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GCSE (9-1)

Examiners' report

MATHEMATICS

J560
For first teaching in 2015

J560/06 Summer 2019 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. 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 can be downloaded from OCR.

Paper 6 series overview

This is the third and final paper taken by Higher tier candidates for the GCSE (9-1) Mathematics specification.

Use of calculators

It is expected that calculators will be used in this paper.

It is important that accuracy is maintained in calculations and also with values which are transferred between processes e.g.in Q5, Q17 and Q18.

Candidates should be familiar with and make use of the functions available on their calculators. In particular, they should be able to perform calculations with fractions, percentages, negative numbers and numbers in standard form, and be able to find cube roots e.g. in Q1, Q2, Q6, Q10, Q12(b), Q18 and Q19(a).

The breadth of content examined, and the distribution of marks allocated to AO1, AO2 and AO3, are similar to 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 1, 2, 3, 4, 6, 7 and 8 were also set on the Foundation tier paper J560/03.

Candidate performance overview

Candidates who did well on this paper generally did the following.

- Performed almost all standard techniques and processes accurately e.g. in Q1(a), Q4, Q5, Q12(b), Q15, Q16, Q17, Q19 and Q22.
- Usually interpreted and communicated mathematics accurately. In particular, information presented in words or diagrams was understood and correct notation was used when presenting a mathematical argument e.g. in Q2, Q3, Q9, Q11, Q13 and Q14.
- Produced clear solutions to multi-step tasks e.g. in Q6, Q10, Q14 and Q18.

Candidates who did less well on this paper generally did the following.

- Made errors in performing low-grade processes e.g. in Q2, Q5, Q6, Q17(a) and Q18.
- Produced responses that lacked notation of an appropriate standard e.g. in. Q9, Q13 and Q14.
- Showed poor setting out of multi-step tasks e.g. in Q6, Q10 and Q14.
- Misinterpreted questions and information or did not follow instructions e.g. in Q3, Q8, Q9, Q11(a)(i), Q14, Q15, Q17(b) and Q19.

Many candidates would gain more marks if they made better use of their calculators. Instead, they made errors when trying to perform the calculations by hand.

In questions where candidates are asked to show a particular statement is right or wrong, it is important to complete the argument. This often means showing a comparison between two results which then leads to the appropriate conclusion being stated.

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

Question 1 (a)

1 A grain of salt weighs 6.48×10^{-5} kg on average.
A packet contains 0.35 kg of salt.

(a) Use this information to calculate the number of grains of salt in the packet.

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

This AO1 processing question was also on Foundation paper 3.

The vast majority of the Higher tier candidates correctly identified the need to divide the weight of the packet by the average weight of a grain. Those who used the standard form facility on their calculator were more successful in obtaining the correct answer as they avoided the possibility of making an error when converting to ordinary form. However, some gave a decimal answer, which is not appropriate in this context.

Question 1 (b)

(b) Explain why your answer to part **(a)** is unlikely to be the actual number of grains of salt in the packet.

....

....

.... **[1]**

The vast majority of candidates gave an acceptable explanation, usually referencing that the weight of the grains of salt will vary or that the calculation was based on an average. Following a decimal answer in part (a), comments that this was not possible were accepted. Comments suggesting that the grains were too small to count were not accepted.

Question 2

2 Tom researches the weights of plant seeds.

- One poppy seed weighs 3×10^{-4} grams.
- 250 pumpkin seeds weigh 21 grams.
- One sesame seed weighs 3.64×10^{-6} kilograms.

Write the three types of seed in order according to the weight of one seed.
Write the lightest type of seed first.
You must show how you decide.

.... , ... , ...**[4]**

lightest

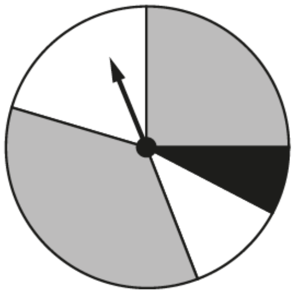
This question, which was also on Foundation paper 3, provided a good challenge. About one third of the Higher tier candidates scored full marks but there was also a significant number who made limited progress.

The question assessed strands of AO1, AO2 and AO3. Candidates needed to decide whether to work in grams or kilograms, and in standard form or ordinary form. They then needed to find the three weights in their chosen unit and form, so that the weights could be compared. Candidates who achieved this usually went on to order the seeds correctly, and so the award of 3 marks was unusual.

The majority chose to work in grams and ordinary form, but higher ability candidates were equally successful if using standard form. Candidates given 2 marks usually obtained 0.0003 g for a poppy seed and 0.084 g for a pumpkin seed. Conversion of sesame seeds from kilograms in standard form to grams in ordinary form was found difficult, especially if trying to do the unit conversion first. Some candidates found the number of pumpkin seeds per gram rather than the grams per pumpkin seed and so were limited to a maximum of 1 mark.

Question 3 (a)

3 (a) This spinner has two grey sections, two white sections and one black section.



Vlad says

The probability of the spinner landing on black is $\frac{1}{5}$.

Explain why Vlad is not correct.

....

....

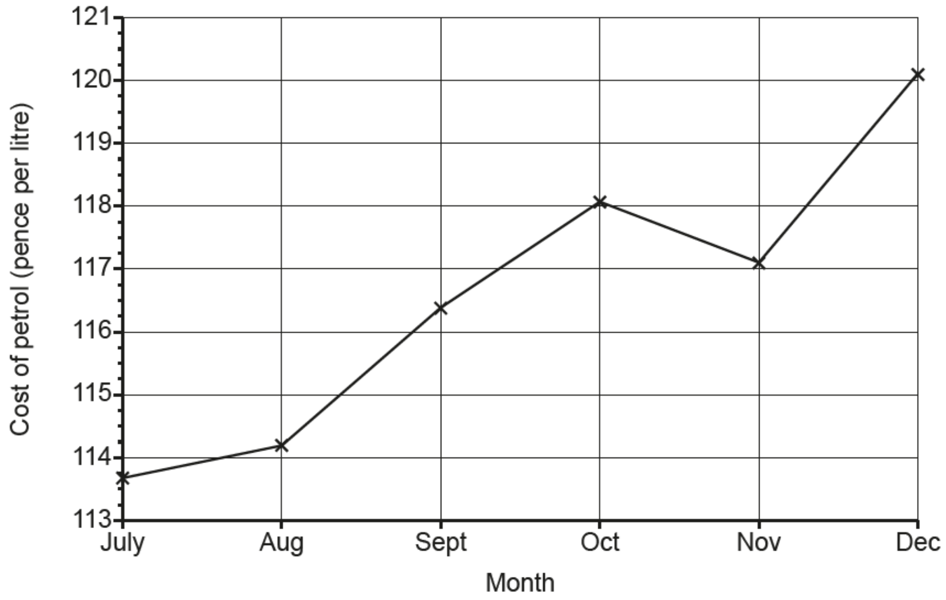
.... **[1]**

This AO2, communication, question was also on Foundation paper 3.

Most candidates did not appreciate the detail needed in the explanation. The common answer that 'the sectors were not of equal size' was not sufficient – they do not have to be for the probability of black to still be $\frac{1}{5}$. Valid explanations usually referred to the sector's angle or area.

Question 3 (b)

(b) The graph shows the cost of a litre of petrol for the last six months of 2017.



Explain why this graph is misleading.

....

....

.... **[1]**

Candidates often stated what the graph showed but did not explain why it was misleading. For example, some candidates just said the graph showed 'a large increase in price'. Better responses noted the large increase conveyed by the lines was in contrast to just a 6p increase from a starting value of 114p on the vertical scale. Many comments that were not accepted said the cost should be in pounds rather than pence, that there was only one reading per month or that the graph did not start from January – the latter suggesting that the question had not been read carefully.

Question 4

4 Sophie is organising a raffle.

- Each raffle ticket costs 50p.
- She sells 400 tickets.
- The probability that a ticket, chosen at random, wins a prize is 0.1.
- Each winning ticket receives a prize worth £3.

Sophie says

I expect the raffle to make over £100 profit.

Show that Sophie is wrong.

....

.... **[4]**

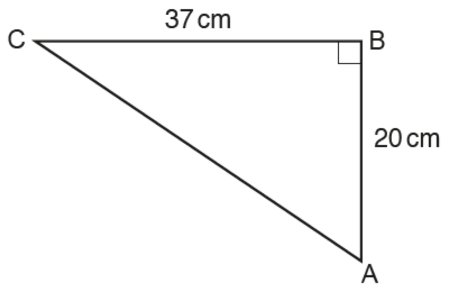
This question also appeared on Foundation paper 3.

Although the question has an AO2 'show' element and a little AO3 problem solving to decide what needs to be done, the question really just involves two strands of AO1 processing and a comparison. Almost all Higher candidates showed sufficient working and a concluding statement in words or symbols.

The vast majority of Higher candidates scored full marks. Those that did not usually scored 1 mark for finding the income of £200, but then subsequently used this as 200 tickets when finding the value of the prizes.

Question 5

5 ABC is a right-angled triangle.
AB = 20 cm and BC = 37 cm.



Not to scale

Calculate angle BAC.

.... ° **[3]**

Trigonometry in a given right-angled triangle is a routine AO1 process.

About two thirds of candidates scored full marks. However, candidates of all abilities, including some with full marks, often avoided using the tan function. This was perhaps caused by a lack of certainty about the tan ratio since use of tan BAC = $\frac{20}{37}$ was quite common. Many, therefore, used Pythagoras' theorem to find the hypotenuse. Premature rounding of this answer before using sin inverse, cos inverse or attempting the cosine rule led to an inaccurate final answer and a loss of a mark. The use of Pythagoras' theorem on its own scored 0 marks, as it was unnecessary if the most efficient method had been selected.

Question 6

6 A bag contains some counters.

- There are 300 counters in the bag.
- There are only red, white and blue counters in the bag.
- The probability of picking a blue counter is $\frac{23}{50}$.
- The ratio of red counters to white counters is 2 : 1.

Calculate the number of red counters in the bag.

.... **[4]**

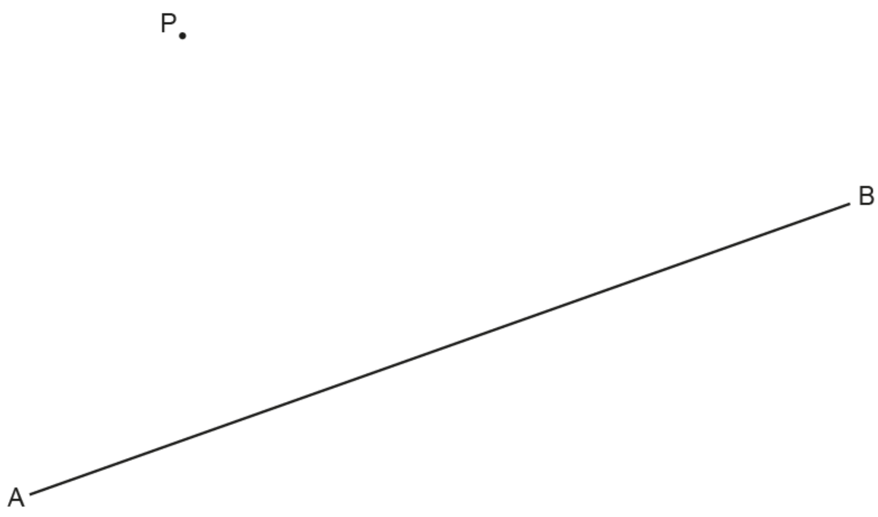
This question also appeared on Foundation paper 3.

The vast majority of the Higher candidates scored full marks. Those who did not usually made an arithmetic error which sometimes led them to abandon the question. After such an error, candidates could still gain method marks if they showed correct subsequent working.

Although the values were relatively straightforward, candidates who are less competent at fraction arithmetic should be encouraged to make use of their calculator.

Question 7

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



[2]

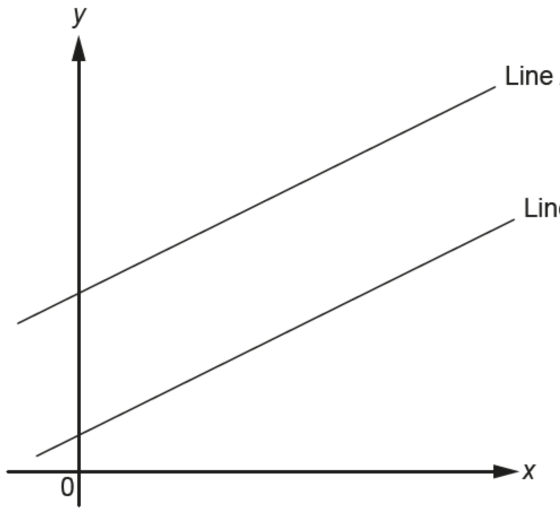
This question also appeared on Foundation paper 3. This appears to be one of the lesser known constructions.

About half of the Higher candidates knew how to complete the construction. Several constructions that produced the desired perpendicular were seen. The two constructions that were most common were:
(i) to draw an arc from P that intersected line AB in two places, and then intersecting arcs from those two points, effectively producing a rhombus;
(ii) an arc centred on A through P intersecting twice with an arc centred on B through P, effectively producing a kite.

Some candidates produced the perpendicular bisector of AB and then what appeared to be a parallel line by eye through P. If the line through P was perpendicular to AB, then 1 mark was given. Candidates who bisected angle APB scored 0.

Question 8

8 The graph shows two parallel lines, Line A and Line B.



Not to scale

Line A has equation $y = 6x + 7$.
Line B passes through the point (4, 26).

Find the equation of Line B.

.... **[4]**

This question also appeared on Foundation paper 3.

The question was generally answered well by the Higher candidates.

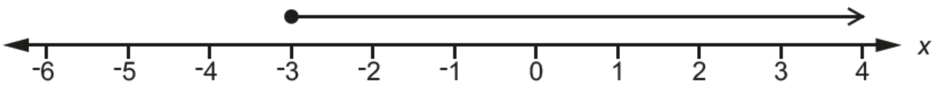
The most common and efficient method was to recognise that the gradient of the parallel line is 6 and to substitute (4, 26) into $y = 6x + c$. A less efficient but successful method used by some of the lower ability candidates involved using the gradient and the sketch to generate a sequence of points from (4, 26) to (3, 20) to (2, 14), (1, 8) and finally (0, 2).

Common wrong answers were $y = 6x + 4$, $y = 6x + 26$, $y = 4x + 26$ and, following $\frac{26}{4}$, $y = 6.5x + 7$.

These wrong answers often lacked supporting work.

Question 9

9 Martha's solution to the inequality $8x + 5 \leqslant 3x - 10$ is shown on the number line.



Is her solution correct?
Explain your reasoning.

....

.... **[4]**

Candidates were expected to give a full explanation to score 4 marks. The question produced the full range of marks with about a third of the candidates scoring full marks, while a quarter scored 0.

Most candidates attempted to solve the given inequality algebraically, correctly gathering the x terms on one side and the constants on the other. Candidates obtaining $5x \leq {}^{-}15$ usually reached $x \leq {}^{-}3$, scoring 3 marks, whereas those obtaining $15 \leq {}^{-}5x$ often went wrong at the next step. Candidates who had the incorrect inequality or an equals sign were limited to 2 marks. About a quarter of the candidates reaching $x \leq {}^{-}3$ thought the number line was correct.

Some candidates used trials, often concluding that the two sides were equal when $x = {}^{-}3$ but not relating their other findings to what was depicted on the number line. Depending on the variety and accuracy of the trials and the conclusion, it was possible to score full marks by this method but most attempts were given 1 or 0 marks.

Question 10

10 In 2017, the value of a house increased by 4%.
In 2018, the value of the house then decreased by 3%.

Teresa says

Over the two years the value of the house increased by exactly 1% because 4 - 3 = 1.

Show that Teresa is wrong.

....

.... **[6]**

Candidates needed to decide for themselves how to tackle this question (AO3), and then perform the necessary processing (AO1) in order to justify the given statement (AO2).

Just over half of the candidates scored full marks. Two methods were in evidence in approximately equal number. Two comparable mark schemes were necessary, with both producing the full range of marks.

The most efficient method, which tended to be used by the higher ability candidates, was 1.04 × 0.97 = 1.0088, and hence only a 0.88% increase. Candidates using this method often scored 6 marks for a relatively small amount of work. However, some made errors such as using multipliers of 1.4, 0.96 or 1.03 which limited the marks that could be given, or were unable to interpret 1.0088 correctly and so scored 5 marks.

Rather more candidates achieved 6 marks by a longer method, if they used a calculator to ensure accuracy. Here, candidates invented a value for the house, although some hindered their progress by choosing a value that proved difficult to work with. They worked out the increase by 4% followed by the decrease by 3%, often performing these calculations in stages by hand, and then compared with a 1% increase. Candidates not using a calculator often made arithmetic errors, while omissions, such as not explicitly finding the 1% increase or making a concluding statement, were common in this method.

The mark schemes gave 2 marks for the use of 1.04 or correct method to increase the value of the house by 4%, or 3 marks for following this with the use of 0.97 or correct method to decrease the new value by 3%. The presentation of working in this second method was often low, with scattered but connected calculations and restarts being common.

In a high-value 'Show that' question like this, candidates should be encouraged to cover all aspects of the question. They are advised to state what they believe to be obvious rather than leave it out.

Question 11 (a) (i)

11 You are given that

$$270 = 3^3 \times 2 \times 5 \quad \text{and} \quad 177\,147 = 3^{11}$$

(a) **(i)** Find the lowest common multiple (LCM) of 270 and 177 147.
Give your answer using power notation and as an ordinary number.

(a)(i) using power notation ....

as an ordinary number .... **[2]**

Candidates found this question challenging.

Some used a Venn diagram approach, often completed correctly, but confused the lowest common multiple (LCM) with the highest common factor (HCF). Another common mistake was to multiply both sets of prime factors together.

Some candidates found the prime factors of the two given numbers, failing to notice that they had been given this information.

Question 11 (a) (ii)

(ii) Write 177 147 000 000 as a product of its prime factors.

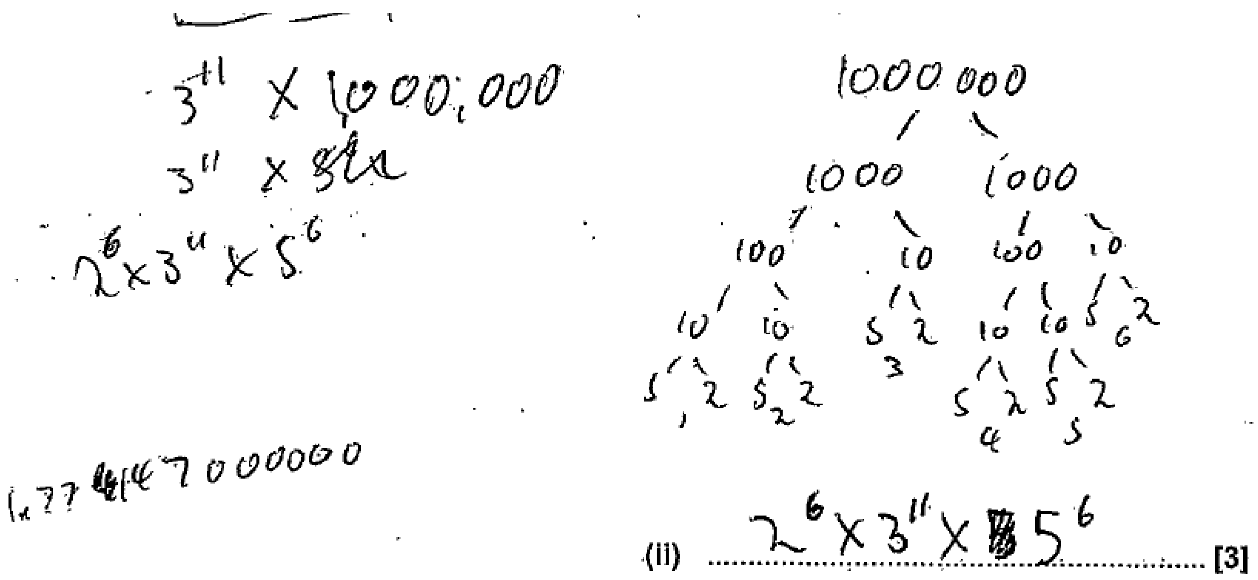
(ii) .... **[3]**

Those that developed their correct answers in part (a)(i) were often able to just write down the answer here. Other candidates with incorrect answers in (a)(i) often restarted. Therefore, more candidates scored full marks in part (a)(ii) than part (a)(i).

Candidates not seeing the connection between the two parts usually reverted to a prime factor tree. Some then spotted the shortcut of splitting the given number as $177\,147 \times 1\,000\,000 = 3^{11} \times 10^6$ and hence $3^{11} \times 2^6 \times 5^6$, cutting out much of the laborious task of finding all the prime factors. Those that attempted a full prime factor tree usually made errors.

1 mark was given for an answer involving 3^{11} and 1 mark for 2 and 5 identified as factors.

Exemplar 1



In this exemplar, the candidate has used the information given in the stem to write 177 147 as 3^{11}. This just left 1 000 000 to be expressed as the product of prime factors. The candidate appears to have not known this is equal to 10^6, and hence $2^6 \times 5^6$, which would have been more efficient but instead produces a prime factor tree for 1 000 000 to finish the question.

Many candidates merely created a huge prime factor tree. Few obtained 3^{11} by this method, although some did receive a mark for finding 2 and 5 as factors.

Question 11 (b)

(b) $3^n = 177\,147 \times 9^5$.

Find the value of n.

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

About one third of the candidates were able to reach a correct value of n, with slightly more than half of these demonstrating the use of indices to reach their answer. Changing 9^5 into 3^{10} scored 1 mark and then correct application of the law of indices scored 1 mark.

Most candidates were unable to use the index approach. Instead, they resorted to calculating 177 147 × 9^5. Although it was rare to see any trials, it was most likely that candidates had tried various powers of 3 until they reached a correct value of n. Those solving by trial or other unclear method could score either 3 marks for the correct answer or 0 marks.

Question 12 (a)

12 Antonio rolls two fair six-sided dice and calculates the **difference** between the scores.
For example, if the two scores are 2 and 5 or 5 and 2 then the difference is 3.

(a) Complete the sample space diagram to show the possible outcomes from Antonio's dice.

Dice 2

Dice 1	difference	1	2	3	4	5	6
	1	0					
	2					3	
	3		1				
	4						
	5		3				
	6						

[2]

Completion of the table was almost always correct. A few candidates included some negative answers and scored 1 mark.

Question 12 (b)

(b) Antonio rolls the two dice three times.

Calculate the probability that he gets a difference of 1 on all three rolls.
Give your answer as a fraction in its lowest terms.

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

While almost all candidates identified their correct probability from the table, scoring 1 mark, only about one third of the candidates raised this to the power 3.

Instead, the vast majority attempted to multiply by 3. Although an invalid method, it was noted that many could not perform $\frac{10}{36} \times 3$ correctly, with answers of $\frac{30}{108}$ being obtained and then simplified back to $\frac{10}{36}$ and $\frac{5}{18}$.

Candidates should be encouraged to use their calculators to perform fraction calculations.

Question 13

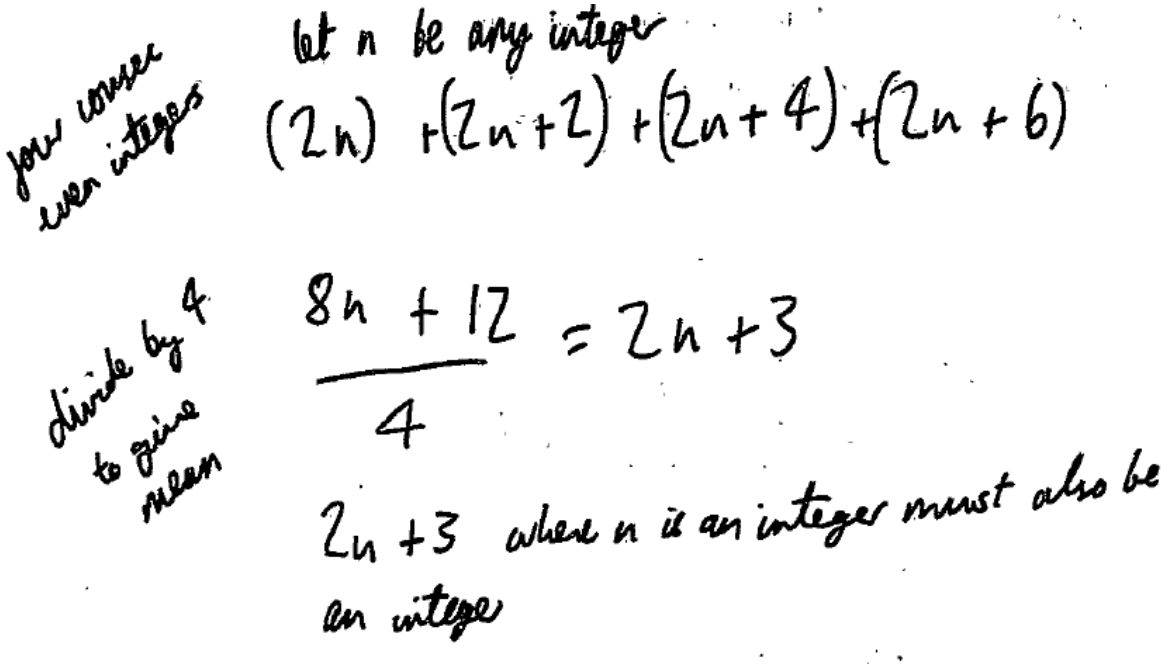
13 Prove that the mean of any four **consecutive** even integers is an integer. **[4]**

Less than a quarter of the candidates used a correct algebraic method. They found the sum of 2*n*, 2*n* + 2, 2*n* + 4 and 2*n* + 6, divided by 4 and stated that the result of 2*n* + 3 was an integer.

Other algebraic terms were used, such as *n*, *n* + 2, *n* + 4 and *n* + 6. Many of these candidates scored 3 marks but, to achieve full marks, they needed to define *n* as an even integer. Some candidates used algebraic terms that did not represent consecutive even numbers, such as 2*n*, 4*n*, 6*n* and 8*n*.

About a quarter of the candidates merely produced numerical examples, which scored 1 mark only.

Exemplar 2



This is an excellent example of how to present an algebraic proof. The candidate defines what *n* represents. Here, because they are using the form 2*n*, the mark scheme did not require that step but it is best practice to do so. Many candidates who did not use 2*n* dropped a mark for not defining their *n* as being even. All of the algebraic processing is correct and the words just add even more clarity. Some candidates did not make the concluding statement that 2*n* + 3 is an integer.

Question 14

14 The length of the longest diagonal of a cube is 25 cm.

Calculate the total surface area of the cube.

.... cm^2 **[5]**

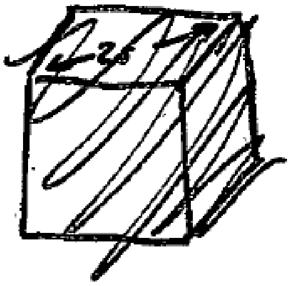
Only a small number of candidates scored more than 3 marks.

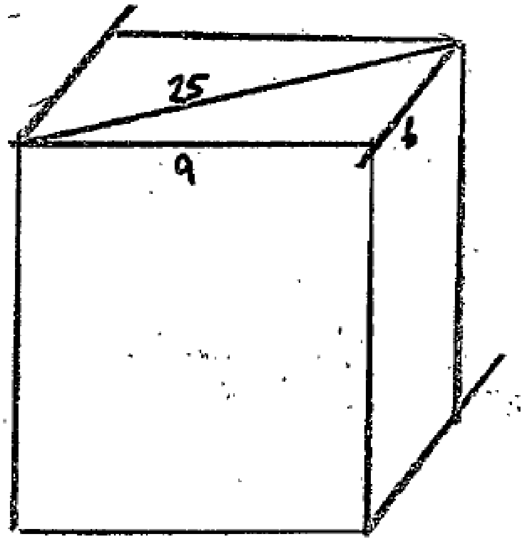
Much of the work demonstrated a lack of understanding of 3D mathematics and the clarity of presentation and notation was often low. Very few candidates were able to set up a correct version of 3D Pythagoras. Many of the diagrams and sketches were incorrect with the 'diagonal' added to a face of the cube. Quite often the sides of the cube were labelled as 25 or 5.

Many of the incorrect responses had starting points such as $3x^2 = 25$, $2x^2 = 625$ or $x^2 = 625$, where x was the size of the cube. Some method marks were available for correct subsequent working. Having obtained a value of x, most candidates realised they needed to then find $6x^2$ to finish the question.

There is a very efficient way of answering the question, but this was rarely seen:
the correct starting point is $x^2 + x^2 + x^2 = 25^2$ or $3x^2 = 625$;
the surface area = $6x^2$ which, therefore, is $2 \times 625 = 1250$ cm^2.

Exemplar 3





$a = 6$

$2a^2 = 25^2$ (pythagoras)

$2a^2 = 625$

$a^2 = 312.5$

312.5×6

$= 1875\text{ cm}^2$

1875 .... cm^2 **[5]**

This is a well presented example of a common, wrong, starting point. It scores 3 out of 5.

The diagram shows their diagonal is on a face of the cube. As a consequence, they give an incorrect starting equation of $2a^2 = 625$ rather than $3a^2 = 625$. They score M1 for 625. They then efficiently and accurately complete the question, scoring an implied accuracy mark for the value *a* and a method mark for what in effect is $6a^2$. Most candidates were less concise and solved $a^2 = 312.5$, then subsequently squared the answer to find the area of one face before finally multiplying by 6. Often they rounded their value of *a* before squaring and so did not get back to 312.5.

The standard of presentation of the vast majority of candidates was much lower than in this exemplar. They often lacked a clear order of processing and many retained multiple false starts with no clear final attempt.

Question 15

15 Solve by factorisation.

$$5x^2 + 7x + 2 = 0$$

$x =$ .... or $x =$ .... **[3]**

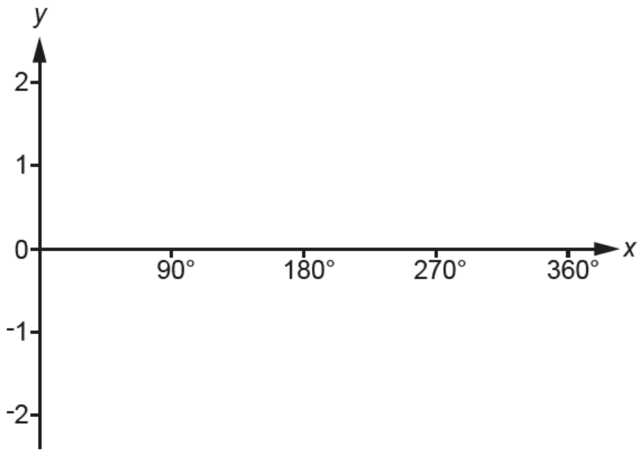
Nearly half of the candidates scored full marks and a third scored 0 marks.

Candidates who first use grid or partitioning methods to help find the factors should still state their final factorisation.

Many of the other candidates obtained the correct answers, but not by factorisation as instructed. These were given 1 mark.

Question 16

16 Sketch the graph of $y = -\sin x$ for $0° \leqslant x \leqslant 360°$.



[3]

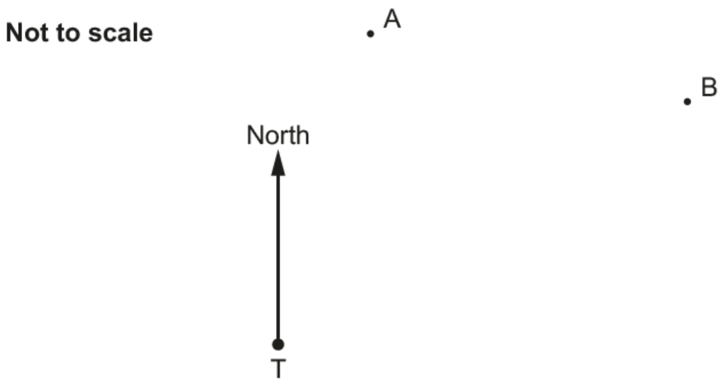
Most candidates attempted a trigonometric graph, although $y = \sin x$ was very common.

The marks were allocated as 1 for a sine curve, 1 for the amplitude, and 1 for the maximum and minimum at the correct values of *x*.

Question 17 (a)

17 T is a radar tower.
A and B are two aircraft.

At 3pm
- aircraft A is 3250 km from T on a bearing of 015°
- aircraft B is 4960 km from T on a bearing of 057°.



(a) Aircraft A flies directly towards radar tower T at a speed of 890 km/h.

At what time will the aircraft pass over radar tower T?
Give your answer to the nearest minute.

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

The anticipated and most commonly seen method required candidates to perform a time/distance/speed calculation, convert the decimal answer from hours into hours and minutes and then add this onto the start time of 3 pm. An alternative method involved first changing km/h into km/min before working out the time taken in minutes.

The time = distance/speed calculation was performed correctly by the vast majority of the candidates. However, many were unable to convert 3.65(…) hours into hours and minutes and thus made no further progress. 4 hours 5 minutes and just 4 minutes were very common incorrect conversions.

There was also a lack of working from those attempting the conversion, with 3 hours 42 minutes being common (presumably from 3.7 × 60). If candidates showed their method, they could get some credit even if their answer was incorrect.

Question 17 (b)

(b) Calculate the distance that was between aircraft A and aircraft B at 3pm.

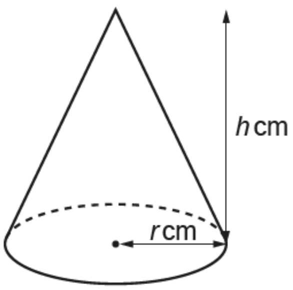
(b) .... km **[4]**

Less than half of the candidates recognised the need to use the cosine rule and many of these did so incorrectly. The most common error was to use an angle of 57˚ rather than 42˚, limiting the award to 2 marks. Other errors were having a mistake in the formula or evaluating it incorrectly.

Nearly half of the candidates scored 0. Many merely found the difference between the two distances; others assumed a right-angled triangle and used Pythagoras' theorem or trigonometry. However, there was 1 mark available if the angle of 42˚ was found.

Question 18

18 A cone has radius r cm and height h cm.



The height is three times the radius.
The volume of the cone is 2100 cm^3.

Calculate the radius of the cone.

[The volume V of a cone with radius r and height h is $V = \frac{1}{3}\pi r^2 h$.]

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

Not many candidates scored full marks and over half scored 0. Many of the responses demonstrated a low understanding of algebraic manipulation in a context.

Candidates were expected to start by substituting h with $3r$ in the given formula, for 1 mark. If they set up an equation in r they scored 2 marks. However, many did not attempt that substitution at all, or did so after earlier incorrect working. It was quite common for candidates to reach $r^2h = \frac{3 \times 2100}{\pi}$ or its equivalent and then attempt the square root of both sides, the left hand side becoming rh. It was only at this stage that $h = 3r$ was introduced. Others stated $r^2h = r^2 \times 3r = 4r$. Some did reach $3r^3 = 2005$ but square rooted rather than cube rooting. Even then, many gave the square root of $3r^3$ as $3r$ and similarly for the cube root.

Question 19 (a)

19 The point ($^-5$, 2) lies on the circumference of a circle, centre (0, 0).

(a) Find the equation of the circle.

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

Over half of the candidates scored 0, with many attempting gradients, equations of lines or to find the circumference of the circle.

Many of those substituting ($^-5$, 2) into $x^2 + y^2$ obtained an answer of $^-21$, which is not a possible value for r^2. These candidates were given 1 mark, even if they proceeded to the equation $x^2 + y^2 = {}^-21$. For full marks candidates needed be accurate and give the answer as $x^2 + y^2 = 29$. Those giving $x^2 + y^2 = 5.38^2$ introduced an unnecessary inaccuracy and were given 3 marks.

Question 19 (b)

(b) Work out the gradient of the tangent to the circle at ($^-5$, 2).

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

Only about one third of candidates made any progress. Some had their gradient inverted but scored 1 mark if they then used $m_1m_2 = {}^-1$. Others scored 1 mark if they found the equation of the tangent without explicitly stating the gradient.

Question 20 (a)

20 **(a)** Show that the equation $x^4 - x^2 - 9 = 0$ has a solution between $x = 1$ and $x = 2$. **[3]**

Similar questions have been set in previous series, and the expected and most successful approach was to substitute $x = 1$ and $x = 2$ into the equation. Most candidates obtained the correct answers of $^-9$ and 3. For full marks, these needed to be used to show why $1 < x < 2$. Various approaches were allowed including 'change of sign' and '$^-9 < 0 < 3$'. A few candidates used other values of x. This was acceptable provided they produced a valid, narrower interval than $1 < x < 2$.

Some centres had taught their candidates the technique of creating an iterative formula and using a starting point such as $x_1 = 1$. This approach was acceptable and successful provided the candidate actually answered the question asked. One iteration, for example, was not sufficient. Additionally, if using this method, it would be good practice to show the values of x_1, x_2, x_3 etc.

Attempting to solve the equation algebraically was very common. It can be solved as a quadratic in x^2 and this was very occasionally seen in part (b) but not part (a). The algebraic attempts seen here invariably contained incorrect algebraic manipulation such as $x^4 - x^2 = x^2$ and scored 0 marks.

Question 20 (b)

(b) Find this solution correct to 1 decimal place.
Show your working.

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

Candidates usually continued their method from part (a). Those who previously scored 0 or omitted the part, usually did so again. Those using the expected trial and improvement method made further substitutions for *x* which were almost always evaluated correctly. A mark was dropped for not testing two appropriate values of *x* between 1.85 and 1.95 in order to justify the selection of 1.9 as the solution to 1 decimal place.

Iteration and use of the quadratic formula were rare but, when seen, were usually successfully applied.

Question 21

21 Toy building bricks are available in two sizes, small and large.
The small and large bricks are mathematically similar.

A small brick has volume 8 cm^3 and width 2.1 cm.
A large brick has volume 15.625 cm^3.

Calculate the width of a large brick.

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

Nearly all candidates scored 4, 1 or 0 marks, approximately in equal numbers. The award of 2 or 3 marks was rare.

Having found the volume scale factor of 1.95… for 1 mark, candidates either knew to cube root this to find the linear scale factor and invariably proceeded to complete the question correctly, or they wrongly used the 1.95… as their linear scale factor.

Question 22 (a)

22 At the start of 2018, the population of a town was 17 150.
At the start of 2019, the population of the town was 16 807.

It is assumed that the population of the town is given by the formula

$$P = ar^t$$

where P is the population of the town t years after the start of 2018.

(a) Write down the value of a.

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

Most candidates answered this correctly. The most common wrong answer was 17 500, which comes from 17 150 ÷ 0.98. The demand 'write down' suggests that no calculation would be needed.

Question 22 (b)

(b) Show that $r = 0.98$. **[1]**

Most candidates showed the value of *r* correctly. The expected method was 16 807 ÷ 17 150 = 0.98, although embedded statements, such as 17 150 × 0.98 = 16 807, were accepted.

Question 22 (c)

(c) Show that the population is predicted to be less than 16 000 at the start of 2022. **[2]**

Most correctly identified and evaluated $17\,150 \times 0.98^4$ as 15 818 to 15 819, scoring both marks. Candidates who scored 0 marks usually found 2% of 17 150 = 343, and then 17 150 – 4 × 343 = 15 778.

Question 22 (d)

(d) Use the formula to work out what the population might have been at the start of 2017.

(d) .... **[2]**

About half of the candidates scored full marks for $17\,150 \times 0.98^{-1}$, or equivalent, evaluated as 17 500. The usual wrong method was 17 150 × 1.02 = 17 493.

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