

GCSE (9–1)

Examiners' report

MATHEMATICS

J560

For first teaching in 2015

J560/06 November 2022 series

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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 OCR.

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Paper 6 series overview

This calculator paper is the third of the three papers taken by Higher candidates for the GCSE (9-1) Mathematics specification. Questions 2, 4, 6, 7 and 8 were also set on the Foundation tier paper, J560/03 (Questions 22-26).

There was a very small entry for this paper. Some of the questions could be answered using a variety of methods and the mark scheme was written in anticipation of the most likely and was updated in the light of the scripts seen. Some of the anticipated methods were not seen but the proposed mark schemes are to aid centres in the future.

Almost all candidates were able to show some positive achievement. Some candidates struggled to score marks in the second half of the paper, although there were marks in Question 12, 13, 16 and 17 (b) that were accessible to all candidates. The omission rates for whole questions and parts of questions were low except for the least able candidates and for the last few questions. There was a very wide range of marks, from below 10 to above 90.

It appeared that candidates had sufficient time to complete the paper.

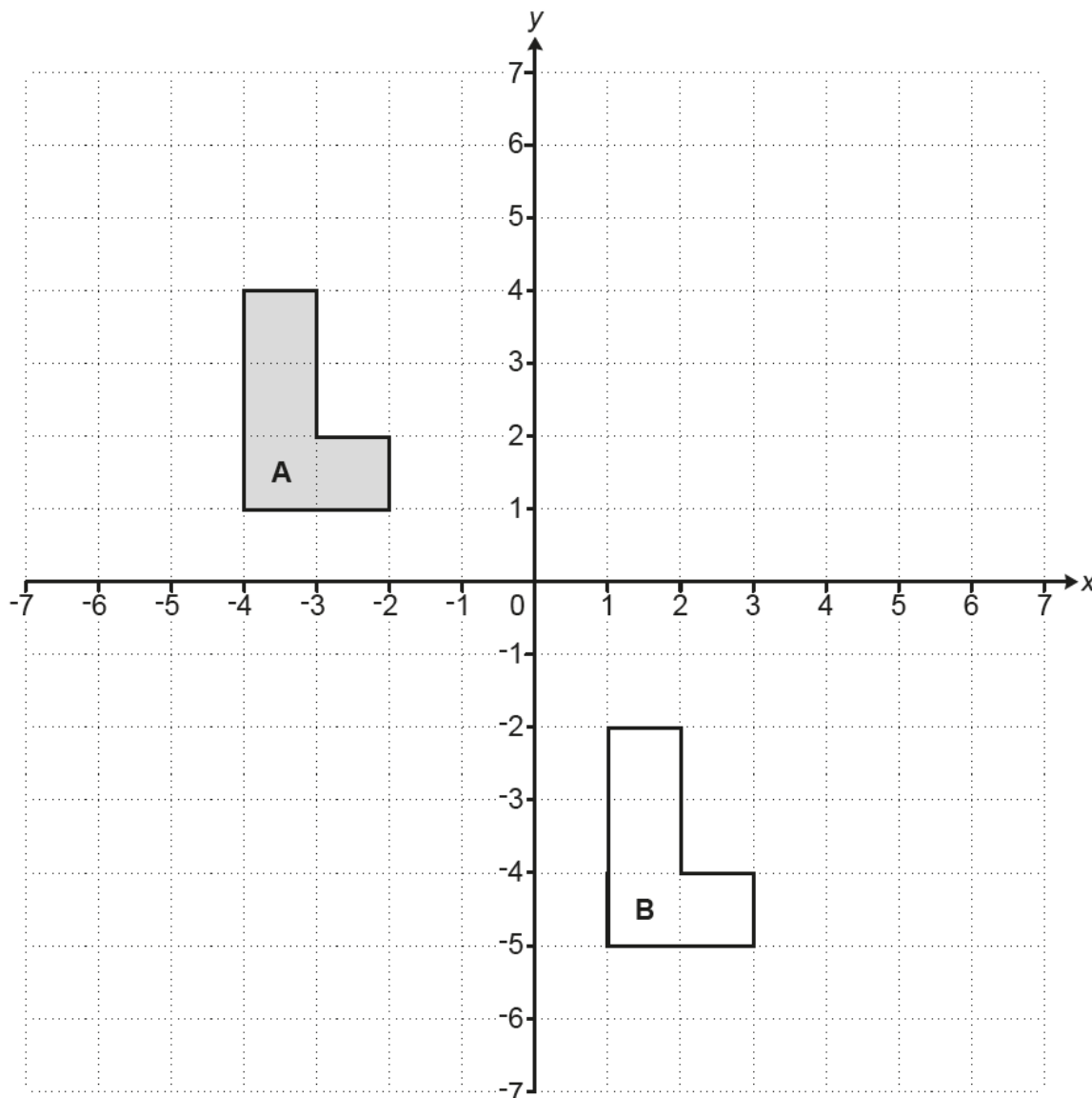
To do well on this paper, candidates need to be confident and competent in the specification content and be able to:

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

Candidates who did well on this paper generally did the following:	Candidates who did less well on this paper generally did the following:
<ul style="list-style-type: none"> • Performed almost all standard techniques and processes accurately. Questions 1, 2, 4 (b), 4 (c), 11, 14 (b), 19, 20. • Usually interpreted and communicated mathematics accurately. Information presented in words or diagrams was understood and the correct notation was used when presenting a mathematical argument. Questions 1 (a), 7 (a), 10, 12 (a), 15 (a), 15 (b). • Produced clear solutions to multi-step tasks. Questions 7 (b), 9, 12 (b), 14 (a), 16, 19. 	<ul style="list-style-type: none"> • Made errors in performing standard techniques and processes. Questions 1, 4 (b), 5 (b), 12 (b). • Produced responses that lacked notation of an appropriate standard. Questions 1 (a), 5 (a). • Did not set out multi-step tasks clearly. Questions 7 (a), 10, 14 (a). • Misinterpreted questions and information or did not follow instructions. Questions 3, 16, 17.

Question 1 (a)

1 Shape **A** and shape **B** are drawn on the coordinate grid.



(a) Describe fully the single transformation that maps shape **A** onto shape **B**.

.....

..... [2]

Many candidates did not state 'translation' or give the correct vector. Descriptions of a movement were common, while 'transformation', 'reflection' and incorrect vector notation were often seen.

Question 1 (b)

(b) Reflect shape **A** in the line $x = -1$.

[2]

Some correct reflections were seen but many candidates attempted a reflection in $y = -1$, and often completed it incorrectly. Some responses showed a translation of $\begin{pmatrix} -1 \\ 0 \end{pmatrix}$.

Assessment for learning



Transformation questions are often a good source of procedural marks for Higher tier candidates. Knowledge of the lines $x = k$ and $y = k$ is important. They can be assessed, either within geometry, as here, or within questions on algebraic graphs.

Question 2

- 2 A recipe for a batch of jam needs 3 oranges, 5 lemons and 1.5kg of sugar. A cook uses the recipe to make lots of batches of jam. They use 16 **more** lemons than oranges in total.

Find how much sugar the cook should use.

..... kg [3]

Many candidates answered this correctly and almost all responses showed good working. Most candidates either scored full marks or 0 marks. The most common approach was to use a scaling of 3 oranges and 5 lemons. Almost all candidates using this method reached 24 oranges and 40 lemons to give the required difference of 16, and then finished with $8 \times 1.5 = 12$ kg of sugar.

Candidates who scored 0 marks generally used random unstructured working, trialling different values.

Question 3

- 3 In 1980, Ling's flat was worth £23 000.
Today, Ling's flat is worth 1200% of its value in 1980.

Calculate the value of Ling's flat today.

£ [2]

Most candidates answered this question correctly. The common errors were multiplying £23 000 by 1200 or by 13 and dividing £23 000 by 12.

Misconception



Some candidates were uncertain on how to interpret a percentage greater than 100%. These are often used to make comparisons between the values of a single quantity at two points in time. When a later value is more than 100% of an earlier value, it means the quantity has increased over time.

Question 4 (a)

- 4 Sam and Taylor are playing a game against a computer. They can win, draw or lose the game.

Sam says

I think the probability of us winning the game is 0.3.

Taylor says

I think the probability of us losing the game is 0.75.

- (a) Explain why Sam and Taylor cannot both be correct.

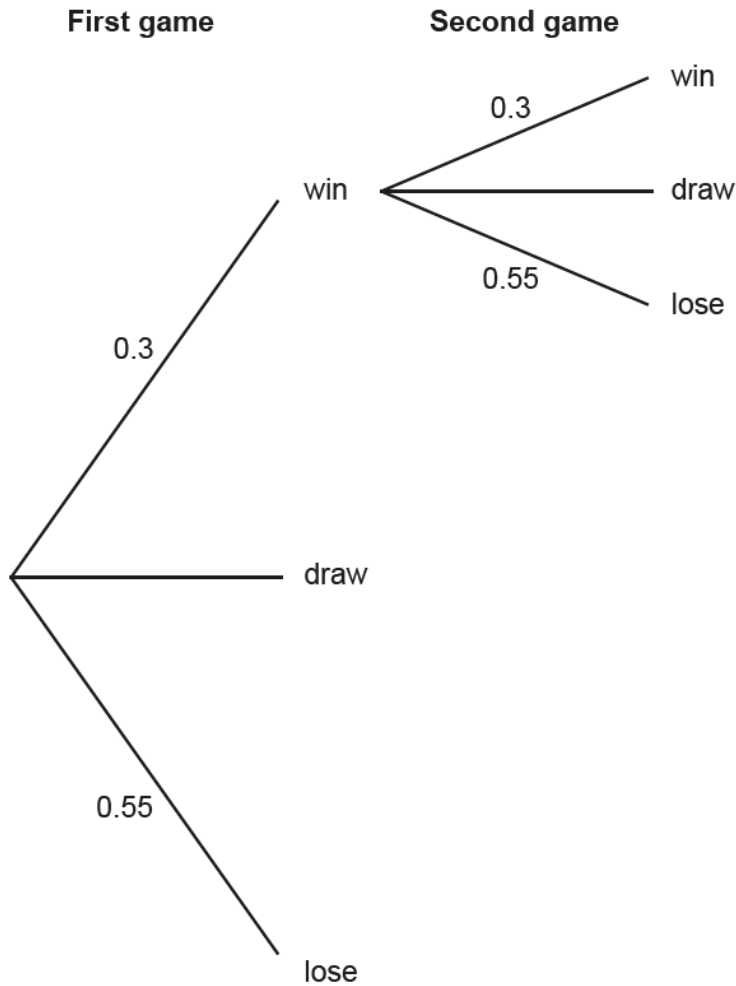
.....
..... [1]

Candidates were expected to use the given information and identify that $0.3 + 0.75 > 1$ is not possible. Some explanations were too general and did not relate to the given context, and others were vague or inaccurate, such as 'probabilities must add to 1'.

Question 4 (b)

- (b) Sam is correct. The probability of them winning the game is 0.3.
Taylor is not correct. The probability of them losing the game is actually 0.55.

Complete this **partly drawn** tree diagram to show **all** the possible outcomes of playing the game twice.



[3]

Most candidates scored marks on this question, either for finding $P(\text{draw}) = 0.15$ or for correctly drawing and labelling the two sets of three branches. Candidates did not always label the branches in the same order, and this led some to write the wrong probabilities on their branches.

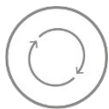
Question 4 (c)

(c) Find the probability of them winning the first game and losing the second game.

(c) [2]

Most candidates correctly multiplied the two probabilities. A considerable number of candidates also incorrectly added the probabilities.

Assessment for learning



In probability 'and' usually implies the need to multiply and 'or' implies the need to add. In the case of a tree diagram, multiply along the branches and add the answers.

Question 5 (a)

5 In space, distances can be measured in Astronomical Units.
In this question, use the conversion $1 \text{ Astronomical Unit} = 1.5 \times 10^8 \text{ km}$.

(a) On a particular day the distance from Earth to Neptune is 29.09 Astronomical Units.

Calculate the distance from Earth to Neptune in kilometres on that day.
Give your answer in standard form.

(a) km [3]

Most candidates showed the correct process of multiplication and only a few candidates tried to convert 1.5×10^8 into ordinary form beforehand. As most calculators present the answer in ordinary form, many candidates did not convert this back into standard form to get the final answer mark.

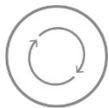
Question 5 (b)

(b) On a particular day the distance from Earth to Mars is 78 340 000 km.

Calculate the distance from Earth to Mars in Astronomical Units on that day.

(b) Astronomical Units **[2]**

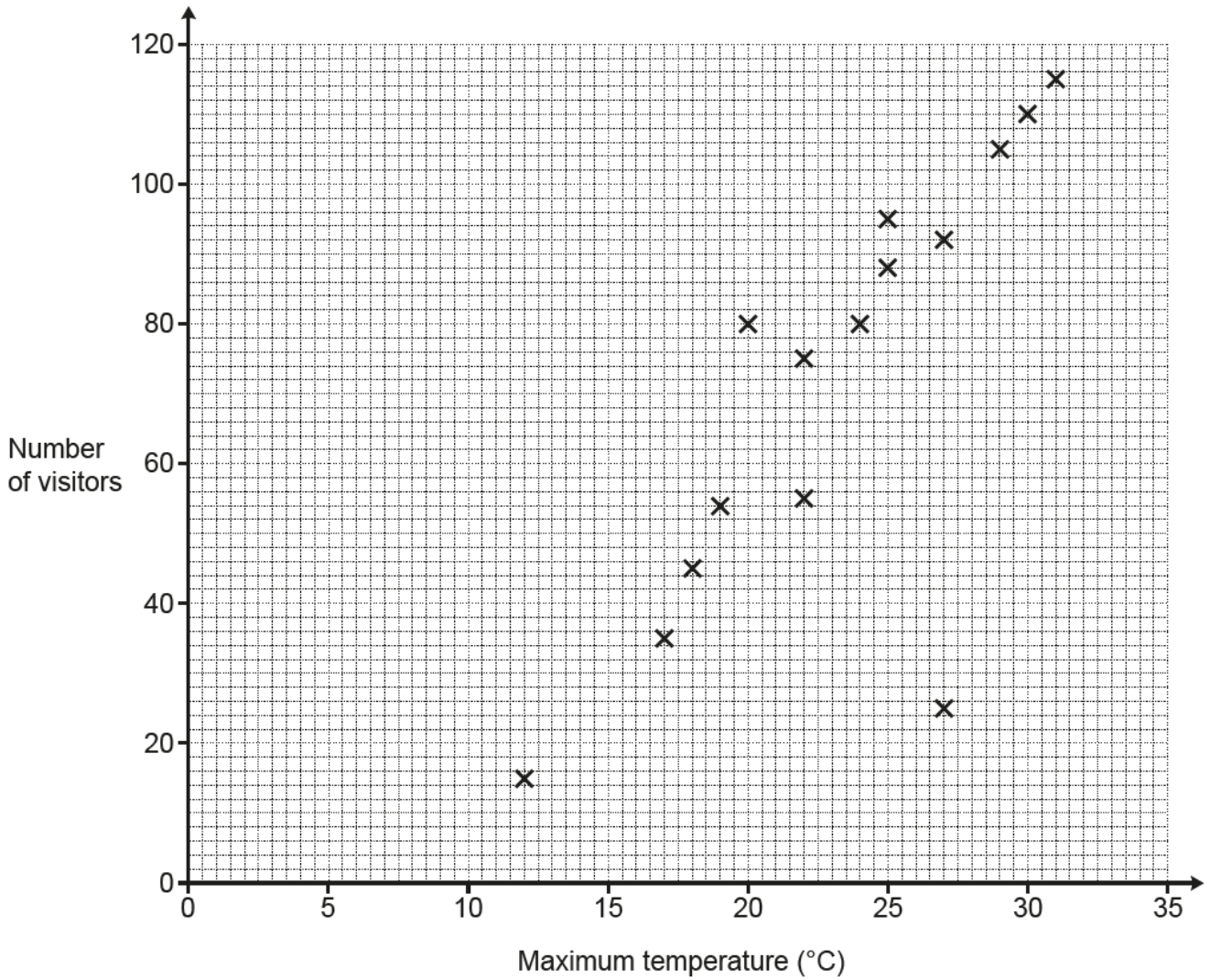
While the need to divide was recognised by most candidates, some used 29.09 rather than 1.5×10^8 . Others gave incorrect answers that started with the correct figures of 52, suggesting they had mis-keyed a value into their calculator.

Assessment for learning

In standard form questions in calculator exams, it is unlikely there will be a mark for converting a value into ordinary form. It is, therefore, generally advisable to use the calculator facility to enter the values in standard form rather than trying to convert and make a mistake.

Question 6 (a)

6 The scatter diagram shows the number of visitors to a children's playground and the maximum temperature on fifteen Saturdays in summer.



(a) Describe the type of correlation shown in the scatter diagram.

(a) [1]

Almost all candidates correctly described the correlation as 'positive'.

Question 6 (b) (i)

(b) One Saturday was a hot but stormy day.

(i) Circle the most likely point on the scatter diagram for this Saturday. [1]

Almost all candidates circled the correct point.

Question 6 (b) (ii)

(ii) Explain why you chose this point.

.....
..... [1]

Most candidates correctly referred to the weather and the low number of visitors. Instead, some candidates gave the acceptable alternative that the point was an 'outlier'.

Question 6 (c)

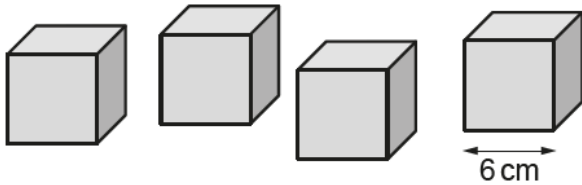
(c) Use a line of best fit to predict the number of visitors on a Saturday that has a maximum temperature of 21 °C.

(c) visitors [2]

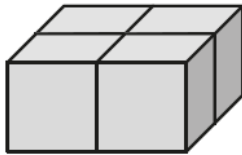
The lines of best fit were almost always ruled and within the permitted tolerance. A few candidates lost a mark by either joining the points with a series of zigzag lines or curves, or starting their line at (0, 0). The predicted number of visitors was almost always within the range given on the mark scheme.

Question 7 (a)

7 A child has four identical wooden cubes of side length 6 cm.



(a) They arrange the cubes in a 2 by 2 by 1 arrangement to form a cuboid.



Show that the surface area of the cuboid is 576 cm^2 .

[2]

This was a 'Show that...' question and, therefore, candidates needed to make it clear how they were obtaining the given answer of 576 cm^2 . Structured evidence with no omissions or incorrect work was required. Six methods are shown on the mark scheme, and all require the dimensions of the faces to be given for 2 marks. Candidates who only gave the areas of the six faces were credited 1 mark. A few candidates tried combinations of numbers unrelated to the cuboid arrangement to find a sum or product with an answer of 576, and these attempts scored 0.

Question 7 (b)

(b) The child rearranges the cubes in a 4 by 1 by 1 arrangement to form a different cuboid.



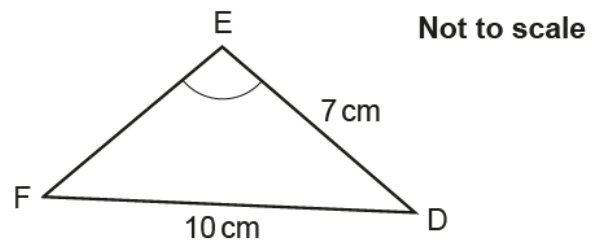
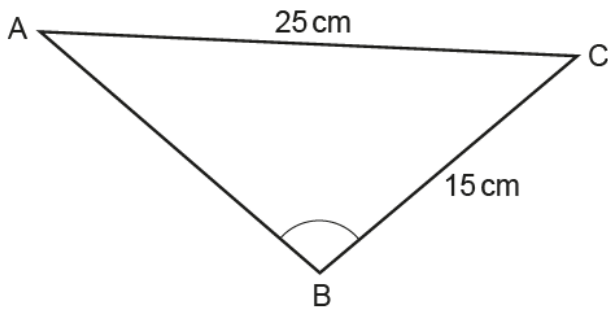
Calculate the percentage increase in surface area for this cuboid compared with the 2 by 2 by 1 cuboid.

(b) % [4]

Some of the less able candidates omitted this part. This was not a 'Show that...' question so it was not necessary to give the dimensions of the faces. Most candidates attempting the question found the surface area of the new arrangement correctly. For the percentage calculation, many incorrectly used this surface area as the denominator rather than the 576 from the 2 by 2 by 1 arrangement.

Question 8

- 8 Triangles ABC and DEF are mathematically similar.
 Angle ABC = Angle DEF.



Calculate the perimeter of triangle ABC.

..... cm [4]

Many candidates found the scale factor, 2.5. A few of these candidates stopped at this point, but most proceeded correctly to full marks. A small number of candidates assumed the triangles were isosceles so did not show any scale factor work and scored 0.

Question 9

- 9 Given that $(2^k)^6 \times 8 = 2^{45}$, find the value of k .

$k =$ [3]

This question differentiated the more able candidates from the rest. The most efficient approach was to change 8 into 2^3 and then apply the laws of indices to obtain and solve $6k + 3 = 42$. Less efficient and less successful, was first to use a calculator to find $\sqrt[6]{\frac{2^{45}}{8}}$ and then to recognise that $128 = 2^7$.

Question 10

- 10** The highest common factor (HCF) of two numbers is 14.
The lowest common multiple (LCM) of the same two numbers is 210.
The two numbers are **not** 14 and 210.

Find the two numbers.

..... and [3]

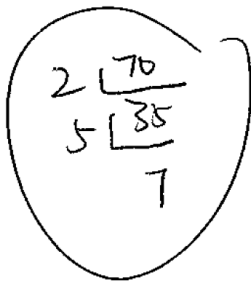
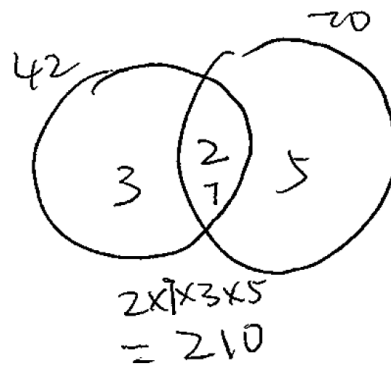
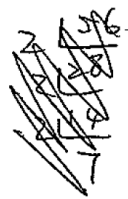
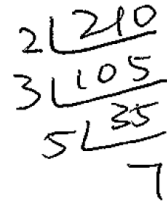
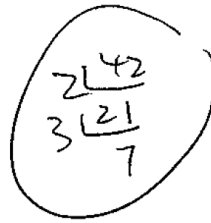
Methods used were often difficult to follow, with a lot of processing and unstructured jottings. A good number of candidates did find the two correct numbers though. The clearest, and perhaps easiest, method was to find the prime factors of 14 and 210, scoring 1 mark, and then to use a Venn diagram.

Exemplar 1

10 The highest common factor (HCF) of two numbers is 14.
 The lowest common multiple (LCM) of the same two numbers is 210.
 The two numbers are **not** 14 and 210.

Find the two numbers.

- 14
- 28
- 42
- 56
- 70



..... 42 and 70 [3]

This was one of the clearer responses although it is not logically structured.

In the top left of the script, the candidate has listed four correct multiples of 14 and so could score M1 by the mark scheme's alternative method if this has been used to reach their final answer. They have also found the prime factors of 210 in the top-right but, in the absence of the prime factors of 14 being explicitly shown, this would not have scored M1.

It is difficult to know exactly how the candidate has reached 42 and 70 but there is no wrong working so full marks are given.

They may have trialled 42 and 70 and the rest of the working is a check, or they may have found the prime factors of 14 but did not show them. The prime factors of 210 and 14 are then seen in a Venn diagram. Without the final answers, the Venn diagram on its own scored M2; a Venn diagram with just 2 and 7 correctly placed scored M1.

Question 11

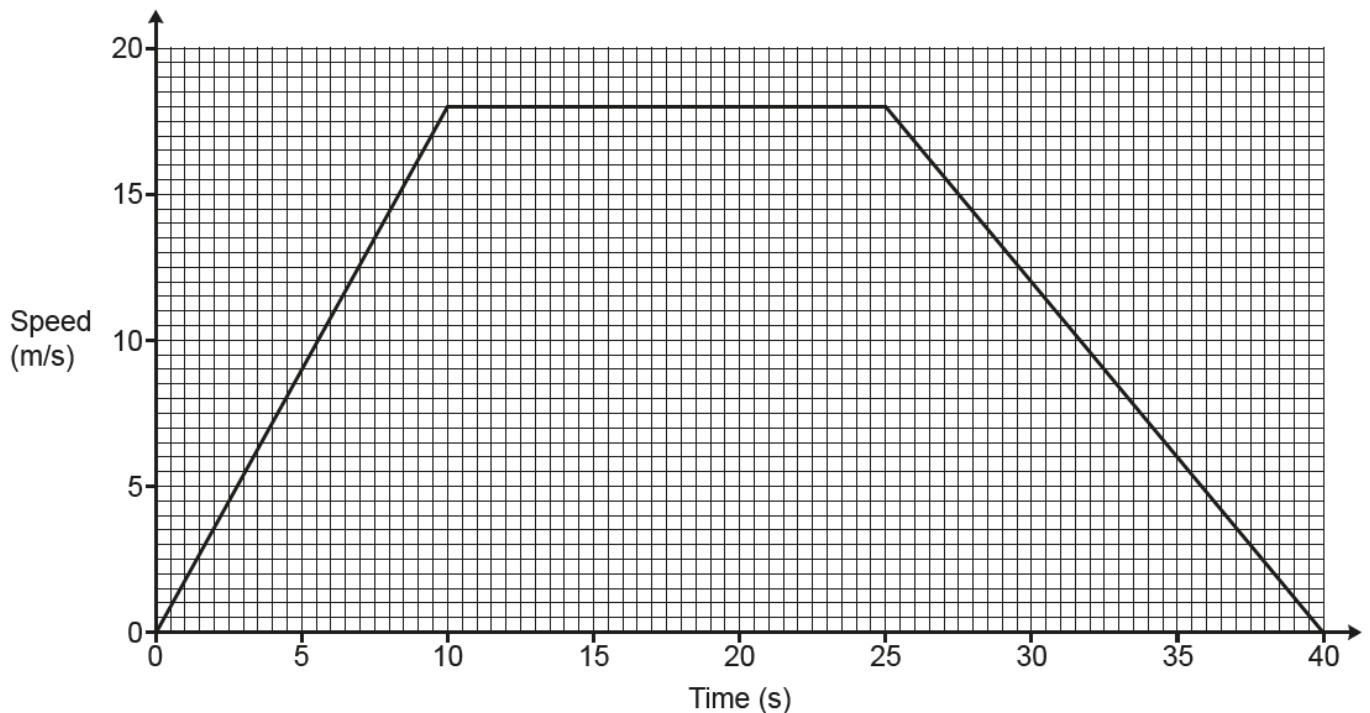
11 Factorise fully $30x^2 + 2x - 4$.

..... [3]

Candidates who performed well across the paper as a whole were often successful. Some were able to find two brackets that, when expanded, produced two of the three terms to score 1 mark. The majority of candidates made little progress.

Question 12 (a)

12 The graph shows the speed of a car during the first 40 seconds of a journey.



(a) Write down the acceleration of the car between 10 seconds and 25 seconds.

(a) m/s^2 [1]

Less than half of the candidates gave the correct answer of 0. Many read the vertical axis and gave an answer of 18.

Question 12 (b)

- (b)** Work out the average speed of the car, in m/s, during the 40 seconds.
You must show your working.

(b) m/s [5]

Few candidates scored full marks. Most attempted to find three separate areas rather than the area of the trapezium. A very common error when attempting to find the areas of the triangles was to only perform base \times height. Misreading the vertical scale as 16 rather than 18 was also common. Candidates with the correct area often stopped at that point and did not divide by 40 to obtain the average speed.

Some candidates found the mean of the gradients of the three lines; others found the mean of the speeds at 5, 10, 15 ... seconds.

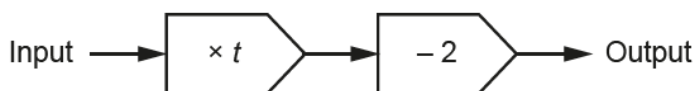
Misconception



Some candidates may associate 'average' with adding values and dividing by the number of values. Average speed is calculated by dividing the total distance travelled by the time taken to travel that distance. In speed-time graphs the time taken can be read from the x-axis, but the distance travelled is represented by the area under the graph.

Question 13 (a)

- 13 (a)** Here is a function.



When the input is 6, the output is 18.

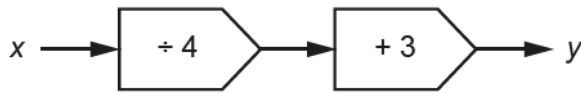
Find the value of t .

(a) $t =$ [3]

Most candidates made good progress, and many found the correct value of t . A small number of candidates stopped at $6t = 20$ or proceeded to an inaccurate answer of 3.

Question 13 (b)

(b) Here is another function.
When the input is x , the output is y .



Write an algebraic expression for x in terms of y .

(b) [2]

Many candidates scored full marks. The use of brackets within $4(y - 3)$ was very good. Many other candidates scored 1 mark for $y = \frac{x}{4} + 3$.

Question 14 (a)

14 (a) The time taken to paint a wall is inversely proportional to the number of people painting. It takes 40 minutes for 3 people to paint the wall if nobody stops painting.

Layla, Mia and Nina start painting the wall.
After 10 minutes Layla stops painting.
She leaves Mia and Nina to finish painting the wall.

Assume that Layla, Mia and Nina paint at the same rate.

Work out the **total** time taken to paint the wall.

(a) minutes [3]

Candidates often applied inverse proportion to correctly identify that a total of 120 minutes were needed to paint the entire wall. This scored M1. Various approaches could then be used to answer the question and a good number of correct final answers were seen. Those that did not find the answer of 55 minutes often did not score a second method mark because the logic in their working could not be followed.

Probably the most efficient method seen was to reason 120 minutes were needed in total and Layla had stopped after 10 minutes; therefore, Mia and Nina needed to paint for $120 - 10 = 110$ minutes between them, so it will take them 55 minutes.

Exemplar 2

$$40 \times 3 = 120$$

~~$$40 \times 3 = 120$$~~
$$30 \times 3 = 90$$

$$120 - 30$$

$$\text{Mia} = 40 + \left(\frac{40 - 10}{2} \right)$$

$$\text{Nina} = 40 + \left(\frac{40 - 10}{2} \right) =$$

$$\text{Layla} = 10 \text{ minutes}$$
~~$$\text{Mia} = 40 \text{ minutes}$$~~

$$\text{Mia} = 55$$

$$\text{Nina} = 55 \text{ minutes}$$

(a) 55 minutes minutes [3]

In this exemplar the candidate finds that a total of 120 minutes is needed but then changes direction. Instead, they reason that 40 minutes is needed per person to paint the wall. So when Layla stops after 10 minutes, there is an extra (40 – 10) minutes of painting that needs to be done, to be divided between Mia and Nina. Therefore, it will take $40 + \frac{(40 - 10)}{2}$ minutes to paint the wall.

Some candidates continued from 120 with $120 - 30 = 90$, representing the number of minutes needed to finish the wall after Layla stops at 10 minutes. This 90 minutes is divided between Mia and Nina as 45 minutes each. With the initial 10 minutes, this also makes a total of $10 + 45 = 55$ minutes.

Question 14 (b)

(b) y is inversely proportional to x^3 .
 $y = 16$ when $x = 2$.

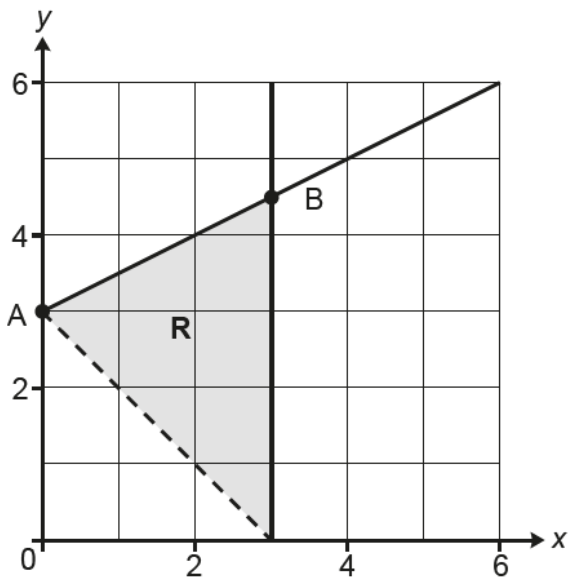
Find the value of y when $x = 8$.

(b) [3]

Candidates who were able to interpret the proportional relationship in a correct algebraic statement usually completed the question correctly. Starting with either $y = kx^3$ or $y = \frac{k}{x}$ was common though.

Question 15 (a)

- 15 The region **R** is shown on this grid.
 A is the point (0, 3) and B is the point (3, 4.5).



- (a) Show that an equation of the straight line through A and B is $2y = x + 6$. [3]

More able candidates usually understood how to ‘Show that...’ for an algebraic answer. Their working was clear and easily followed, and they used a variety of approaches including $y = mx + c$ and $y - y_1 = m(x - x_1)$.

Some candidates scored a mark for using points A and B to find the gradient as 0.5 and then stopped, while a small number of candidates verified that the two points, A and B, satisfied the equation that they had been asked to show. Candidates who worked backwards from the given equation to obtain a gradient of 0.5 were given 0.

Exemplar 3

(a) Show that an equation of the straight line through A and B is $2y = x + 6$. [3]

$$A = (0, 3) \quad B = (3, 4.5)$$

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{4.5 - 3}{3 - 0} = \frac{1.5}{3} = \frac{1}{2}$$

$$y = \frac{1}{2}x + c$$

$$(0, 3)$$

$$3 = \frac{1}{2}(0) + c$$

$$3 = c$$

$$y = \frac{1}{2}x + 3$$

$$y = \frac{1}{2}x + \frac{6}{2}$$

$$2y = x + 6$$

In this fully correct response the candidate has shown clear working which flows from one line to the next.

The middle two lines, where c is established as being 3, are not strictly necessary for full marks since the value is the y-intercept and could be read from the graph.

Question 15 (b)

(b) Write down the three inequalities that define region R.

(b)

.....

..... [5]

A few candidates scored full marks. Some candidates scored 1, 2 or 3 marks for at least one partly correct response, often with an error in the inequality notation. Many candidates did not know how to write the inequalities though.

Question 16

16 A plane flies from London to Tokyo.

The distance is 9600 km, correct to the nearest 100 km.

The plane travels at an average speed of 820 km/h, correct to the nearest 10 km/h.

Calculate the shortest possible flight time of the plane.

Give your answer in hours and minutes, correct to the nearest minute.

You must show your working.

..... hours minutes **[5]**

Candidates scored the full range of marks. Almost all candidates provided sufficient working for at least the first 3 marks to be considered. The working for the fourth mark for converting decimal hours into hours and minutes was often omitted.

Candidates should have been using the bounds of 9550 and 825 leading to a time of 11.5757... hours. Many used the given 9600 and 820 leading to a time of 11.707... hours instead.

Candidates should then have shown, for example, $0.5757... \times 60$ or $0.707... \times 60$. The correct answer of 11 hours 35 minutes was often achieved, except when the decimal time was rounded which led to an answer of 11 hours 34 minutes.

Question 17 (a) (i)

17 Charlie weighs many apples.

The weights of the apples are summarised below.

- heaviest apple = 75 g
- range = 50 g
- median = 60 g
- lower quartile = 45 g
- 50% of the apples weigh between 45 g and 65 g
- mean = 63 g

(a) (i) Write down the interquartile range for the weights of the apples.

(a)(i) g **[1]**

Few candidates could deduce the interquartile range. A wide variety of wrong answers were given.

Question 17 (a) (ii)

(ii) Write down the percentage of the apples that weigh between 45g and 60g.

(ii) % [1]

It was extremely rare for a candidate to know that the interval between the lower quartile and the median contained 25% of the apples. Instead, answers of 50% and 37.5% were both very common.

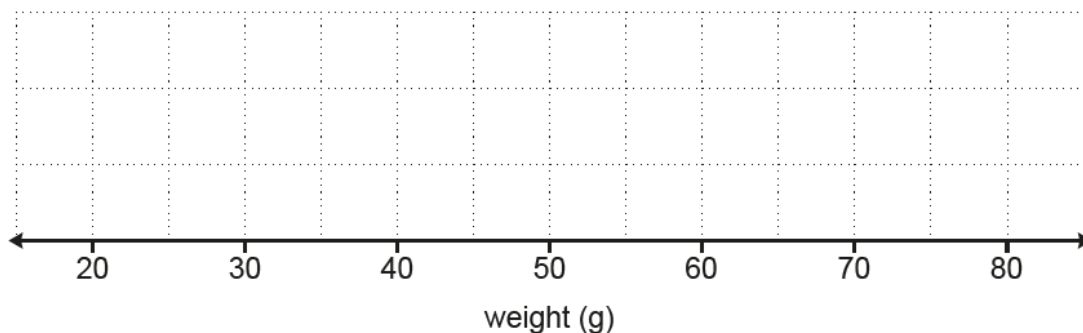
Misconception



The very low success rate in parts (a)(i) and (a)(ii) suggests that candidates of all abilities may be mechanically constructing or reading the key statistics from box plots without really appreciating what the quartiles and median actually represent in terms of percentage.

Question 17 (b)

(b) Draw a box plot to show the distribution of the weights of the apples.



[3]

Most candidates plotted markers at the given values of 45, 60 and 75. Errors commonly seen included not finding the weight of the lightest apple correctly, marking the mean in addition to the median, or not marking 65 as the upper quartile. When candidates had the five correct markers, they usually produced a correctly drawn box plot.

Question 17 (c)

- (c) Charlie eats two of the apples.
The apples that they eat weigh 58 g and 66 g.

Charlie says

The mean weight of all the apples was 63 g.
I ate one apple that weighed less than the mean and another apple that weighed more than the mean.
Therefore, the mean of the remaining apples will still be 63 g.

Is Charlie correct?
Explain your reasoning.

.....

.....

..... [2]

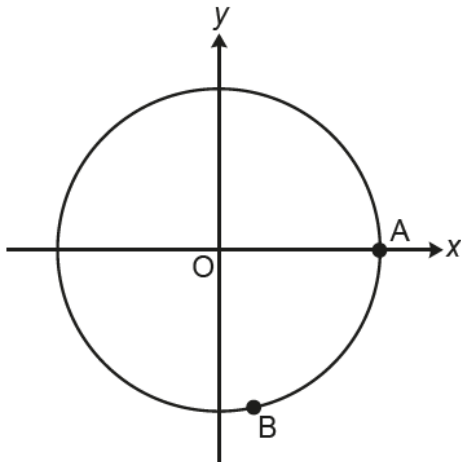
Candidates needed to engage with the context, and this was best done by using the figures and then interpreting the outcome. Good responses found the mean of the two apples as 62 g and then reasoned that the mean of the remaining apples must therefore be greater than 63 g. Similarly, for arguments based on one eaten apple being 5 g below the mean and one being 3 g above the mean.

Many worked with the figures correctly but then interpreted that the mean of the remaining apples will be less than 63 g.

Question 18 (a)

18 A circle has equation $x^2 + y^2 = 100$.

The sketch shows the circle and two points, A and B, which lie on the circumference of the circle.



(a) Write down the coordinates of point A.

(a) (..... ,) [1]

More able candidates usually answered this correctly. A wide variety of incorrect answers was seen, including (0, 0), (100, 0) and (0, 10).

Question 18 (b)

(b) Point B has x-coordinate 3.

Find the exact value of the y-coordinate of point B.

(b) [3]

Few candidates gave the correct answer of $-\sqrt{91}$. Rather more candidates gave either $\sqrt{91}$ or $-9.539\dots$ which scored 2 marks. A method mark was available for $9 + y^2 = 100$ but this was rarely seen from less able candidates.

Question 18 (c)

(c) Another point, C, lies on the circle and has a y -coordinate that is seven times its x -coordinate.

Find the two possible pairs of coordinates for point C.

Give your answers in exact form.

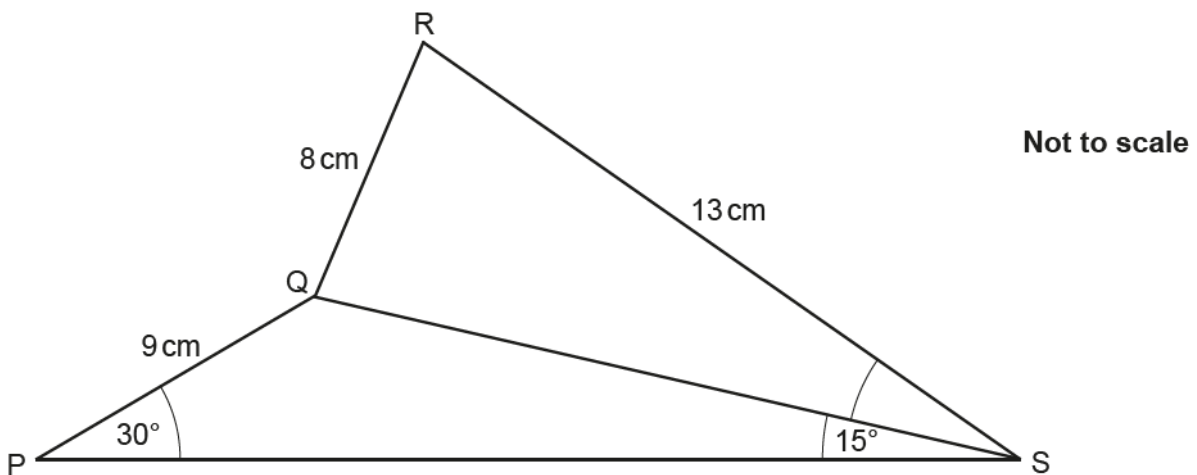
You must show your working.

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

Some of the more able candidates scored full marks. There was a wide variety of wrong answers with no working. Candidates could score a mark for $7x$, which was often seen substituted incorrectly for y as $x^2 + 7x^2 = 100$. These candidates usually abandoned the question soon after, whereas the correct answer for x at this stage of $\pm\sqrt{2}$ usually enabled candidates to continue.

Question 19

19 PQS and QRS are triangles.



PQ = 9 cm, QR = 8 cm and RS = 13 cm.
 Angle QPS = 30° and angle PSQ = 15° .

Calculate angle QSR.
 Give your answer correct to 1 decimal place.
 You must show your working.

..... $^\circ$ [6]

Given the challenge of the question, a reasonable proportion of the candidates realised they needed to find QS first and attempted the sine rule in triangle PQS. Some of these then made some progress with the cosine rule in triangle QRS. 5 or 6 marks were achieved by some candidates who scored less than half marks on the paper as a whole.

Question 20

20 Write as a single fraction in its simplest form.

$$10 - \frac{6x + 45}{3x + 5}$$

..... [4]

The algebraic manipulation required in this question was beyond most candidates, but the more able generally scored full marks. The usual issue for these candidates was in dealing with the subtraction sign correctly.

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