Qualification Accredited

Examiners' report

GCSE

MATHEMATICS

OCR Level 1/Level 2 GCSE (9-1) in Mathematics

J560

For first teaching in 2015

J560/06 Summer 2025 series

Version 1

Contents

Introduction

Our examiners' reports are produced to offer constructive feedback on candidates' performance in the examinations. They provide useful guidance for future candidates.

The reports will include a general commentary on candidates' performance, identify technical aspects examined in the questions and highlight good performance and where performance could be improved. A selection of candidate responses is also provided. The reports will also explain aspects which caused difficulty and why the difficulties arose, whether through a lack of knowledge, poor examination technique, or any other identifiable and explainable reason.

Where overall performance on a question/question part was considered good, with no particular areas to highlight, these questions have not been included in the report.

A full copy of the question paper and the mark scheme can be downloaded from Teach Cambridge.

Paper 6 series overview

J560/06 is a calculator paper and is the third and final paper sat by Higher tier GCSE (9-1) Mathematics candidates.

To do well on this paper, candidates should be confident and competent in all of the specification's content. They also need to be able to use and apply standard techniques (AO1), reason, interpret and communicate mathematically (AO2) and solve problems within mathematics and in other contexts (AO3).

The breadth of content examined and the distribution of marks allocated to AO1, AO2 and AO3 are consistent with the J560/04 and J560/05 papers.

Questions 1, 2, 3, 4, 6, 8 and 9 were also set on the Foundation tier Paper J560/03.

Candidates were very well prepared for this paper. A few candidates achieved 90+ marks, and there was strong performance from all on many of the 3 and 4-mark questions in the middle of the paper.

Many candidates made good attempts at the 5 and 6-mark questions, often getting at least half marks. As in previous series, some candidates did not set their work out clearly, and, particularly on multi-step problem solving questions, solutions were often scattered over the page. This was particularly the case with Question 7 and Question 25; these could be tackled using a variety of mathematical methods and candidates often switched from one method to another without crossing anything out, so that often the result was candidates not actually making valid progress with any method.

Candidates of all abilities struggled with questions requiring a comment or explanation, either having trouble expressing themselves clearly or with mathematical precision. For some that achieved 90+ marks, it was these questions requiring a written response where they missed marks.

As mentioned in previous reports, some candidates would benefit from greater consideration of the number of marks allocated to a question, the amount of working space provided and the question's position within the paper.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• attempted all questions • demonstrated good calculator skills, such as using indices, roots and trigonometry functions correctly • maintained accuracy when using an interim answer and evaluated formulae accurately • performed almost all standard techniques and processes accurately • understood information presented in words or diagrams and used correct notation and terminology when presenting their own mathematical arguments • set out work clearly and in an orderly manner • chose the most appropriate and efficient method in cases where there was a choice • crossed out redundant working that was abandoned in reaching their answer • showed all the stages in their working, particularly in questions worth 3 or more marks.	• did not use formulae correctly, even if it was given on the formulae sheet or within the question • did not always use a calculator, often using inefficient non-calculator methods that commonly lead to arithmetic errors • rounded values too soon while working through a method, leading to a lack of accuracy in final answers • made errors in performing routine processes • misinterpreted questions and information, or did not follow instructions • had limited competency and/or confidence in applying algebraic techniques • used methods that were inefficient or inappropriate, such as trial and improvement rather than more formal mathematical processes • did not show all steps in working, particularly when answering questions that stated 'show your working'.

Assessment for learning

Both parts of Question 9 required students to use their algebra skills and were both answered extremely well. These involved solving a linear equation with the unknown on both sides and solving a three-term quadratic by factorising.

However, in other questions, many candidates consistently had difficulty using algebra in context or in solving relatively simple equations that include a power.

Depending on the method used, candidates may have encountered the equations below in this year's paper and in each case the common error was to attempt to take the root first rather than isolating the unknown first.

$6x^2 = 36\pi$ (Question 10)

$1352 = P(1 + \frac{4}{100})^2$ (Question 11)

$10x^2 = 70$ (Question 21)

$98b^3 = 84$ (Question 23)

Higher tier candidates in particular are likely to encounter equations similar to these across the question papers, so they are worth practising.

Question 1 (a)

1 A fair four-sided dice is numbered 3, 4, 5 and 6.
The dice is rolled twice and the two scores are multiplied together.

(a) Complete the table to show all the possible outcomes.

First roll

	×	3	4	5	6
Second roll	3		12	15	18
	4	12	16	20	24
	5	15	20		30
	6	18	24	30	

[1]

The first question was responded to very successfully. It was extremely rare for this mark not to be given.

Question 1 (b)

(b) Find the probability that the outcome is a multiple of 8.

(b) .... **[2]**

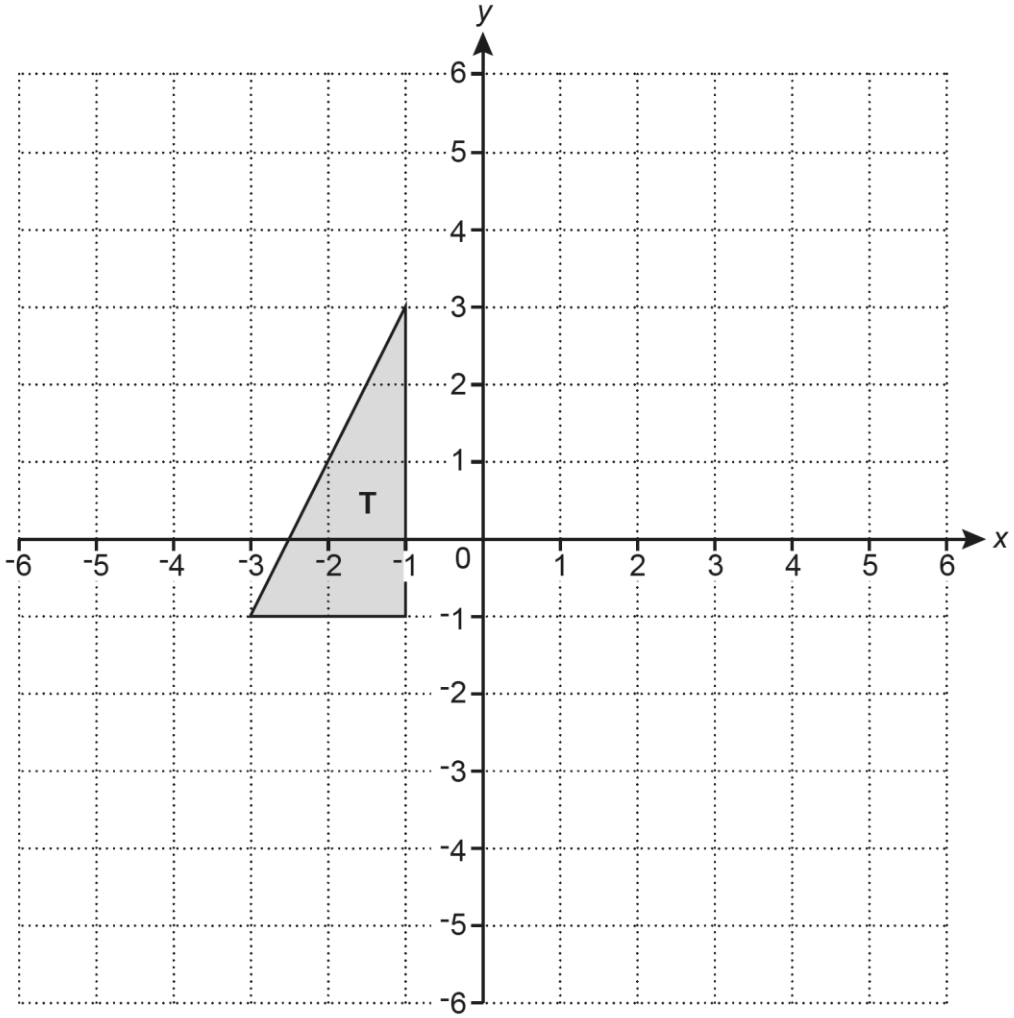
Most candidates gave the correct answer of $\frac{3}{16}$ here, or the decimal equivalent.

If a candidate made an error in part (a) and had an incorrect table, follow-through was given here. For example, if the candidate had 24 in their table where they should have had 25, they would pick up the full 2 marks here for responding with $\frac{4}{16}$ (or equivalent).

Candidates could pick up 1 mark for identifying the multiples of 8 in their table or using their count of the multiples as the numerator in $\frac{\textit{their}\ 3}{n}$ where $n \geq 13$.

Question 2

2 Triangle **T** is drawn on a coordinate grid.



Translate triangle **T** by vector $\begin{pmatrix} 3 \\ -2 \end{pmatrix}$. **[2]**

Almost all candidates drew the correct translation.

Very occasionally, the translation in either the *x*-direction or the *y*-direction was incorrect, getting B1.

The most common error was to confuse the *x* and *y*-components. Very rarely, the triangle was drawn with an incorrect dimension.

Question 3 (a)

3 **(a)** The price of a laptop is reduced in a January sale from £450 to £382.50.

Work out the percentage reduction in the price of the laptop.

(a) .... % **[3]**

This question was answered very well, more so than similar past questions.

There were many correct answers. Finding the price change first and then finding this as a percentage of the original amount (i.e. $\frac{450 - 382.50}{450} \times 100$) was probably the most common method. Others found $\frac{382.50}{450}$ first.

A few candidates found the price difference of 67.50 and then attempted non-calculator methods to identify what percentage of 450 it could be, e.g. 10% of 450 = 45, so 5% of 450 = 22.50 and hence 15% of 450 = 67.50. In this question, it was relatively easy to identify that 67.50 was 15% of 450, but questions may use values that aren't so easy to identify, and candidates are recommended to use more direct calculator methods where possible.

Those that had a correct method that would lead to 0.15 or 15 yet made a calculation error could pick up M2, or, for errors in a method that would lead to 0.85 or 85, they could pick up M1.

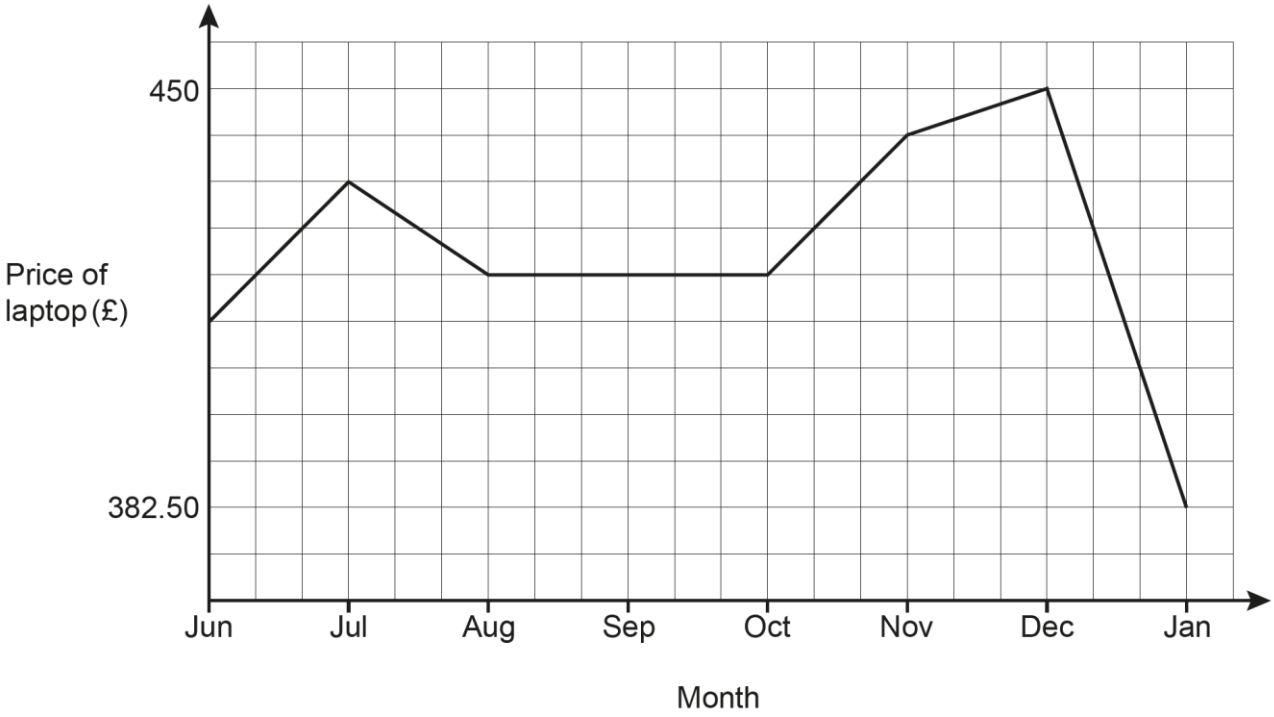
A few candidates found the price change as a percentage of the sale price instead of the original price. This is a conceptual error and was not given credit.

Assessment for learning

Candidates should be discouraged from using non-calculator methods on a calculator paper. Here the values could be determined relatively easily, but, in many similar questions, non-calculator methods are much less likely to work and risk candidates coming away with no marks and/or spending far longer than intended on a question.

Question 3 (b)

(b) The graph shows the price of the laptop in the months before the January sale.



Explain why this graph is misleading.

....

.... **[1]**

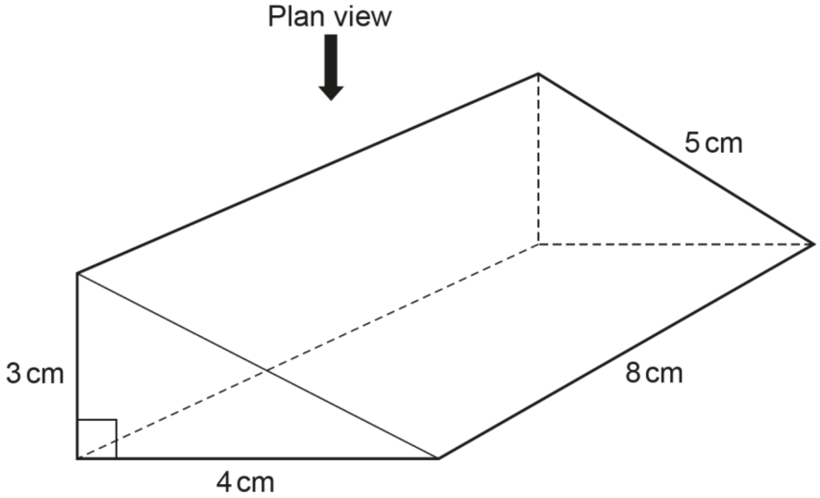
Few candidates got this mark. Most made comments about a lack of scale, difficulty in reading values or comments about the months.

Very few candidates commented that it was the prices that did not start at zero. Many comments lacked specificity and could not be credited with the mark, for example saying that 'it' or 'the graph' did not start at zero without clarifying what they were referring to. Candidates often referred to the vertical axis as the '*y*-axis', which was condoned.

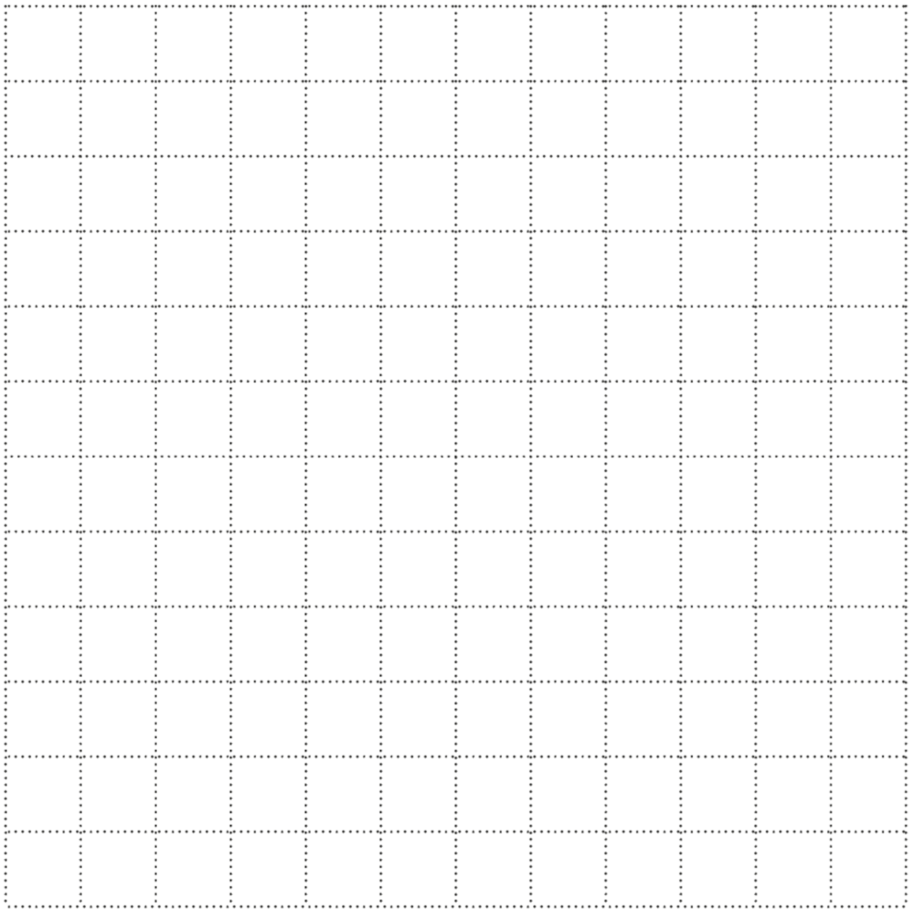
Candidates could also correctly respond by saying that the scale exaggerated the price reduction, but this was only given occasionally.

Question 4

4 The diagram shows a prism of length 8 cm.
The cross-section of the prism is a right-angled triangle.



Draw an accurate plan view of the prism on the one-centimetre grid below.



[2]

Almost all candidates correctly drew a single rectangle, but roughly the same number of candidates drew an 8 cm by 5 cm rectangle (B1) as drew the correct 8 cm by 4 cm rectangle. Rectangles with other dimensions were rarely seen.

A few rectangles were seen with extra lines inside. Some included an elevation as well (and some included nets and 3D drawings, but these were very rare); if a candidate gives multiple responses to a question, examiners cannot select the correct response for them and so these received 0 marks.

Question 5

5 A teacher asks their class which of the following values is the smallest.

2^{-1} 4^{-3} 10^{-2}

One student says

2^{-1} is the smallest because 2 is smaller than 4 and 10.

Explain the error made by the student in their **reasoning** and write down the smallest value.

The error is: ....

....

.... The smallest value is .... **[2]**

Many candidates explained how *they* found the smallest value themselves, rather than commenting on the error in the student's reasoning; this could not pick up the mark, although they could still get 1 mark for the answer 10^{-2}. Some explanations indicated the candidate incorrectly thought that the smallest power would give the smallest value, accompanied with an answer of 4^{-3}.

Explanations given the mark were usually along the lines of 'the student has not considered the powers'.

Question 6 (a)

6 A kitchen has space for a fridge.

(a) The width, w, of the space is 70 cm, correct to the nearest centimetre.

Complete the error interval for the width, w.

(a) .... $\leqslant w <$ .... **[2]**

Most candidates gave the correct error interval.

Occasionally wrong answers such as $69 \leq w < 71$ or $65 \leq w < 75$ were seen.

Almost all candidates appeared familiar with the terminology and notation.

Question 6 (b)

(b) A fridge is advertised as having a width of 69.5 cm, correct to 1 decimal place.

Show that this fridge may **not** fit in the space. **[2]**

Candidates often made this more difficult than was needed.

The most commonly seen correct answer was simply 'space = 69.5 cm, fridge = 69.54 cm'. These values fit the description of the intervals for the space and the fridge, are unambiguously assigned and satisfy the requirement that the fridge may be wider than the space.

Often an error interval for the fridge (which was not required) was given, followed by '69.5 < 69.55'. Although this is a true mathematical statement, it is not clear what the values represent in the context of the question. For example, it could be part of their working for the fridge's error interval.

Candidates frequently gave 69.55 as their value for the fridge, despite writing '< 69.55' elsewhere. This was given B0, but the B1 for a valid and assigned value for the width of the space could still be accessed.

Question 7

7 Each member of a tennis club is classed as a junior, an adult or a senior.

- 16% of the members are seniors.
- The ratio of the number of juniors to the number of adults is 9 : 5.
- There are 95 more juniors than seniors.

Work out the **total** number of members of the tennis club.
You must show your working.

.... **[6]**

Many of the candidates got the full 6 marks here, although an almost equal amount were given 0 marks. Almost all candidates attempted the question. However, unproductive calculations using 84, 16 and 95 were common.

Multiple valid methods were used by candidates; six of them are seen in the mark scheme, but there also were a number of variations and also hybrid methods combining two or more of them.

Some candidates attempted several methods yet didn't progress any of the very far. When abandoned attempts are not crossed out, determining a candidate's final response can be a challenge. This question also had the request 'You must show your working', which meant that supporting working for the final method used needed to be identified.

By far the most common and most successful method was the main one written into the mark scheme. The breakdown of 84% into the ratio 9 : 5 was crucial here and while many found the required 54% and 30%, some or all of the working '$\frac{100-16}{9+5} \times 9$' and '$\frac{100-16}{9+5} \times 5$' was frequently omitted. At this point, there was a split between the candidates; those who knew how to deal with the information that there were 95 more juniors than seniors would invariably reach a correct final answer (by calculating that 54 – 16% is 95 members, so 1% is 2.5 members and 100% is 250 members). Many others, however, found 54% and 30% and then stopped, often restarting using another method.

Less common, yet equally successful, was the method of finding the quantity of ratio parts for 16%. This mirrored the main scheme to a large extent but led to a ratio of 9 : 5 : $\frac{8}{3}$ rather than 54 : 30 : 16. The main challenge with this method was the presence of recurring decimals in the working, which often led to inaccuracies.

Methods using algebra were far less successful and also often involved recurring decimals. Setting up the equations using the information provided was a challenge, with confusion seen in defining the variable (total members, number of juniors, etc.). Often percentages were mixed in with algebra, for example 's = 16%' and 'j = 16% + 95' instead of '$s = 0.16t$' and '$j = 0.16t + 95$'. Correct final answers via an algebraic route were rare; however, one or two correct equations were often seen and could be given part marks.

Using trials was fairly common. Some showed no clear strategy to choosing their values to trial and seemed to be making guesses for what to use. Attempts often amounted to a page of numbers with little clear working seen, which, in a question requiring working to be shown, could rarely be given credit. There was frequently a lack of evidence of checking that a proposed answer satisfied all the information given in the question.

Exemplar 1

$\cancel{Sa}$.S = 16%

$= \frac{16}{100}$

9+5 = 14

14 parts = 84%

1 part = 6%

9x6 = 54% are juniors

54-16 = 38% = 95 j~~a~~rs

1% = 2.5

2.5x100 = 250 ~~m~~ members

This is a concise and efficient solution that can be easily followed and marked. It shows the most common and successful method used. It contrasts with many others seen that filled the whole page with various scattered attempts and workings.

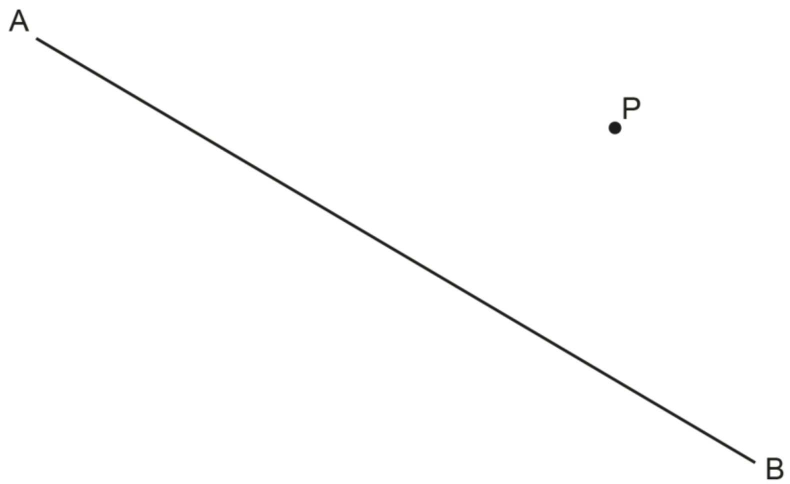
There is a 'You must show your working' requirement. There are two stages to the full solution and the minimum requirement for 'correct working' was seeing either M1 or B1 in the first stage and then also M1.

The first stage is to divide 84% into 14 parts, which they do correctly and then identify that one part represents 6% of the members (getting M1 for the first stage). This is then multiplied by 9 to find the percentage of the members that are juniors (increasing the mark on this first stage to M2). Very unusually, it should be noted that this candidate does not trouble themselves with finding the percentage that are adults, which isn't actually needed to find the total number of members. Some candidates took a risk in not showing full working in this stage, but, if they found both 54% and 30%, they were given B1, thus satisfying the 'correct working' criteria for the first stage.

This candidate then calculates the difference between the percentage of juniors and the percentage of seniors to be 38% and notes that this represents 95 members, leading to 1% representing 2.5 members (getting M1 for the second stage). Some candidates then calculated the number of juniors (2.5 × 54) and/or adults (2.5 × 30) and/or seniors (2.5 × 16), but this candidate efficiently goes straight to the total by multiplying by 100 (increasing the mark on this second stage to M2).

Question 8

8 Construct the perpendicular from the point P to the line AB.
Show all of your construction lines.



[2]

About half of the candidates gave a correct response here and picked up 2 marks.

Several construction methods were seen. The two that were most common were (I) drawing an arc from P that intersected line AB in two places, then drawing intersecting arcs from those two points, effectively producing a rhombus, or (II) an arc centred on A and drawn through P, which intersects twice with an arc centred on B and drawn through P, effectively producing a kite.

Some candidates constructed the perpendicular bisector of AB and then drew a parallel line through P. If this line through P was perpendicular to AB, then 1 mark was given. Candidates who bisected angle APB received 0 marks.

Question 9 (a)

9 (a) Solve.

$8x - 11 = 6x + 3$

(a) $x =$ .... **[3]**

Most candidates got full marks here.

Candidates' presentation of working for this type of question seems to be evolving. It was quite common to see a pair of long parallel lines drawn downwards, one line either side of the printed '='. Additional '=' symbols were then written between the lines for each subsequent row of working. Looping arrows with (for example) '+ 11' were often written on each side to show the process that was taking place. This seemed to work very well for candidates and meant that they were showing formal algebra.

Some candidates left out the '=' symbols, however, and this led to incorrect working. For example, the row $2x – 14$ was sometimes seen and then followed with an answer of $x = {}^{-}7$. If such a candidate had used '=' symbols, they might have had $2x – 14 = 0$ instead, then leading to the correct $x = 7$.

Candidates who chose to move all terms (both x terms and constant terms) to the same side of the equation were noticeably less successful than those who gathered them on separate sides.

Question 9 (b)

(b) Solve by factorising.

$$x^2 + 15x - 16 = 0$$

(b) $x =$ .... or $x =$ .... **[3]**

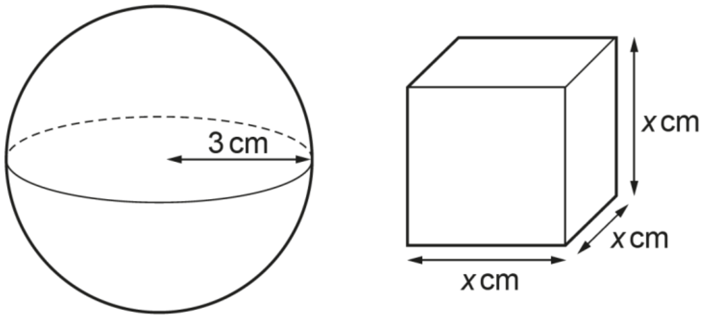
Almost all candidates demonstrated that they knew what was required here and many were successful.

The most common incorrect factorisations were $(x - 16)(x + 1)$ and $(x - 1)(x - 15)$. Neither qualified for M1, but B1FT was given if they followed these with the correct solutions for the factorisation.

A few used the quadratic formula. The question states 'by factorising', so the factorisation needed to be given.

Question 10

10 The diagram shows a sphere with radius 3 cm and a cube with side length x cm.



The surface area of the sphere is equal to the surface area of the cube.

Work out the side length, x cm, of the cube.
You must show your working.

[The surface area, A, of a sphere with radius r is $A = 4\pi r^2$.]

.... cm **[5]**

Most candidates correctly calculated the surface area of the sphere as 36π or a value in the range 113 to 113.143, with many staying in exact form. This got B2.

This was then equated to the surface area of the cube. Most who gained full marks used an equation such as $36\pi = 6x^2$, but others worked in two steps by first finding the area of one face and then the side length, which was usually successful.

Some that reached $36\pi = 6x^2$ incorrectly took the square root before dividing by 6. Others had a correct equation such as $36\pi = 6 \times x \times x$, but simplified $x \times x$ to be $2x$.

Other errors in the surface area of the cube were to miss out the '6' and just use x^2 (leading to $36\pi = x^2$), while some didn't have the x^2 and simply divided the surface area of the sphere by 6, 3, 4 or 12. Many mistakenly used the volume of a cube and had $36\pi = x^3$, so 4.83 was a common wrong answer.

Question 11

11 Amit invests some money at a rate of 4% per year compound interest.
After 2 years the value of Amit's investment is £1352.

Work out how much money Amit invested.

£ .... **[4]**

Most candidates answered this correctly. Incorrect attempts using simple interest or repeatedly subtracting 4% of 1352 were not too common.

The most efficient and successful method came from realising the problem was equivalent to a reverse percentage question and going straight to $\frac{1352}{1.04^2}$. Some candidates performed the equivalent calculation in stages one year at a time, so $\frac{1352}{1.04} = 1300$ followed by $\frac{1300}{1.04} = 1250$.

Candidates who used the compound interest formula often made errors, with 1352 commonly being substituted as P, or 1.04 substituted as r. Some made processing errors by taking the square root of both sides as a first step.

Some correctly reached 1250 but missed a mark by subtracting it from 1352 and giving the amount of interest earned as their answer rather than the amount invested.

Question 12

12 You may use these kinematics formulae to answer this question.

$$v = u + at$$
$$s = ut + \frac{1}{2}at^2$$

where a is the constant acceleration, u is the initial velocity, v is the final velocity, s is the displacement and t is the time taken.

A particle has an initial velocity of 2 m/s.
After 6 seconds the particle has a velocity of 11 m/s.
The particle had constant acceleration.

Work out the distance the particle has travelled in the 6 seconds.

.... m **[4]**

There were many fully correct answers; however, many candidates seemed insufficiently familiar with the equations.

Common errors included confusing u and v or incorrectly rearranging $v = u + at$ before substitution. Those who substituted first were generally more successful in finding the acceleration than those who rearranged first.

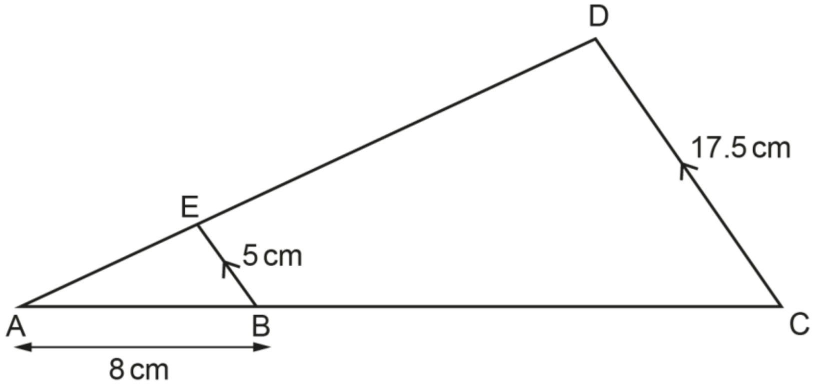
When using the second equation, common errors were calculating/writing $s = 2 \times 6 + \frac{1}{2} \times (1.5 \times 6)^2$ or substituting in unsupported values for a (including 0).

Some correctly reached $s = 39$ but then multiplied 39 by 6 (presumably believing s was speed) and spoilt their method.

Two alternative methods were seen that candidates used successfully. The first was to sketch a velocity-time graph and then find the area underneath it; this is a trapezium and so led to $\frac{2 + 11}{2} \times 6$. The second was to approach it as 'average speed' × time, which led to the same calculation.

Question 13

13 The diagram shows two similar triangles, AEB and ADC.



Not to scale

AB = 8 cm, BE = 5 cm and CD = 17.5 cm

Work out the length of BC.

BC = ... cm **[3]**

Candidates answered this well.

The usual method was to find the scale factor from BE to CD as 3.5, then multiply this by 8 to reach 28 for the length of AC. An alternative method to find AC was to work out the scale factor from BE to AB as 1.6, then multiplying 17.5 by this.

Many candidates gave the length AC (28 cm) as their final answer and so only got M2. They should have subtracted length AB from this, to give a final answer of 20 cm.

A few candidates assumed the triangles were right-angled and then used Pythagoras' theorem or trigonometry. The diagram states 'not to scale', and, if measured, there are no right angles anyway. If the triangles were right-angled, the right-angle symbol would have been used. Candidates responding in this way received 0 marks.

Assessment for learning

Candidates should not make assumptions about diagrams that are 'not to scale'. In particular, if a right angle is present, then it will normally be stated in the question and/or indicated on the diagram.

Question 14

14 $16\,807 = 7^5$.

Write 16 807 000 000 as a product of its prime factors.

.... **[3]**

Similar questions have been set in the past and there were many correct answers here this year. However, despite the mark tariff and the limited working space, lengthy factor trees were still common and were the cause of many incorrect answers.

Candidates should recognise that 16 807 000 000 is 16 807 × one million, so the given 7^5 will form part of the answer (answers including 7^5 picked up at least B1). One million is 10^6, which is $(2 \times 5)^6$ and this is $2^6 \times 5^6$, which forms the rest of the answer. Some candidates made a slip in the number of zeros but could still pick up B1 for this part of the answer if they had 2 and 5 in their answer both with the same power.

Assessment for learning

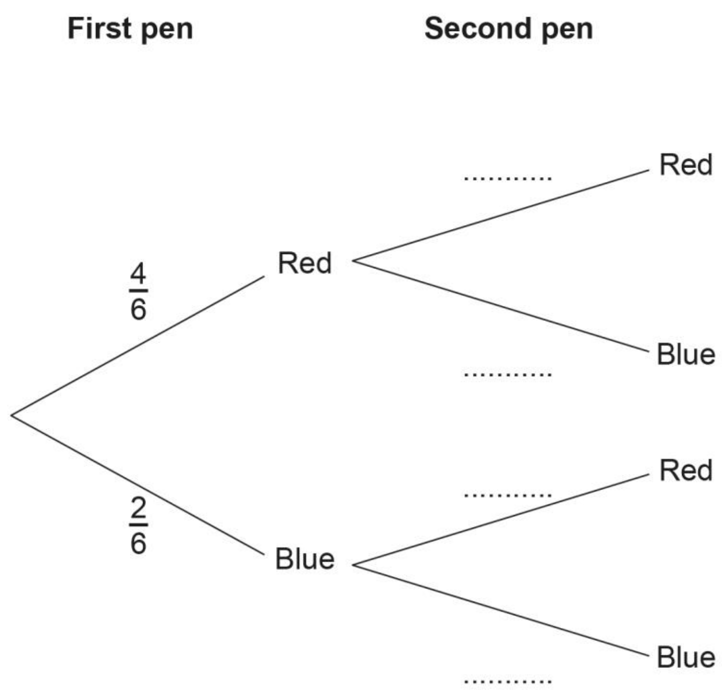
Candidates should be encouraged to consider the number of marks and amount of working space given. A low/medium mark allocation and limited working space are usually good indicators that there is an efficient method available.

Question 15 (a)

15 A packet of 6 pens contains 4 red pens and 2 blue pens.

A pen is taken at random from the packet and is not replaced.
A second pen is then taken at random from the packet.

(a) Complete the tree diagram.



[2]

Most candidates answered this part correctly.

A few responded as if the first pen was returned to the packet and so had denominators of 6, resulting in 0 marks here.

Question 15 (b)

(b) Find the probability of taking two pens of the same colour.

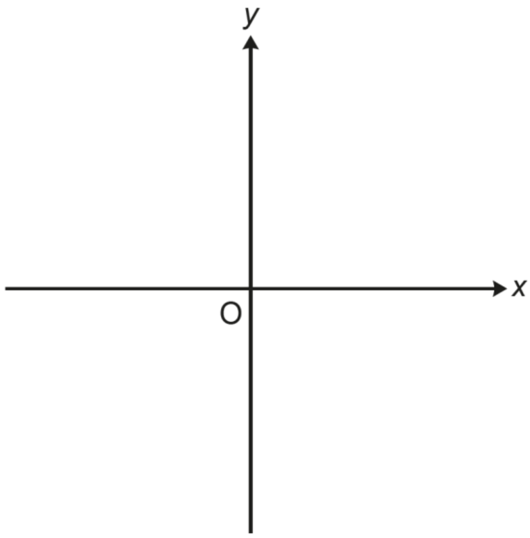
(b) .... **[3]**

Most candidates multiplied their probabilities for the correct two options and then added their two products together. The method marks were follow-through, so those who had made errors in part (a) could still pick up M1FT for one correct product or M2FT if they found both products correctly and added them.

A few candidates worked out the two products correctly, but then either multiplied them together or calculated their mean. These candidates received M1 only.

Question 16 (a)

16 **(a)** On the axes below, sketch the graph $y = {}^{-}x^2$.



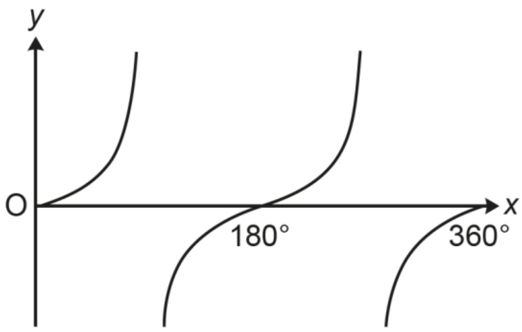
[2]

Many candidates struggled here. While quite a few responded well and were given 2 marks, 1 mark was often given because the turning point was too far from the origin (even with a bit of tolerance given). The graph was not sufficiently symmetrical in the y-axis, or it had poor curvature. Examples are included in the appendix of the mark scheme.

Graphs of $y = {}^{-}x$, $y = x^2 + c$, $y = x^3$ and $y = {}^{-}x^3$ were common and picked up 0 marks here.

Question 16 (b)

(b) Write down a possible equation for the graph sketched below.



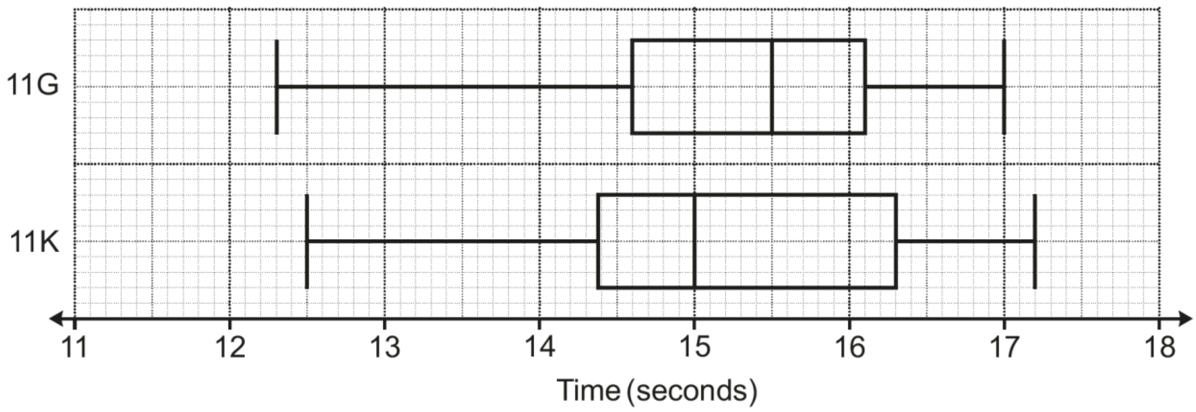
(b) $y =$ .... **[1]**

The intended answer was $y = \tan x$, but $y = \tan\theta$ was accepted.

Common wrong answers were $y = \tan$ (a numerical value), $y = \tan$, $y = \cos x$ and $y = x^3$.

Question 17 (a)

17 Two Year 11 classes, 11G and 11K, record their times for a race.
The box plots show the distribution of the times, in seconds, for each class.



(a) Write down the percentage of students in **11G** who took longer than 14.6 seconds.

(a) .... % **[1]**

Nearly half of the candidates gave the correct answer of 75%.

There were many different incorrect answers including 100% and 25%, but also others where it wasn't as clear to see how they were obtained. 51% was seen quite often and this came from $\frac{\text{max} - \text{LQ}}{\text{range}} = \frac{17 - 14.6}{17 - 12.3}$.

Question 17 (b)

(b) Which class, 11G or 11K, was fastest on average?
Include values to support your decision.

Class .... because ....

....

.... **[2]**

A roughly equal number of responses got 1 mark here as got 2 marks. Almost all of these referred to the median or average, but those that got 1 mark usually did not give values as requested.

Some chose 11G but could still get 1 mark if they gave correct median values.

Answers that got 0 marks often compared quartile values or the interquartile range.

Question 18

18 Sasha creates a four-digit passcode.

They use four digits from 0 to 9.
They do not use any digit more than once.

Work out how many of the possible four-digit passcodes are even.

.... **[4]**

This was another question where some candidates attempted multiple different methods and left it to the examiner to determine exactly which work led to the final answer. This question was less 'routine-based' than other questions, and the responses suggested candidates generally found it challenging.

Successful candidates usually started with 10 possibilities for the passcode's first digit, 9 possibilities for the second digit, etc., leading to 10 × 9 × 8 × 7 = 5040. This picked up M2. Candidates should have then divided this by 2 (because only half of the passcodes will be even), although some gave 5040 as their final answer.

Some reached 5040 but then divided it by 4 or multiplied it by $\frac{4}{9}$ or $\frac{4}{10}$ (the latter perhaps from thinking that a passcode ending in 0 would not be even). 5040 was also seen as the denominator of a fraction, with another product such as 5 × 4 × 3 × 2 as the numerator.

While many recognised that a product was needed, candidates often struggled to identify the values to use. 10 × 9 × 8 × 5 was common and this was one of several that were given SC1 for identifying the first three values. Some candidates thought that there were nine possible numbers for each position of the passcode, while others thought there were only five or four possibilities (4 × 3 × 2 × 1 = 24 was quite a common wrong answer).

An alternative method that was seen occasionally was fixing the passcode's fourth digit as even, then looking at the different combinations of odd and even for the first three digits. The approach was inefficient, and omissions were common; solutions of this type needed to be well-organised to have any degree of success.

Candidates occasionally misinterpreted the question and produced solutions involving probabilities. These answers generally did not score well.

Candidates who did not use products and attempted to list all the passcodes did not succeed (there were 2520 of them to be found).

Assessment for learning

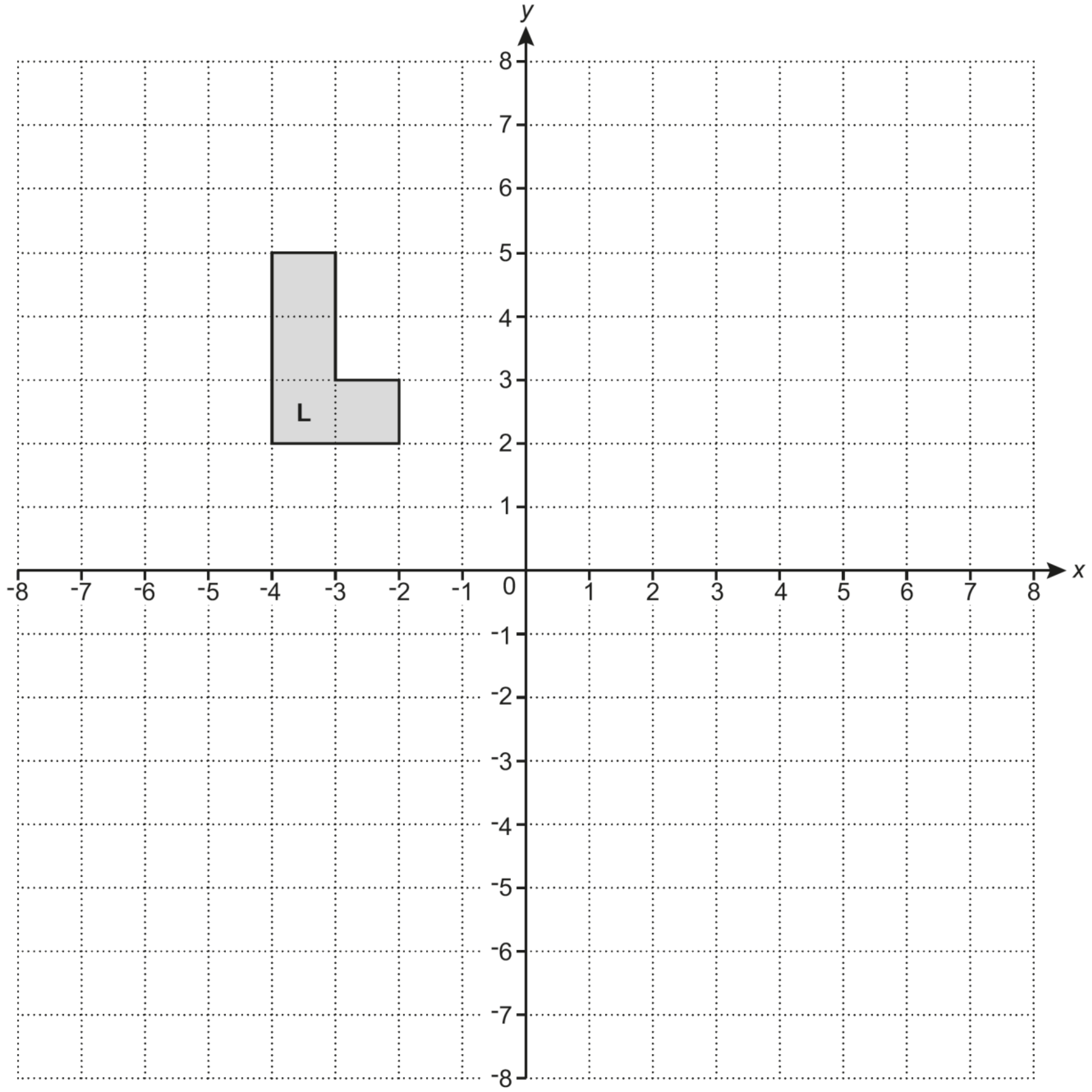
Candidates should be encouraged to consider the placement of questions on the paper. For questions on combinations, if listing is a viable method, then the question would likely appear early in the paper. If a combinations question appears later in the paper (such as this Question 18), it would more likely be testing the Higher tier topic of using the product rule.

Misconception

Many candidates did not realise that an even number can end in 0.

Question 19

19 Shape **L** is drawn on the grid.



Enlarge shape **L** with scale factor $^{-}2$ and centre of enlargement at $(^{-}1, 2)$. **[3]**

Quite a few candidates picked up full marks. A few had the correct size and orientation but in the wrong position (picking up B2), or the correct orientation yet incorrect size (picking up B1). Those with an incorrect size had most commonly used a scale factor of $-\frac{1}{2}$.

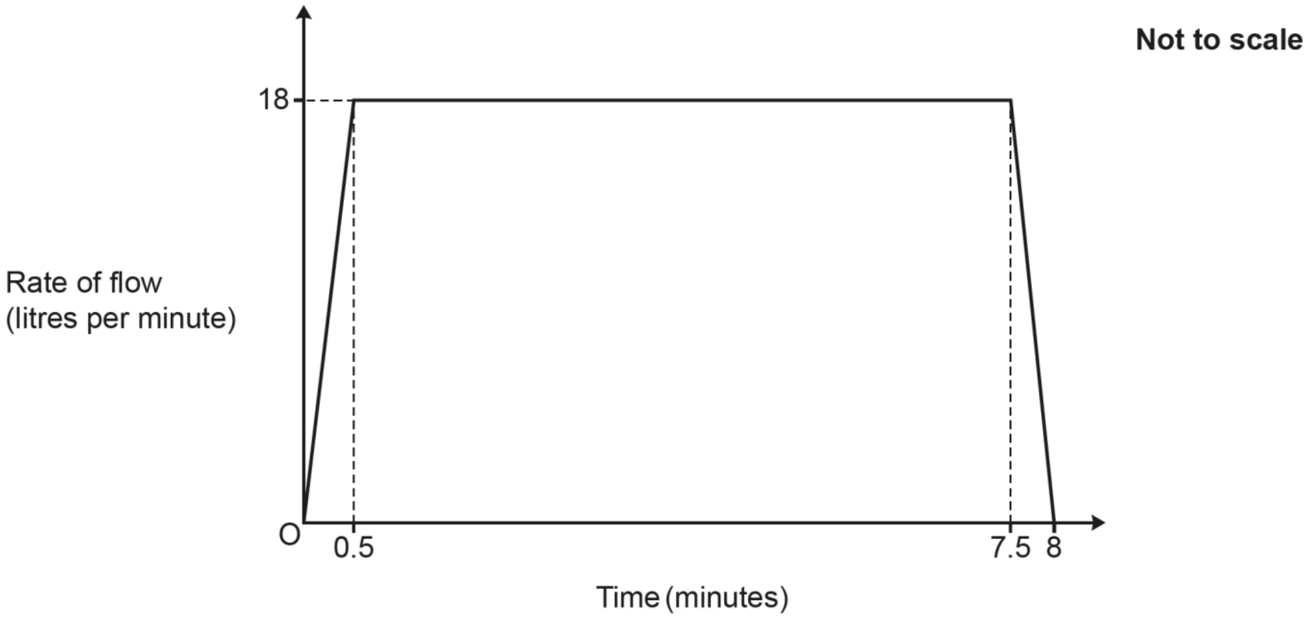
Most candidates showed little evidence of working and so probably answered by counting squares. Those that drew rays sometimes had accuracy errors in their construction, leading to their image being out of tolerance.

Most candidates appeared unfamiliar with a negative scale factor. Many enlargements using a scale factor of 2 or $\frac{1}{2}$ were seen.

Question 20 (a)

20 A container takes 8 minutes to be filled with water.

The graph shows the rate of flow, in litres per minute, of the water into the container during the 8 minutes.



(a) Show that 126 litres of water flows into the container between 0.5 minutes and 7.5 minutes. **[1]**

Most candidates picked up this mark, with full working showing (7. 5 – 0.5) = 7 followed by 7 × 18 = 126.

A few candidates had a first step of 7.5 × 18 = 135 and then subtracted 9 to reach the required 126, without any indication of where the 9 had come from. This could be a valid method (the area of the 7.5 × 18 rectangle – the area of the initial 0.5 × 18 triangle would show the required flow), but the 9 needs to be justified with a calculation such as $\frac{1}{2}$ × 0.5 × 18 or similar.

A few gave a method that used the value that they were asked to show, for example 126 ÷ 18 = 7. In 'Show that…' questions, candidates should be discouraged from using the value that they are trying to show; however, in this question, these candidates could still pick up the mark if they related their answer (e.g. 7) to the context of the question.

Question 20 (b)

(b) Work out the average rate of flow, in litres per minute, of water into the container during the 8 minutes.

(b) .... litres per minute **[4]**

Quite a few candidates had no problem with this part, but many struggled to find the area of the trapezium. Most broke the trapezium down into a rectangle and two triangles, but the triangles often caused problems, and candidates commonly found the area of each to be 9. This led to the common wrong area for the trapezium of 144, but if this was then divided by 8 to get an average rate of flow then a special case mark was given.

Some found the area under the graph and then stopped, either not realising they needed to go further or were not sure how to proceed.

Question 21

21 The graph of $y = {}^{-}3x$ intersects the graph of $x^2 + y^2 = 70$ at two points.

Work out the exact coordinates of the two points.
You must show your working.

(................ , ...) and (................ , ...) **[5]**

This question had a relatively high omit rate, but candidates who recognised it as simultaneous equations and started carefully usually got some marks.

Those that substituted $y = {}^{-}3x$ into $x^2 + y^2 = 70$ and then progressed to $x^2 + 9x^2 = 70$ or similar picked up M2. The simplest way forward was then to simplify it to $10x^2 = 70$, then $x^2 = 7$ and finally $x = \pm\sqrt{7}$ to pick up M3A1. Some candidates instead rearranged it to $10x^2 - 70 = 0$ and then attempted to solve this, either by factorising or using the quadratic formula; candidates had mixed success with this.

Most that reached $x = \pm\sqrt{7}$ went on to find the correct corresponding y values and full marks, but some used decimal equivalents that missed the final accuracy mark (the question does ask for 'exact coordinates').

Some candidates only gave $x = +\sqrt{7}$ and then seemed to re-start, to either find a second value for x or to find a value of y.

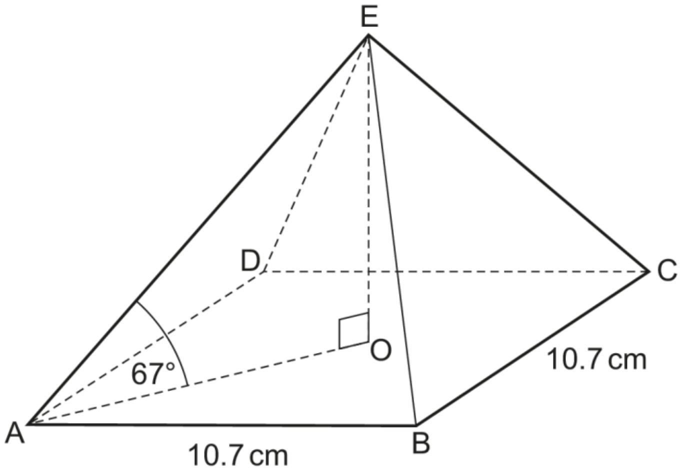
Candidates could pick up M1 for showing the initial substitution as $x^2 + ({}^{-}3x)^2 = 70$, but candidates often missed the brackets and had $x^2 + {}^{-}3x^2 = 70$; this was condoned if candidates recovered in their later working, but instead candidates often arrived at $-2x^2 = 70$ and then stopped.

Some candidates had trouble with squaring ${}^{-}3x$. Some had $x^2 - 9x^2 = 70$, while others had $x^2 + 9x = 70$ and then went on to use the quadratic formula.

A few candidates started by incorrectly square rooting $x^2 + y^2 = 70$ to $x + y = \sqrt{70}$ and then substituted in $y = {}^{-}3x$. Others produced tables of coordinate values or sketches. All of these got 0 marks.

Question 22

22 The diagram shows a square-based pyramid ABCDE.
O is the centre of the base.



The length of the base is 10.7 cm.
Angle EAO is 67°.

Calculate the length of AE.
You must show your working.

AE = ... cm **[6]**

Nearly half of the candidates got 0 marks here, but many also got full marks. Those that picked up part marks often reached 3 marks for finding AO. The question stated 'You must show your working', and the minimum requirement for this was a relatively minimal 'M1 AND M1'. Even so, there were still candidates who calculated AO without showing any working.

Candidates who got 0 marks often made incorrect assumptions about lengths, such as AO = 5.35 or 10.7 and/or AC = 10.7, rather than realising that they needed to be calculated.

Most candidates who picked up marks started with Pythagoras' theorem, either without the square root such as $10.7^2 + 10.7^2$ (to pick up M1), or with such as $\sqrt{10.7^2 + 10.7^2}$ (M2). Candidates could work with either a triangle with hypotenuse AO or a triangle with hypotenuse AC; some of those working with the larger triangle (with hypotenuse AC) forgot to halve their hypotenuse to obtain the length of AO, but those reaching AO = 7.56… picked up A1.

An alternative method for finding AO was trigonometry using a triangle with a 45° angle and both triangle ABC and triangle AOB were seen for this. This was generally successful and picked up M1 or M2 depending on how far candidates proceeded.

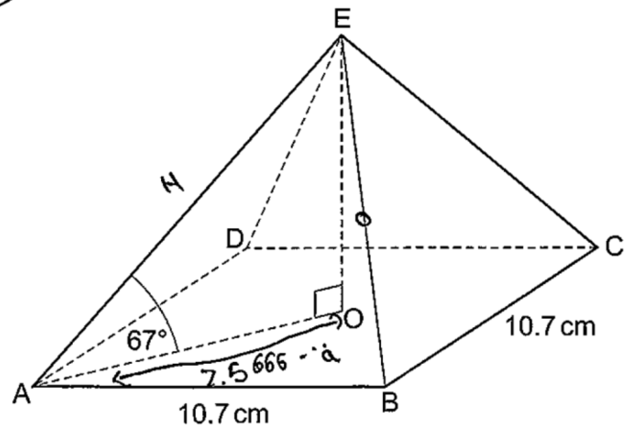
Very occasionally, candidates seemed to attempt a method for AO involving finding the area of square ABCD, then the area of triangle ABC, then the area of triangle AOB before finally equating this to $\frac{1}{2}AO^2$ and solving, but these were rarely presented with any clarity.

Candidates who reached AO = 7.56… without working did not satisfy the 'You must show your working' requirement but could pick up SC2 for it (or SC3 if they proceeded to the final answer).

Working for the second stage of the solution was always present. Again, there were a variety of methods, but using right-angled trigonometry to get $\frac{7.56\ldots}{\cos 67}$ (picking up another M2) was the quickest and most successful. A few candidates rounded their AO to 7.6 in the calculation, resulting in a length for AE outside the mark scheme's acceptable range and missing the final accuracy mark. Alternatively, some candidates instead first found the length of EO and then used it along with AO in a Pythagoras' theorem equation; most of these were still successful, but there was no credit for finding EO as it was unnecessary.

Exemplar 2

22 The diagram shows a square-based pyramid ABCDE.
O is the centre of the base.



The length of the base is 10.7 cm.
Angle EAO is 67°.

Calculate the length of AE.
You must show your working.

	sin	÷ cos	= tan
0°	$\frac{\sqrt{0}}{2}$	$\frac{\sqrt{4}}{2}$	0
30°	$\frac{\sqrt{1}}{2}$	$\frac{\sqrt{3}}{2}$	$\frac{1}{\sqrt{3}}$
45°	$\frac{\sqrt{2}}{2}$	$\frac{\sqrt{2}}{2}$	= 1
60°	$\frac{\sqrt{3}}{2}$	$\frac{\sqrt{1}}{2}$	$\sqrt{3}$
90°	$\frac{\sqrt{4}}{2}$	$\frac{\sqrt{0}}{2}$	

$\tan(67°) = \frac{O}{7.5666\ldots}$

$\tan(67) \times 7.5666\ldots = O = 17.8258927$

$\sqrt{7.5666\ldots^2 + 17.825\ldots^2} =$

$= 19.3653436$

$= 19.4$

$\cancel{\frac{10.7 \times 2 = 21.4}{2}}$

$\cancel{\frac{10.7 \times 10.7 = 114.49}{2} = 57.245}$

$\cancel{\frac{57.245}{2}} =$

$\sqrt{10.7^2 + 10.7^2} = 15.13208512 \div 2 =$

$= 7.566042559.$

AE = 19.4? cm **[6]**

This exemplar has the correct answer and has satisfied the 'M1 AND M1' working requirement, so full marks are given.

The first stage is the work using Pythagoras' theorem to find AC, seen at the bottom of the page. $\sqrt{10.7^2 + 10.7^2}$ is correct working and has the square root present, so picks up M2. After finding AC, they divide it by two to obtain AO = 7.56…, so increase the mark to M2A1 (the presentation isn't ideal and essentially reads as $\sqrt{10.7^2 + 10.7^2}$ = 7.56…, but this is condoned).

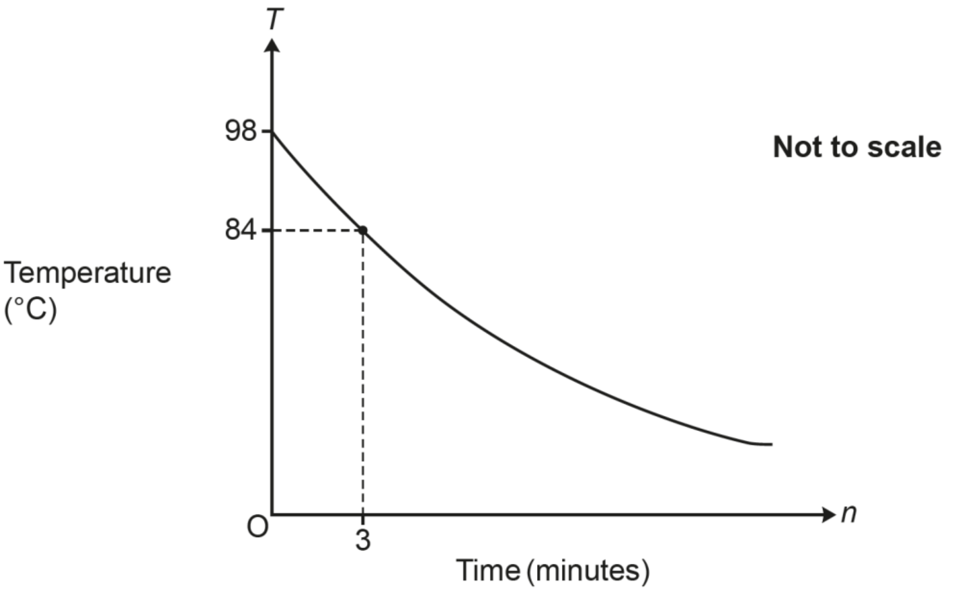
The second stage working to find AE is then seen above the first stage, alongside the question. Rather than going straight to AE, they first work out tan 67 × 7.56… and reach EO = 17.82… (which picks up no credit), then use this in $\sqrt{7.56\ldots^2 + 17.82\ldots^2}$ (which picks up M2). The final answer is marked at its most accurate, which is 19.36… and this is correct.

Question 23

23 A pot of tea is made using boiling water and left to cool.
The temperature, T°C, of the pot of tea after n minutes is given by the formula

$T = ab^n$.

The graph shows some information about the temperature of the pot of tea.



Find the value of a and the value of b.

a = ...

b = ... **[3]**

Finding $a = 98$ could be done from inspection of the graph, and this picked up B1. Some, however, substituted (0, 98) into the given formula to get $ab^0 = 98$, then were unable to progress further; there was no mark for this as it was an unnecessary step.

However, there was a mark available for the similar substitution of (3, 84) into the formula to get $ab^3 = 84$ (or $98b^3 = 84$), since it is a productive first step to finding b.

Dealing with this cubic equation was a challenge for candidates. A common error was to start by taking the cube root leading to $ab = \sqrt[3]{84} = 4.38$, which then often resulted in $a = 2.19$ and $b = 2.19$.

Other errors were to have 98 ÷ 84 instead of 84 ÷ 98, or to find the square root instead of the cube root.

Question 24 (a)

24 (a) Show that the equation $x^4 + 3x^2 - 2x - 5 = 0$ has a solution between $x = 1$ and $x = 2$. **[3]**

The expected and most successful approach was to substitute $x = 1$ and $x = 2$ into the equation. Most candidates obtained the correct answers of $^-3$ and 19, but some omitted the working, which is not good practice in 'Show that…' questions. The substitutions, evaluations and an interpretation were all required for full marks. Various forms of interpretation were accepted, such as 'change of sign' or '$^-3 < 0 < 19$', but not '$^-3 < x < 19$'.

A few candidates used other values of x. This was acceptable provided they produced a valid, narrower interval than $1 < x < 2$, with one evaluation that was positive and the other negative.

Question 24 (b)

(b) Find this solution correct to **1** decimal place.
You must show calculations to support your answer.

(b) $x =$ .... **[4]**

Many candidates omitted part (b), despite a similar question being set in the recent past. Candidates who omitted part (a) or got 0 marks in it usually did similarly again here in part (b).

Those who picked up marks usually continued the trial and improvement method started in part (a) by making further substitutions for x, which were almost always evaluated correctly. For full marks, it was necessary to test two values of x between 1.25 and 1.35 in order to justify the selection of $x = 1.3$ as the solution to one decimal place. Trialling $x = 1.2$ and $x = 1.3$ without going further got M2.

More candidates attempted to create an iterative formula than in the past. This approach is not expected, but is valid and was successful, provided the candidate actually answered the question asked. One iteration, for example, is not sufficient. Additionally, if using this method, it would be good practice to show the values of x_1, x_2, x_3, etc.

Part (b) included the statement 'You must show calculations…'. This was used to minimise any advantage to those that had a calculator with a function to solve a polynomial equation. A few unsupported responses of $x = 1.3$ were used and given 1 mark only, while those who gave $x =$ 1.277181… got 0 marks.

It was quite common to see inappropriate methods, such as trying to use the quadratic formula.

Question 25

25 A bag contains only round tiles and square tiles.
Each tile is either black or white.

The ratio of round tiles to square tiles is 3 : 1.
45% of all the tiles are round black tiles.
9% of all the tiles are square white tiles.

Show that the proportion of round tiles that are black is less than the proportion of square tiles that are black. **[6]**

As would be expected for the final question of the paper, this was a challenging question. However, it was pleasing to see almost all candidates making an attempt. This was also an indication that time was not an issue in paper completion.

The best approach for candidates was to nominate a number of tiles with which to work, providing a much sounder conceptual base for them to access the question. Those who did this normally found the number of square black tiles without a problem, getting B3. Some stopped at this point however and did not attempt the remaining conditional aspect.

Methods using decimals, fractions or percentages proved to be less successful. While converting the ratio to an equivalent of 75% and 25% was a straightforward step for many, it was not often recognised that the other key pieces of information given are percentages of the total; unproductive product calculations, such as 45% × 75%, were frequently seen.

Whichever method was adopted, the key to success was in organising the information. Those that put information into a table were far more likely to succeed than those scattered working across the page. A well-organised response was also helpful in achieving the 'Show that…' aspect. Often, candidates who had all the necessary information yet had presented it in a disorganised fashion were unable to identify the values to use in their proportions to complete the question.

Exemplar 3

1 : 3

	square	round	total
black	16	45	61
White	9	30	39
total	25	75	100%

$100 \div 4 = 25$
$25 \times 3 = 75$

$45\% > 16\%$

In this exemplar, the information is clearly presented in a table. The given ratio of 3 : 1 is converted into 75% and 25% and then the given 45% and 9% are recorded in the appropriate cells. The remaining cells can then be found by simple arithmetic. The table gets B3 because the proportion of square black tiles has been calculated as 16% of the total.

Like many, this candidate did not deal with the conditional aspect of the question and makes no further progress, despite having all the necessary information in their table. Extracting the proportion of the round tiles that are black as $\frac{45}{75}$ and the proportion of the square tiles that are black as $\frac{16}{25}$ would have increased the mark to B5. For the final mark, a comparison of values in comparable form was required, such as $\frac{45}{75} < \frac{48}{75}$ or 60% < 64%.

This exemplar highlights the simplicity and benefit of using a two-way table as well as working in percentages. Those choosing to work with a fixed number of tiles would need to do some percentage calculations (such as finding 45% of their number) but could produce a similar table. Those not using a table or other diagram format (like a tree) often lost track of what their values represented.

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