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OCR
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GCSE (9–1)

Examiners' report

MATHEMATICS

J560

For first teaching in 2015

J560/06 Summer 2024 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 that 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 OCR.

Paper 6 series overview

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

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 of the specification's 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 2, 3, 4, 5 and 6 were also set on the Foundation tier J560/03 assessment.

Candidates showed themselves to be well-prepared for this paper. For example, Question 15 and Question 17 (a) were two relatively familiar questions that were answered with great success by candidates right across the ability range.

There were fewer question parts in the paper this summer compared to recent series, with the consequence that there were more high-value questions, particularly in the middle and at the end of the paper. Generally, most candidates coped with this very well and gained some initial marks in longer problems rather than earning those marks by correctly answering an extra question. Along with the aforementioned good preparation, this may have been a contributory factor in this paper having a significant rise in the mean mark for each quartile of the ability range (especially for those in the top two quartiles, for example the proportion of candidates scoring 80+ marks was nearly double that of Summer 2023).

As has been seen before, however, candidates struggled to set their work out clearly and solutions to multi-step problems often ended up scattered over the page. This was particularly true of Question 19, which could be tackled using a variety of methods and several candidates seemed to attempt more than one of them, not successfully progress any of them to an answer and then submit a response without anything crossed out or any indication of which method they wished to be marked.
Most questions requiring a comment or explanation appeared in the first half of the paper and candidates of all abilities struggled to express themselves clearly. Particular instances are covered in detail below, together with some AfL guidance.

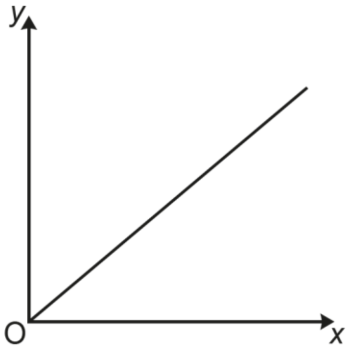
As mentioned in previous reports, some candidates would benefit from paying greater attention to the number of marks allocated to questions and their position within the paper. For example, Question 5 (a) involved right-angled triangles; being a 6 marks question is likely to have two or three stages to its solution using either trigonometry or Pythagoras' theorem, but as it is Question 5 it should not require the greater complexity of the sine or cosine rule.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• attempted all questions • demonstrated good calculator skills by using functions such as indices, roots and trigonometry correctly, maintaining accuracy when using an interim answer and evaluating formulae accurately • performed almost all standard techniques and processes accurately • understood information presented in words or diagrams • 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 response • showed all the stages in their working in questions worth more than 2 marks.	• did not use formulae correctly, even if given on the formulae sheet or within the question • rounded values too soon while working through a method, leading to a lack of accuracy in final responses • made errors in performing routine processes • misinterpreted questions and information, or did not follow instructions • had limited facility and confidence in applying algebraic techniques • used methods that were inefficient or inappropriate, for example selecting a trig. function that then required Pythagoras' theorem to reach the solution, rather than using a different trig. function • did not show all steps in working, particularly when answering questions that stated 'Show…'.

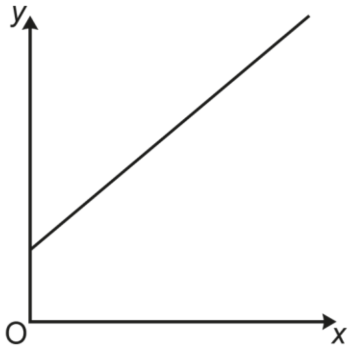
Question 1

1 Below are six graphs, numbered 1 to 6, that show different relationships between x and y.

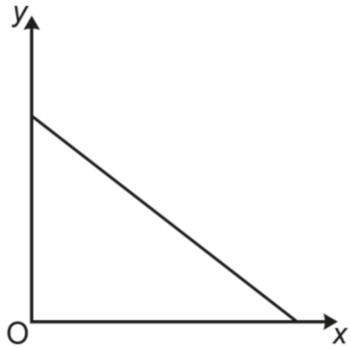
Graph 1



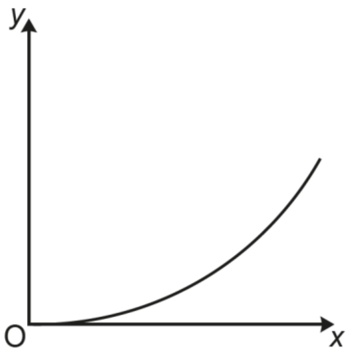
Graph 2



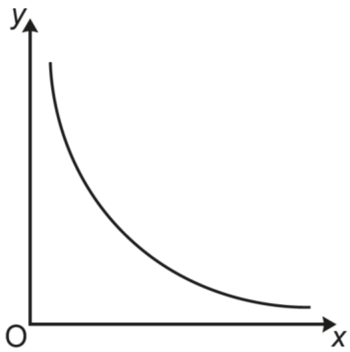
Graph 3



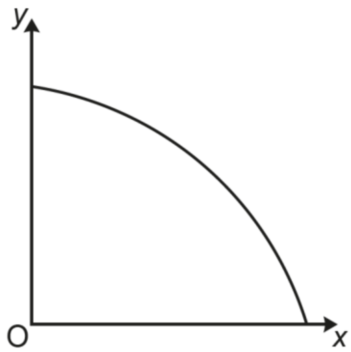
Graph 4



Graph 5



Graph 6



For each description below, write down the number of the graph that best represents the relationship between x and y.

x: temperature in °C
y: temperature in °F, where $y = 1.8x + 32$. Graph ....

x: average speed when running 200 m
y: time taken to run 200 m. Graph ....

x: mass of a solid object made from clay
y: volume of the same solid object. Graph ....

[3]

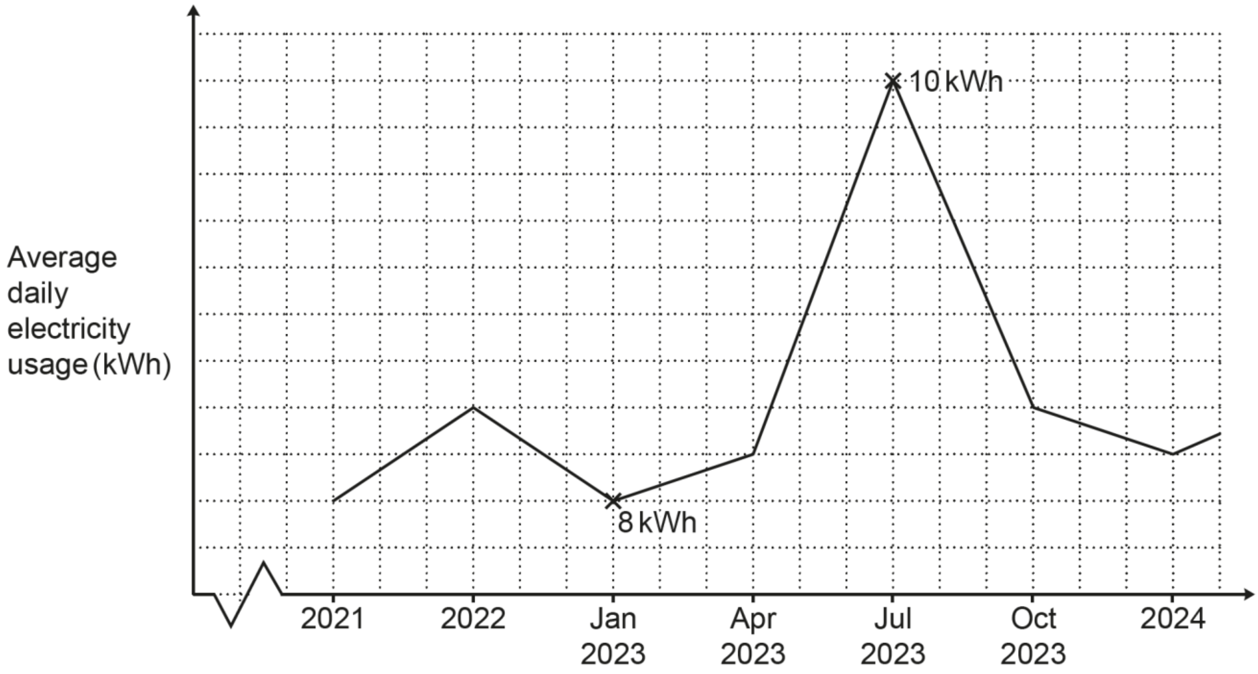
This is probably the first time a question has been set that so explicitly assessed the content of statement 7.04a in the specification, 'graphs of real-world contexts' including 'temperature conversion' and 'direct and inverse proportion'. It highlighted a considerable lack of understanding among all abilities.

While providing an accessible start to the paper with virtually all candidates responding, about 25% of the candidates got all three graphs wrong and less than 10% got all three correct.

The temperature graph was the most successfully identified, probably because the equation was given and could be recognised as a $y = mx + c$ straight line (graph 2). The time/distance/speed context is a common example of inverse proportion (graph 5). The mass/volume context is an example of direct proportion (graph 1). Together the three graphs covered 7.04a.

Question 2

2 The graph shows a household's average daily electricity usage, in kilowatt hours (kWh).



Give **two different** reasons why this graph is misleading.

Reason 1: ....

....

Reason 2: ....

.... **[2]**

Candidates needed to give two different reasons. This was more easily achieved by giving one reason about the average daily electricity usage and one reason about the inconsistent dates. Those who gave two reasons about a single aspect (for example, the dates) often repeated the same thing twice using different words.

The mark scheme appendix contains many examples of reasons given and how they were marked.

Assessment for learning

Candidates often struggle to write clear mathematical statements, but there are a few things that can easily be done to try and boost candidates' marks in the future.

The word 'it' should not be used; the word should be replaced with the name or description of what candidates are referring to. For example, 'It does not start from 0' is unclear and scores 0, whereas 'The Average daily electricity usage does not start from 0' is specific and scores 1 mark (alternatively, 'The vertical axis does not start from 0' could be used or even 'The *y*-axis…' scored here).

Candidates should also be double-check any mathematical terminology to make sure it is correct; if in doubt, they could consider if using another word or a short phrase would be a suitable alternative. For example, 'The *y*-axis does not have labels/units' scores 0 because the axis has both a label ('Average daily electricity usage') and units ('kWh'). What the *y*-axis is missing is 'a scale' or 'numbers'.

Question 3

3 The word MATHEMATICS is spelt using tiles.

M	A	T	H	E	M	A	T	I	C	S

The tiles are put into an empty bag.

One at a time, 99 children each take a tile at random from the bag.
They record the letter and then put the tile back in the bag.

Work out how many times the letter M is expected to be taken from the bag.

.... **[3]**

About $\frac{3}{4}$ of the candidates scored full marks. Some first found the probability of taking a letter M (scoring B1 for $\frac{2}{11}$) and then used the idea of 'expected value = probability × number of trials' to write down $\frac{2}{11} \times 99$ (increasing the mark to M2). Others worked out that each tile was likely to be taken 99 ÷ 11 times (scoring M1 if they wrote down the calculation, although just writing '9' on its own couldn't be credited) and then multiplying this by 2 as there are two M tiles (increasing the mark to M2).

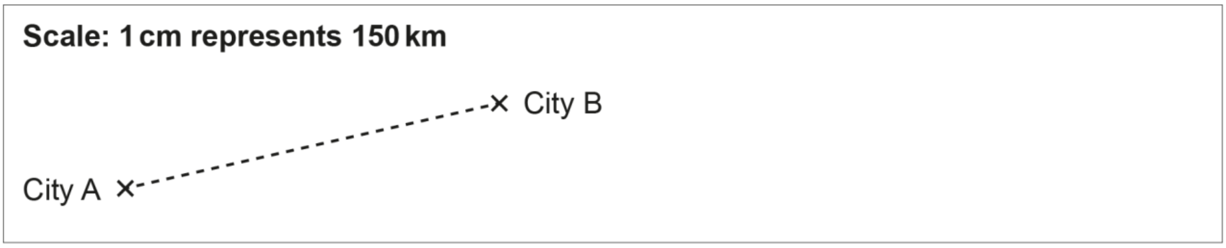
Candidates who tried other methods often did not reach the correct answer of 18. For example, attempting to use equivalent fractions often led to working such as $\frac{2}{11} = \frac{18}{99}$ and then $\frac{18}{99}$ given as the final answer (which scored B2) or it was then cancelled back down to the original $\frac{2}{11}$ (scoring B1).

The use of an incorrect probability was very rare, but the mark scheme enabled a possible M1 for these candidates.

Question 4 (a) (i)

4 1 cm on a map represents 150 km in real life.

(a) Below is part of the map showing City A and City B.



Heidi is planning to walk from City A to City B for charity.

Heidi measures the straight-line distance on the map from City A to City B accurately as 5 cm.
Heidi says she will walk from City A to City B at an average speed of 2.5 km/h for 10 hours per day.

(i) Use this information to work out how many days Heidi needs to complete the walk from City A to City B.

(a)(i) .... days **[4]**

The vast majority of candidates scored full marks here.

Almost all used the scale to get a distance of 750 km (scoring M1). Very occasionally the scale was overlooked and candidates just used 150 km for the distance, but they could still progress to score other marks. It was extremely rare for candidates to use an inaccurate measurement of their own instead of the given 5 cm.

Successful candidates either worked out that Heidi walks 25 km each day (scoring another M1) and the number of days as 750 ÷ 25 (increasing the mark to M2), or they worked out 750 ÷ 2.5 to give a total walking time of 300 hours (scoring M1) and then 300 ÷ 10 hours (increasing the mark to M2).

A common error in the latter method was using 300 ÷ 24 to find the number of days. A few other candidates correctly found 30 days, then subsequently spoilt it by multiplying by 10, dividing by 10 or dividing by 24.

Question 4 (a) (ii)

(ii) Explain why the information used in part **(i)** is likely to give an underestimate for the number of days Heidi needs to complete the walk.

....

.... **[1]**

Most comments related to Heidi's ability to maintain a constant speed of 2.5 km/h or her need to take breaks, etc. These all scored 0 marks; the question states 'average speed' and factors such as taking breaks will already have been covered in an average.

The flaw in Heidi's method that is likely to cause an underestimate is her use of a straight-line distance and acceptable comments needed to reference this. About 15% of candidates gave an acceptable response and some examples are included in the mark scheme appendix.

Question 4 (b)

(b) Yoshi writes the scale of the map, 1 cm represents 150 km, as the ratio 1 : 150.

Explain Yoshi's error and write the scale correctly in the form 1 : *n*.

Yoshi's error is ....

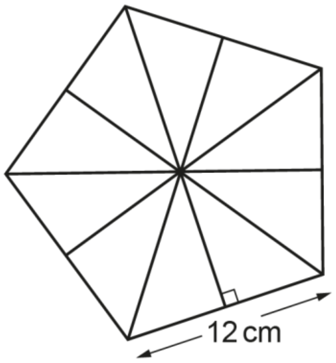
....

The correct answer is 1 : .... **[2]**

Most candidates were able to identify Yoshi's error, but some were not precise or careful enough in describing it. A statement such as 'Yoshi did not convert the units' is vague and something like 'Yoshi did not convert km into m' is not describing an error. The marks were independent, so candidates who didn't score the first mark could still score the second mark for the correct conversion.

Question 5 (a)

5 The diagram shows a regular pentagon made using ten congruent right-angled triangles.
The length of one side of the pentagon is 12 cm.



Not to scale

(a) Show that the area of the pentagon is 247.75 cm^2, correct to **2** decimal places. **[6]**

To make progress in this question candidates needed to calculate either one of the angles at the centre or half of the interior angle of the pentagon. Many of those that did then successfully used trigonometry to find the height of a smaller triangle (*h*) and went on to calculate the total area. A significant number however did not show the given result with sufficient accuracy and couldn't be given the final mark; candidates should be reminded that in order to 'show' something is correct to a specific degree of accuracy, we need to see their answer to a greater accuracy than the given answer.

Most successful candidates found *h* directly using right-angled trigonometry (either 6 × tan54 or $\frac{6}{\tan 36}$). It was however also found less efficiently by using the sine rule to get $\frac{6\sin 54}{\sin 36}$, or with even less efficiency by first finding the hypotenuse of one of the small triangles (10.20…) using trigonometry and then applying Pythagoras' theorem.

The area of one small triangle was usually found via $\frac{1}{2} \times 6 \times h$ and then this answer was multiplied by 10 to get the area of ten of these triangles. Some candidates paired triangles and worked out $\frac{1}{2} \times 12 \times h$ and then multiplied this by 5. An alternative method (particularly if the hypotenuse of a small triangle had been found) was to use $\frac{1}{2}ab\sin C$ for either a single triangle or a pair of triangles.

Some candidates assumed that the pentagon consisted of equilateral triangles and worked with an angle of 60° or 30°; others assumed it consisted of isosceles triangles and used 45°.

By far the most common error was applying a circular argument (using the given area to work backwards to find the height of a triangle and then using this height to find the area).

It was rare to see a well-presented method and many seemed to struggle to follow their steps to the answer.

Question 5 (b)

(b) The regular pentagon is the base of a pyramid.

The pyramid has volume $450\,\text{cm}^3$.
The perpendicular height of the pyramid is h cm.

Calculate the value of h.

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

(b) $h =$ .... **[3]**

Many were able to correctly use the given formula for the volume of a pyramid to find the height of the pyramid. Some appeared to not realise they needed to use the area of the pentagon from the previous part and made no progress.

Most candidates who used the correct values worked out h as 5.449… without premature rounding. Some candidates multiplied 450 by $\frac{1}{3}$ and others lost accuracy by changing $\frac{1}{3}$ to 0.3.

A few candidates replaced $\frac{1}{3}$ in the formula with $\frac{1}{2}$. It was not clear if this was a misread or intentional due to division by 0.5 being easier to perform than division by $0.\dot{3}$. These candidates were given 0 marks.

Question 6 (a)

6 **(a)** Two numbers, A and B, are written as the product of their prime factors.

$A = 2 \times 3 \times 7^2$
$B = 2^3 \times 7$

Find the lowest common multiple (LCM) of A and B.
Give your answer as an ordinary number.

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

Many correct responses with no working were seen (working wasn't required to be shown here and so these scored 2 marks). Where given, working was often difficult to follow and so more often than not the M1 couldn't be given and incorrect responses scored 0.

The most common method that could be followed and given M1 was to present the factors in a Venn diagram. This is a productive start towards finding the LCM, even if a candidate subsequently gives the HCF of 14 as their answer. Another method was working out *A* and *B* and then listing their multiples, which is an inefficient method, yet valid and so could also score M1 if the correct answer wasn't reached.

Comparing the prime factorisations, crossing out values and similar strategies did not prove to be successful methods; candidates often included too many 2s in their working.

Some candidates simply multiplied *A* and *B* together.

Question 6 (b)

(b) A number, R, is written as the product of its prime factors.

$R = 2 \times 3^2 \times 5 \times k$, where k is a prime number.

The highest common factor (HCF) of R and another number, P, is 26.

Find the value of k.

(b) $k =$ .... **[2]**

As with part (a), there were many correct responses here supported by no method or a very unclear method.

A partially completed Venn diagram was a helpful visualisation for candidates and again was a means of scoring M1. By writing the HCF of 26 in the overlap as 2 and 13, it could be deduced that *k* must be 13. An alternative was a factor tree with 26, 2 and 13 written in.

A few candidates thought *k* would be 7, since that is the next prime number.

Question 7 (a)

7 Two bags of fruit contain only apples and bananas.
In bag X, the ratio of apples to bananas is 5 : 7.
In bag Y, $\frac{5}{12}$ of the fruit are apples.

(a) Finley says

Bag X and bag Y contain the same number of apples.

Tick the correct statement.

☐ Finley is definitely correct

☐ Finley might be correct, or might not be correct

☐ Finley is definitely not correct

Show how you decided.

....

....

....

.... **[3]**

Clear explanations were rare. Most candidates were given just the first mark on the mark scheme, followed by awarding both the first and third marks (the third mark was not given just for ticking the middle box, it was dependent on at least one other mark).

Most candidates compared the fraction and ratio successfully to convey the idea that there could be the same number of apples in the bags. This was often by showing that 5 : 7 in bag X meant a total of 5 + 7 = 12 fruits and since five of these were apples, $\frac{5}{12}$ of the bag was apples, the same as in bag Y. Others started with bag Y, stating that if $\frac{5}{12}$ of its fruit were apples then $\frac{7}{12}$ would be bananas and that $\frac{5}{12} : \frac{7}{12}$ was equivalent to bag X's ratio. Explanations like these usually led to a tick in the first box, to score 1 mark.

Other candidates used the same argument, but suggested that bag X's 5 : 7 could have been simplified while bag Y contained five apples, or similar. This usually led to the selection of the second box, to score 2 marks. A fuller and clear explanation including numerical examples could receive 3 marks.

Many explanations were vague, however if they included the idea that knowing the total amount of fruit in the bags was key to deciding if Finley was correct and the middle box was ticked, an SC mark could be given.

Many examples of comments and how they were marked are included in the mark scheme appendix.

Question 7 (b)

(b) Finley adds 4 apples to bag X.
The ratio of apples to bananas is now 11 : 14.

How many bananas are in bag X?

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

Questions like this have been set quite regularly on J560/06 previously and this was probably a more accessible version than most.

The simplest approach is to obtain two ratios of apples : bananas, with the same number of bananas. This was usually done with 10 : 14 for the old bag X and 11 : 14 for the new bag (as given in the question). These ratios have the same number of bananas (scoring B1) and a difference of one apple. Multiplying each ratio by 4 gives 40 : 56 and 44 : 56 (scoring B2). Some candidates did not multiply by 4 and instead listed ratios of 5 : 7 and 11 : 14 until they reached a pair with the same number of bananas and a difference of 4 in the number of apples. A few candidates then extracted an incorrect answer from their working, but most successfully interpreted what they had found as meaning there were 56 bananas.

Setting up an equation is an equally valid method, but candidates attempting it were generally less successful. They usually started with [$\frac{\text{number of apples after the extra 4}}{\text{number of bananas}}$ =] $\frac{5x+4}{7x} = \frac{11}{14}$. Many correctly solved this to reach $x = 8$, but then often didn't know what to do with it. The words included in the equation above were rarely seen, but shows they needed to multiply their x by 7 to get to the number of bananas.

Trials and addition or multiplier methods were quite common, but almost always scored 0.

Question 8 (a)

8 **(a)** Complete this table for $y = x^3 - 3x^2$.

x	−2	−1	0	1	2	3	4
y	−20		0	−2	−4		16

[2]

Many could not correctly evaluate y when x = -1, with responses of 2 or -10 being very common. However, the vast majority of candidates correctly worked out that when x = 3, y would be 0.

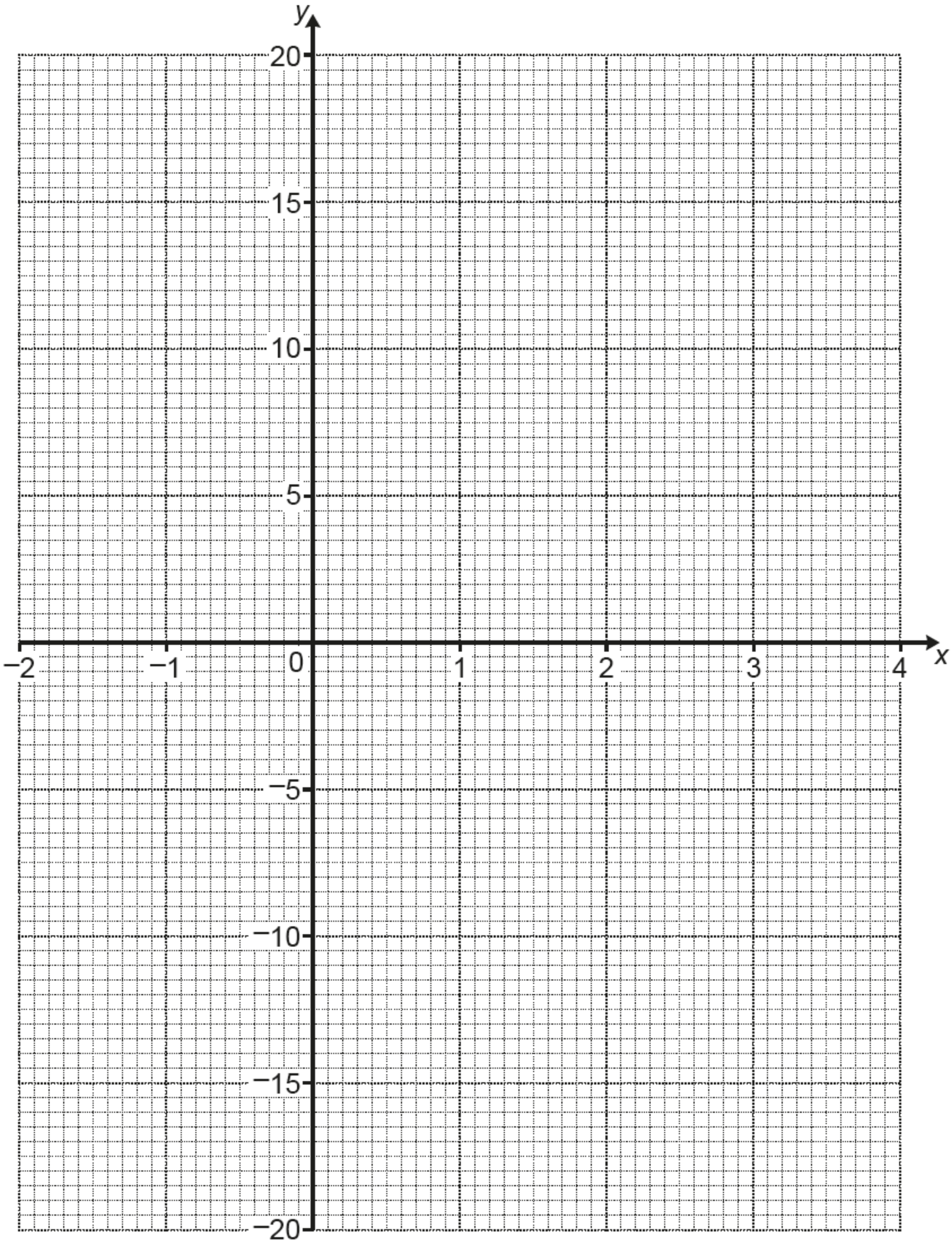
Assessment for learning

Candidates often struggle to evaluate formulae or expressions that involve negative numbers. Sometimes, they may be more successful applying mental or pen and paper techniques (or at least using these methods to check their calculator's answer). When using a calculator, it is essential that candidates are aware how to correctly use brackets around negative numbers.

For example, here many will have keyed:
(i) -1 'x^3' – 3 × -1 'x^2', which gives an answer of 2, or
(ii) (-1) 'x^3' – (3 × -1) 'x^2', which gives an answer of -10.

Question 8 (b)

(b) Draw the graph of $y = x^3 - 3x^2$ for values of x from $^-2$ to 4.



[3]

Most candidates were able to plot at least six of their points with sufficient accuracy to score B2. There were however instances of candidates incorrectly using the vertical scale when trying to plot at $y = {}^-2$ or $y = {}^-4$. The correct curve was required for the full 3 marks.

Question 8 (c)

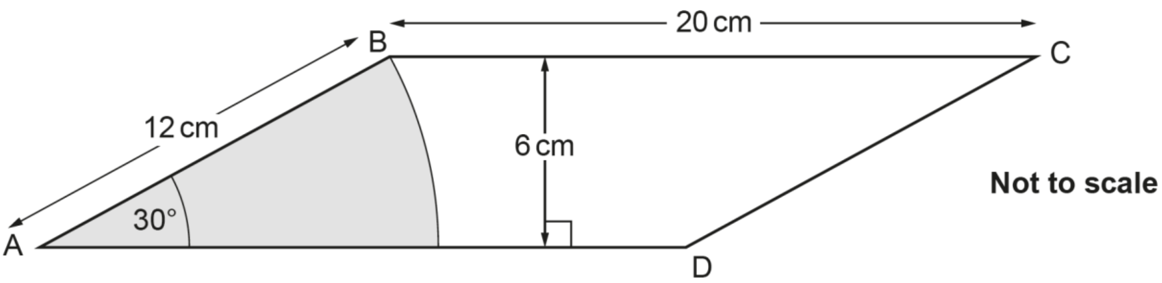
(c) Use the graph to solve the equation $x^3 - 3x^2 = 5$.
Give your answer to **1** decimal place.

(c) .... **[1]**

Most candidates with a graph in part (b) attempted to use it correctly to solve the equation here. Some made an error in reading the *x*-axis scale.

Question 9 (a)

9 The diagram shows a shaded sector inside a parallelogram.
The sector has an angle of 30°.
The parallelogram, ABCD, has length BC = 20 cm and AB = 12 cm.
The perpendicular distance between BC and AD is 6 cm.



(a) Show that the area of the sector is 37.7 cm^2, correct to **3** significant figures. **[3]**

This was answered well, with most candidates substituting directly into the formula for the area of a sector. This was a 'Show that…' question, so sufficient working needed to be seen for the full 3 marks. For example, $\frac{30}{360}$ (or the interim step $\frac{360}{30}$ = 12 rather than just 12) needed to be seen. Jumping straight from 12π to the given 37.7 also did not satisfy the demand, as a more accurate response such as 37.69… should be shown.

Those candidates that didn't score often tried methods such as splitting the sector into a triangle and another area then applying trigonometry or Pythagoras' theorem, or trying to include the parallelogram within their calculations.

Question 9 (b)

(b) Work out the percentage of the parallelogram that is **not** shaded.

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

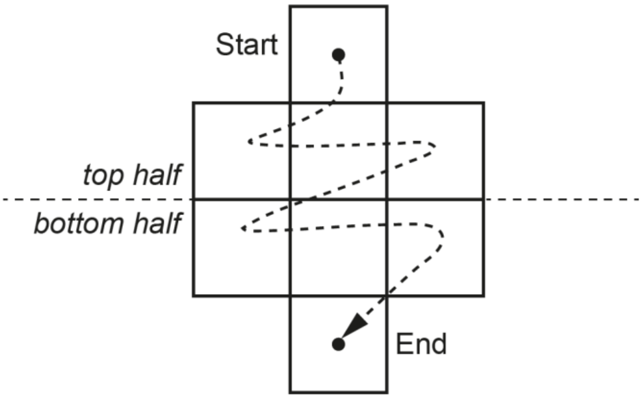
The question had a relatively high omission rate, with a large number of candidates seemingly not knowing how to find the area of a parallelogram even when given the perpendicular height.

For the parallelogram's area, base length × slant length (20 × 12, leading to 240 cm^2) was very commonly used. Many lengthy methods that involved partitioning the parallelogram into smaller areas were seen, sometimes two triangles and a rectangle, but also more awkward shapes as a result of using sectors. Very occasionally these complex methods did reach exactly 120 cm^2, but more often than not they were inaccurate or completely wrong.

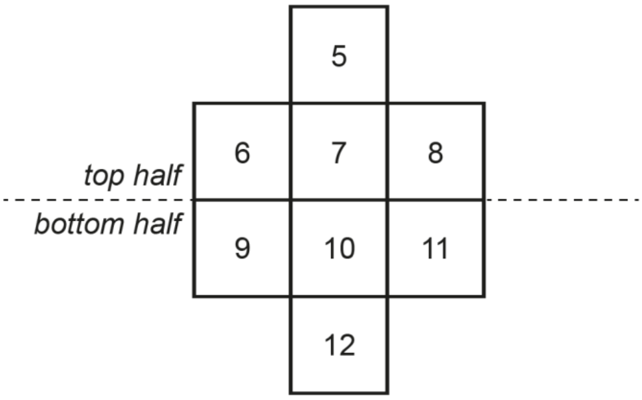
Most candidates that reached an area for the parallelogram (even if incorrect) were able to find the unshaded area as a percentage of the whole and so were able to earn the 2 marks allocated to the percentage stage.

Question 10 (a)

10 Eight consecutive numbers are written in ascending order in this grid, starting from the top and working left to right.



(a) Kareem writes the numbers 5 to 12 in the grid.



Show that for Kareem's grid, the sum of the numbers in the top half of the grid is 16 less than the sum of the numbers in the bottom half of the grid. **[1]**

The vast majority of candidates scored the mark here, but a few did not write the subtraction that was required for this 'Show that….' mark.

Question 10 (b)

(b) **Use algebra** to prove that for **any** set of eight consecutive numbers written in this grid in the same way, the sum of the numbers in the top half of the grid is 16 less than the sum of the numbers in the bottom half of the grid. **[5]**

Candidates seemed comfortable using algebra in this question. Working was usually clear and well set out. The most common issue came at the final step when showing the difference of 16, where the final mark could not be given because of an incorrectly written statement (such as '$4n + 22 – 4n + 6 = 16$').

Mistakes in the early steps were usually in setting up the algebraic terms. Some made progress if they chose consecutive terms (e.g. $2n$, $2n + 1$, …). The terms n, $2n$, $3n$, etc. were quite common, but these do not represent consecutive integers (and candidates also simplified the algebraic summation required at the next stage) and therefore scored 0 marks.

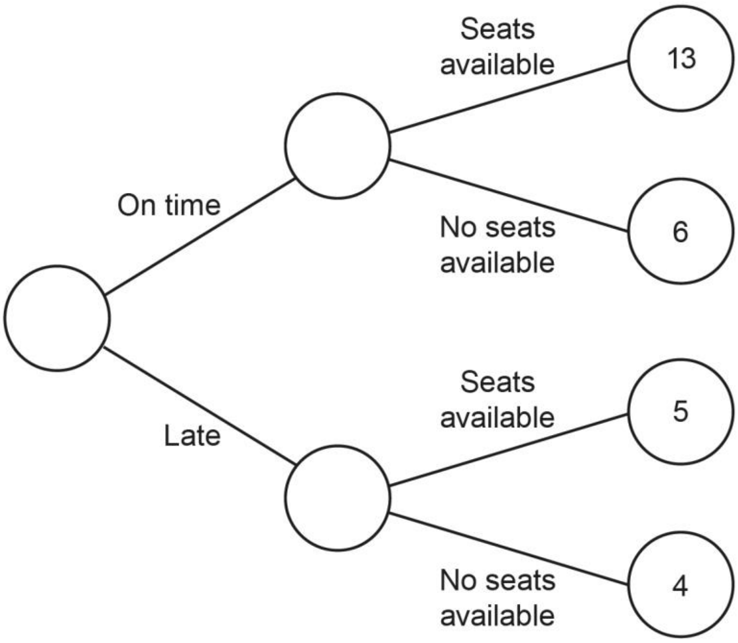
Candidates that didn't provide an algebraic proof often gave at least one correct numerical example, earning an SC mark.

Question 11 (a)

11 Jack travels to work each day by train.

He records whether
- the train is on time or late
- there are seats available or no seats available.

Jack's results are shown on this partly completed frequency tree.



(a) Find the relative frequency of there being no seats available on Jack's train journey.

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

Frequency trees have not been assessed very often on Higher tier papers, but almost all candidates responded to this question. Many candidates unnecessarily (yet correctly) completed the missing values. Knowledge of relative frequency was however generally low and over half of candidates scored 0 marks.

For those with stronger knowledge of relative frequency, this was often a straightforward 2 marks for the correct response. A very small number of candidates scored 1 mark for a fraction with 10 as the numerator and an incorrect denominator (usually 18, from the number of journeys with seats available). Many candidates overcomplicated the question by turning it into a probability tree diagram and multiplying along the branches. Others just found the frequency of no seats being available (6 + 4 = 10).

Misconception

Candidates should be aware that relative frequency is a proportion or fraction, not just a frequency.

Question 11 (b)

(b) Jack says

If the train is late, travellers are less likely to find seats available than if the train was on time.

Does Jack's data suggest he is correct?
Show how you decide.

.... because ....

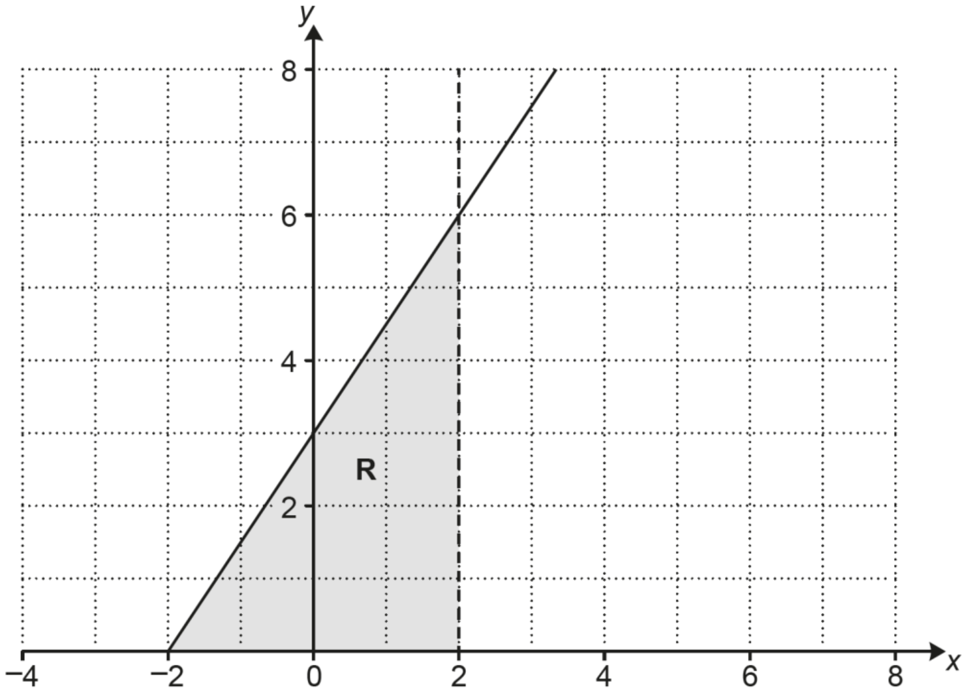
....

.... **[3]**

Many misinterpreted the values in the diagram as representing the number of seats available rather than the number of journeys. Many responses hence just compared 13 and 5, or 6 and 4. For those making a correct attempt, a variety of comparisons were made, usually the relative frequencies of seats being available ($\frac{13}{19}$ and $\frac{5}{9}$) or not available ($\frac{6}{19}$ and $\frac{4}{9}$). Having given the correct relative frequencies, not all candidates converted these to a comparable form, such as decimals, percentages or fractions with a common denominator.

Question 12

12 The region **R** is shown on this grid.



The region **R** is defined by three inequalities.
The first inequality is given below.

Complete the second inequality and write down the third inequality needed to define region **R**.

$y \geqslant 0$

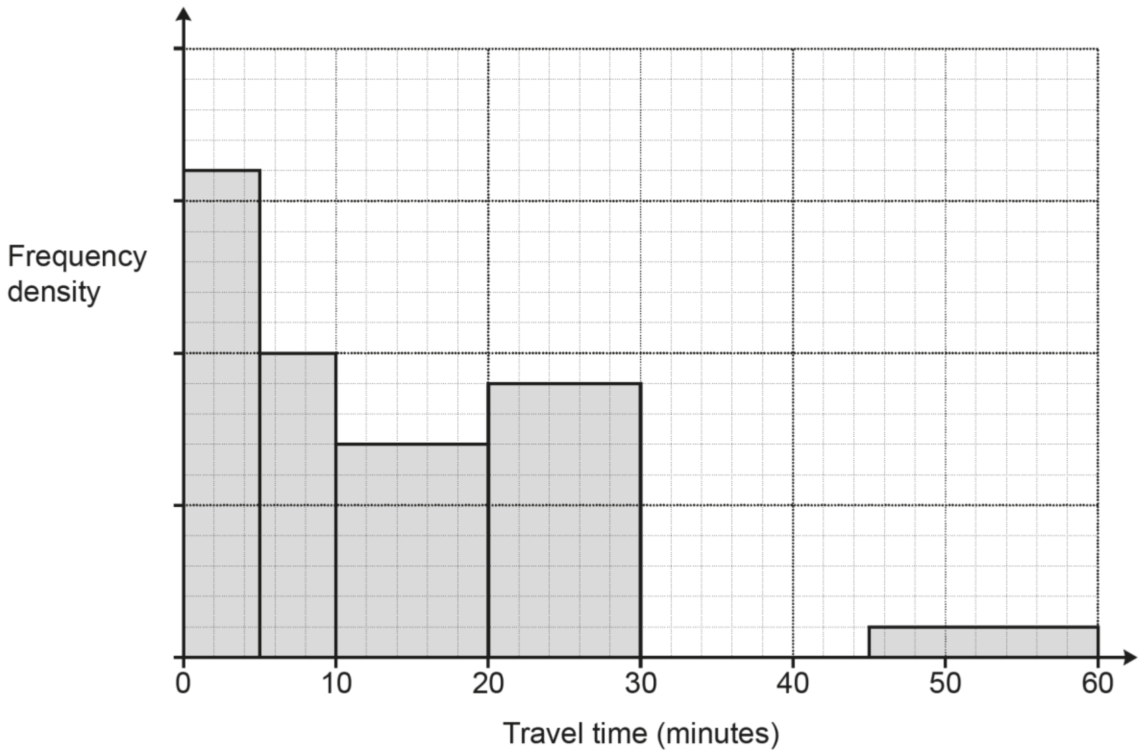
$2y$ .... $3x + 6$

.... **[3]**

Knowledge of the inequality symbols and the notation for showing regions was limited and about 40% of candidates scored 0 marks. The second line was completed with almost equal occurrences of <, ≤, =, > and ≥. The final line was often a repeat of the second line, except with a different inequality symbol. Other common wrong answers were $x > 2$, $x \leq 2$ and $y < 2$.

Question 13 (a)

13 A group of students record the time taken to travel to school.
All students in the group took less than an hour to travel to school.
Some of their results are recorded on this histogram.



16 students took less than 5 minutes to travel to school.

(a) How many students took less than 20 minutes to travel to school?

(a) ....students **[4]**

Success here was dependent on candidates approaching it as a histogram and not as a frequency diagram.

Those approaching it as a histogram almost always found the correct number of students, with the only errors being numerical slips. The most successful candidates first identified the frequency density of the first bar via 16 ÷ 5, often marking 3.2 on the vertical scale; they then completed the scale or showed working for the other two areas (5 × 2 and 10 × 1.4).

Other successful candidates used a proportional approach, either finding the areas of the bars in terms of the number of little squares (40, 25 and 35) or by multiplying the widths in minutes by the heights in little squares (leading to 80, 50 and 70). Final answers of 100 and 200 quite often arose from these methods, due to a lack of appreciation for the scaling impact of what they had done.

A few used a valid method, but calculated one bar too many or one too few, often scoring 2 or 3 marks. Others scored B1 for identifying the frequency density of the first bar as 3.2 without further progress.

Those not approaching it as a histogram almost always gave the answer 33, from reading the heights as representing the frequencies (this scored 0).

Misconception

? Candidates should know that histograms use area to represent frequency.

Question 13 (b)

(b) 9 students took between 30 and 45 minutes to travel to school.

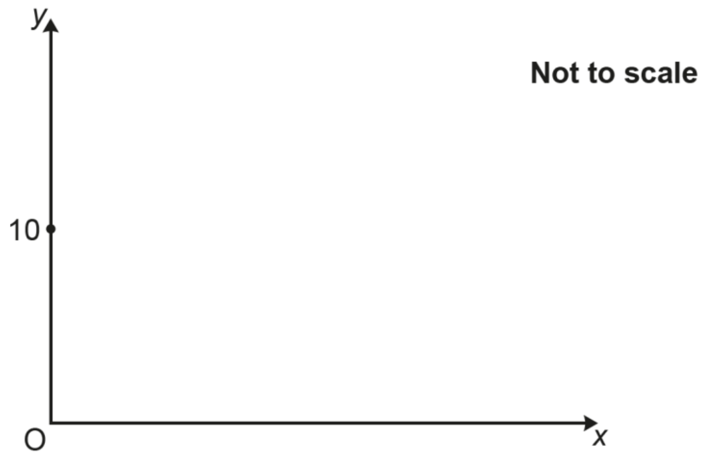
Add these students' results to the histogram. **[2]**

Those candidates who identified a frequency density of 3.2 in part (a) usually drew this bar correctly. A bar of height nine little squares was very common from candidates who had scored 0 marks in part (a).

It was rare to see any working. When present, 15 ÷ 9 was nearly as frequent as 9 ÷ 15.

Question 14

14 The sketch shows the coordinate axes and the point (0, 10).



The distance from the point (0, 10) to a point (12, *t*) is 12.5 units.

Work out the **two** possible values of *t*.
You must show your working and you may use the sketch to help.

t = ... and .... **[5]**

20% of candidates omitted this question. The key to success was realising that because it involved the distance between two points, Pythagoras' theorem would be needed. Candidates who marked a point for (12, *t*) and drew a line to (0, 10) often proceeded to full marks (with the exception of those who marked (12, 0)).

Successful candidates usually set-up an equation such as $12^2 + h^2 = 12.5^2$ or $12^2 + (t - 10)^2 = 12.5^2$, rearranged and solved to find $h = 3.5$ or $t - 10 = \pm 3.5$ and hence the answers. Candidates who stopped at $h = 3.5$ scored M2B1 if working was shown.

Incorrect uses of Pythagoras' theorem came from using (12, 0) or (*h*, 12).

Methods equating the given distance of 12.5 to a gradient formula ($\frac{y - y_1}{x - x_1}$) or using it within $y = 12.5x + c$ were very common and unproductive. Others used 12.5 – 12 = 0.5 to get answers of 9.5 and 10.5.

There are alternative longer methods involving trigonometry, but they were rarely seen and few attempts were free of error.

Question 15

15 y is inversely proportional to x^3.
$y = 4$ when $x = 12$.

Find a formula linking x and y.

.... **[3]**

Similar questions have been set in the past and many candidates were well-prepared for this question. Nearly half scored full marks, however around a third still scored 0 marks.

Candidates scored M1 for $y = \frac{k}{x^3}$ or $4 = \frac{k}{12^3}$.

While most evaluated k correctly as 6912 to score B1, others wrote 12^3 yet calculated 12^2 and hence found k to be 432. Of those that reached $k = 6912$, some gave it as their final answer and did not write the requested formula ($y = \frac{6912}{x^3}$).

There were some instances of starting with $y = kx^3$, $y = kx$ and $y = \frac{k}{x}$, all of which scored 0 marks.

Question 16

16 Write $\frac{9x^7 \times 2\sqrt{x}}{3x^4}$ in the form kx^m.

.... **[4]**

Only about 10% of candidates scored full marks here. The most commonly scored marks were B1 for 6 from $\frac{9 \times 2}{3}$ and B1 for x^3 from $\frac{x^7}{x^4}$. Very few candidates demonstrated that they knew $\sqrt{x} = x^{\frac{1}{2}}$, with many just ignoring it, or treating it as x or even x^2.

A few candidates tried to deal with the $\sqrt{x}$ by squaring expressions, often the starting one. This would have led to $36x^7$, which is the square of the answer and so would need to have been squared at the end, however candidates did not progress that far, with errors often being made at the squaring stage. Other unsuccessful approaches included multiplying top and bottom by x^4.

Question 17 (a)

17 (a) Without using a calculator, show that $0.\dot{1}\dot{8}$ can be written as $\frac{2}{11}$. **[3]**

Candidates seemed very familiar with this sort of question, even though the topic is more commonly found on the non-calculator paper. This was a 'show that…' question and so detailed working was required showing the steps needed. Candidates responded very well and nearly 70% of candidates scored full marks.

The most common approach was to label the recurring decimal or its expanded form as *x*, then to work out the value of 100*x* before showing two subtractions to produce 99*x* equated to 18.

Question 17 (b)

(b) Explain how $\frac{2}{11} = 0.\dot{1}\dot{8}$ can be used to find $\frac{10}{11}$ as a decimal and write down its value.

....

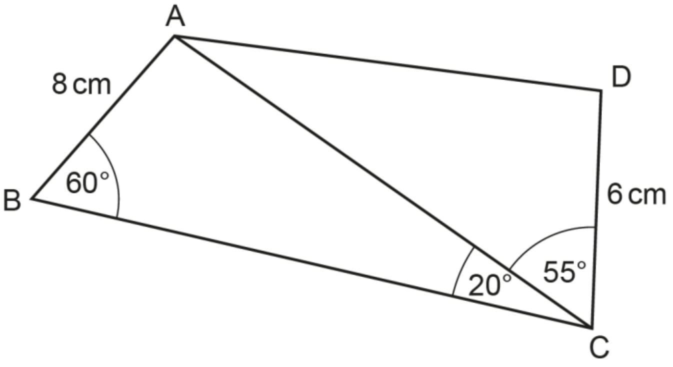
.... $\frac{10}{11} =$ .... **[2]**

Most candidates were able to explain and apply a method, such as 'multiply by 5' or 'divide by 2 and multiply by 10'. A few explanations lacked clarity, such as 'find $\frac{8}{11}$ and add it on' without addressing how to find $\frac{8}{11}$. Answers of $0.\dot{9}\dot{0}$ with no explanation scored 0 marks.

Question 18

18 The diagram shows two triangles ABC and ADC.

Not to scale



Angle ABC = 60°, angle ACB = 20° and angle ACD = 55°.
AB = 8 cm and DC = 6 cm.

Calculate length AD.
You must show your working.

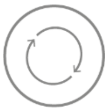
AD = ... cm **[6]**

Over 30% of candidates scored 6 marks and a further 20% scored 3, 4 or 5 marks. The remainder generally scored 0 marks due to incorrect assumptions, such as that BAC is a right angle, or ABCD is a cyclic quadrilateral, or AD and BC are parallel.

Successful candidates often recognised that two stages would be necessary and also that the first step required use of the sine rule. As a result, there were many solutions that quickly and correctly found AC to be 20.25…. Some were less efficient in their method (for example, first finding BC by the sine rule and then AC by the cosine rule), but they usually reached the correct value for AC in the end.

The next step caused greater difficulty. Some assumed ADC was a right angle and used Pythagoras' theorem or right-angled trigonometry. Those that realised they needed to use the cosine rule usually substituted accurately into the formula, but there were the usual occurrences of incorrect processing in separating cos55 from 2*bc*. Premature rounding of the value of AC resulted in a few candidates losing the final accuracy mark.

Assessment for learning



When presented with geometric diagrams, right angles will normally be indicated by notation and may also be referred to in the text, unless their identification is part of the assessment, (e.g. angle in a semicircle).

Similarly, parallel lines will normally have arrow notation on the diagram and may be referred to as parallel in the text (or implied, for example from a quadrilateral being described as a parallelogram).

Assessment for learning

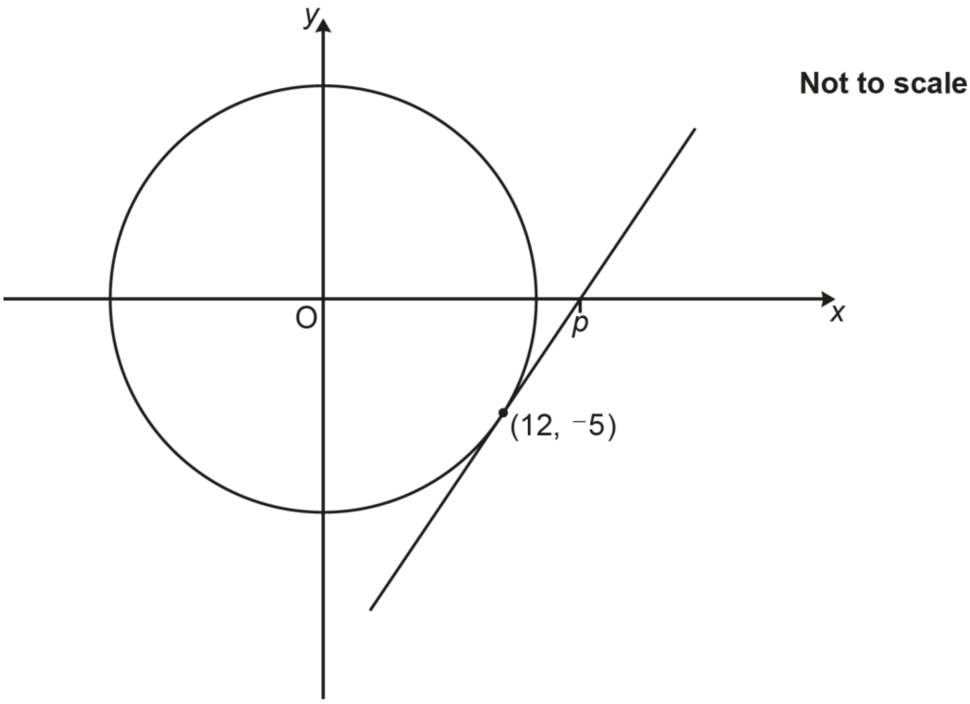
Many candidates struggled to evaluate the cosine rule correctly. While the cosine rule was given on the formulae sheet this series, there are still generally 3 marks available for its use; one for correct substitution, one for reaching an acceptable response for a^2 and one for reaching an acceptable response for a (it is unlikely there would be extra evaluation marks). Mistakes were made and marks lost by finding $b^2 + c^2 - 2bc$, an unnecessary and an incorrect step in the evaluation.

Candidates are advised to write down the whole expression for a^2, then enter that into their calculator, write down the answer and then finally show the square root step.

Some candidates wrote 'ANS' in their calculations. While this was condoned if the correct answer followed, it is not best practice. In a question like this, the value of 'ANS' actually changes several times. It is good practice to use the 'ANS' function on the calculator to preserve accuracy, but in written working it is better to write the actual values (for example, '20.25…').

Question 19

19 The diagram shows a circle with centre (0, 0) and a tangent at (12, $^{-}5$).
The tangent at (12, $^{-}5$) crosses the x-axis at (p, 0).



Find the exact value of p.
You must show your working.

p = ... **[5]**

About 10% of candidates scored 5 marks, and a further 30% scored some marks. Candidates who worked in fractions rather than decimals were more likely to get the exact answer requested.

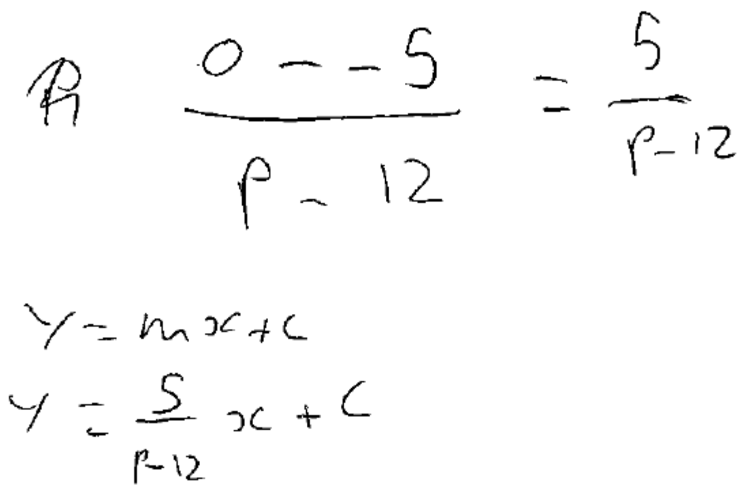
The mark scheme covers multiple methods that were commonly seen. The most common approaches involved using gradients and the equation of a straight line in its various forms, of which there were three main methods. The other alternative methods were rarely seen through to a successful conclusion, but did still lead to marks being given (particularly M1 for identifying the radius of the circle as 13, which could have then been used in trigonometry or a similar triangles approach).

Presentation was generally poor, with multiple attempts often being left for the examiner to decide what to mark; it was also often left to their judgement as to what incorrect gradients, such as $\frac{-12}{5}$, represented.

The best responses used some words, for example 'gradient of radius = $\frac{-5}{12}$, gradient of tangent = $\frac{12}{5}$' (scoring M1 for the radius, increasing to M2 for the tangent). Most candidates used their tangent gradient in the $y = mx + c$ form for the straight line (scoring M1) and then substituted in $(12, {}^{-}5)$ to try and find c. They then needed to substitute in $(p, 0)$ to reach a correct equation solely in p, such as $0 = \frac{12}{5}p - \frac{169}{5}$ to score the fourth mark.

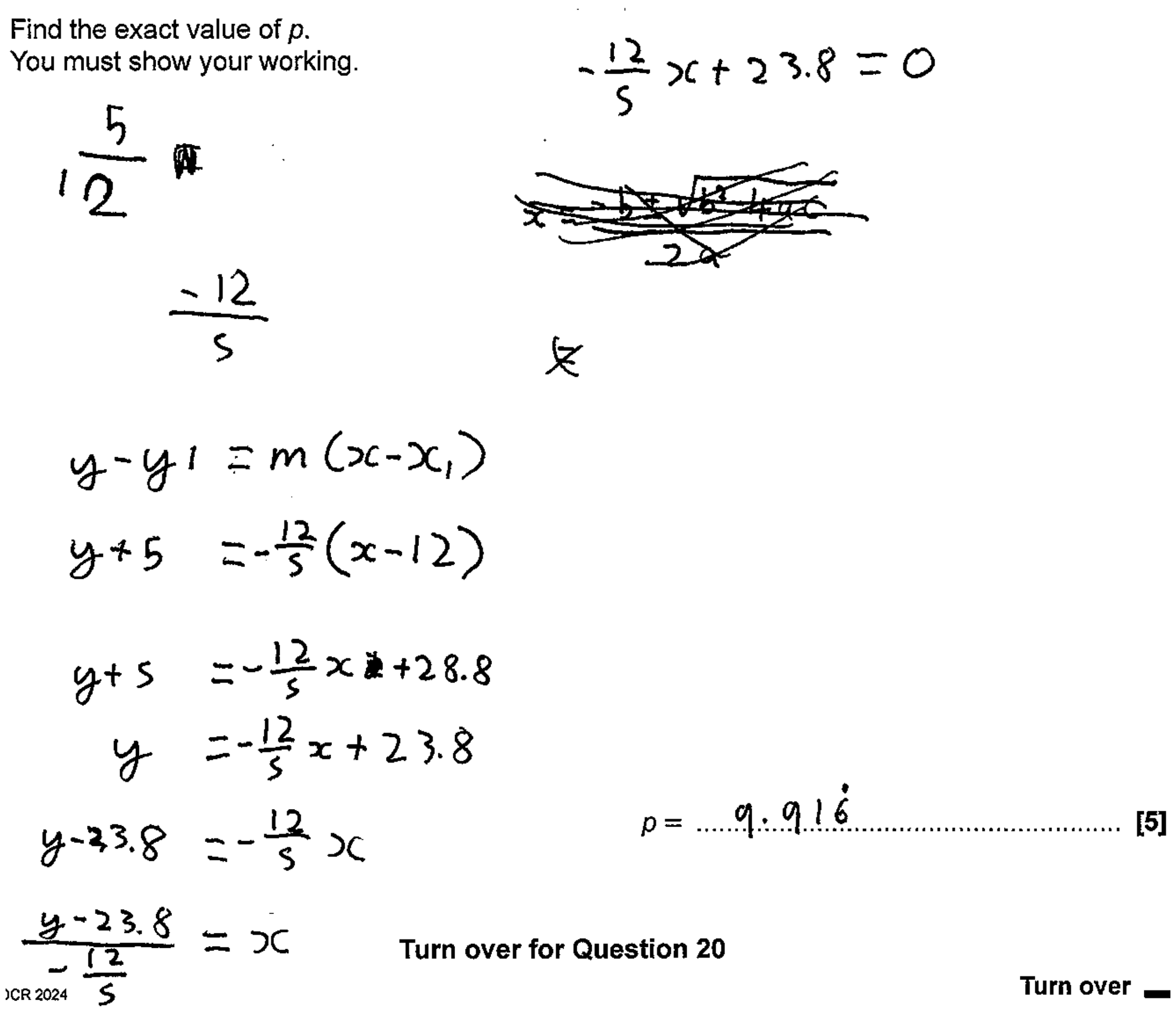
An efficient alternative approach that was sometimes seen (perhaps with a variation) was to draw a vertical from $(12, {}^{-}5)$ to the x-axis to create a right-angled triangle. The gradient of the tangent ($\frac{12}{5}$, from before) is the gradient of the hypotenuse of the triangle, so $\frac{12}{5} = \frac{5}{p - 12}$, leading to $p = \frac{169}{12}$.

Exemplar 1



It may have been helpful to both the candidate and the examiner if a vertical line from $(12, {}^{-}5)$ to the x-axis had been drawn or 'gradient of tangent =' had been added, however $\frac{5}{p - 12}$ is a correct gradient for the tangent and so M2 is given. This is then correctly substituted into $y = mx + c$, scoring another M1.

Exemplar 2


Find the exact value of p.
You must show your working.

$\frac{5}{12}$

$\frac{-12}{5}$

$y - y1 = m(x - x_1)$

$y + 5 = -\frac{12}{5}(x - 12)$

$y + 5 = -\frac{12}{5}x + 28.8$

$y = -\frac{12}{5}x + 23.8$

$y - 23.8 = -\frac{12}{5}x$

$\frac{y - 23.8}{-\frac{12}{5}} = x$

$-\frac{12}{5}x + 23.8 = 0$

$p = 9.91\dot{6}$ [5]

Turn over for Question 20

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Neither gradient is correct, but it looks as though $\frac{-12}{5}$ is intended to be their gradient of the tangent and it is the negative reciprocal of the other gradient, so M1 is given. Their gradient is then presented correctly with (12, ⁻5) in a $(y - y_1) = m(x - x_1)$ form of the equation of straight line, scoring another M1. Although they reach an equation solely in x, it will be an incorrect equation because of the wrong gradient and so M2 is not given.

Question 20

20 Write as a single fraction in its simplest form.

$$4+\frac{x^2-49}{(x+7)(x-3)}$$

.... **[5]**

About 20% of candidates scored full marks. Dealing with the '4 +' term caused the greatest problem.

Most candidates decided to start by factorising the difference of two squares and then cancelling down the resulting fraction. Many did this accurately and scored M2. Following the cancellation, errors were common however and several candidates changed a sign in the process, for example quite often (x – 3) changed to (x + 3). Relatively few candidates were able to use correct algebra to continue beyond $4+\frac{x-7}{x-3}$; those that could proceed did usually go on to obtain the correct final answer, however some made slips when collecting terms.

Others started the question by correctly combining the two terms as $\frac{4(x+7)(x-3)+x^2-49}{(x+7)(x-3)}$, scoring M1. Some achieved the second and third marks by expanding and simplifying the numerator to $5x^2+16x-133$, however very few could factorise this for the fourth mark.

Other candidates decided to start by expanding the denominator. This in itself was not productive and scored 0 marks. Having done this, candidates often cancelled the x^2 and x terms from the numerator and the denominator, leaving a value of $4+\frac{-49}{-21}$ that then led to an incorrect final answer of $\frac{19}{3}$.

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