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GCSE (9–1)

Examiners' report

MATHEMATICS

J560

For first teaching in 2015

J560/04 Summer 2023 series

Version 1

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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 4 series overview

Students misread a question or ignoring part of the instruction was a big problem in this paper. Question1 asked for the answer to 3 significant figures, yet some candidates provided different levels of accuracy. Question 3 (a) states that Jack gets £720, not that is was shared by all of them and in part (b) Casey's share is $\frac{2}{3}$ of the total, not of the other two shares. Question 4 was on simple interest, not compound interest. In Question 7 (a) it states clearly that $x \neq 0$, yet many plotted a point for $x = 0$ and in part (b) they were asked for the positive solution given to 1 decimal place, but many different answer types of were seen. Question 11 requires a single transformation, not multiple. In Question 14 a few candidates assumed that there were 16, 15 and 19 subjects respectively in the option groups. Questions on proportionality are often misread and here Q15 was no exception. It was also noticed that some candidates used a highlighter pen to emphasise important parts of a question, which is good practice.

We saw that attempts on the problem solving questions have improved. While algebra is good among the higher scoring candidates, the use of brackets was not strong overall. Angle and circle properties were not well known and a systematic approach to arrangements would have assisted responses to Question 14. The use of non-calculator methods rarely led to the correct answer.

More candidates are using trials to solve the problem solving questions. This topic is no longer in the specification. In some cases this method will be rewarded, however we do expect to see the number trialled and the outcome of that trial and usually at least two trials will be required for full marks. Question 18 tested the topic "Iteration" and is typical of questions on that topic.

Assessment for learning

Higher scoring candidates tend to preserve numerical accuracy throughout a question, writing down more figures after stages, but also keeping the number on the calculator.

Candidates who did well on this paper generally:	Candidates who did less well on this paper generally:
• read each question accurately • set their work out clearly and logically • maintained numeric accuracy throughout a question • used calculators accurately • knew geometric properties well • provided clear and accurate algebraic manipulation.	• misread some questions • made lots of 'crossing out' and their work was not easy to follow • prematurely rounded or truncated results • made errors in calculations • used incorrect geometric terms • did not use brackets to show the priority of operations.

Question 1

1 Calculate.

$$\sqrt{5.2^2 - 4.8 \times -6.3}$$

Give your answer correct to **3** significant figures.

..... **[2]**

Most candidates answered the question correctly, but a few could not calculate this accurately on their calculator. Some candidates did not round their answer as requested, even though the '3' was in bold to highlight this to candidates.

Question 2

2 The price of petrol decreases from £1.32 per litre to £1.02 per litre.

Calculate the percentage decrease in the price.

..... % **[3]**

We did accept answers as integers, but it is recommended that one decimal place is the more appropriate accuracy in an examination for this type of question. The common error was to divide the difference by 1.02 and not 1.32, thus finding the percentage out of 1.02. There were some non-calculator methods, but very few of them got anywhere near the correct answer and they were often difficult to follow.

Question 3 (a)

3 **(a)** Eve, Jack and Ling share some money in the ratio 2 : 3 : 4.
Jack gets £720.

Work out how much Ling gets.

(a) £ ..... **[2]**

The most common method was to calculate $\frac{720}{3} \times 4$ to get an answer of 960. The most common error was to treat the £720 as the money they all share so we saw $\frac{720}{9} = 80$ followed by $80 \times 4 = 320$.

Question 3 (b)

(b) Amir, Beth and Casey share some money in the ratio 3 : 5 : *c*.
Casey's share is $\frac{2}{3}$ of the total.

Find the value of *c*.

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

The most common correct method was to decide that 8 is $\frac{1}{3}$ of the total so the total is $8 \times 3 = 24$ (from which students worked out *c*), or alternatively that *c* is $\frac{2}{3}$ so it is $8 \times 2 = 16$. The common error was to calculate $\frac{1}{3}$ of 8. Some treated the $\frac{2}{3}$ as the proportion for *c* but wrote the other two as 3 and 5. Much working was not logical or clear and therefore was hard to follow.

Question 4 (a)

4 Alex invests £4500 at a rate of 7.5% per year simple interest.

(a) Find the value of the investment at the end of 4 years.

(a) £ ..... **[3]**

Misreads were commonplace in both parts (a) and (b), with a large number of candidates using compound interest, which made the question more difficult. Those candidates who used simple interest and $\frac{7.5}{100}$ or 0.075 in many cases found the interest of £337.50 for one year and usually went on to obtain the correct answer. Some candidates tried to use year-by-year calculations and inaccuracies would often creep in when they rounded or truncated numbers prematurely. Other common mistakes included using 0.75 for 7.5% instead of 0.075.

Question 4 (b)

(b) At the end of t years, the value of the investment is over £13 500 for the first time.

Find the value of t.

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

The most common technique used to obtain the correct answer was $\frac{9000}{337.50}$ with simple interest, although $\frac{200}{7.5}$ following $\frac{13500 - 4500}{4500} = 2$ was a very unusual method seen. For those who misread the question and used compound interest, using trials was the most common method to find t.

Question 5 (a)

5 **(a)** Write 0.00386 in standard form.

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

This question was answered very well, with only a few putting 10^3 instead of 10^{-3}. A few candidates gave the incorrect answer of 3.86×10^{-5} when counting the decimal point to the end of the number and a few dropped the 6 and wrote 3.8×10^{-3}.

Question 5 (b)

(b) The speed of sound is 3.43×10^{-1} km/s.
An object is travelling at the speed of sound.

Work out how far the object travels in one day.

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

The majority of candidates answered this question correctly. Those that didn't usually only multiplied by 24 and one 60 or multiplied by 24 and three 60s.

Question 5 (c)

(c) In a science fiction story, a spacecraft travelling faster than the speed of light is said to be travelling at 'warp n' where n is an integer.

Warp n is defined as $n^3 \times$ the speed of light.

In the story, a spacecraft needs to travel from Earth to Neptune in less than 2 minutes.

- The speed of light is 3.00×10^5 km/s.
- The distance from Earth to Neptune is 4.41×10^9 km.

Find the smallest possible warp n at which the spacecraft can travel.
You must show your working.

(c) $n =$ ..... **[3]**

Many candidates found this part difficult. It was common to award a method mark for either $\frac{4.41 \times 10^9}{120}$ or $\frac{4.41 \times 10^9}{3 \times 10^5}$. Some attempted to calculate $\sqrt[3]{14700}$ and others $\sqrt[3]{3.675 \times 10^7}$. A common error was to invert the fraction given above or add the powers of ten instead of subtracting them when the calculation was not done completely on their calculator. Some candidates got to 122.5 but forget that $n^3 = 122.5$. A few candidates used square rooting instead of cube rooting. A popular approach was to use trials, however only a handful got the correct answer from this method. There were some who only used 5 as a trial, but it was not clear how they had arrived at this value. If trials are used, we commonly expect to see at least two attempts to reach the correct answer. There was much confusion between distance and speed so incorrect formulae were used.

Question 6

6 A six-sided numbered spinner is thrown 50 times.
The score for each throw is recorded.
Some of the results are shown in the table.

An 8 was thrown f times.
An unknown number on the spinner is represented by n.

Score	Frequency
1	12
3	2
5	9
6	16
8	f
n	4
Total	50

The mean score of the 50 throws is 5.5 .

Find the value of f and the value of n.

$f =$.....

$n =$.....

[4]

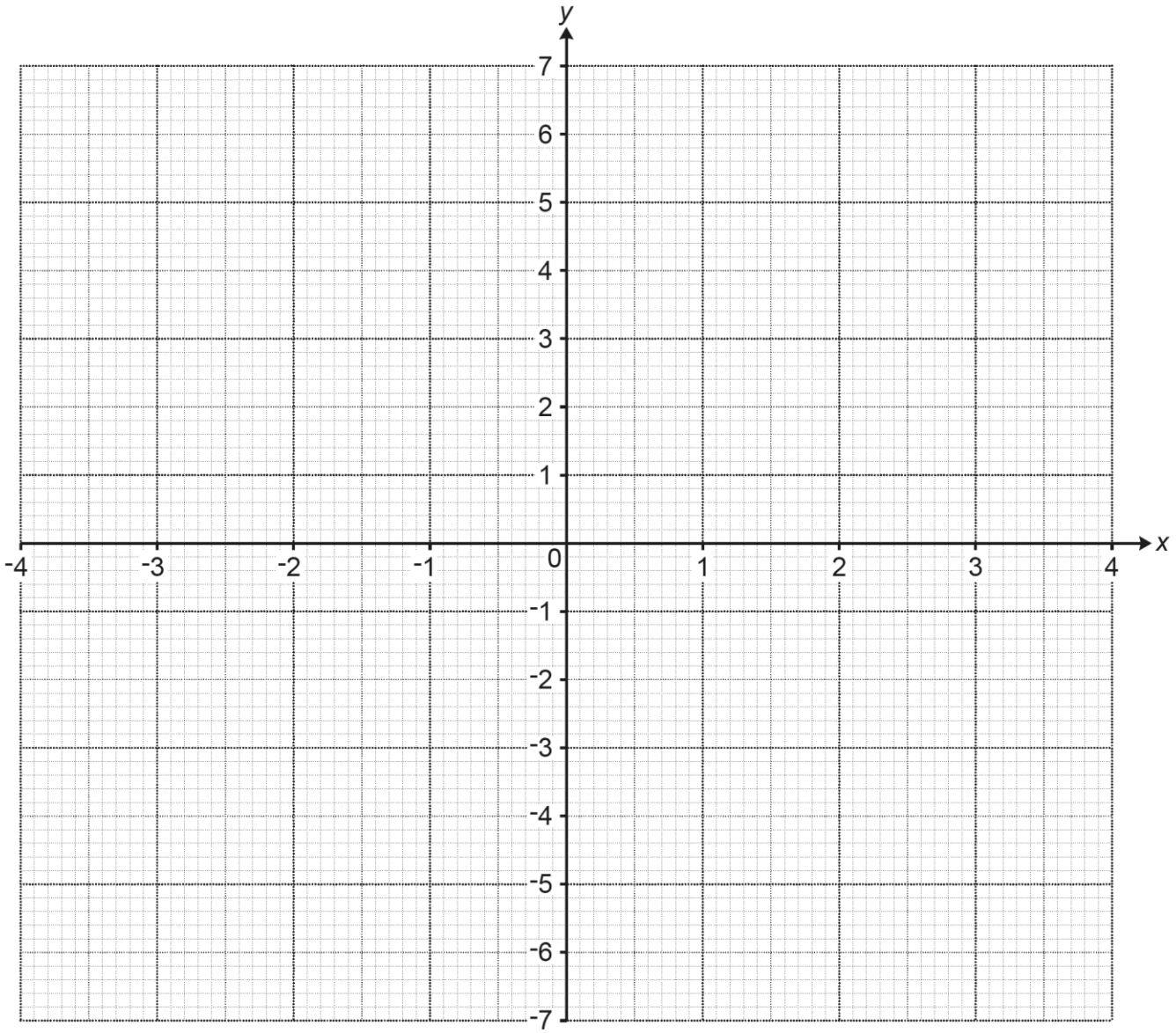
Most candidates found the value of f as 7 without a problem. However, many candidates were unable to find n. Those that didn't find n successfully tended to misunderstand how the mean is calculated from a frequency table, with frequency density or cumulative frequency seen near the table. The most common misconception was to multiply 5.5 by 6 [to get 33], add the scores [to get 23], rather than score × frequency and then 33 – 23 to arrive at n = 10. Occasionally candidates were able to get to a correct total score of 275, but either did not attempt to multiply score by frequency or did not add these figures together correctly.

Question 7 (a)

7 Here is a table of values for $y = \frac{6}{x} - 2x$.

x	$^{-}4$	$^{-}3$	$^{-}2$	$^{-}1$	1	2	3	4
y	6.5	4	1	$^{-}4$	4	$^{-}1$	$^{-}4$	$^{-}6.5$

(a) Draw the graph of $y = \frac{6}{x} - 2x$ for $^{-}4 \leqslant x \leqslant 4, x \neq 0$.



[3]

Almost all candidates attempted this question, with the majority plotting seven coordinates correctly. The final mark for drawing the curves was lost for various reasons; being unaware of asymptotes, incorrectly linking *their* fourth and fifth points to connect the curves through the *y*-axis, inaccuracy in missing the correct points by more than the allowed tolerance, using a ruler instead of a freehand line to join points, excessive feathering or 'tram lines' in joining points, or they did not draw the curve at all.

Question 7 (b)

(b) Use your graph to find the positive solution of $\frac{6}{x} - 2x = 0$.

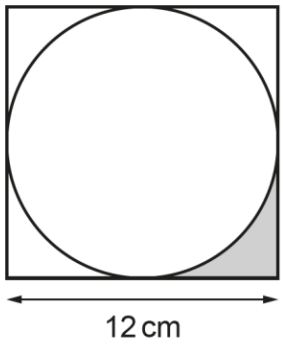
Give your answer to **1** decimal place.

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

Many candidates did not realise that the solution to the equation was where the curve crossed the x-axis so very few gave an acceptable answer. The question did ask for the positive solution to one decimal place, but many gave either a negative value or included than one decimal place.

Question 8

8 The diagram shows a circle inside a square of side 12 cm.



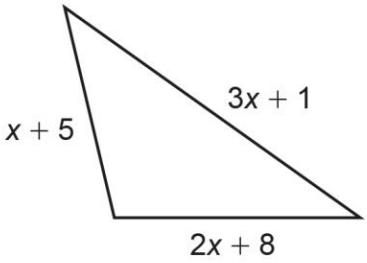
Work out the percentage of the square that is shaded.
You must show your working.

..... % **[6]**

The most common (and most successful) approach was to find the area of the square and the area of circle and most were able to do this. Pleasingly, there seemed less confusion here between the area and the circumference of a circle than seen in previous years'. The next step was generally to find the shaded area by subtraction of the area of the circle from the square followed by division by four. The next step was then to find the area as a percentage of the full square. The final step proved to be the most challenging. Candidates who found the area of the full circle as a percentage of the square first were less likely to get the final answer correct. Common wrong answers were 7.73, the shaded area, or 21.46 (the percentage of four corner areas).

Question 9 (a)

9 The sides of this triangle are given in centimetres.
The perimeter of the triangle is 80 cm.



Not to scale

(a) Find the length of each side of the triangle.
You must show your working.

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

This question was generally very well answered, with most candidates using an algebraic approach and solving the equation correctly. Some attempted to use trials and we required just one complete evaluation of the three expressions with the number tried, then added and the result clearly seen.

Question 9 (b)

(b) Is the triangle above a right-angled triangle?
Use calculations to show how you decide.

..... because .....

.....

..... **[3]**

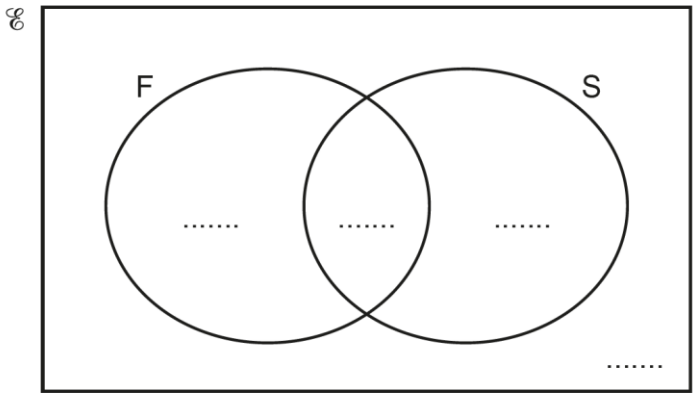
It was expected that Pythagoras' theorem would be used and clearly demonstrated that it holds for these three values, so showing that the largest angle was a right angle. It was not sufficient to just write down 'Pythagoras' theorem', we required to be shown that it holds for this triangle. The cosine rule was another good method, if a little more demanding. Using normal trigonometry is harder as it assumes the right angle and also the other two angles are irrational numbers, so showing they sum to 90 is difficult.

Question 10 (a)

10 100 people were asked whether they had visited France (F) or Spain (S).

- 55 had visited France
- 60 had visited Spain
- 4 had not visited either country.

(a) Complete the Venn diagram.



[3]

While many candidates answered this question correctly, many lacked the concept needed to ensure that each whole circle relates to one group. The two most common errors demonstrated this, having either the correct totals for those who visited Spain and for those that visited France yet their overall total wasn't 100, or had the correct total of 100 yet the totals for individual countries were incorrect. The most successful method was 60 + 55 + 4 = 119, intersection = 119 - 100 = 19 then subtracting 19 from the two totals for France and Spain. A common error was to forget to include the 4 people who had visited neither country in this calculation (this gave an intersection of 15).

Question 10 (b) (i)

(b) One of these 100 people is chosen at random.

(i) Write down the probability that this person had visited exactly **one** of the countries.

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

This part of the question was generally answered correctly for their Venn diagram.

Question 10 (b) (ii)

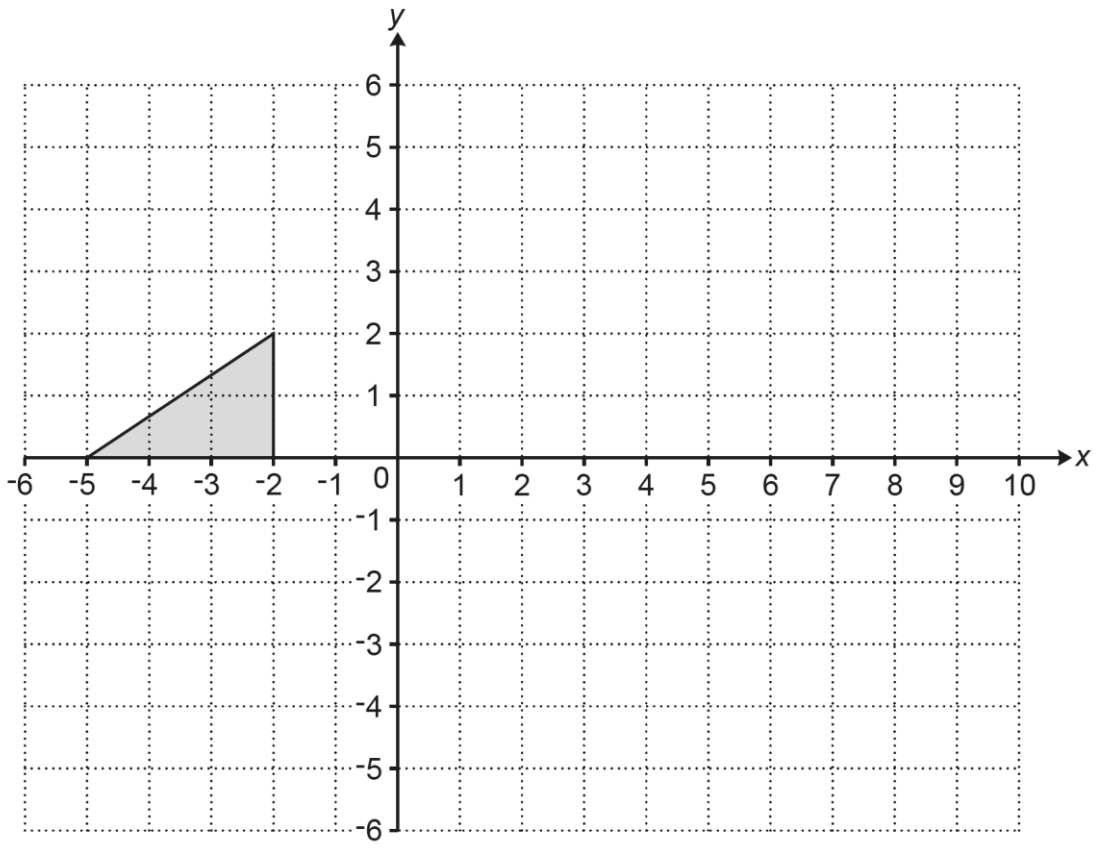
(ii) Write down the probability that this person had visited France given that they had also visited Spain.

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

Many candidates did not understand that they were finding the probability of a person being selected from the 60 who had visited Spain. From this error, a very common wrong answer was $\frac{19}{100}$ or 19% (or their equivalent of these, if their Venn diagram was not correct), instead of $\frac{19}{60}$.

Question 11

11 You may use this coordinate grid to help you answer the following question.



Describe fully the **single** transformation that is equivalent to:

- a rotation of 180° with centre (0, 1), followed by
- a translation of $\begin{pmatrix} 4 \\ 0 \end{pmatrix}$.

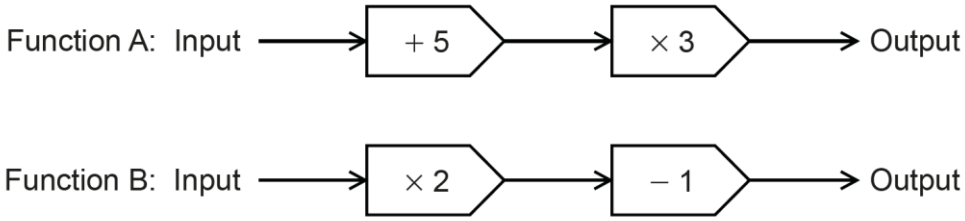
.....

..... **[3]**

Many candidates did answer this question correctly. Several candidates used two transformations in their description, despite the request in bold for a single transformation (most often involving a translation in their description of their combined transformation). Some of these did correctly draw one or both images on the diagram and gained credit.

Question 12 (a)

12 Here are two functions.



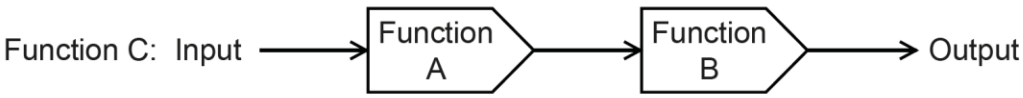
(a) Write an algebraic expression for the output of function A when the input is x.

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

Many candidates answered this question correctly. The common incorrect answers were x + 5 × 3, x + 15 or 3x + 5 with no bracket. A high number of candidates did not recognise the importance of brackets.

Question 12 (b)

(b) Here is a composite function C.



The input to function C is x.
The output from function C is $2x + 1$.

Find the value of x.
You must show your working.

(b) $x =$ ..... **[5]**

Those with strong algebraic skills processed the information effectively, while those with weak algebraic skills could not cope with the demands of the question and often put more than one incorrect attempt down. Writing down a combined expression proved difficult, mainly due to the absence of brackets in the many attempts. The expansion of single brackets was also poorly executed with the second term in the bracket usually not multiplied by the factor outside. Manipulation of an equation with an 'x' term on both sides proved difficult to many. Another error was to see $6x + 30 - 1$ evaluated to $6x - 29$.

Question 13 (a)

13 Here are two pieces of work.

Each shows a question and the **first line** of an incorrect solution.

For each part, describe the error made in the first line of the solution.
You do **not** need to complete the solution.

(a)

Question:
Simplify. $\frac{2}{x-1} + \frac{3}{x+4}$

Solution:
$\frac{2}{x-1} + \frac{3}{x+4} = \frac{2(x-1)+3(x+4)}{(x-1)(x+4)}$

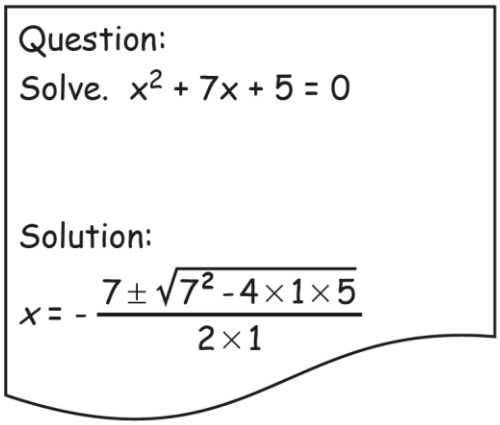
.....

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

Most candidate recognised what was wrong with the expression and were able to convey that in their answer, however a few fell a little short of an acceptable statement. Statements such as 'they should be cross multiplying' were far too vague and lacked the detail required. We needed to know what was wrong with the expression and we did accept a corrected expression.

Question 13 (b)

(b)



.....

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

The intention for this question was for students to note that the negative sign should be on the top of the fraction. While the expression given is not in the standard form, it does not however contain an error; it is a perfectly valid, if unusual, first step. After analysing candidate performance during marking, we decided the fairest approach was to award all candidates 1 mark.

Question 14

14 A college offers 41 different subjects including 9 different languages.
Students are asked to choose one subject from Option A, one subject from Option B and one subject from Option C.

Each of the 41 different subjects appears only once, either in Option A, or in Option B or in Option C.

Option A : 14 subjects including 2 languages
Option B : 12 subjects including 3 languages
Option C : 15 subjects including 4 languages

Work out the proportion of all the possible subject combinations that include **at least one** language.
You must show your working.

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

This question was intended to assess arrangements, particularly using the product rule for counting the numbers of outcomes. Some attempted to use probability, which made the problem even more challenging. However many candidates struggled to access the context of this question; many candidates were able to find the total number of arrangements, but nothing else. Some candidates misread the question and thus attempted the question with initially incorrect values, so a scheme for marking these was included in the mark scheme appendix.

Question 15

15 y is inversely proportional to the square root of x.
$y = 7$ when $x = 144$.

Find the value of y when $x = 16$.

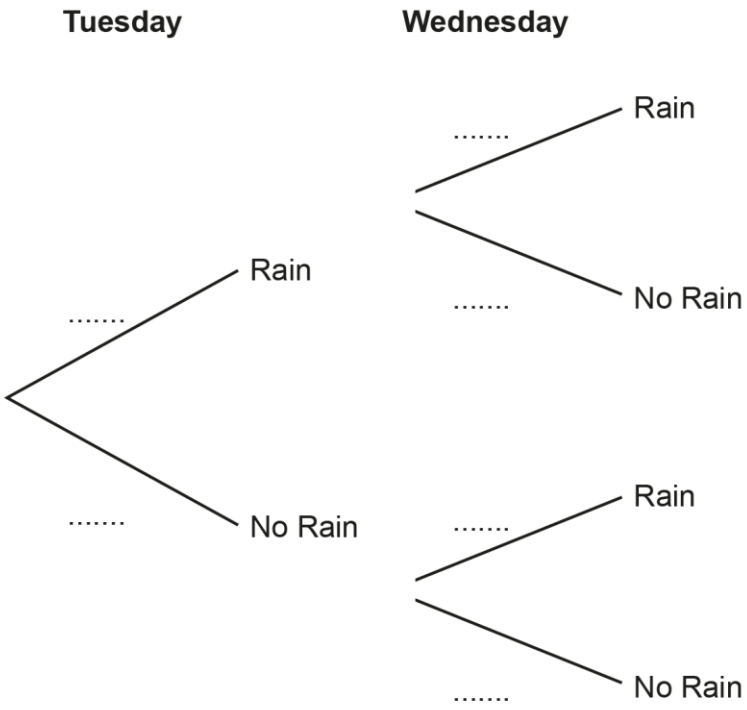
$y =$ ..... **[3]**

This question was answered well. Quite a few candidates were able to get as far as $y = \frac{k}{\sqrt{x}}$ and $k = 84$, but then gave an answer of 5.25 from $\frac{84}{16}$ (not applying the square root to 16). Common misconceptions included attempting y inversely proportional to x^2 or y directly proportional to the square root of x. Only a few candidates used the alternative method, which started with $\frac{144}{16} = 9$, but then they generally attempted 7×9 or $\frac{7}{9}$ instead of doing $7 \times \sqrt{9}$.

Question 16 (a)

16 If it rains on a given day the probability that it will rain the next day is 0.65.
If it does **not** rain on a given day the probability that it will rain the next day is 0.3.
It rained on Monday.

(a) Complete the tree diagram.



[2]

Many correct tree diagrams were seen and these were overall better than in previous years. The common errors were in Wednesday's second branch to write 0.7 for 'Rain' and 0.3 for 'No Rain', or to write 0.65 for all 'Rain's and 0.3 for all 'No Rain's.

Question 16 (b)

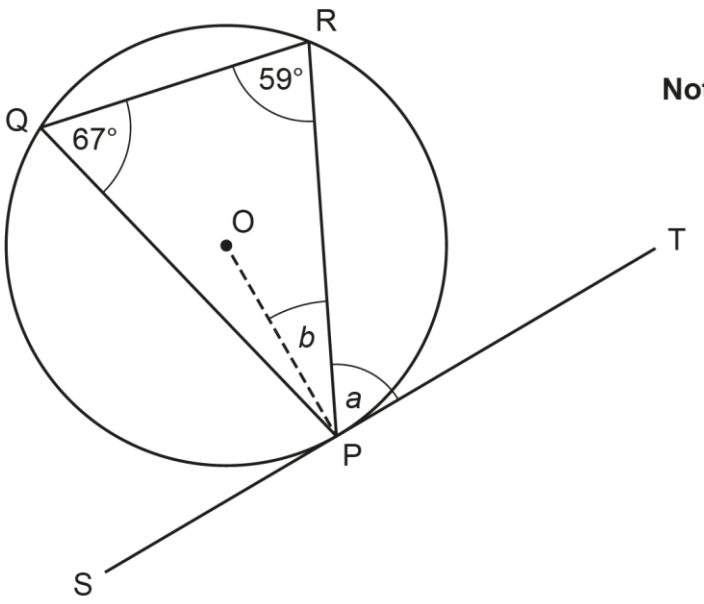
(b) Find the probability that it rains on Wednesday.

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

There were many correct solutions, the two main errors being just considering one branch (either 0.65 × 0.65 or 0.65 × 0.3). Many candidates were awarded follow through marks for a correct answer from their incorrect tree diagram.

Question 17 (a) (i)

17 (a) P, Q and R are points on the circumference of a circle, centre O.



Not to scale

Angle PRQ = 59° and angle PQR = 67°.
Line SPT is a tangent to the circle.

(i) Work out angle *a*.
Give a reason for your answer.

Angle *a* = ...° because .....

.....

..... **[2]**

Some candidates gave the correct answer 67°, but many of those did not give the correct reason. The two most common incorrect angles were 59° and 54. For the reason, the two most important terms are 'alternate' and 'segment' (there were many reasons involving 'alternate angles'). There were many attempts to explain it using other words, but this is very difficult.

Assessment for learning

It is well worth spending time learning the correct terms for the circle and learning the circle properties. The concepts of circle theorems is something that most candidates seem to find difficult. Candidates often quote random angle facts and hope that they are the appropriate ones.

Exemplar 1

Angle a = 67 ° because alternate segment theorem means angle PQR is equal to angle RPT.

Correct geometric property stated with implication for this question.

Exemplar 2

Angle a = 59 ° because alternate angles → it is a equal to $\hat{QRP}$

Students were not told that ST and QR are parallel, so this has been incorrectly assumed.

Question 17 (a) (ii)

(ii) Work out angle b.
Give a reason for your answer.

Angle b = ...° because .....

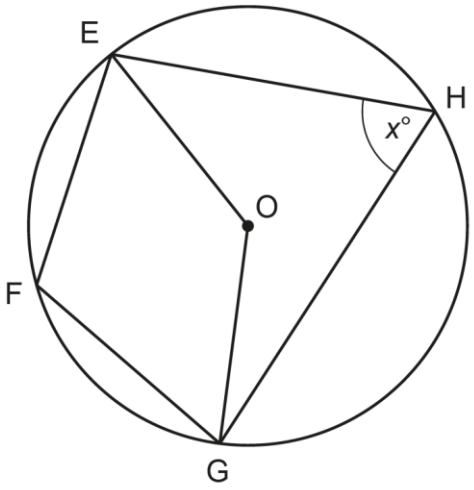
.....

..... **[2]**

This was answered better than Question 17 (a)(i), with many candidates following through from their incorrect answer to part (a)(i) correctly. The reason often involved 'angles on a straight line add up to 180' or 'angles on a tangent add up to 90'. Some did not use the term 'radius' so we would see 'from centre to tangent…' or 'line from centre to tangent…', however this reason was more well-known than the reason in part (a)(i).

Question 17 (b) (i)

(b) E, F, G and H are points on the circumference of a circle, centre O.
Acute angle EHG = $x°$.



Not to scale

(i) Complete the following, giving the values of the angles in terms of x.

Obtuse angle EOG = ... ° because .....

.....

.....

Therefore, reflex angle EOG = ... °

Therefore, angle EFG = ... ° **[3]**

In the first part many candidates did write $2x$, but some of these did not give the reason correctly. There were many candidates who did not use the correct term for 'centre', the most common ones being 'middle' or 'origin'. Some did not use the term 'circumference' and instead used 'edge' or 'perimeter'. A few wrote $360 – 2x$, not reading the word 'obtuse' in the demand. The second angle was given correctly more often than the first one. The third angle was dependent on the other two because it was part of a 'proof'. Very few candidates wrote the third angle correctly; a common wrong answer was $180 – 2x$.

Question 17 (b) (ii)

(ii) Write down what your working in part **(b)(i)** has proved.

.....

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

Few candidates answered this question correctly, although some did mention a quadrilateral in a circle or even a cyclic quadrilateral and some wrote that the angles of a quadrilateral added up to 360, which is not what this proves.

Question 18 (a)

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

Most found the two values at $x = 1$ and $x = 2$, but some did not comment on how this shows that there is a solution (the reason we required was that 0 lies between the two values they had found). We allowed other values to be calculated, as long as they were within 1 & 2 and if the two signs were different. At this stage we did not expect an attempt at a solution, or to use an iterative formula.

Question 18 (b)

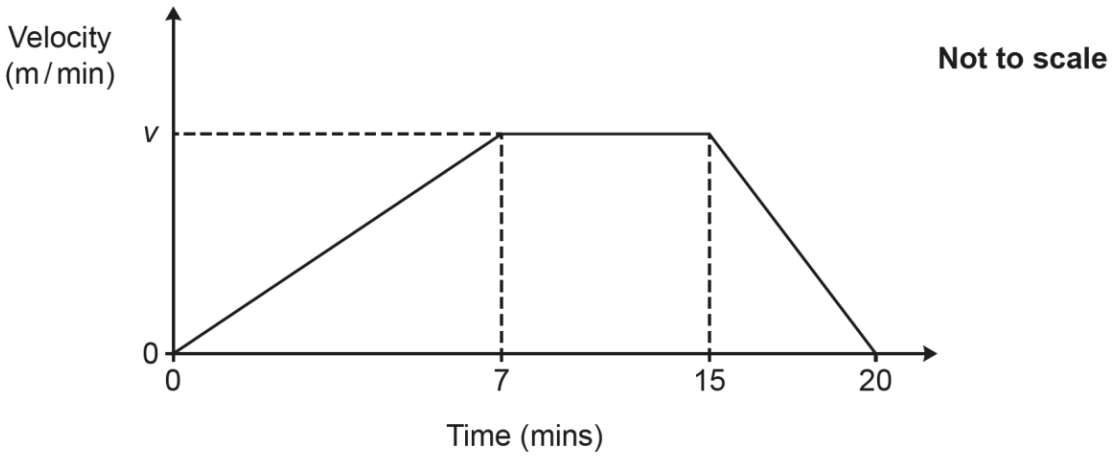
(b) Find this solution correct to **1** decimal place.
You must show calculations to support your answer.

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

Firstly, if any calculations in part (a) were relevant then they should be repeated here or indicated. Secondly, we require both the input value and the output value to be clear and the output value to be accurate to ideally at least three significant figures. As this is iteration, we expect attempts near the solution and to both sides of it. The common error was to write $x^3 + x^2 = x^5$ and attempt the fifth root of 5.

Question 19

19 The graph shows the velocity of a particle over the first 20 minutes of its motion.



Between 7 minutes and 15 minutes the velocity of the particle is v metres per minute.
The average velocity of the particle over the 20 minutes is 11.55 metres per minute.

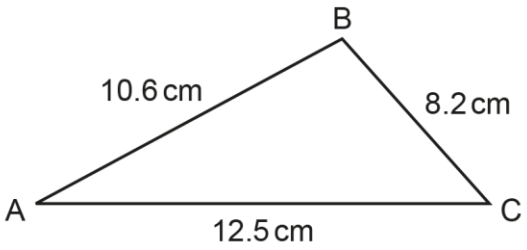
Find the value of v.
You must show your working.

$v =$ ..... **[5]**

Many candidates were able to get credit by working out 231 or by making an attempt at part of the area. Most candidates split the area under the graph into a triangle, a rectangle, and another triangle to find the area under the graph. Once an expression for the area was found, most candidates then struggled to manipulate the algebra to obtain $14v = 11.55 \times 20$. A common error was to multiply through by 2, but many did not multiply $8v$ by 2, and therefore they showed an incorrect expression for the area of $7v + 8v + 5v$. Those who attempted the area as an entire trapezium were often more successful.

Question 20 (a)

20 The diagram shows triangle ABC.



Not to scale

AB = 10.6 cm, BC = 8.2 cm and AC = 12.5 cm.

(a) Show that angle BAC = 40.5°, correct to **1** decimal place. **[3]**

Most candidates recognised the need to use the cosine rule, though many of them could not fully manipulate the expression to the form with the angle as the subject or wrote the cosine rule for the wrong angle. Most who reached 265 × cos BAC = 201.37 went on to find the angle, but not all of these gave the more accurate 40.54 that was essential to show the value is indeed 40.5 correct to 1 decimal place. Common errors in the method were substituting 40.5 into the formula and finding the length of BC as 8.2 and a very few used right-angled trigonometry thinking that angle B was 90°. A few used the sine rule involving the use of 40.5, which enabled them to find the size of the other two angles; this was not an efficient way to proceed, but it was more often used in part (b).

Misconception

Many candidates thought that angle ABC was 90°.

Question 20 (b)

(b) Work out the area of triangle ABC.

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

There were many correct answers, however some candidates made it harder for themselves by calculating one or both of the other angles before substituting in the values. Not all candidates used the correct sides for their chosen angle, the most common being when using 40.5 as the angle they would use the side 8.2 in their calculation.

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