Qualification Accredited

Oxford Cambridge and RSA

GCSE (9–1)

Examiners' report

MATHEMATICS

J560

For first teaching in 2015

J560/06 Summer 2023 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 answers 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 our secure Teach Cambridge site (https://teachcambridge.org).

Paper 6 series overview

J560/06 is a calculator paper and is the third and final paper in the Higher tier of the GCSE (9-1) Mathematics specification.

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

To do well on this paper, candidates need to be confident and competent in all the qualification content. They also need to be able to:

- use and apply standard techniques (AO1)
- reason, interpret and communicate mathematically (AO2)
- solve problems within mathematics and in other contexts (AO3).

Questions 1, 3, 5, 6, 7 and 8 were also set on the Foundation tier Paper J560/03.

Some candidates produced excellent responses and were not challenged by the paper, but the proportion scoring 90+ marks was less than in previous series. Other high scoring candidates generally attempted every question and scored full marks on some of the later questions but could either not deal with the more novel questions, or they over-complicated some of the more straightforward responses. As in previous series, lower scoring candidates still often resorted too readily to non-calculator methods, trials or rounded prematurely when using a calculator.

The paper included some questions on topics from the specification that have been assessed rarely in the previous series or were set slightly differently on this occasion. Often omission rates and responses showed that many candidates were not prepared for these variations. This issue is expanded on in the question commentaries below.

Some candidates struggled to set their work out clearly and solutions of multi-step problems often ended up scattered over the page. Additionally, it was common to see multiple attempts at a question with no obvious indication of which was the final attempt. Candidates should be advised to clearly highlight the work that they would like to be marked or risk losing credit for work that might otherwise have received some marks.

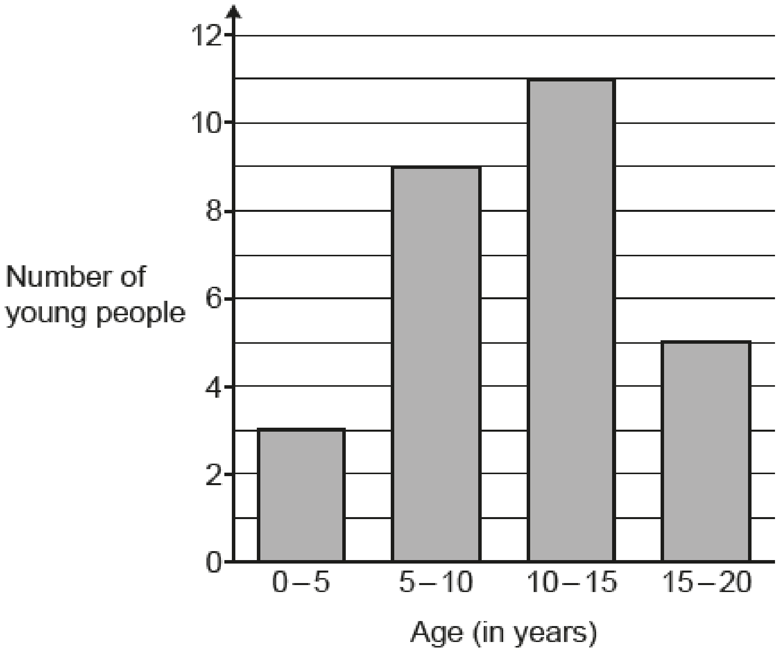
A common recurring problem is in questions where candidates are required to show a given result, or to justify a given statement. As in previous years, all too often the starting point for candidates was to use the information that was needed to be shown.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• attempted all questions • highlighted key words, phrases and values in the question • demonstrated good calculator skills, used functions such as roots and trigonometry correctly and maintained accuracy when using an interim answer • performed almost all standard techniques and processes accurately	• did not use formulae correctly, even if given on the formulae sheet • did not always use a calculator, often using inefficient non-calculator methods leading 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 low-grade processes

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• 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 in questions worth more than 2 marks.	• misinterpreted questions and information, or did not follow instructions • had limited facility and confidence in applying algebraic techniques • made multiple attempts that were difficult to follow when answering problem solving questions • used methods that were inefficient or inappropriate, such as trial and improvement, rather than applying a more formal mathematical process • did not show all steps in working, particularly when answering questions that stated 'Show…'.

Question 1

1 Alex draws a bar chart to show the age of the young people attending a youth club.



Make **one** criticism of Alex's bar chart.

....

....

.... **[1]**

Candidates were expected to identify that the age groups overlapped in this question. This could have been by highlighting the fact that 5 (for example) appeared in two age groups, or by correcting the age group intervals. However, many comments referred to the gaps between the bars, the width of the age groups being too wide or the vertical scale going up in twos.

Question 2 (a)

2 **(a)** Rearrange this formula to make u the subject.

$$v^2 = u^2 + 2as$$

(a) .... **[2]**

Candidates often scored the M1 for reaching [u^2 =] $v^2 - 2as$ in this question. However, many were unable to write the square root of this expression correctly, with [u =] $\sqrt{v - 2as}$ and [u =] $v - \sqrt{2as}$ being common errors. Candidates who started by subtracting u^2 from both sides made the question more difficult for themselves and usually made a sign error as a consequence.

Some candidates started by dividing by $2as$, but almost always did so incorrectly, leading to [u =] $\sqrt{\frac{v^2}{2as}}$ or $\frac{v}{\sqrt{2as}}$.

However, the rearrangement in part (a) was answered far more successfully than the substitution in part (b).

Question 2 (b)

(b) A rocket accelerates at 90 m/s^2 and travels 270 km.
The rocket's final velocity is 8000 m/s.

Using part **(a)**, or otherwise, calculate the rocket's initial velocity in m/s.

(b) .... m/s **[3]**

Most candidates ignored the suggestion to use part (a) even if they had answered that part correctly. Instead, they started afresh, substituting the given values into the original formula to create an equation that they attempted to solve, often with errors.

It was very common for candidates to confuse the meaning of the variables and roughly half of the candidates scored 0. It was evident that some candidates thought that *s* represented speed and that 90 m/s^2 was a measure of time. The calculation $s = \frac{\text{distance}}{\text{time}} = \frac{270}{90}$ or $\frac{270\,000}{90}$ was hence often performed before substitution into the given formula.

Candidates also very commonly did not convert 270 km into 270 000 m, in which case they may have scored M1 depending on the accuracy of the rest of the substitution.

There was a follow through mark for correct substitution into their rearrangement in part (a), but this was seldom awarded because of the number of candidates who started afresh.

Misconception

Candidates need to learn the meaning of the variables in the kinematics formulae. These are clearly stated in Section 6.02e of the specification.

Assessment for learning

When a question suggests the use of a previous part, it is intended to help candidates. Doing so here could have avoided unnecessary work and errors for many candidates and some would have picked up the follow through mark for substitution.

Question 3 (a)

3 A bag contains 150 counters.
The counters are either red or yellow.

(a) Riley picks a counter from the bag, records its colour, and replaces it.
They do this nine times.

Here are Riley's results.

Red	𝍸
Yellow	||||

Use Riley's results to work out how many red counters are likely to be in the bag.

(a) .... red counters **[3]**

Most candidates showed correct working and maintained sufficient accuracy to arrive at the correct answer.

A small number of candidates did not use Riley's results and instead assumed an equal chance of picking red and yellow counters.

Assessment for learning

Candidates should develop confidence in calculator use where interim answers are not exact decimals. They should be encouraged to write interim answers in their working to at least 3 significant figures, while at the same time retaining and using the exact value on their calculator (for example, by using the 'Ans' button). Learning how to use the fraction functions would potentially be an even more useful skill.

Question 3 (b)

(b) Ling uses the same bag of counters and picks the counters in the same way.

Here are Ling's results.

Red	𝍸 𝍸 II
Yellow	𝍸 III

Use Ling's results to estimate the probability of choosing a red counter from the bag.
Give your answer as a fraction in its simplest form.

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

Most candidates answered this correctly. A few misread the question, treating it as the same as part (a) and obtaining an answer of 90 or $\frac{90}{150}$.

The most common wrong answer was $\frac{2}{25}$, which is the simplification of $\frac{12}{150}$ (the number of red counters taken by Ling as a fraction of the total number of counters in the bag).

Question 3 (c)

(c) Explain why Ling's results are likely to give a better estimate of the probability of choosing a red counter from the bag than Riley's results.

....

.... **[1]**

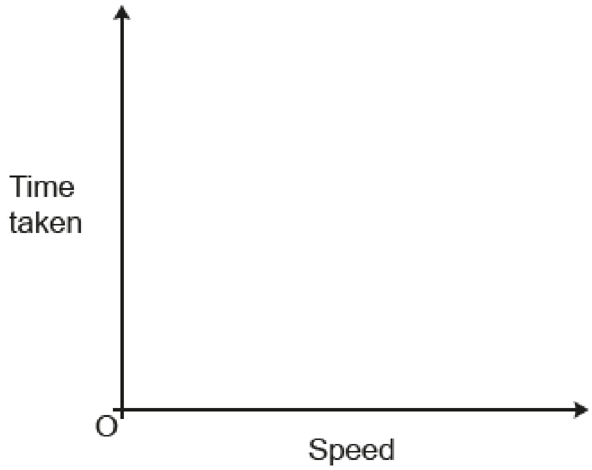
Nearly all responses were sufficiently correct to be accepted. Most referred to Ling having more results, more trials, picking more counters, a larger sample, etc.

A few unacceptable responses stated, 'Ling had more counters in the bag', 'Ling picked more red counters', 'they did the experiment many times' (which is a statement of fact rather than a comparison) or that 'Ling was more accurate because they did an even number of trials' (perhaps alluding to the fact that the interim answer in part (a) of 83.3… was not an integer).

Question 4 (a)

4 **(a)** The time taken to complete a journey halves as the speed doubles.

On the axes below, sketch a graph to show this relationship.



[2]

Very few candidates drew the correct graph. Those that did produce an appropriate decaying curve usually realised that it should not touch the axes.

Most sketches were straight lines. Some had a negative gradient and either reached the axes or stopped slightly short, while others were straight lines through the origin.

Question 4 (b)

(b) It takes 40 minutes to fill a garden pond using water from 5 identical hose pipes.

Assuming the rate of flow of water from each hose pipe is the same, work out how many minutes it would take to fill the same garden pond using 2 of these hose pipes.

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

Candidates generally either recognised the context as being inverse proportion and then usually scored full marks, or they dd not and scored zero. Most of the latter showed an incorrect two-step calculation based on direct proportion, i.e. 40 ÷ 5 = 8 minutes for 1 hose, and so 8 × 2 = 16 minutes for 2 hoses.

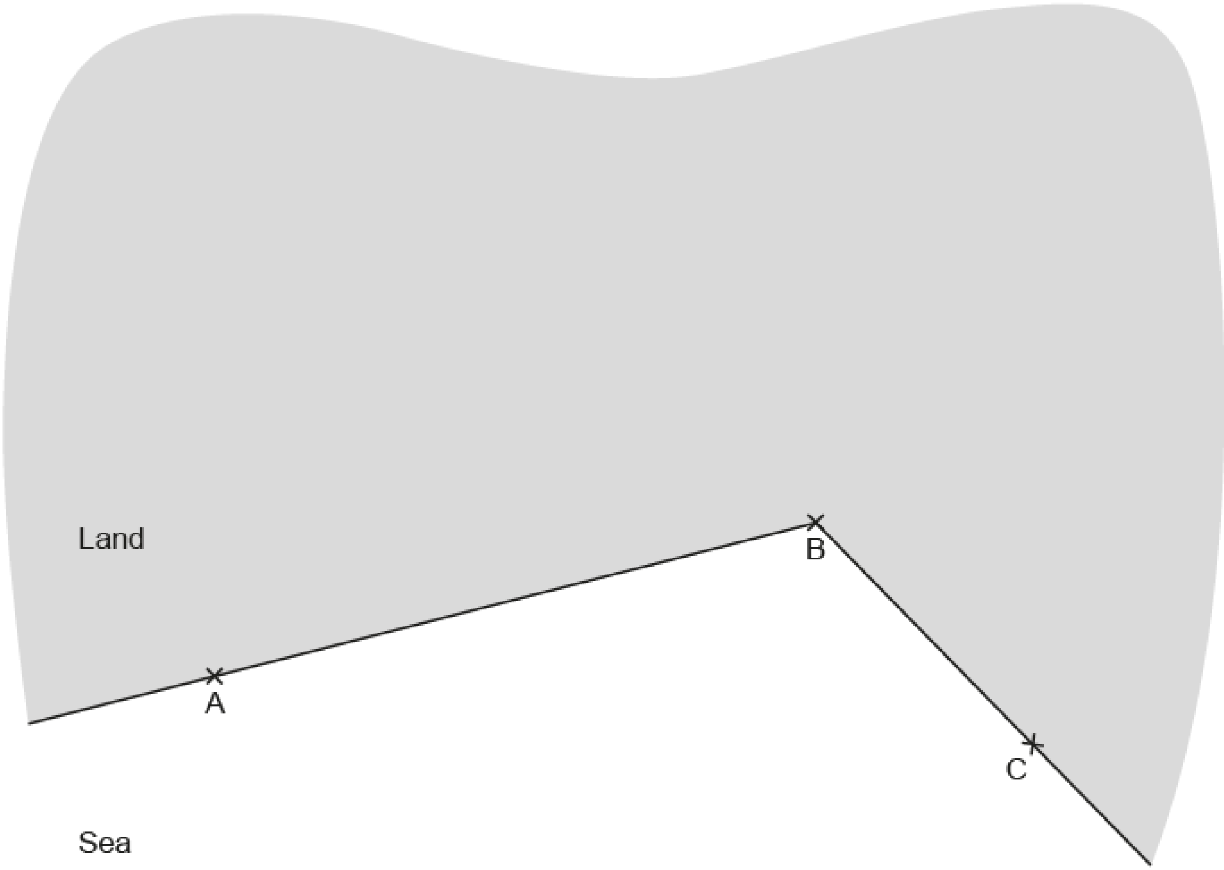
Successful candidates either started with 40 × 5 = 200 minutes for 1 hose pipe and then halved to get the time for 2 hose pipes, or they used a table/scaling approach showing that 5 hose pipes to 2 hose pipes is a division by 2.5 (or a multiplication by 0.4) and so because of inverse proportion, 40 × 2.5 = 100 minutes.

A few candidates showed some understanding of inverse proportion, if not the context. For example, some candidates stated that it would take 80 minutes for 2.5 hoses but they were then unable to deal correctly with 0.5 of a hose pipe. These candidates had not really made any worthwhile progress beyond what was given in the question and so scored 0 marks.

Question 5

5 The diagram represents a coastline.

A, B and C are lighthouses.



A boat is
- the same distance from A and B
- the same distance from AB and BC.

Using a ruler and compasses only, construct the position of the boat.
Label the position of the boat clearly. **[5]**

Constructions is a topic area that candidates of all abilities can often score well on. On this occasion, about a third of the candidates scored full marks and about another third scored 0, which can make quite a difference to the overall outcome for a candidate.

Even though the actual constructions were within a context, many candidates were able to determine what was required and provide the necessary constructions with supporting arcs. There also appeared to be fewer instances of 'false' construction arcs being added to a line that had been drawn by eye.

The perpendicular bisector of AB was constructed particularly well. The 'same distance from AB and BC' was less well understood as requiring an angle bisection. Those bisecting angle ABC usually did so correctly, but a significant number of candidates instead constructed the perpendicular bisector of BC.

Assessment for learning

Construction arcs are an essential part of the working. Some candidates appeared to either erase them or drew them very faintly. Candidates should be using a dark pencil for their constructions and only erase what they do not wish to be marked.

Question 6 (a)

6 At the end of each year, a driver records how many kilometres they have driven.

In 2021, they drove 18% more kilometres than in **2020**.
In 2022, they drove 25% more kilometres than in **2020**.

In 2022, they drove 3500 km.

(a) Kai says

I can work out how many kilometres were driven in 2020 by reducing 3500 by 25%.
$3500 \times 0.75 = 2625$ km.

Explain why 2625 is **not** the correct number of kilometres driven in 2020.

....

....

.... **[1]**

Given the large number of very vague explanations, the mark scheme needed to be strict in its requirement in order to achieve consistency in marking across Papers 3 and 6.

Many responses were lengthy and hard to decipher. Candidates often tried to explain the mistake in too general or vague terms, for example 'They need to work backwards from 2020 not forwards from 2022' or '3500 is 125% not 100%'. Some candidates tried to explain that '25% is not a fixed amount so you can't just take 25% off'. Others even included references to 2021, 18% or 82%.

The most successful responses just stated Kai should have divided by 1.25 rather than multiplying by 0.75 or showed that $2625 \times 1.25 \neq 3500$.

Question 6 (b)

(b) Calculate the number of kilometres driven in **2021**.

(b) .... km **[4]**

Over half of the candidates scored full marks. The most successful responses divided by 1.25 and multiplied by 1.18 on their calculators, with these candidates seeming to understand the multiplier methods well and scoring all 4 marks.

Less successful responses showed some confusion over whether a multiplication or division was necessary and which value should be used. Non-calculator methods were common, very lengthy and often led to mistakes.

Part (a) was intended to help candidates avoid an initial mistake in part (b). However, there were plenty of candidates who worked out 3500 × 0.75, often using non-calculator methods, to obtain the 2625 given in part (a) and then did not appreciate that they had been told this answer was wrong.

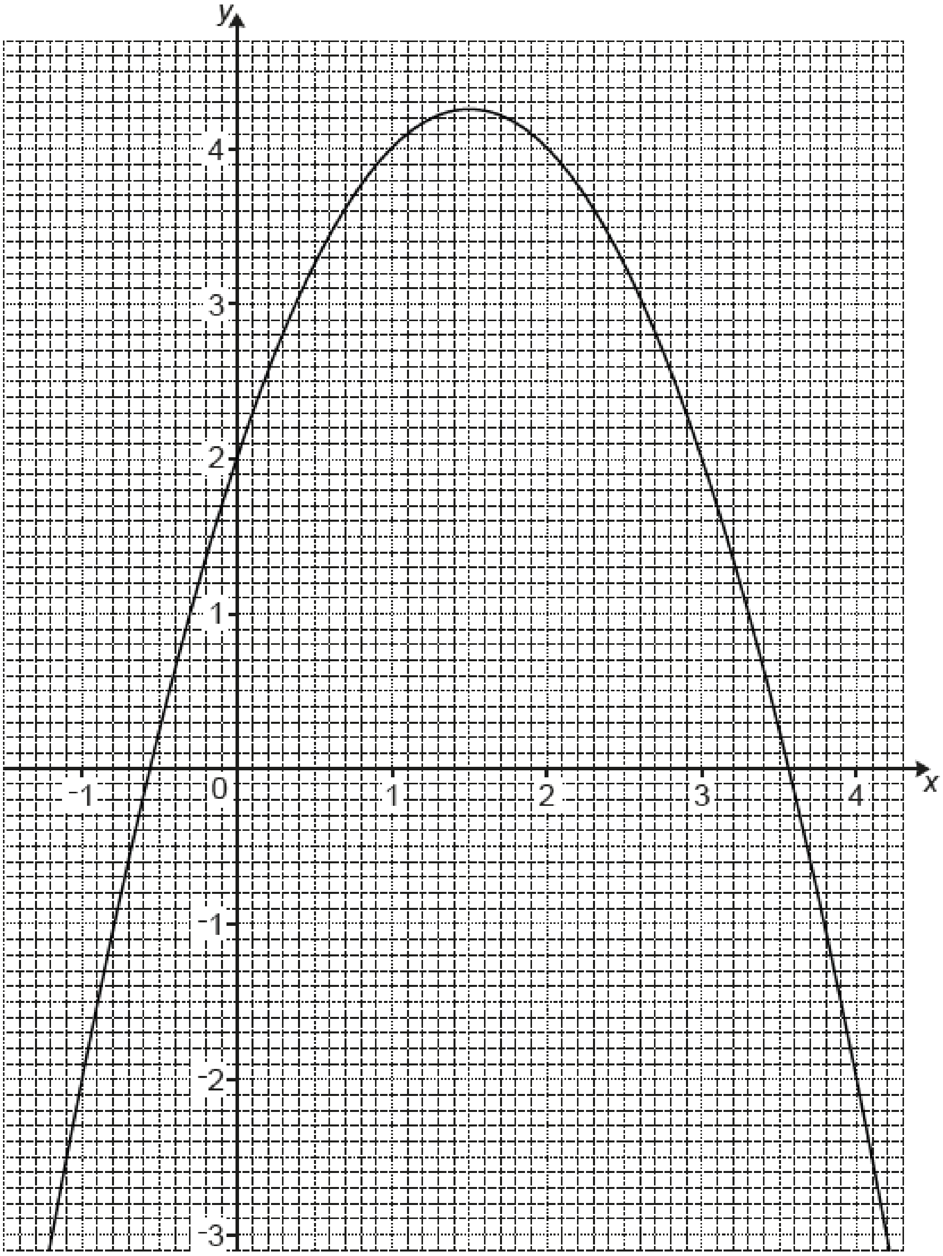
A small number of candidates used 75% and 82% for their calculations and some others reduced the 2022 distance by 7%. An appreciation of the validity of an answer was not always evident, with some giving an answer for 2021 that was greater than that of 2022 or below that of their 2020 value.

Assessment for learning

On calculator papers, candidates should be using a calculator unless the question says otherwise. In particular, candidates should not be resorting to non-calculator methods to work out percentages. On a calculator paper, writing 2800 × 1.18 (for example) is sufficient to show the intention to increase 2800 by 18%.

Question 7 (a)

7 The diagram shows the graph of $y = kx - x^2 + 2$, where k is an integer.



(a) Show that $k = 3$. **[2]**

This part of the question had a relatively high omission rate, perhaps because it is not the usual 'complete the table of values' demand. Candidates were expected to substitute an integer point from the graph into the equation, and then solve to reach $k = 3$, however, this was not seen very often. Many candidates substituted their integer point and $k = 3$ at the same time and then produced working to show that, for example, 4 = 4.

A few candidates tried using (0, 2). Some later realised that this point is unhelpful as the *k* term is multiplied by zero and so cannot be found. Those who then went on to use a different point were not penalised for the initial choice of point.

A few candidates used either ($^-0.6$, 0) or (3.6, 0), but the problem with these points is that they are not exact. Candidates using one of these points ended up with an answer that $k \neq 3$ (although candidates often claimed it did).

A small number of high ability candidates over-complicated things by attempting differentiation and gradients of chords or tangents, but with no success.

Question 7 (b)

(b) Use the graph to solve $3x - x^2 + 2 = 3$.
Give your answers to **1** decimal place.

(b) $x =$ .... or $x =$ .... **[2]**

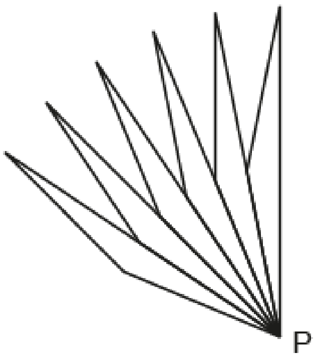
Only about a quarter of the candidates gave the two correct *x* values.

Many candidates either misread or misinterpreted the question as wanting the roots of $3x - x^2 + 2 = 0$. Others omitted the question.

Question 8

8 Taylor designs a logo using isosceles triangles joined at a central point, P.

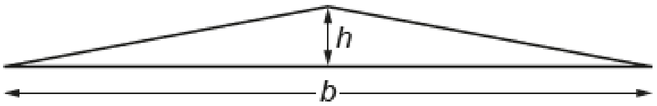
This is the start of Taylor's design.



Not to scale

The completed design will have rotational symmetry, order 60 about point P.

Each triangle has base, b, and height, h, measured in mm.



Not to scale

Calculate h when $b = 40$ mm.
Give your answer correct to **1** decimal place.

.... mm **[4]**

A question appearing in the first half of the paper is likely to be targeted at grade 4-6 candidates (in fact, this question was also on Foundation Paper 3). As in the previous question however, some high ability candidates often went wrong by making the question more difficult than it actually is.

All methods required a realisation that each triangle had an angle of 6° at P. The isosceles triangle can then be split into two right-angled triangles and h found using $20 \times \tan 6$. Many candidates thought the angle was 10° however (perhaps from measuring the diagram, despite it stating 'Not to scale' in bold); they could though still score M2 if they showed correct follow through working, such as $20 \times \tan 10$.

Instead of this short method, some candidates used the sine rule $h = \frac{20 \times \sin 6}{\sin 84}$. These candidates were usually successful, although a few candidates used 40 in place of 20.

Other candidates also used the sine rule, but far less efficiently. After the calculation $\frac{40 \times \sin 6}{\sin 168} = 20.11\ldots$ to find one of the equal sides of the isosceles triangle, they then used Pythagoras' theorem and calculated $h = \sqrt{20.11\ldots^2 - 20^2}$. Some other candidates obtained 20.11… from $\frac{20}{\cos 6}$ and then applied Pythagoras' theorem, or alternatively equate areas using $\frac{1}{2} \times 40 \times h = \frac{1}{2} \times 40 \times 20.11\ldots \times \sin 6$. Many of these candidates who used unnecessarily lengthy and complex methods often went wrong or lost accuracy at some stage.

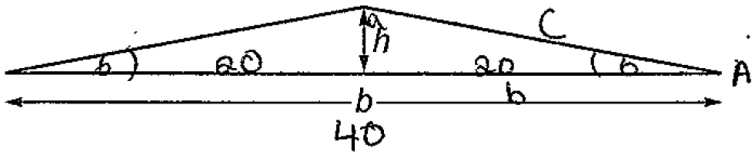
A few candidates approximated the perimeter of a 60-sided regular polygon with side-length h to the circumference of a circle with centre P and radius 20. This gave $60h \approx 40\pi$ and hence an answer that happens to round to the mark scheme's answer of 2.1. The method is only an approximation and so did not score marks.

Assessment for learning

Candidates should try to consider the order of questions within the paper and the number of marks being allocated, to help them consider what method might be appropriate and efficient.

There seemed to be a general unawareness or unwillingness to use tan.

Exemplar 1



Not to scale

Calculate h when $b = 40$ mm.
Give your answer correct to **1** decimal place.

$360/60 = 6^\circ$ angles

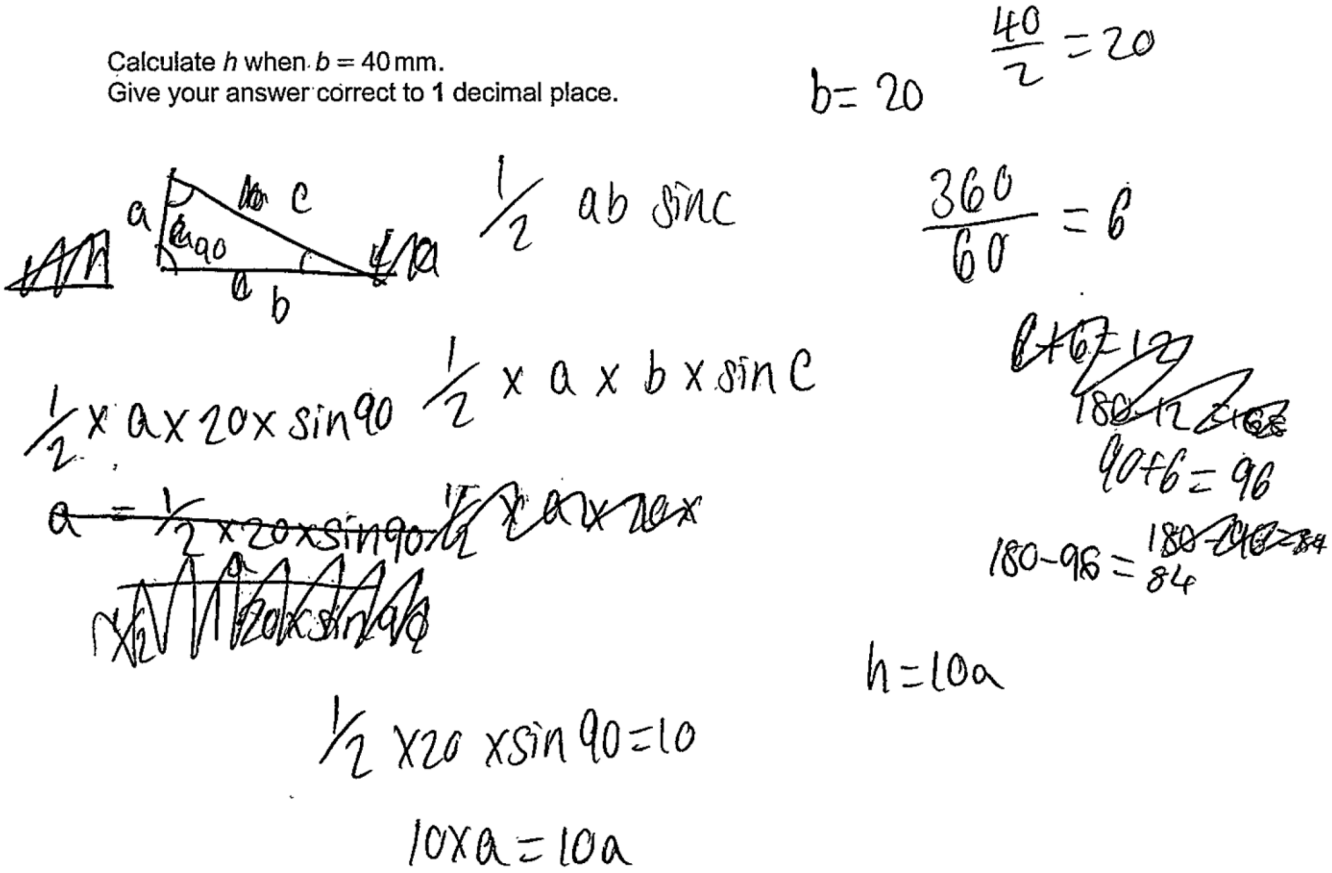
$\tan A = \frac{a}{b}$

$\tan(6) = \frac{a}{20}$

$20\tan(6) = 2.1$

The exemplar shows a concise, efficient method that covers each individual mark in the mark scheme, essentially 1 mark per line.

Exemplar 2



This exemplar is from a candidate who overall performed significantly better than the candidate of exemplar 1 above but struggled in this question. While this candidate may be familiar with $\frac{1}{2}ab\sin C$, they have tried to do something far more complex than should be necessary on a question in the first half of the paper. As a consequence, they made no progress and score 0 marks.

The candidate has also made two attempts and with nothing on the answer line, the poorest is marked. Had the area work been crossed out, then the method on the right starting with $\frac{360}{60} = 60$ would have scored M1. Alternatively, had 6 been used in the area work, then this response would have been treated as one method.

Question 9

9 On Heidi's bookcase, the ratio of fiction to non-fiction books is 2 : 3.
Heidi removes 2 fiction books from the bookcase.
The ratio of fiction to non-fiction books is then 5 : 8.

How many books are left on the bookcase in total?

.... books **[4]**

The question could be answered using a variety of methods including ratios, listing, fractions and by setting up algebraic equations, or by combinations of these methods.

One of the most successful methods was through realising that the number of non-fiction books remains unchanged and, therefore, the number of non-fiction books must be a multiple of 24 (3 × 8). This leads to the ratios being rewritten as 16 : 24 and 15 : 24. Candidates then realised that this has a difference of 1 fiction book, so doubling gives 32 : 48 and 30 : 48, and hence the answer of 30 + 48 = 78. A few candidates gave the answer of 32 + 48 = 80 rather than 30 + 48 = 78. A common incorrect answer from ratios was 26, usually from using 12 : 18 and 10 : 16.

A similar approach, but different presentation, was listing. This was seen more frequently, although only with some success. Candidates needed to list multiples of 5 (2 + 3) and 13 (5 + 8) until they found a multiple of 5 that was greater than a multiple of 13 by 1 (i.e. 40 and 39) and then double or continue listing to get a difference of 2 (i.e. 80 and 78).

Other candidates worked in fractions, commonly ending up with a denominator of 65 that then led to a variety of wrong answers. A mark was quite frequently given for certain fractions, such as $\frac{5}{13}$ and $\frac{2}{5}$.

Candidates attempting to use algebra often had trouble setting up the equations and made no progress. The exception was candidates who initially equated the two ratios after the two fiction books had been removed; for some integer value x, $2x - 2 : 3x$ must be in the ratio 5 : 8, which leads to $8(2x - 2) = 15x$ and then $x = 16$; substituting this into the first ratio gives 30 : 48 and, hence, 78 books.

This question was particularly susceptible to multiple attempts. Often the working was confused and abandoned methods were not crossed out, making it difficult for the examiner to decipher. Some candidates had something creditworthy on the page but could not score method marks for it because it did not form part of the method leading to their final answer.

Exemplar 3

$f : N$	$f-2 : N$
$2 : 3$	$5 : 8$
$\downarrow \times 8$	$\downarrow \times 3$
$16 : 24$	$15 : 24$
$\downarrow \times 2$	$\downarrow \times 2$
$32 : 48$	$30 : 48$

$32 - 2 = 30$

$30 + 48 = 78$

78 books

The exemplar above shows a clear presentation of a method using ratios. The candidate aims for a common number of non-fiction books in the two ratios, scoring M2 for 16 : 24 and 15 : 24. They then double the two ratios to give a difference of 2 in the number of fiction books, with 32 : 48 and 30 : 48 moving the mark to M3, before going on to the correct answer.

Question 10 (a)

10 **(a)** Show that 95 is **not** a prime number.

....

.... **[1]**

Almost all candidates answered this question successfully, either by showing a relevant calculation or factor tree, or by explaining that numbers that end in 5 are always divisible by 5.

Question 10 (b) (i)

(b) **(i)** 2000 and 8750 are written below as the product of their prime factors.

$2000 = 2^4 \times 5^3$
$8750 = 2 \times 5^4 \times 7$

Find the highest common factor (HCF) of 2000 and 8750.

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

Candidates often put the prime factors onto a Venn diagram. Most were then successful in finding the HCF.

A few candidates gave answers of 70 000 (the LCM) or 280 (the product of the prime factors not in the overlap region of the Venn diagram).

Question 10 (b) (ii)

(ii) Write 2×10^{12} as a product of its prime factors.

(ii) .... **[2]**

This type of question has appeared several times in the past and the limited working space is intentional. Candidates should also notice there were only 2 marks allocated. Still, there were many candidates who produced very large factor trees starting from 2×10^{12} written in ordinary form, almost always with errors.

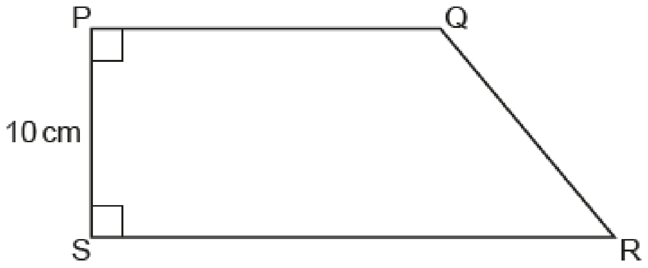
Instead, candidates should know that $10 = 2 \times 5$, so $10^{12} = 2^{12} \times 5^{12}$, from which the answer is just a short step away.

Assessment for learning

This is another example of where candidates should consider the number of marks and amount of answer space being allocated. This may help them identify more appropriate and efficient methods.

Question 11

11 The diagram shows a quadrilateral, PQRS.



Not to scale

PS = 10 cm.
Angle QPS = Angle PSR = 90°.

SR is 6 cm longer than PQ.
The area of quadrilateral PQRS is A cm^2.

Write a simplified expression for the length PQ in terms of A.
You must show your working.

.... **[5]**

Good responses tended to be characterised by working that was easily followed, but in many cases, working was haphazard and often difficult to follow. For some this led to self-induced slips in their working.

A number of candidates scored 1 mark, usually for the area of the triangle. Some tried to use Pythagoras' theorem or trigonometry to find the unnecessary length QR. Many others mixed up their PQ and SR lengths. The main difficulty for those that made progress was in rearranging 'for the length PQ in terms of A'. Many got to the M2A1 answer of $10x + 30$, but no further.

Overall, of those that did score marks, the trapezium method and the rectangle + triangle method were used in roughly equal numbers and the use of 'x' and '$x + 6$' was more successful than the use of 'PQ' and 'PQ + 6'. The omission of brackets was a common problem and statements such as $A = 5 \times 2x + 6$ or other similar variations were often seen. A small proportion of candidates left units in their answer.

A very efficient solution was to define the area of the rectangle as both 10PQ and A – 30, which led to a simple solution for PQ.

Question 12 (a)

12 A box contains 200 matches, correct to the nearest ten matches.

(a) Complete the error interval for n, the number of matches in the box.

(a) .... $\leqslant n \leqslant$ .... **[2]**

Most candidates treated this question as being the same as that set in previous series and did not appreciate the integer context. An example of this type of question is included in 4.01c of the specification.

Many candidates gave the correct lower bound of 195. Far fewer gave the correct upper bound of 204.

Question 12 (b)

(b) The box is a cuboid with

- length 7 cm, correct to the nearest cm
- width 5 cm, correct to the nearest cm
- volume 248 cm^3, correct to the nearest cm^3.

Show that the smallest possible height of the box is 6 cm. **[3]**

Candidates were expected to show the calculation $\frac{247.5}{7.5 \times 5.5}$, perhaps performed in two steps, and evaluated it to exactly 6. Candidates using one incorrect bound scored B1, as well as usually M1 for the division, depending on the values used.

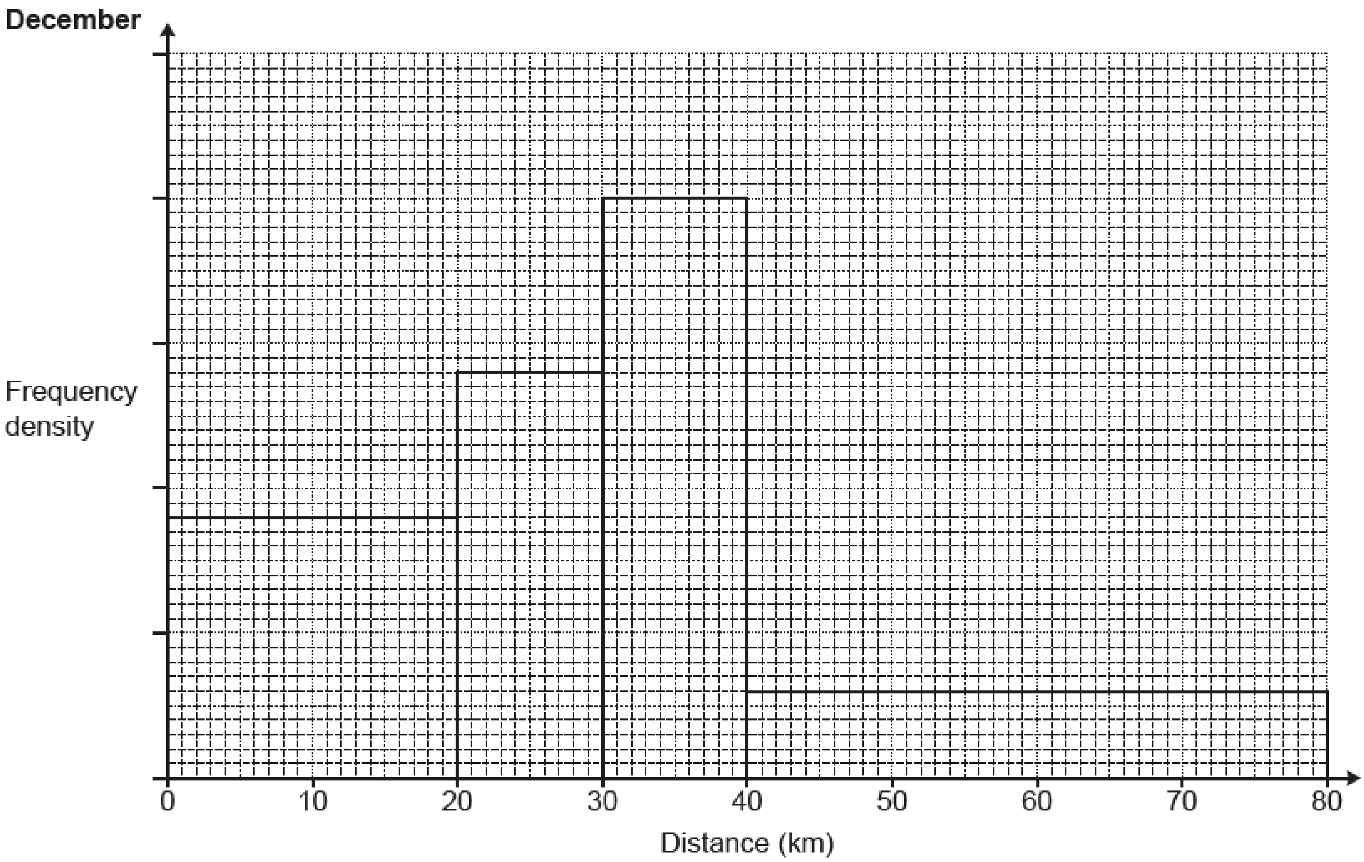
Many candidates used the '6' that they were asked to show and worked out 7 × 5 × 6, perhaps with an attempt at bounds for some or all of these dimensions. This scored 0 marks, unless their working was 7.5 × 5.5 × 6 which scored B1 for the two correct bounds. If this was evaluated as 247.5, candidates needed to clearly relate the answer as being the lower bound of the volume, but instead almost all candidates merely said it was an answer that rounded to 248.

Assessment for learning

Candidates generally would benefit from more experience of showing results. Here, by assuming '6', they are really at best performing a verification; this should be a strategy of last resort and may receive reduced or no credit depending on the specific question.

Question 13 (a) (i)

13 A running club records the distances run by each member during December.
The results are shown in this histogram.



(a) 18 members run less than 20 km.

(i) Work out the number of members who run more than 30 km.

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

About half of the candidates were able to find 0.9 as the frequency density for the first bar, often marking this on the vertical axis without working. Most of these candidates were then able to find the sum of the areas of the two required bars as 20 + 12 = 32, again with minimal working being shown. Despite having 0.9 correct on their scale, it was common for these candidates to make errors in continuing the scale, with the equivalent of 0.5, 1, 2, 3, 4 being frequently seen. This then leads to an answer of 30 + 12 = 42, but if working was not shown then M marks could not be given for these wrong values.

A very common incorrect scale was 10, 20, 30, 40, 50, which was really just using the bar height as the frequency and then summing the heights of the two bars as 40 + 6 = 46 scoring 0 marks. A little better with the same scale were those who found areas 40 × 10 + 6 × 40 = 640 and these candidates scored M1 if working was shown.

Question 13 (a) (ii)

(ii) Finley says

To estimate the range, I subtracted the smallest possible value from the largest possible value. So, 80 – 0 = 80 km.

Explain why Finley's method is likely to overestimate the true value of the range.

....

.... **[1]**

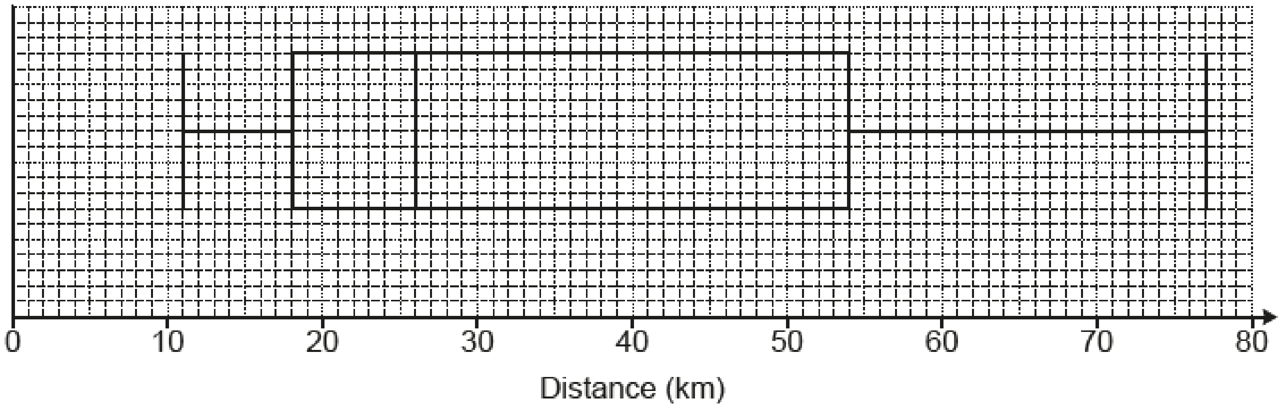
About a third of candidates gave a sufficiently clear explanation. The response most frequently seen was that it was 'unlikely that someone would run 0 km' (or '80 km'). Many responses were too definite in phrasing, such as 'nobody will run…'. Some showed lack of understanding of the range by saying 'not everyone will run 80 km'.

The safest answer, with less chance of unclear wording, was to say, 'it is grouped data and so exact values are not known'. This was seen occasionally, but not frequently.

Question 13 (b)

(b) This box plot shows the distribution of the distance run by each member of the running club during July.

July



During **December**,

- the median distance run was 30 km
- the interquartile range of the distance run was 20 km.

Make **two** comparisons between the distances run during December and the distances run during July.
Include values to support your comparisons.

1. ....

....

....

2. ....

....

....

[4]

Most candidates realised they were being asked to comment on the median and IQR and gave the correct values of each for July, scoring 2 marks. Far fewer explained what they meant in terms of the distances run in the two months.

Despite part (a)(ii) highlighting that the range for December is not known, a few candidates tried to compare the ranges. Other candidates did not heed the instructions to include values and were thus limited to a maximum of SC1.

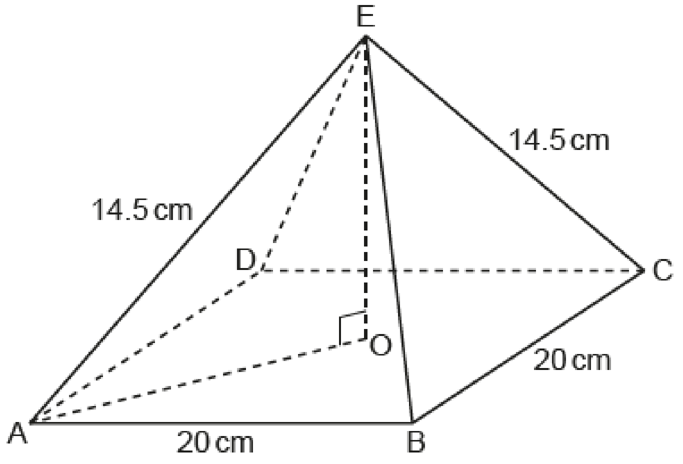
The best responses gave interpretations in context, such as 'the median for July is 26 km, which means members ran further on average in December' and 'the IQR for July is 36 km, which means the spread of distances ran in July was much greater than in December'.

Assessment for learning

Candidates need to be careful in the language used when interpreting statistical data. For example, something like 'July's median of 26 is less than the median for December' was often followed by 'so the average for July is less' despite this adding nothing to the first part. Similarly, referencing July's IQR as showing a 'greater range of distances run' is ambiguous and is better expressed as showing a 'greater variation in distances run'.

Question 14 (a)

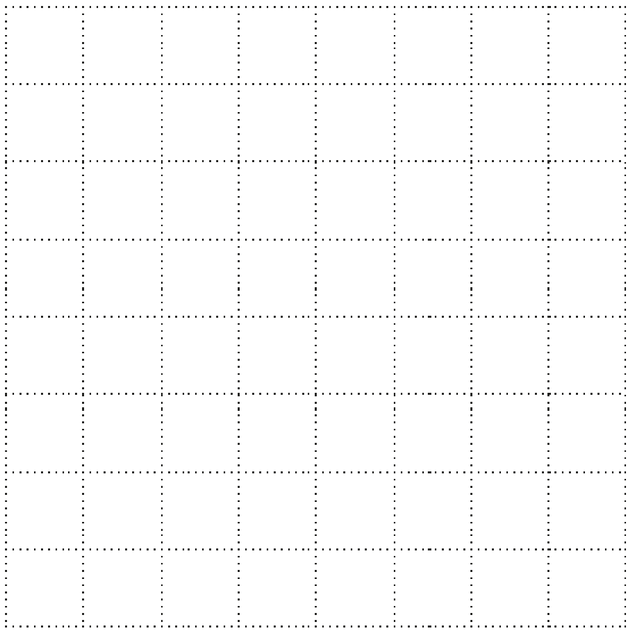
14 The diagram shows a square-based pyramid ABCDE.
O is the centre of the base.



The pyramid has base length 20 cm and each sloping edge has length 14.5 cm.

(a) Draw the plan view of the pyramid on the one-centimetre grid below.

Scale: 1 cm represents 4 cm.



[2]

Most candidates drew a square of the correct size, but it was quite common for the diagonals to be omitted. When drawn, diagonals were usually accurate, passing well within the tolerance of the centre point.

Some candidates seemingly did not know what a plan view was and there were some diagrams of the triangle front elevation, nets and attempts at 3D drawings of the pyramid.

A few candidates did not understand the meaning of the dashed lines on the diagram and drew dashed lines for their square's top and left sides and the top left diagonal.

Question 14 (b)

(b) Calculate the volume of the pyramid.
You must show your working.

[The volume of a pyramid is $\frac{1}{3}\times$ area of base $\times$ perpendicular height]

(b) .... cm^3 **[5]**

Most candidates realised this was a Pythagoras' theorem question and many were able to start by finding the diagonal of the base as $\sqrt{20^2 + 20^2}$ or AO as $\sqrt{10^2 + 10^2}$. Progress from there varied. Most proceeded to $\sqrt{14.5^2 - (10\sqrt{2})^2}$ and, while many evaluated this correctly, there were several different errors made. Some made a simple slip and forgot to take the square root and went on to use 10.25 as the vertical height, but a more common error was to calculate $10\sqrt{2}^2$ instead of $(10\sqrt{2})^2$ leading to a vertical height of 13.79…. Some candidates worked in decimals rather than exact form. While they mostly managed to avoid these computational errors, they often introduced an accuracy error through premature rounding of interim answers (such as using 14.1 for $10\sqrt{2}$).

Very common wrong answers were 1400 (arising from using triangle AOE with AO = 10) and 1933.3… (from assuming the perpendicular height was the same as the slant length of 14.5). Neither of these methods scored a mark as they had bypassed the 3D nature of the demand.

It is possible to use trigonometry to answer this question, but these attempts were rare and often made incorrect assumptions such as angle EAO being 45°.

This question required candidates to show working. Therefore, candidates should be showing the Pythagoras' theorem or trigonometry calculations rather than just adding lines and lengths to the diagram or presenting a sketch of a right-angle triangle with the three dimensions stated.

Question 15

15 Two bottles are mathematically similar.

The small bottle holds 0.5 litres and has a height of 35 cm.
The large bottle holds 2 litres.

Calculate the height of the large bottle.

.... cm **[4]**

There were only really two answers seen here, the wrong answer of 140 and the correct answer of 55.5 to 55.6. Unfortunately, 140 was the one that occurred most of the time. Perhaps the fact that the volume was given in litres meant that some candidates did not link this to being a volume/length scale factor question.

Most candidates correctly obtained the volume scale factor of 4, but only about 1/4 of them then found the cube root and were successful in achieving full marks. The rest did 35 × 4, getting the wrong answer of 140.

A few candidates multiplied 0.5 by 4 to get 2 and then multiplied 35 by 2 to reach 70 cm. There was a very small number of candidates who square rooted or cubed 4 instead of cube rooting.

Question 16 (a)

16 The price of a seat on a flight, £P, is given by

$P = 49 \times 1.009^n$

where n is the number of seats already sold on this flight.

(a) Write down the percentage increase in price of the second seat sold compared to the first seat sold.

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

About half of the candidates simply wrote down the correct answer as instructed. Candidates who gave incorrect answers usually gave 0.009 or did some work to find P for two consecutive values of n and then attempted to find the percentage increase, invariably with at least one error (or they merely subtracted the two answers).

Question 16 (b)

(b) Show that the price of the 40th seat sold is less than £70. **[2]**

Candidates either correctly worked out P when n is 39 or they worked out P when n is 40. The award of 1 mark for using n as 39, but evaluating incorrectly, was rare.

Question 17

17 The kth term of a sequence is r^k, where $r \neq 0$.
The sixth term is equal to three times the second term.

Find the value of r, giving your answer correct to **3** decimal places.

$r =$ .... **[4]**

Many candidates had little idea how to approach this question and many were unable to translate the information in the question into expressions involving the second and sixth terms. Of the candidates who did manage to arrive at $r^6 = 3r^2$, very few could solve this and some very poor algebra was seen.

A few candidates attempted trials, but rarely went far enough (perhaps perturbed by the decimal nature of their answers).

Question 18 (a)

18 **(a)** Describe fully the graph of $x^2 + y^2 = 20$.

....

.... **[3]**

Many candidates did not recognise this as a circle. There were numerous wrong answers, the most common being that it was a graph of direct proportion, positive correlation, a straight line or a quadratic (U-shaped) graph.

Most of the candidates who did state the centre of the circle were correct, but there was more variation in values for the radius. The most common wrong answers for the radius were 20 and 10.

It was not unusual for candidates to give the radius or the centre correctly, but neglect to mention that the graph was that of a circle.

Question 18 (b)

(b) The graph of $y = 3x + 10$ intersects the graph of $x^2 + y^2 = 20$ at two points.

Use an algebraic method to work out the coordinates of the two points.
You must show your working.

(b) (........... , ...) and (........... , ...) **[6]**

For some candidates, this was a question that they knew how to answer and they worked their way through the required algebra carefully, often gaining full marks. On the other hand, many candidates did not attempt this question. Others attempted to find one or both pairs of coordinates by trials, but this rarely had any success.

Of those who squared $y = (3x + 10)$ and substituted into $x^2 + y^2 = 20$, the majority went on to at least get the two correct values of x. The few who started by rearranging to $x = \frac{y - 10}{3}$ before squaring and substituting for x^2 were much less successful because of the fractions they had introduced.

A few began by making basic errors such as $(3x + 10)^2 = 9x^2 + 100$, thereby altering the difficulty of the question and gaining no further credit.

Question 19 (a)

19 **(a)** Show that $\sqrt{11} \times \sqrt{22} = 11\sqrt{2}$. **[1]**

A majority of candidates demonstrated a good understanding of the manipulation of simple surds. The most common issue was candidates skipping steps in this 'Show that…' question. For example, after $\sqrt{11} \times \sqrt{22} = \sqrt{242}$, it was necessary to then give $\sqrt{121} \times \sqrt{2}$ before writing the given answer.

Less able candidates struggled with setting out their work, with many giving a continuous line of expressions connected by '=' symbols that were not actually equal to each other; others had statements connected by arrows. This was particularly a problem when $\sqrt{22}$ was rewritten elsewhere on the page as $\sqrt{11} \times \sqrt{2}$. Some candidates resorted to decimal calculations to show the equivalence, an approach neither rigorous nor exact enough for a 'Show that…' question.

Assessment for learning

Candidates should be reminded to show all details of their working in a 'Show that…' question, no matter how trivial they seem.

Question 19 (b)

(b) Show that $\dfrac{\sqrt{11}}{13+\sqrt{22}}$ can be written in the form $\dfrac{a\sqrt{11}-11\sqrt{2}}{b}$ where *a* and *b* are integers. **[4]**

Candidates who knew to multiply the numerator and denominator by the conjugate were usually able to complete the process successfully.

Common errors involved slips in the multiplications (usually with the signs when multiplying the denominator) or giving the expansion without showing the required working. Occasionally candidates omitted essential brackets or the fraction line at the first stage. It was clear that some had an understanding of what was required but started off by not using the correct conjugate. Some multiplied the numerator and denominator by terms such as $13 + \sqrt{22}$, or just $\sqrt{22}$.

A high proportion of candidates made no attempt at a response. There were also some who seemingly used their calculator to find the answer and then attempted to construct a solution that led to this. These solutions were often full of small mistakes and creative manipulation; they usually did not have the required minimum two terms for the denominator expansion, for example.

Question 20 (a)

20 (a) Write $(2x-5)(x+4)$ in the form $2(x+a)^2-b$.

You must show your working.

(a) .... **[5]**

The vast majority of candidates made a start, but only about 1/4 of them progressed successfully beyond the M1 mark for expanding $(2x – 5)(x + 4)$ as $2x^2 + 8x – 5x – 20$.

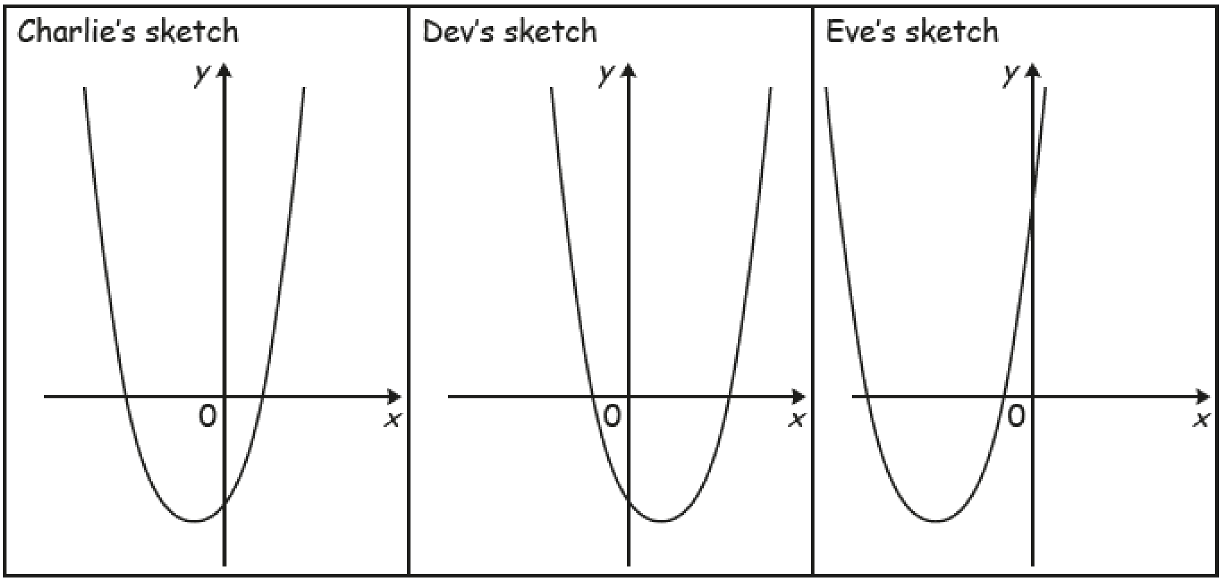
Virtually all candidates who did continue tried to solve the question as a 'completing the square' problem. Most appeared unfamiliar with how to deal with the coefficient of x^2 not being 1, which is shown as an example in 6.01f of the specification.

The most common wrong answer was $2(x + 1.5)^2 – 22.25$. Some candidates expanded this to check whether it was correct, which sometimes led them changing their answer to $2(x + 0.75)^2$, giving access to earn the B3 mark if some method was shown. Many of these candidates still did not get the correct value for b, with the common wrong value being $^-21.25$ from failing to double the 0.75^2.

A small number of candidates realised that the question did not have to be solved by completing the square at all. Instead, they expanded both expressions and matched coefficients, usually very successfully. Using symmetry to identify the x-coordinate of the turning point (7.01c of the specification) was also included on the mark scheme; this was rarely seen, but almost always successful.

Question 20 (b)

(b) Charlie, Dev and Eve all attempt to sketch the graph of $y = (2x - 5)(x + 4)$.



Whose sketch is the most accurate?
Write down the properties of the graph that you used in making your decision.

.... because ....

....

....

.... **[2]**

Most candidates gave an answer, but few were successful. Answers frequently consisted of a vague statement not supported by values.

The most common reason for selecting Charlie was stating the roots correctly as $\frac{5}{2}$ and $^-4$, but candidates could also have referred to the *y*-intercept being $^-20$ together with the turning point being at $x = -\frac{3}{4}$. Some candidates gave the roots incorrectly as $^-5$ and 4.

The most common awards of the SC1 mark were for a correct follow through of the candidate's turning point in support of the selection of Eve, or for Dev and a *y*-intercept of $^-20$.

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