$. Others found the area of the square rather than the required perimeter.

Question 5

(a) (i) Many candidates were successful in interpreting the graph to give the value of f(2). A common error was solving the equation $f(x) = 2$.

(ii) Many candidates were successful in solving the equation $f(x) = 5$. Misreading the scale was a cause of many of the errors seen.

(iii) Many candidates gave a correct value of k with most errors resulting from a misinterpretation of the graph.

(iv) A clear majority of candidates were able to identify the y-axis as an asymptote to the curve. Tangent was the most common error with root and perpendicular also seen.

(b) (i) Many correct straight lines were seen. Common errors included lines with gradient 2 from misreading the scale and lines with a y-intercept of +2.

(ii) Almost all candidates with a correct straight line gave a correct value of x for the point of intersection with the curve.

(c) This proved more challenging and fully correct solutions were in the minority. Most of the candidates that attempted the question understood the need to use integer coordinates from the graph and substitute them into the given function to show that $c = 2$. As this was a show question it was not acceptable to replace c with 2 and attempt to show that for a chosen value of x, they were able to get the correct value for y. A very high proportion of candidates made no attempt at a response.

(d) Only the stronger candidates were successful when answering this question. Most of them were able to find the values of p and q correctly with the occasional slip with a sign when rearranging. Many of the other candidates did not realise that they needed to replace c with 2, equate $x^2 - \frac{2}{x}$ and $x - 2$, and then rearrange to the given form. Some equated the given form with $x - 2$, others substituted values of x in the given form trying to obtain two simultaneous equations, all without any success. A high proportion of candidates made no attempt at a response.

Question 6

(a) Most candidates applied Pythagoras correctly to the triangle and obtained the correct length for the ladder. Some gave insufficient figures in their answer, and some gave the answer in surd form.

(b) Most candidates applied the tangent ratio correctly to find one of the acute angles. Some candidates used less efficient methods by first finding the length *VW* and then using either the sine or cosine ratio. Most of the candidates with a correct angle went on to give a correct bearing. Some were unsure of how to proceed, and a variety of calculations were seen, for example 90 ± their angle and 180 ± their angle.

(c) Many fully correct solutions were seen. Most candidates opted to use the sine rule to find *AB* and were then able to find the perimeter. Some chose less efficient methods such as finding *BD* and applying the cosine rule to find *AB*. Others drew a perpendicular from *D* to *AB* and used a combination of Pythagoras and trigonometry to find *AB*. These less efficient methods often resulted in inaccurate final answers due to premature rounding of intermediate values. Some of those that found *BD* then included it their perimeter calculation. Others assumed that the triangle *ABD* was isosceles.

(d) This proved more challenging than the previous part and fewer fully correct solutions were seen. Stronger candidates had a good understanding and were able to apply the cosine rule to find *PR* and then using it to find the required angle. As in the previous part, premature rounding of *PR* led to inaccuracies in the angle *PQR*. Some recognised that the cosine rule was required but used the rule incorrectly, sometimes omitting the 2, replacing the – with + or using sin 110 instead of cos 110. The negative value of cos 110 also led to errors. A few assumed SPQR was a cyclic quadrilateral and angle PQR = 180 – 110 = 70º was a very common error.

Question 7

(a) (i) Many candidates displayed a good understanding of speed and calculated the correct time in minutes. Leaving the time in hours and dividing the speed by the distance were the common errors.

(ii) This proved more challenging and fewer fully correct answers were seen. The stronger candidates demonstrated a good understanding of lower bounds and showed clear working in obtaining the correct time. Others had the correct idea for the calculation but did not use the correct lower bound for the distance and/or the correct upper bound for the speed. Some mistakenly thought they needed to use the lower bounds of both the distance and of the speed.

(b) This was quite a demanding question and only the more able candidates obtained a correct answer. Their solutions often demonstrated excellent algebra skills and a sound knowledge in the manipulation of fractions and different units of speed. Most candidates attempted to find the distance travelled in each part of the journey and equate their sum to 240. Having found a correct equation some went on to solve it correctly. In cases where this did not happen, it was mainly due to a lack of expertise in dealing with the fractions correctly.

A significant number of candidates were unable to set up a valid equation, although some had a correct expression for at least one of the two distances. Some candidates completely misunderstood the question and thought that each part of the journey was for 240 km thus setting up two equations. Others formed a fraction such as $\dfrac{240}{100 \times \frac{t}{60} + 110 \times \frac{t+60}{60}}$ with no equation seen.

Others used speed ÷ time when they needed speed × time = distance.

Question 8

(a) (i) This proved more challenging and fully correct solutions were in the minority. Some fully correct methods were seen but premature rounding of some of the interim values meant that some candidates lost accuracy in their final answer. Calculating the curved surface area of the cone proved the biggest stumbling block with many candidates using the perpendicular height of the cone rather than using Pythagoras to calculate the slant height. Most were able to correctly calculate the curved surface area of the cylinder. Another common error was forgetting to include the area of the circular end, although some candidates included two, and sometimes three, circular ends. Several candidates used incorrect values for pi, such as 3.14 or $\dfrac{22}{7}$.

(ii) This proved less demanding, and candidates were more likely to obtain the correct volume. Errors were often due to using an incorrect height for one or both parts of the solid. Some did not include the volume of the cylinder in their calculation.

(iii) This proved more challenging and fully correct solutions were in the minority. Many candidates could not make the link with the volume of the solid found in the previous part. Those that did usually went on to obtain the correct volume of the empty space. Many restarted, working from the dimensions of the box and working out the radius of each solid before calculating its volume, usually incorrectly, by treating it as a cylinder of length 17.5 cm. Others attempted to calculate the area of the cross-section for the empty space and stopped there.

(b) Another challenging question with only a small majority of candidates correctly calculating the volume of the smaller solid. Many of those with an understanding of similar solids gave clear and concise working. Those with little or no understanding were unsure of how to approach the question and a variety of fractions were seen, sometimes raised to a power of 2 or 3 and sometimes square rooted or cube rooted. The most common error involved $450 \times \dfrac{98}{200} = 220.5$.

Question 9

(a) (i) Almost all candidates gave the correct probability.

(ii) Again, almost all candidates gave the correct probability.

(b) Many correct answers were seen. Some candidates missed the statement that the first card was replaced. Weaker candidates made a variety of mistakes such as $\frac{2}{7}\times\frac{1}{7}$, adding the denominators rather than multiply and giving the answer as $\frac{2}{7}$.

(c) (i) A small majority of candidates had no difficulty in finding the correct probability. Many others had not considered the two ways in which this event could occur and gave the common incorrect answer of $\frac{2}{7}\times\frac{1}{6} = \frac{1}{21}$. Some candidates added the probabilities instead of multiplying. Some weaker candidates gave the answer as $\frac{2}{7}+\frac{1}{7}=\frac{3}{7}$.

(ii) Candidates were less successful in this part and only a minority of correct answers were seen. The correct answer generally came from $1 - 2 \times \frac{2}{7}\times\frac{1}{6}$ with some candidates mistakenly using either $1 - \frac{2}{7}\times\frac{1}{6}$ or $1 - 4 \times \frac{2}{7}\times\frac{1}{6}$. Some candidates attempted a sample space, but these were rarely complete or correct. Others attempted to consider the ways in which the two letters could be different, and a series of products could be seen which were often incomplete. A significant number of candidates made no attempt at a response.

(d) Candidates found this very challenging and correct responses were in the minority. Many appeared to guess the value of n as working was missing or not related to the answers. Stronger candidates often checked the probability of an A for different values of n, usually starting with $n = 1$ or 2. Others showed random fraction work and others gave answers that were not integers. A high proportion of candidates made no attempt at a response.

Question 10

(a) Those candidates that understood the terminology used in the question almost always differentiated the function correctly with only a few candidates making an error in one part of the derivative. It was evident that many of the weaker candidates did not understand the terminology as many made no attempt, some factorised or rearranged the given equation and others gave random algebraic expressions. In **part (b)** a significant proportion of these went on to differentiate the function correctly.

(b) This proved more challenging and only the stronger candidates were successful. Most recognised the need to substitute $x = -1$ into the equation of the curve to find the y-coordinate of the point. Many made sign errors when dealing with the –1 incorrectly, such as evaluating -1^6 instead of $(-1)^6$. Some recognised the need to find the gradient of the tangent but not all linked this with using the derivative, often finding the gradient of a chord instead. Having reached this point successfully, some made sign errors when trying to find the equation in the form required. A significant number of candidates made no attempt at a response.

(c) Candidates fared a little better in this part and a greater number of correct answers were seen. Most attempts involved equating the derivative to 0. Some candidates had no difficulty in factorising and finding the two x-coordinates, but some were unable to factorise correctly. Some decided they needed to do further differentiation and the number of derivatives often reached four or five. Having found the correct x-coordinates most had no difficulty in finding the corresponding y-coordinates. Some weaker candidates equated the equation of the graph to 0 rather than the derivative. A high proportion of candidates made no attempt at a response.

Question 11

(a) The more able candidates recognised that the ratio of the angles was the same as the ratio of arc lengths. Some recognised that the minor arc was $\frac{3}{10}$ of the circumference and so angle *x* was $\frac{3}{10}$ of 360. In a similar way, some found the angle of the major sector before finding angle *x*. Most candidates opted to set up an equation involving the full formulae for the lengths of the two arcs. Not all cancelled the obvious terms which led to some getting tied up with some large numbers resulting in some unnecessary errors. A significant number of candidates made no attempt at a response.

(b) (i) Those who knew both the formulae for area of a triangle and the area of the sector of a circle were nearly always successful. Errors included using $2\pi r$ instead of πr^2. There was some confusion on which side of the equation to include the $\frac{1}{2}$. Errors in the simplification process were seen and some candidates provided insufficient working for a 'show that' question. Some candidates extended the radius *OB* out to join a perpendicular from *A*. This led to solutions that involved $\sin(180 - y)$ and thus a leap to $\sin y$ which was often not understood. Others drew a perpendicular from *O* to *AB* resulting in an expression for the areas involving half angles. A high proportion of candidates made no attempt at a response.

(ii) This proved less demanding, and most candidates completed the table correctly. Many slips were seen, the most common being the omission of the zeros for 341.00. Some candidates omitted the .00 for 341.00 or forgot to round up to 1. Other rounding errors were seen and these included writing 341.17 instead of 341.18 and 341.50 instead of 341.49.

(iii) Those candidates that realised they were completing a trial and improvement method for finding the value of *y* almost always gave the correct value. Many others did not understand what was required in this question as demonstrated by the high number of worded answers such as: 'wrong'; 'equal'; 'right'; 'not accurate'.