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OCR
Oxford Cambridge and RSA

GCSE (9–1)

Exemplar Candidate Work

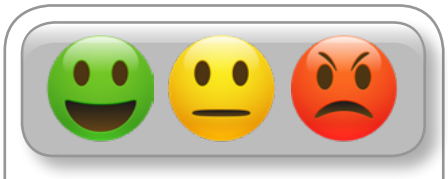
MATHEMATICS

J560
For first teaching in 2015

J560/06 Summer 2018 examination series

Version 1

Contents



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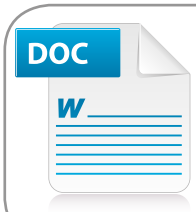

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Introduction

These exemplar answers have been chosen from the summer 2018 examination series.

OCR is open to a wide variety of approaches and all answers are considered on their merits. These exemplars, therefore, should not be seen as the only way to answer questions but do illustrate how the mark scheme has been applied.

Please always refer to the specification https://www.ocr.org.uk/Images/168982-specification-gcse-mathematics-j560.pdf for full details of the assessment for this qualification. These exemplar answers should also be read in conjunction with the sample assessment materials and the June 2018 Examiners' report or Report to Centres available from Interchange https://interchange.ocr.org.uk/Home.mvc/Index

The question paper, mark scheme and any resource booklet(s) will be available on the OCR website from summer 2019. Until then, they are available on OCR Interchange (school exams officers will have a login for this and are able to set up teachers with specific logins – see the following link for further information http://www.ocr.org.uk/administration/support-and-tools/interchange/managing-user-accounts/).

It is important to note that approaches to question setting and marking will remain consistent. At the same time OCR reviews all its qualifications annually and may make small adjustments to improve the performance of its assessments. We will let you know of any substantive changes.

Question 1

1 Ping chooses four numbers.

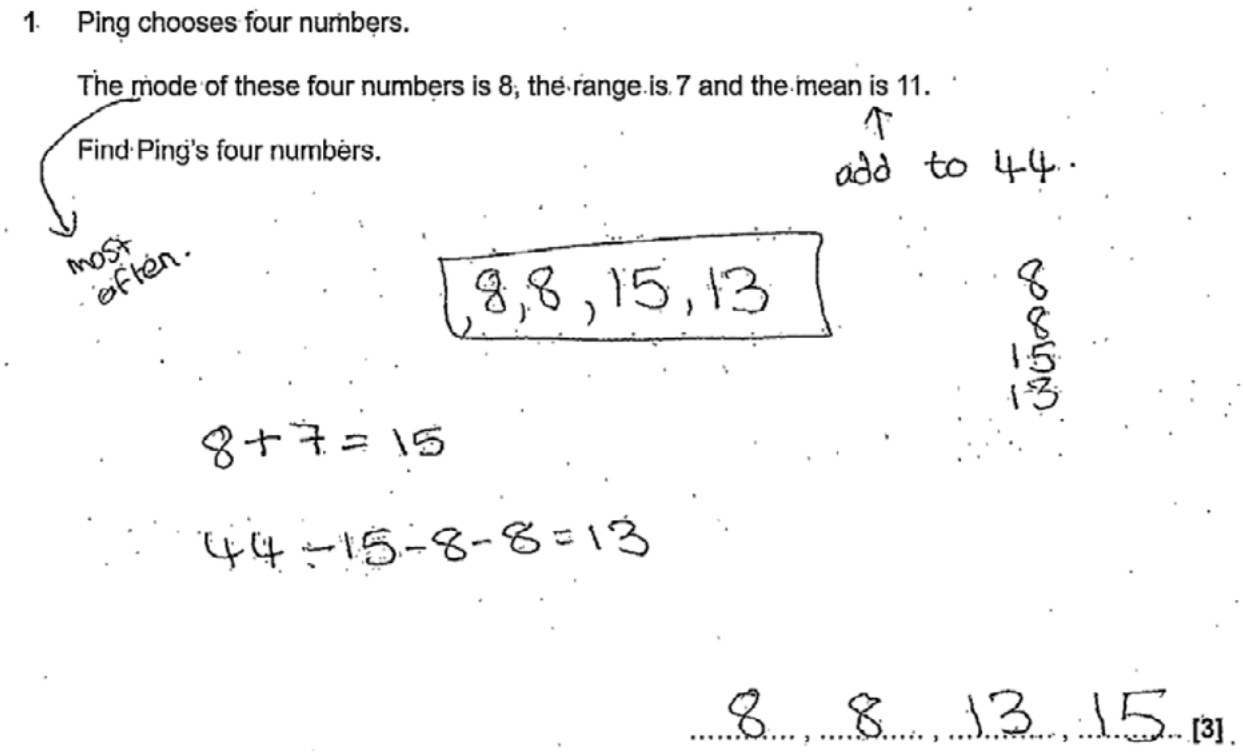
The mode of these four numbers is 8, the range is 7 and the mean is 11.

Find Ping's four numbers.

..... , ... , ... , ... [3]

Exemplar 1

3 marks



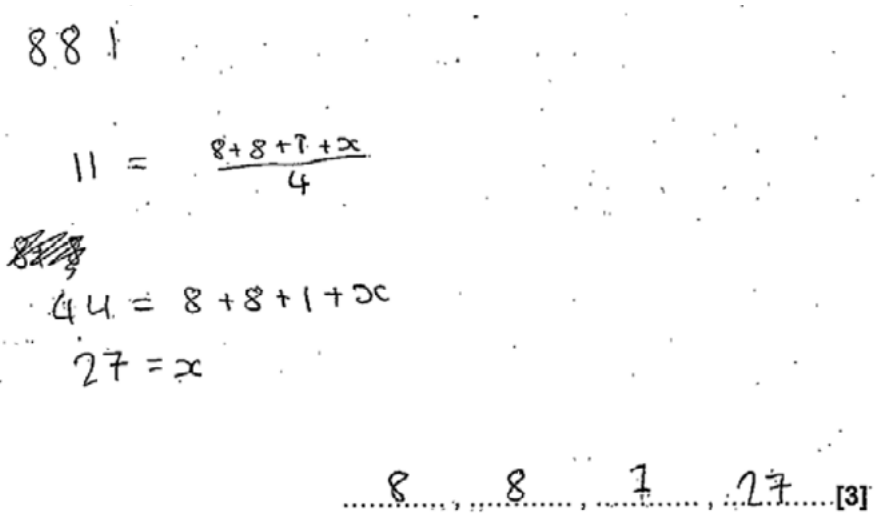
Examiner commentary

The correct answer of 8, 8, 13, 15 scores full marks.

There is clear, logical thinking taking place. The candidate identifies the mode as "most often" and so starts with 8 and 8. They then use the range information to obtain 8 + 7 = 15 and, finally, use the mean information to produce a total of 44.

Exemplar 2

2 marks



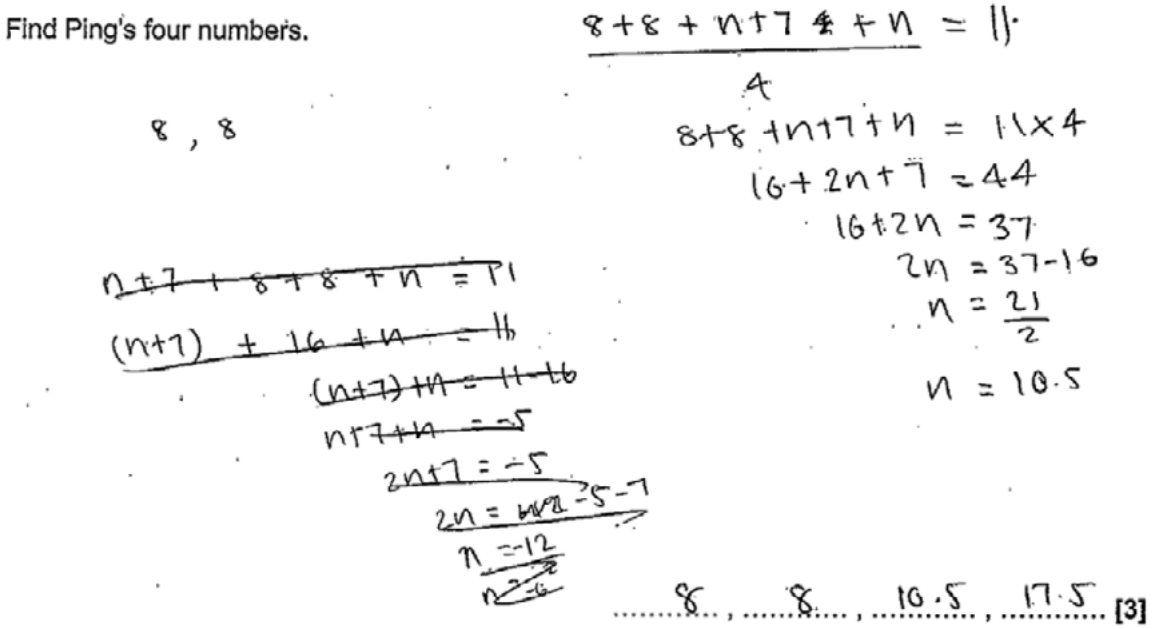
Examiner commentary

8, 8, 1, 27 scores B2 for four numbers satisfying two of the three required conditions: at least two of the values are 8 and there is a total of 44.

This was a common incorrect answer. Having used the mode information to obtain 8 and 8, they then use the range information to obtain 1. They then recognise the need for a total of 44, and so find 27. Unfortunately, they do not realise that their range has now become 26.

Exemplar 3

2 marks

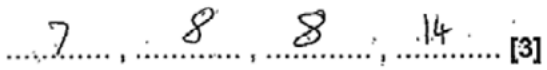


Examiner commentary

8, 8, 10.5, 17.5 scores B2 for four numbers satisfying two of the three required conditions: at least two of the values are 8 and there is a total of 44.

This was the most common incorrect answer. Having used the mode information to obtain 8 and 8, they incorrectly think the two missing values have a range of 7. They then use good algebra with n and n + 7, to obtain 10.5 and 17.5, but this gives a range for all four values of 9.5.

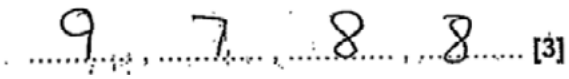
Exemplar 4 2 marks



Examiner commentary

7, 8, 8, 14 scores B2 for four numbers satisfying two of the three required conditions: at least two of the values are 8 and there is a range of 7.

Exemplar 5 1 mark



Examiner commentary

9, 7, 8, 8 scores B1 for four numbers satisfying one of the three required conditions.

Question 2

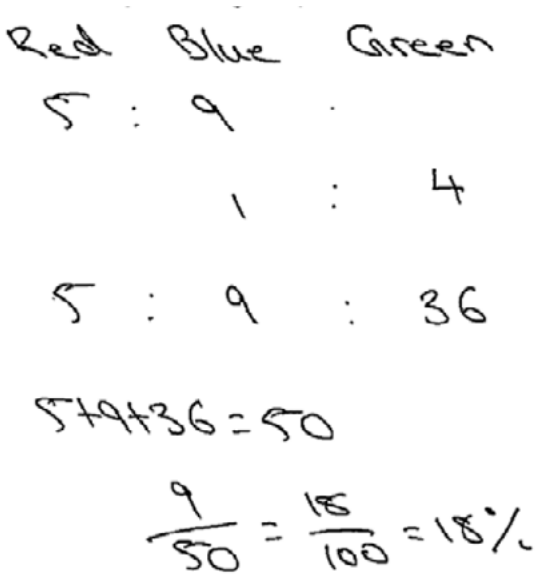
2 A box contains only red, blue and green pens.
The ratio of red pens to blue pens is 5 : 9.
The ratio of blue pens to green pens is 1 : 4.

Calculate the percentage of pens that are blue.

..... % **[4]**

Exemplar 1

4 marks



18 % **[4]**

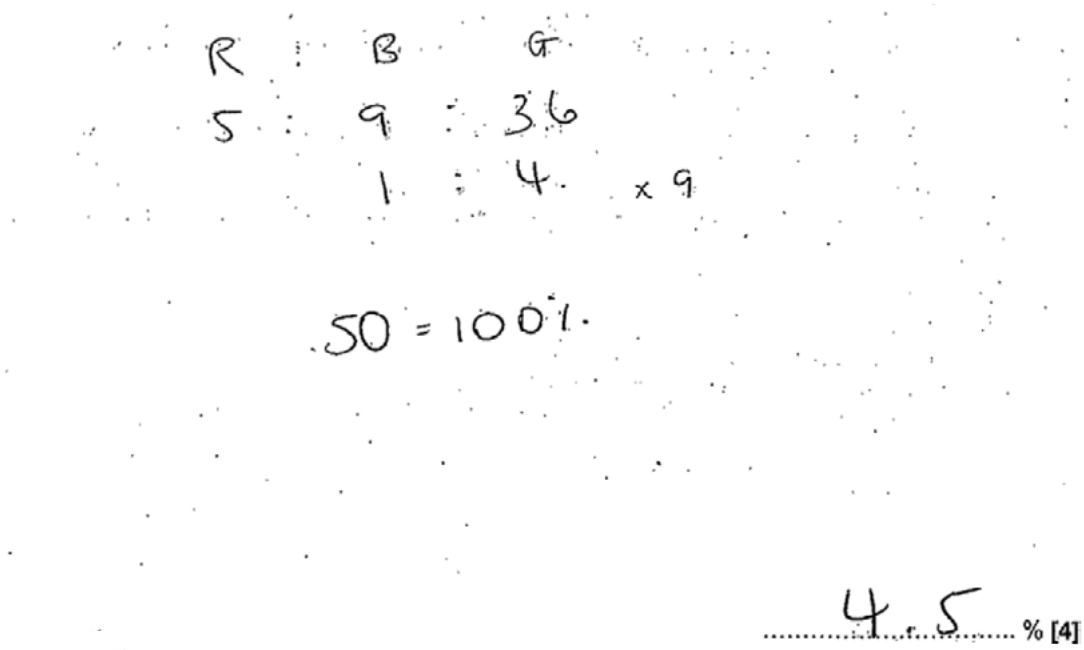
Examiner commentary

The answer 18 is correct and not from wrong working. It scores full marks.

This is a well presented response. Candidates who used a table were generally able to show their working more clearly and were more successful. Here, there is a lack of "× 9" to show how they get from the second to the third row of the table but that does not detract from the presentation. The summation and percentage work is also clearly shown. This candidate also efficiently opts to convert a fraction with a denominator of 50 into one with a denominator of 100, rather than using a "× 100" method.

Exemplar 2

2 marks

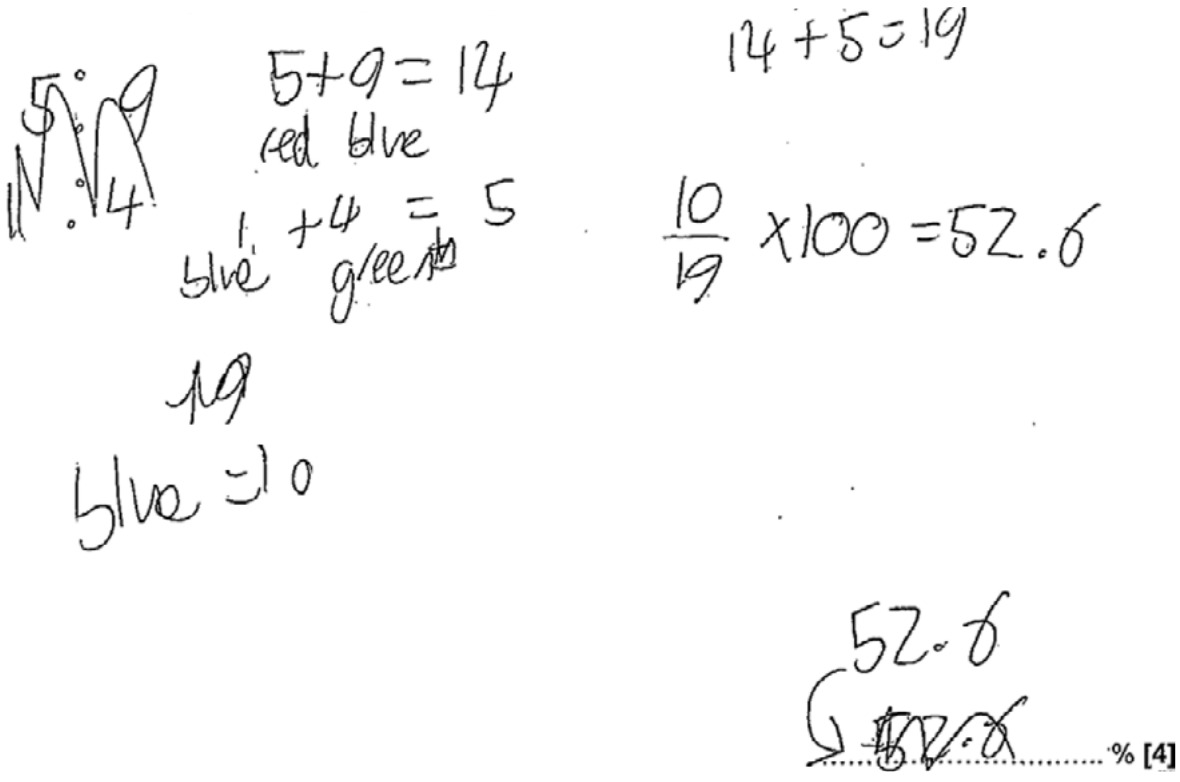


Examiner commentary

The answer 4.5 is incorrect but there is evidence for 2 marks in the working. The ratio 5 : 9 : 36 scores B1 and the "50 = 100%" implies the summation of the ratio parts, scoring M1. The candidate's answer of 4.5 could come from dividing the number of blue pens (9) by 2 rather than multiplying by 2.

Exemplar 3

0 marks

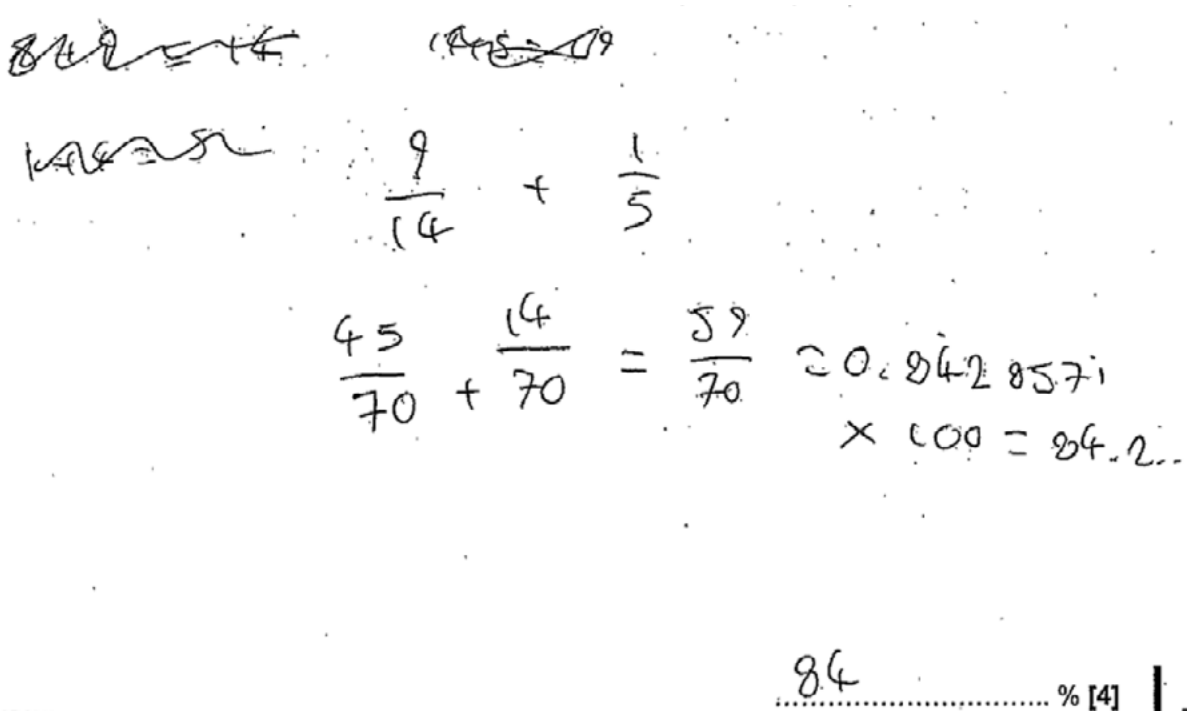


Examiner commentary

This is quite a common response and scores 0 marks. The candidate merely adds the four ratio parts in 5 : 9 and 1 : 4 to produce a denominator of 19. In such cases, there are no follow through marks for the percentage work.

Exemplar 4

0 marks



Examiner commentary

This is another common response that scores 0 marks. The candidate demonstrates excellent ability in adding two fractions together but it is irrelevant to the question. Unless there is an attempt to use two ratios with a common term, responses will score zero.

Question 3

3 Asha worked out $\frac{326.8 \times (6.94 - 3.4)}{59.4}$.

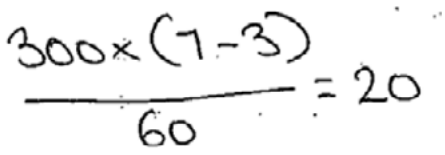
She got an answer of 19.5, correct to 3 significant figures.

Write each number correct to 1 significant figure to decide if Asha's answer is reasonable.

.....

..... [3]

Exemplar 1 3 marks



20 is close to 19.5, so her answer is reasonable.

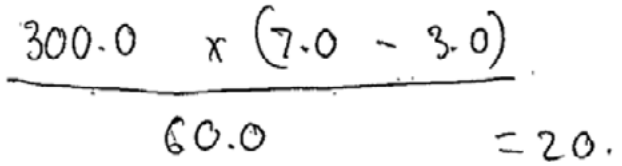
..... [3]

Examiner commentary

All values have been rounded correctly to one significant figure, the calculation has been performed accurately, and the concluding statement is correct. Therefore, this scores all 3 marks.

Exemplar 2

2 marks



Yes.

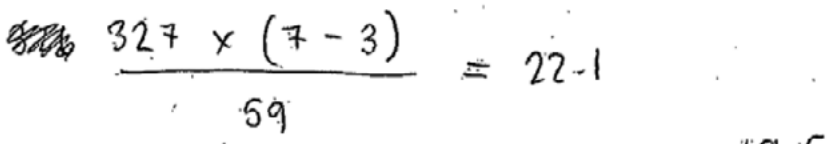
[3]

Examiner commentary

The values should not have zeros after the decimal points. B1 is allowed for this consistent error and a B1dep is then awarded for the result of 20 and the minimal conclusion of "yes".

Exemplar 3

1 mark



Arna's answer is reasonable as I have rounded down numbers so the actual answer will be less [3]

Examiner commentary

Two of the values have been rounded correctly to one significant figure, scoring B1. A B1dep is only available for rounding that leads to an answer of 20, such as occurs in Exemplar 2.

Question 4 (a)

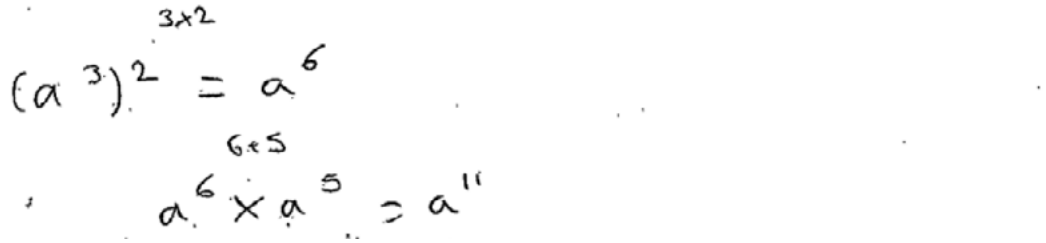
4 (a) Show that $a^5 \times (a^3)^2$ can be expressed as a^{11}. **[2]**

Exemplar 1 — 2 marks

Examiner commentary

The application of the rules of indices are clearly shown and so the response scores full marks.

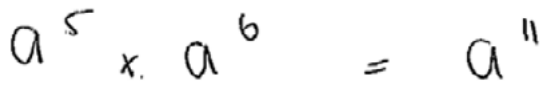
Exemplar 2 — 2 marks



Examiner commentary

Although not as elegantly presented as Exemplar 1, the application of the laws of indices is still clear, via 3×2 and $6 + 5$. Therefore, the response scores full marks.

Exemplar 3 — 1 mark



Examiner commentary

a^6 scores B1. It is not required to show how this is obtained for the award of one mark but, for full marks, the addition of the two powers needs to be seen.

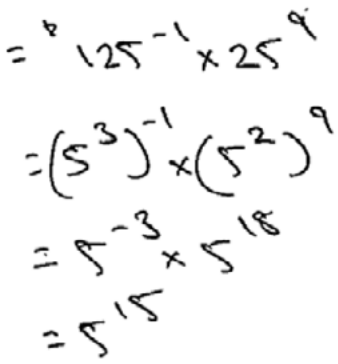
Question 4 (b)

(b) Write $\frac{1}{125} \times 25^9$ as a power of 5.

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

Exemplar 1

3 marks



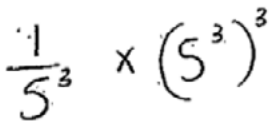
(b) 5^{15} **[3]**

Examiner commentary

The answer line and all supporting work are correct, and so full marks are awarded.

Exemplar 2

1 mark



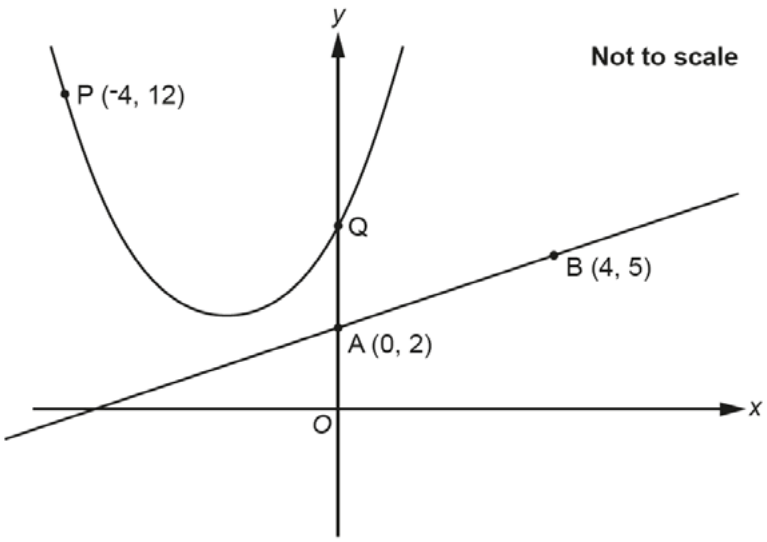
(b) $\frac{1}{5^3} \times (5^3)^3$ **[3]**

Examiner commentary

The answer line is incorrect but 5^3 scores B1. Candidates can score another B1 if showing 5^{18}.

Question 5(a)

5 The diagram shows a straight line that passes through points A and B, and a curve that passes through points P and Q.



(a) Find the equation of the straight line.

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

Exemplar 1

2 marks

(a) Find the equation of the straight line.

$(4, 5)$ x y

$y = mx + c$

$5 = \frac{3}{4} \times 4 + c$

$\frac{5}{3} = 1.6$

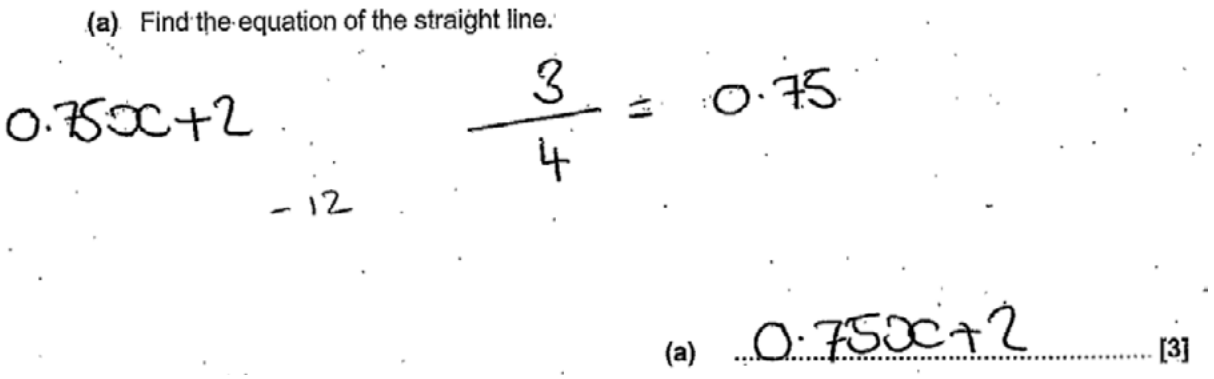
(a) $y = \frac{3}{4}x + \frac{5}{3}$ **[3]**

Examiner commentary

The answer line is of the form "$y = 0.75x$ [+ c]" but the c value is incorrect. This, therefore, scores B2. The working towards finding c is unnecessary as its value is given on the diagram.

Exemplar 2

2 marks

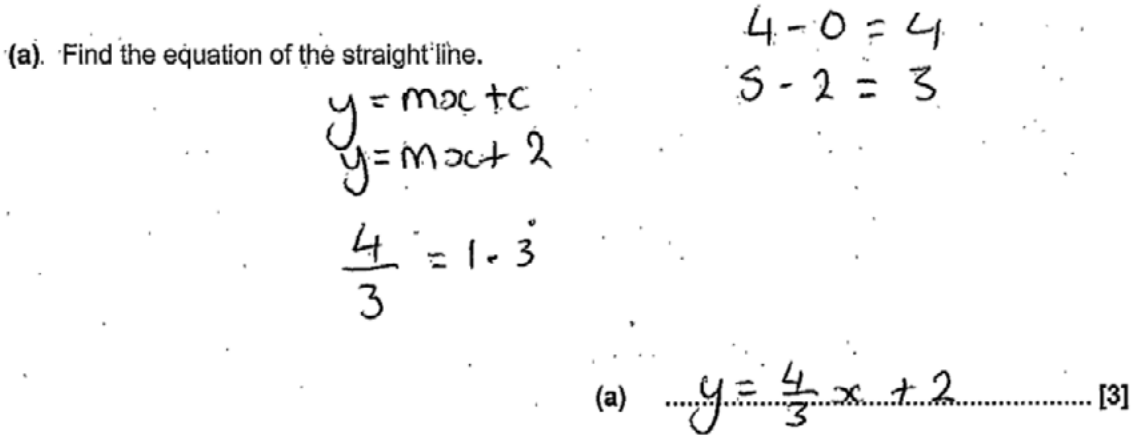


Examiner commentary

The answer omits "$y =$" and so scores B2 only.

Exemplar 3

1 mark



Examiner commentary

The gradient is inverted and, therefore, is an invalid method and does not score the method mark.

The intercept is identified correctly and presented in an equation of the form "$y = kx + 2$ with $k \neq 0$". This scores B1.

Question 5 (b)

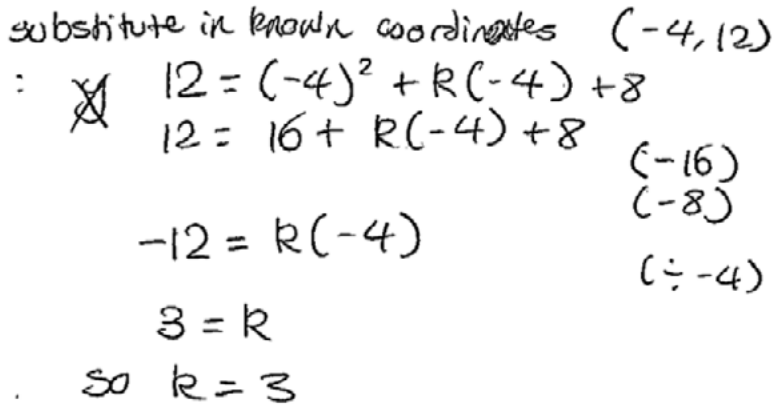
(b) The equation of the curve is $y = x^2 + kx + 8$.

Find the value of k.

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

Exemplar 1

3 marks



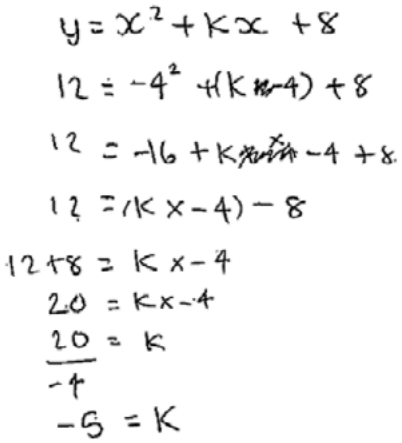
(b) $k =$ 3 **[3]**

Examiner commentary

The response scores full marks. The answer is correct and obtained from clear, correct working. In particular, the use of brackets means that there are no ambiguous arithmetic statements, such as $k - 4$.

Exemplar 2

1 mark



(b) $k =$ -5 **[3]**

Examiner commentary

The point (-4, 12) is substituted into the equation of the curve, scoring M1. Lack of brackets is condoned for this mark but, as here, many candidates not using brackets subsequently made arithmetic errors. This response shows the very common error -42 = -16. There is no follow through.

M2 is available for avoiding such sign errors by obtaining $12 = 16 - 4k + 8$ or better.

Question 5 (c)

(c) Diann draws line BQ.
She says

Triangle ABQ is isosceles.

Is Diann correct?
You must show all your working.

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

Exemplar 1 — 4 marks

point Q $\Rightarrow x = 0$ so $y = 0^2 + 3(0) + 8$
$= 8$
$= (0, 8)$

Line AB $= \sqrt{x^2 + y^2} = \sqrt{(4-0)^2 + (5-2)^2}$
$= 5$

Line BQ $= \sqrt{x^2 + y^2} = \sqrt{(4-0)^2 + (5-8)^2}$
$= 5$

so AB = BQ

As two sides are equal, the triangle is isosceles.

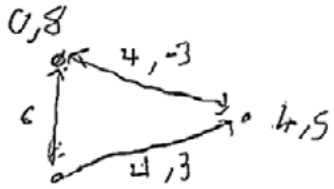
~~As two sides are equal~~ Diann is correct. **[4]**

Examiner commentary

This question lends itself to several approaches. Here, Pythagoras is used and the response is easily followed, scoring full marks. Q is identified as (0, 8), for the first mark, then Pythagoras is used to find AB for the second mark and BQ for the third mark. There is then a correct concluding statement.

Exemplar 2

2 marks



0,2

$\overrightarrow{AB} = \begin{pmatrix} 4 \\ 3 \end{pmatrix}$

$\overrightarrow{QB} = \begin{pmatrix} 4 \\ -3 \end{pmatrix}$

She is correct as the QB and AB are the same length and one congruent sides. [4]

Examiner commentary

This question lends itself to several approaches. Here, vectors are used but the response is insufficient to score more than one mark for Q identified as (0, 8) and one mark for the two vectors. There needs to be more justification of an isosceles triangle rather than merely claiming two sides will be equal.

Exemplar 3

2 marks

Q = (0,8)

Gradient of BQ = $\frac{8-5}{0-4} = \frac{3}{-4}$

Gradient of AB = $\frac{5-2}{4-0} = \frac{3}{4}$

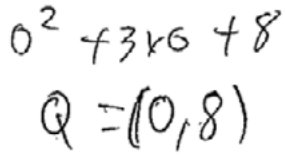
It is isosceles as gradients are the same [4]

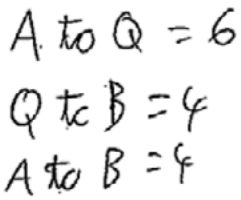
Examiner commentary

This question lends itself to several approaches. Here, gradients are used but the response is insufficient to score more than one mark for Q identified as (0, 8) and one mark for the two gradients. There needs to be more justification of an isosceles triangle, such as using trigonometry to show two angles are the same.

Exemplar 4

1 mark





yes as two of the sides are equal ..... [4]

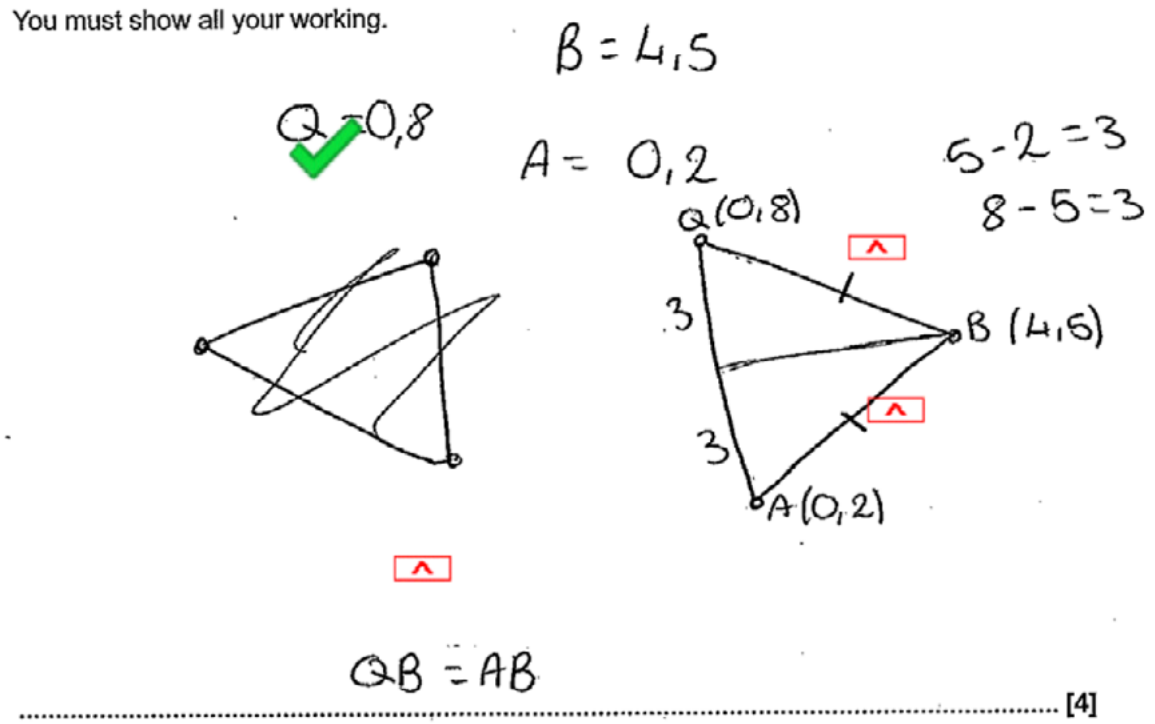
Examiner commentary

There is just one mark for Q identified as (0, 8). This is a common example of a false claim – that two sides are equal but the supporting evidence they are of length 4 is incorrect.

Exemplar 5

1 mark

You must show all your working.



..... [4]

Examiner commentary

This question lends itself to several methods. Here, there is an approach resembling symmetry but there is little communication as to whether an assumption of isosceles leads to symmetry or vice-versa. In the end, the candidate scores just one mark for Q as (0, 8), since QB = AB is not justified. A full justification based on symmetry will include the midpoint of QA being indicated as (0. 5) and the line from (0, 5) to (4, 5) being marked as perpendicular to QA.

Question 6

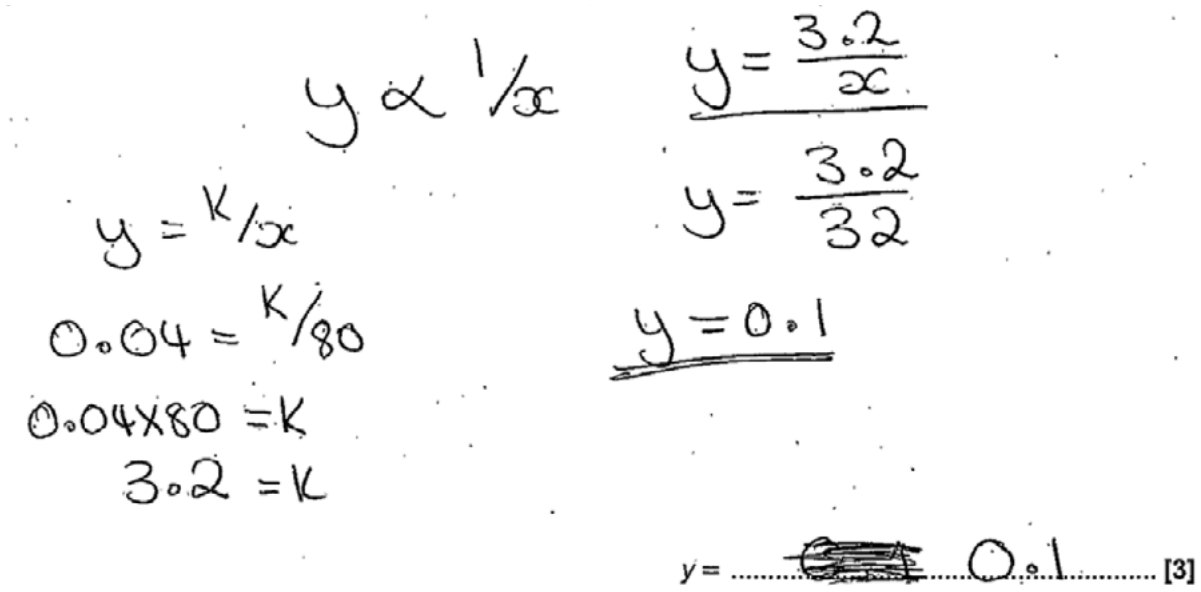
6 y is inversely proportional to x.
$y = 0.04$ when $x = 80$.

Find the value of y when $x = 32$.

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

Exemplar 1

3 marks



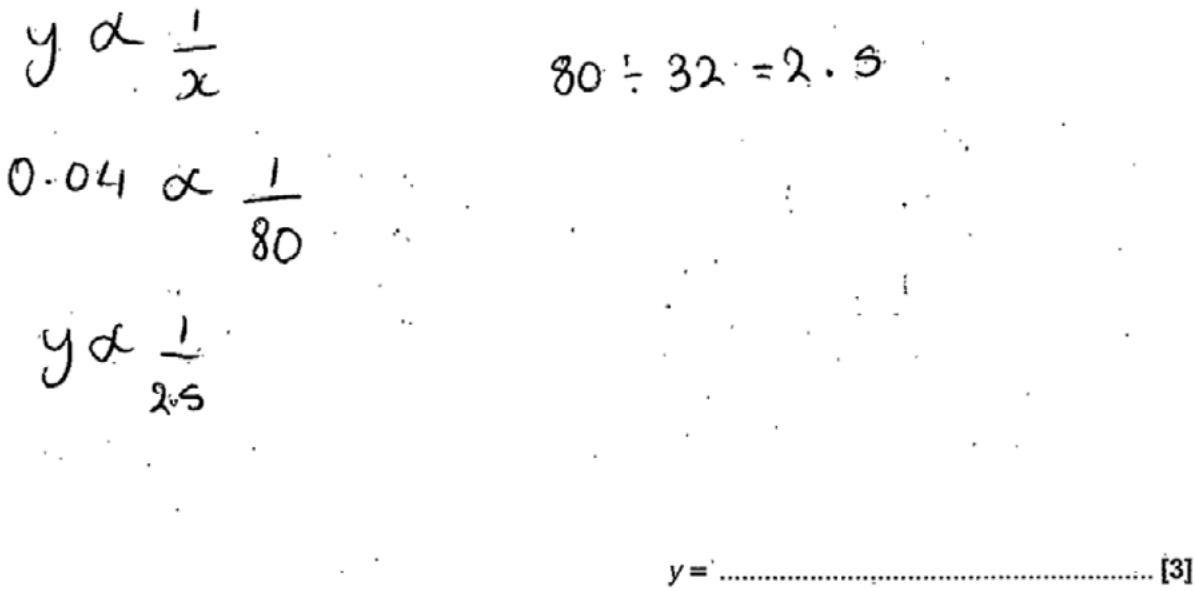
Examiner commentary

The answer line is correct and accurate supporting working is presented. The response scores full marks.

On its own, the working on the left scores M1 for either $y = \frac{k}{x}$ or for 3.2. The working on the right then scores another M1.
Some candidates went wrong in the final evaluation, giving an answer of 10.

Exemplar 2

0 marks

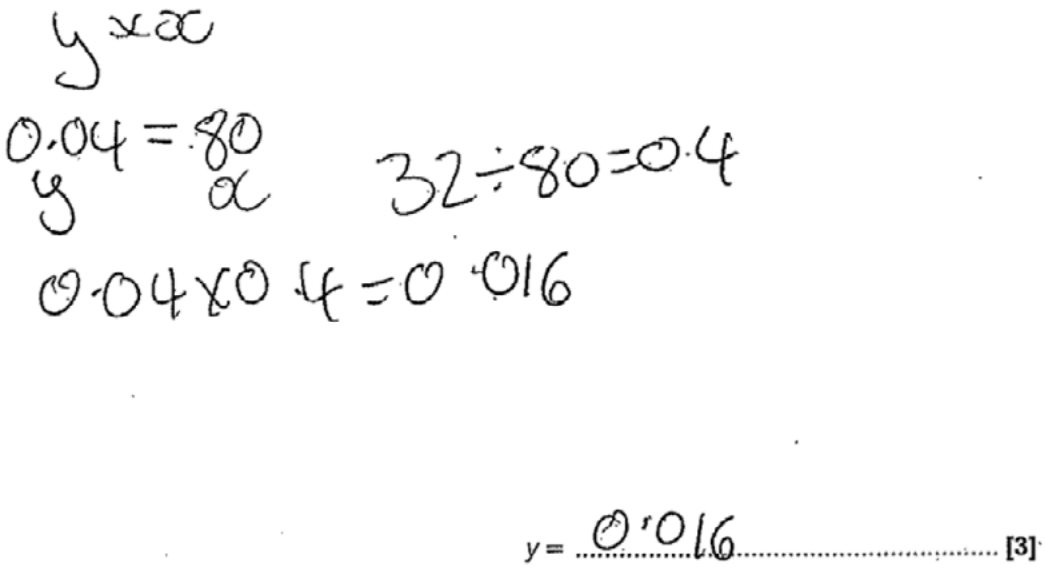


Examiner commentary

There is not quite sufficient evidence to award a mark here. $y = \frac{k}{x}$ is required for M1 and, although 2.5 is a value obtained in method that can lead to the correct final answer, its use is abandoned.

Exemplar 3

0 marks

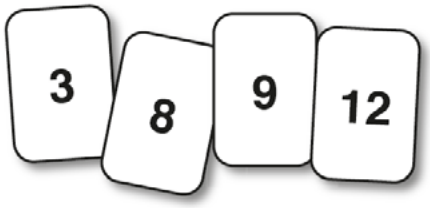


Examiner commentary

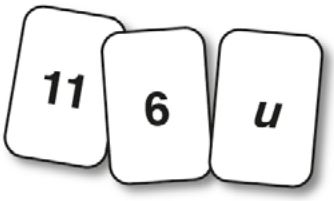
Use of direct proportion was common and scored zero.

Question 7

7 Edsel has four number cards.



Sharon has three number cards.
u represents a number that Sharon knows.



Edsel and Sharon each pick one of their cards at random.
They calculate the **difference** between the numbers on their cards.
This is their sample space.

		Edsel			
		3	8	9	12
Sharon	6	3	2	3	6
	11	8	3	2	1
	u	11	6	r	t

Work out the values of r and t.

$r =$ .....

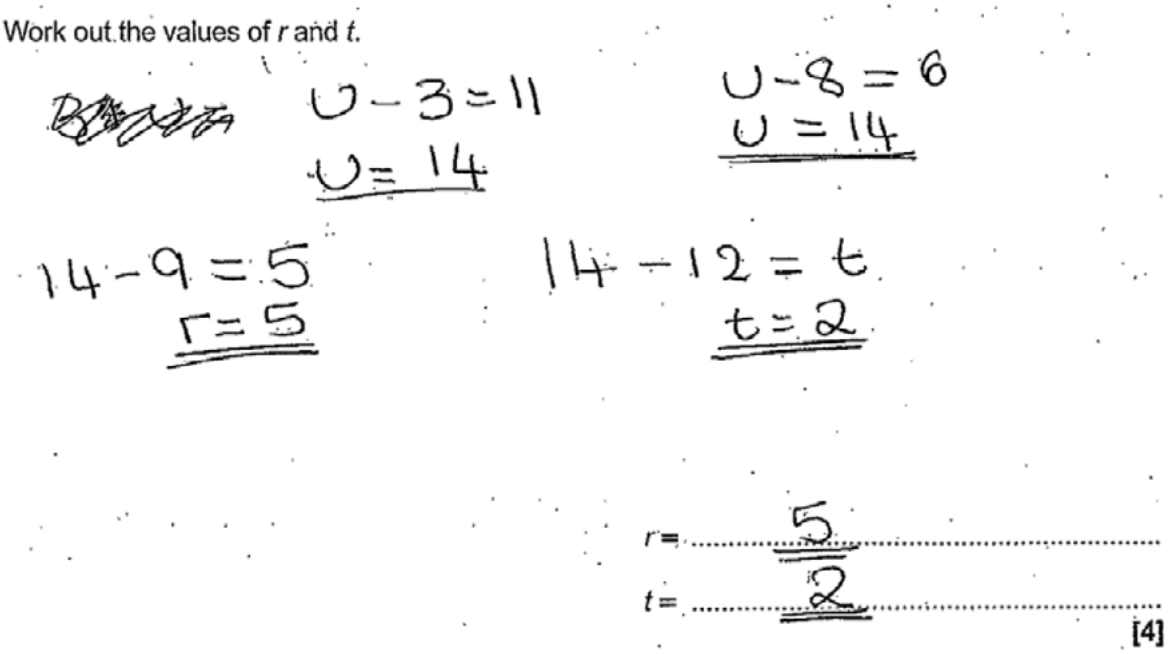
$t =$ .....

[4]

Exemplar 1

4 marks

Work out the values of r and t.



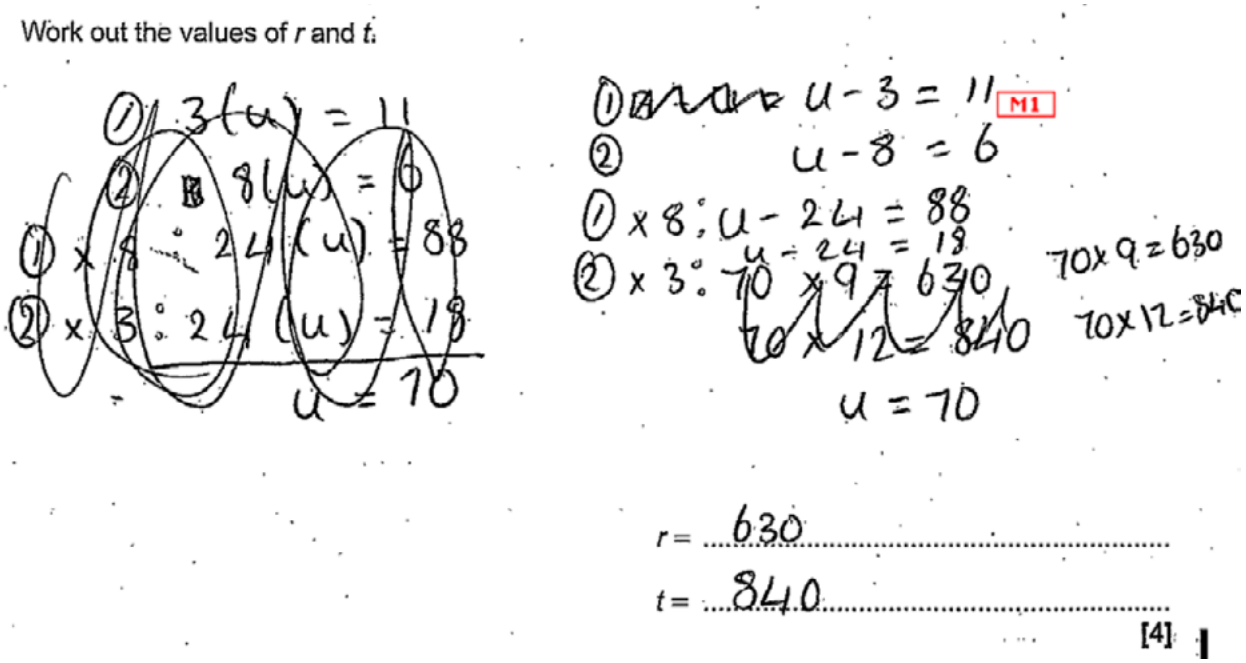
Examiner commentary

The response is correct and scores full marks.

Exemplar 2

1 mark

Work out the values of r and t.

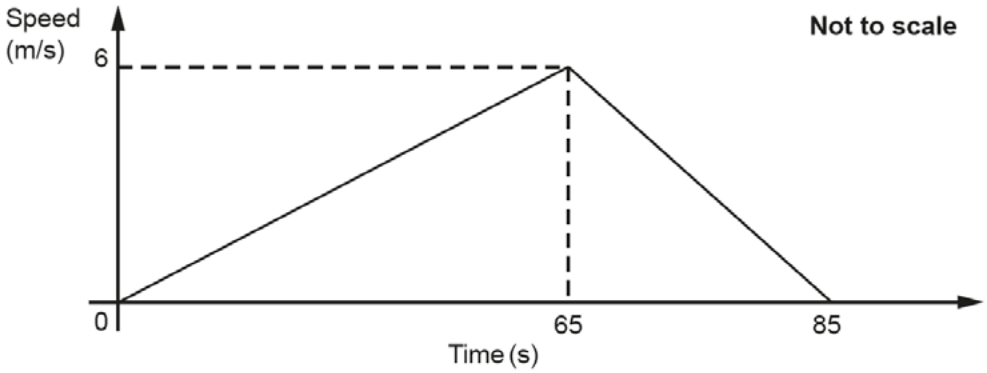


Examiner commentary

Either of the equations $u - 3 = 11$ or $u - 8 = 6$ score M1 but no further progress is made. If $u = 14$ is obtained then M2 is scored, with an A1 following for each of $r = 5$ and $t = 2$.

Question 8 (a)

8 The graph shows the speed of a tram as it travels from the library to the town hall.



(a) Calculate the deceleration of the tram as it approaches the town hall.

(a) ..... m/s^2 **[2]**

Exemplar 1

1 mark

acceleration = $\frac{\text{final speed} - \text{initial speed}}{\text{time}}$

$a = \frac{0-6}{85-65} = \frac{-6}{20} = -0.3 \text{m/s}^2$

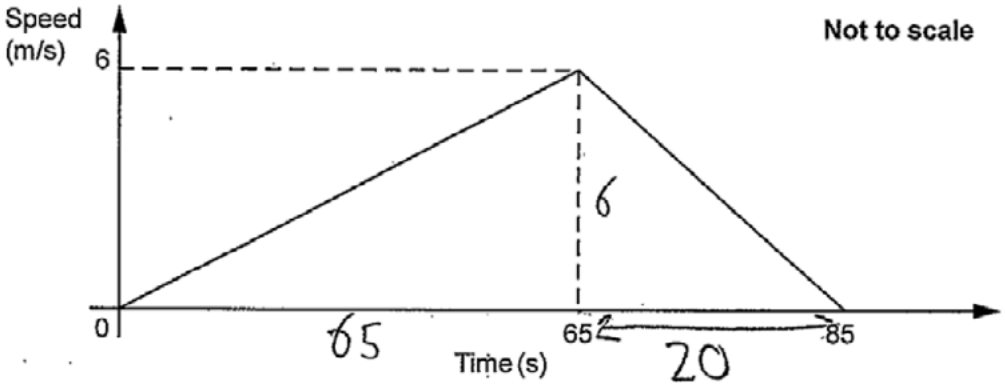
(a) ..... −0.3 ..... m/s^2 **[2]**

Examiner commentary

The gradient of the speed-time graph is found correctly but the answer retains the negative sign, whereas deceleration should be given without. This scores 1 mark only.

Exemplar 2

0 marks



(a) Calculate the deceleration of the tram as it approaches the town hall.

$20 \div 6 = 3.\dot{3}$

(a) $3.\dot{3}$ m/s² [2]

Examiner commentary

This candidate has performed time ÷ speed, which is an invalid method for finding deceleration and so scores 0 marks.

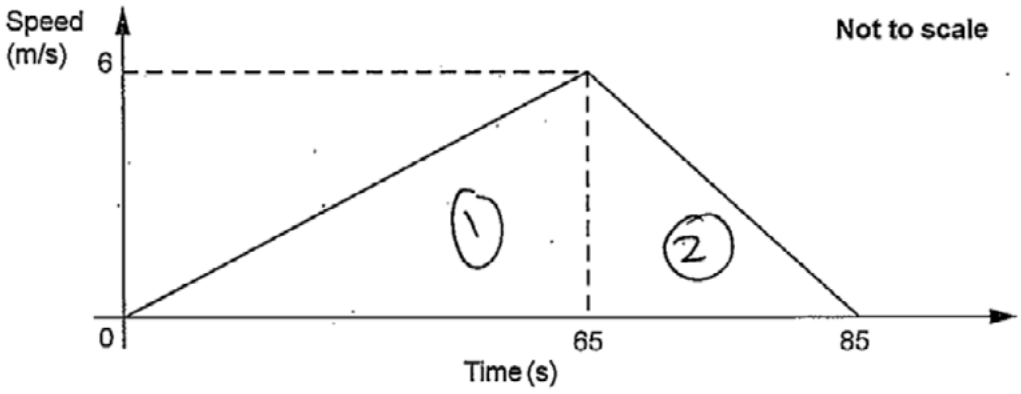
Question 8 (b)

(b) Calculate the distance travelled by the tram between the library and the town hall.

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

Exemplar 1 — 3 marks

8 The graph shows the speed of a tram as it travels from the library to the town hall.



(b) Calculate the distance travelled by the tram between the library and the town hall.

Distance = Area under graph

Area of (1) = $\frac{65 \times 6}{2}$ = 195m

Area of (2) = $\frac{20 \times 6}{2}$ = 60m

∴ 195 + 60 = 255m

(b) 255 m **[3]**

Examiner commentary

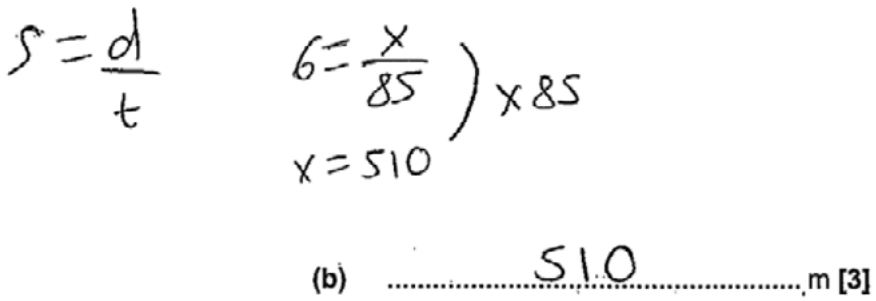
255 on the answer line is correct and scores full marks. This response also shows well-presented working.

As here, most candidates attempted the area of two separate triangles which necessitated more computation than if one large triangle had been used. This also led to more arithmetic errors, with the multiplier of $\frac{1}{2}$ often omitted from one of the triangles. If the correct expressions were seen, then M2 was awarded.

Candidates who found a partial area under the graph, such as one of the two smaller triangles, could score M1.

Exemplar 2

0 marks

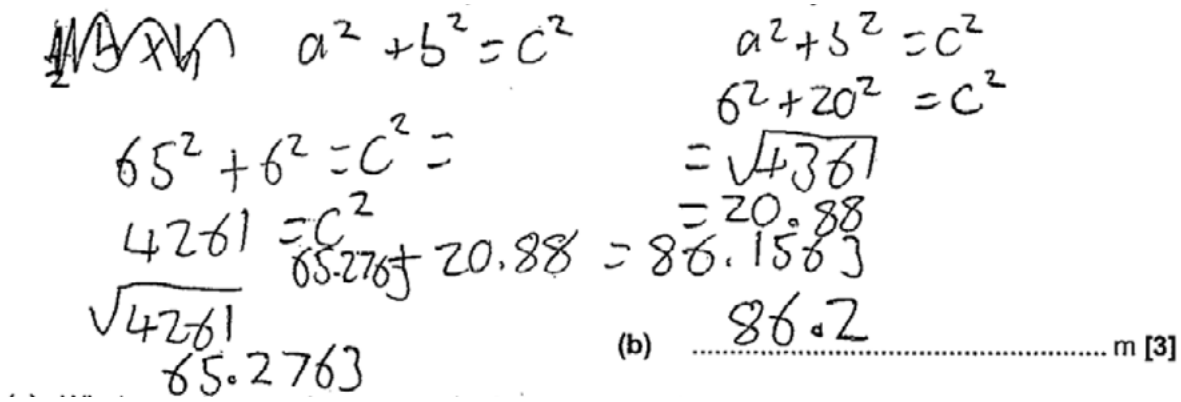


Examiner commentary

On its own, finding the area of a rectangle is an invalid method for finding the area under the graph, and so scores zero marks. In order to receive credit, an area of a triangle needs to be subtracted from the area of the rectangle.

Exemplar 3

0 marks



Examiner commentary

The use of Pythagoras was quite common and irrelevant to the question. This scored 0 marks.

This was quite an interesting misconception; that triangles and the word "distance" were involved led less able candidates to assume Pythagoras was needed without understanding the context.

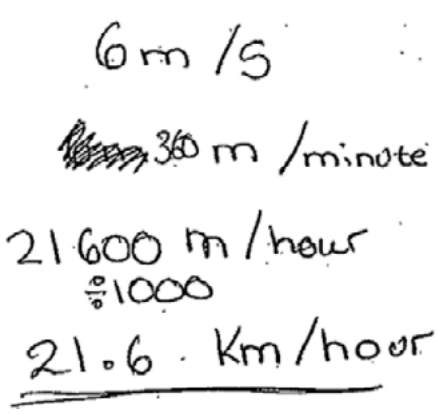
Question 8 (c)

(c) What was the maximum speed of the tram as it travelled between the library and the town hall?
Give your answer in **kilometres per hour**.

(c) ..... km/h **[4]**

Exemplar 1

4 marks



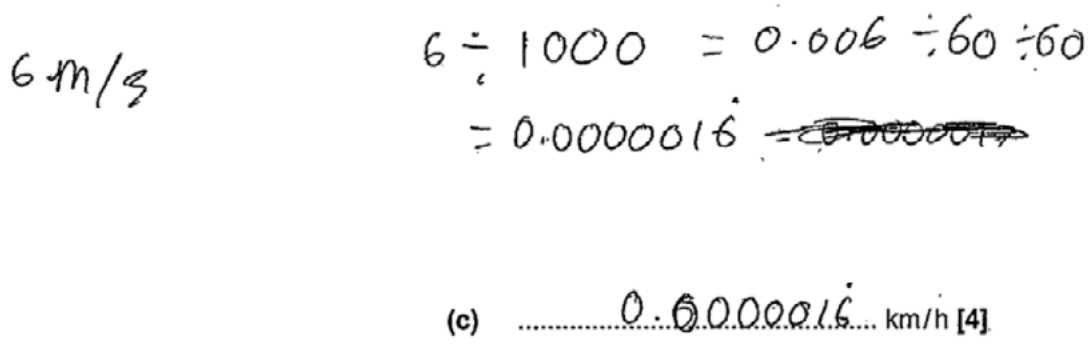
(c) 21.6 km/h **[4]**

Examiner commentary

21.6 on the answer line is correct, and all supporting work is valid. The response shows a clear development from the 6 m/s, taken from the graph, through to 21.6 km/h. Units are clear throughout. Full marks are awarded.

Exemplar 2

2 marks



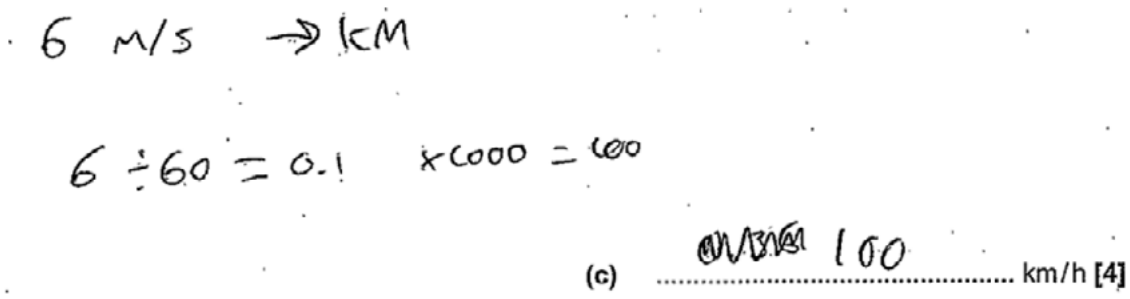
(c) 0.0000016 km/h **[4]**

Examiner commentary

This response scores 2 marks. The maximum speed of 6 m/s is correctly obtained from the graph, scoring B1, and this is converted to 0.006 km/s, scoring M1. The candidate then divides by 60 rather than multiplying.

Exemplar 3

1 mark



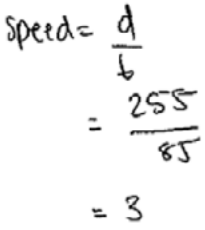
(c) ..... km/h **[4]**

Examiner commentary

This response scores 1 mark. The maximum speed of 6 m/s is correctly obtained from the graph, scoring B1, but the attempted unit conversions are both incorrect.

Exemplar 4

0 marks



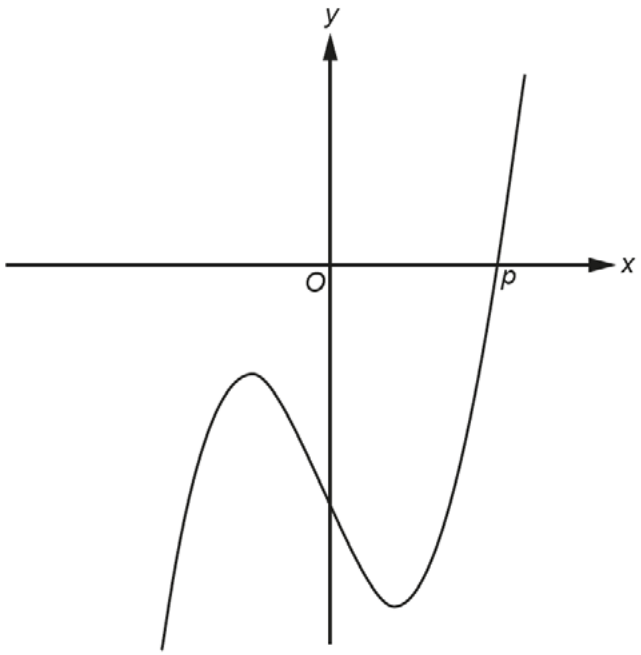
(c) .....3..... km/h **[4]**

Examiner commentary

Average speed is obtained, using distance ÷ time from part (b). This scores B0 as they should be using the maximum speed of 6 m/s from the graph. However, up to 2 marks are available for the unit conversion from m/s into km/h. This candidate did not attempt any unit conversion and so the response scores 0 marks.

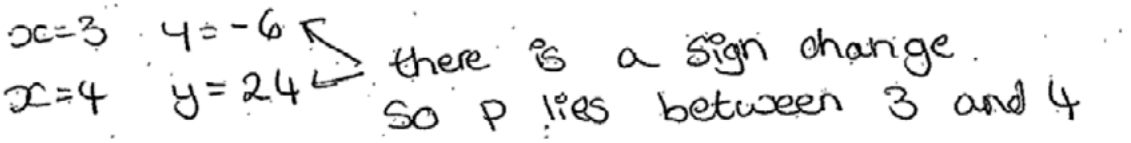
Question 9 (b)

9 The graph of $y = x^3 - 7x - 12$ is shown below.
The root of the equation $x^3 - 7x - 12 = 0$ is p.



(b) Show that $3 < p < 4$. **[2]**

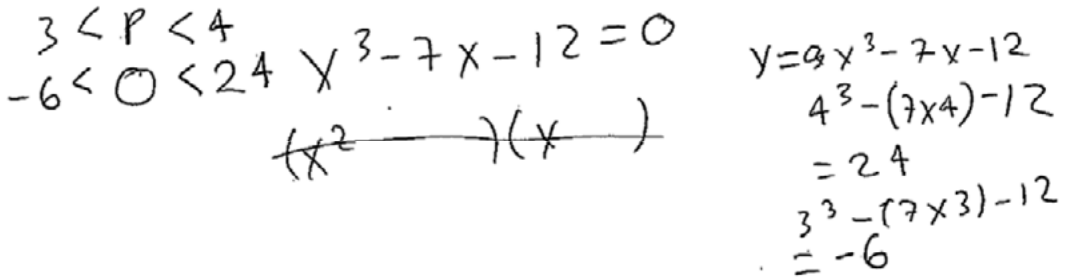
Exemplar 1 — 2 marks



Examiner commentary

One mark for 24 and then one mark for the "change of sign" statement. Merely making the statement does not score unless 24 is seen.

Exemplar 2 — 2 marks



Examiner commentary

One mark for 24 and then, as an alternative to "change of sign", $-6 < 0 < 24$ is accepted for one mark.

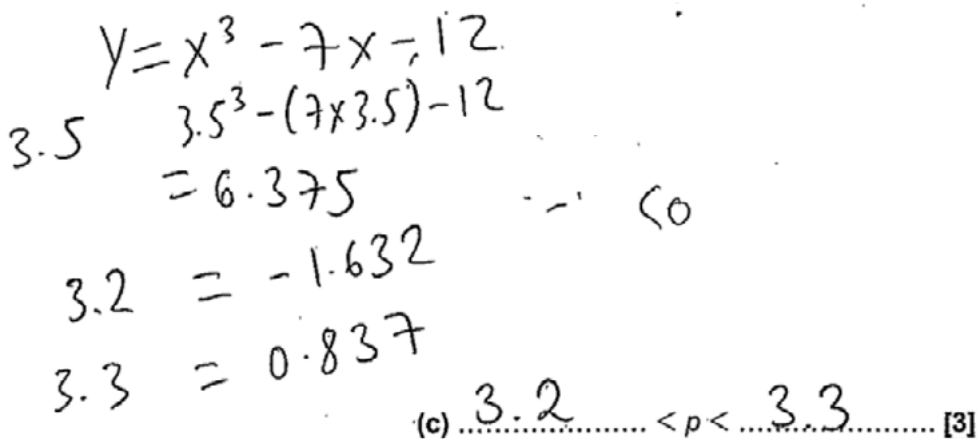
Question 9 (c)

(c) Find a smaller interval that contains the value of p.
You must show calculations to support your answer.

(c) ..... $< p <$ ..... **[3]**

Exemplar 1

3 marks



(c) 3.2 $< p <$ 3.3 **[3]**

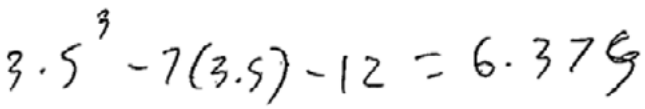
Examiner commentary

y is correctly evaluated for both x = 3.2 and x = 3.3 and the inequality is completed using these values. The response, therefore, scores full marks.

This response contains much more work than is required by the question but is fairly typical of what most successful candidates produced. Some went even further.

Exemplar 2

3 marks



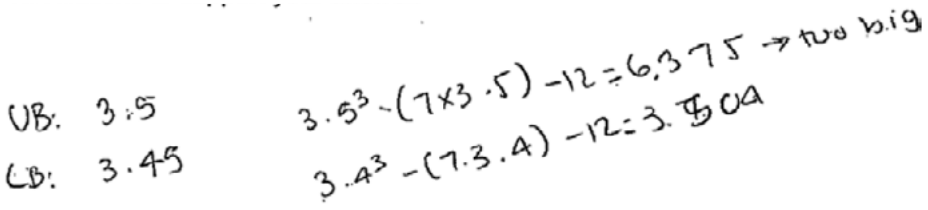
(c) 3 $< p <$ 3.5 **[3]**

Examiner commentary

In contrast to Exemplar 1, this candidate has read the question carefully and does all that is asked for full marks.

Exemplar 3

2 marks



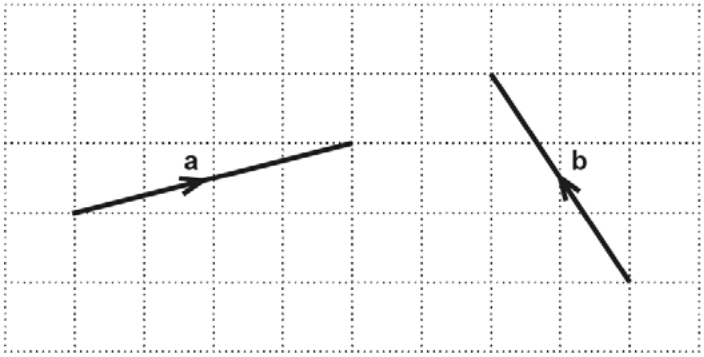
(c) ..... < p < ..... 3.5 ..... [3]

Examiner commentary

The inequality is incomplete. There is one further value of y evaluated correctly using $3 < x < 4$, and so this scores M2. An error in the evaluation of a correct expression using $3 < x < 4$ would score M1.

Question 10

10 Two vectors, **a** and **b**, are shown on the 1 centimetre grid below.



Show that the vector **a** + 2**b** has length 7 cm.
You may use the grid below.

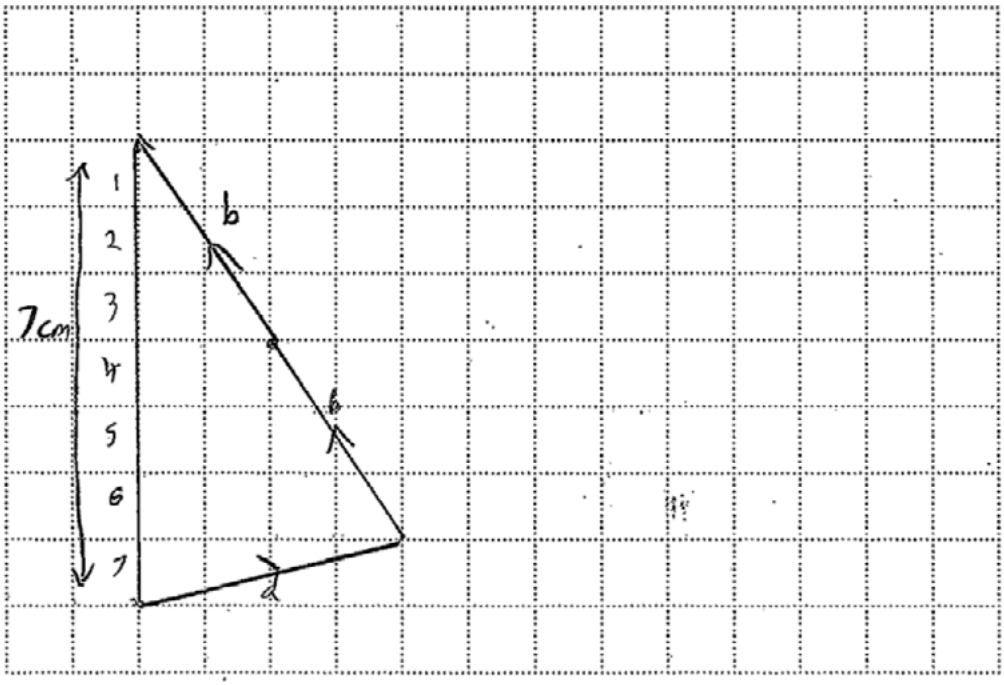
[3]

Exemplar 1

3 marks

$a = \begin{pmatrix} 4 \\ 1 \end{pmatrix}$ $b = \begin{pmatrix} -2 \\ 3 \end{pmatrix}$

$\begin{pmatrix} 4 \\ 1 \end{pmatrix} + \begin{pmatrix} -4 \\ 6 \end{pmatrix} = \begin{pmatrix} 0 \\ 7 \end{pmatrix}$



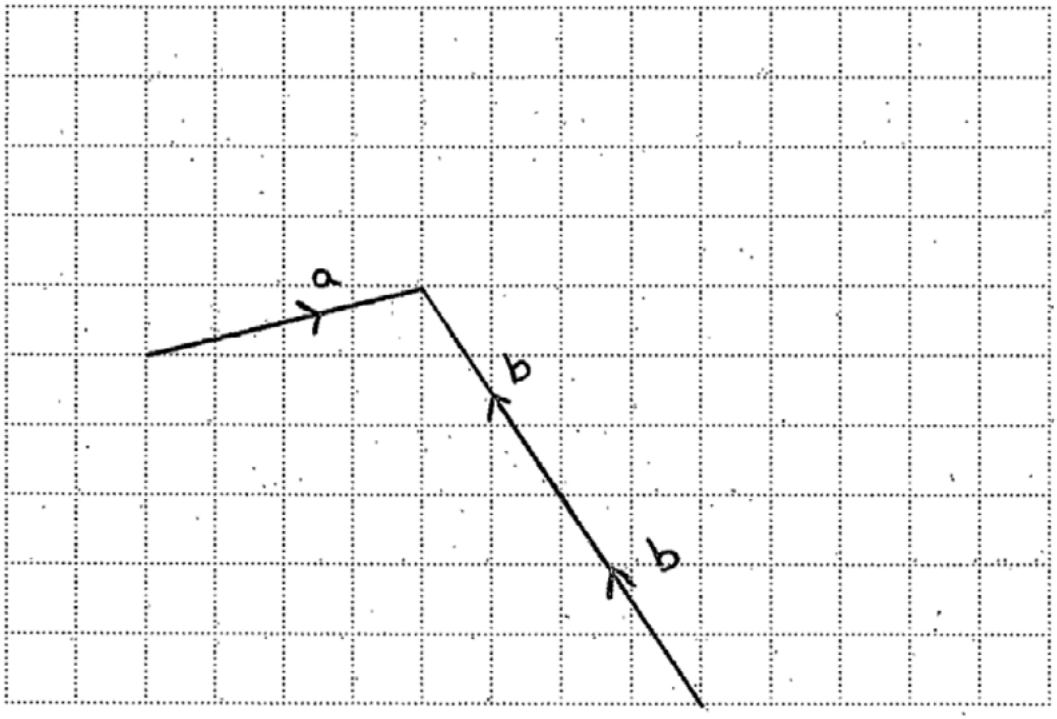
Examiner commentary

This candidate shows both an addition of column vectors method and a vector diagram approach. Both are correct and either scores full marks.

The addition of column vectors required brackets for full marks, with absent brackets being condoned for the award of B1 for each vector. Coordinates were not accepted. For the diagram method, labels and arrows were required for full marks but their absence was condoned for part marks.

Exemplar 2

2 marks

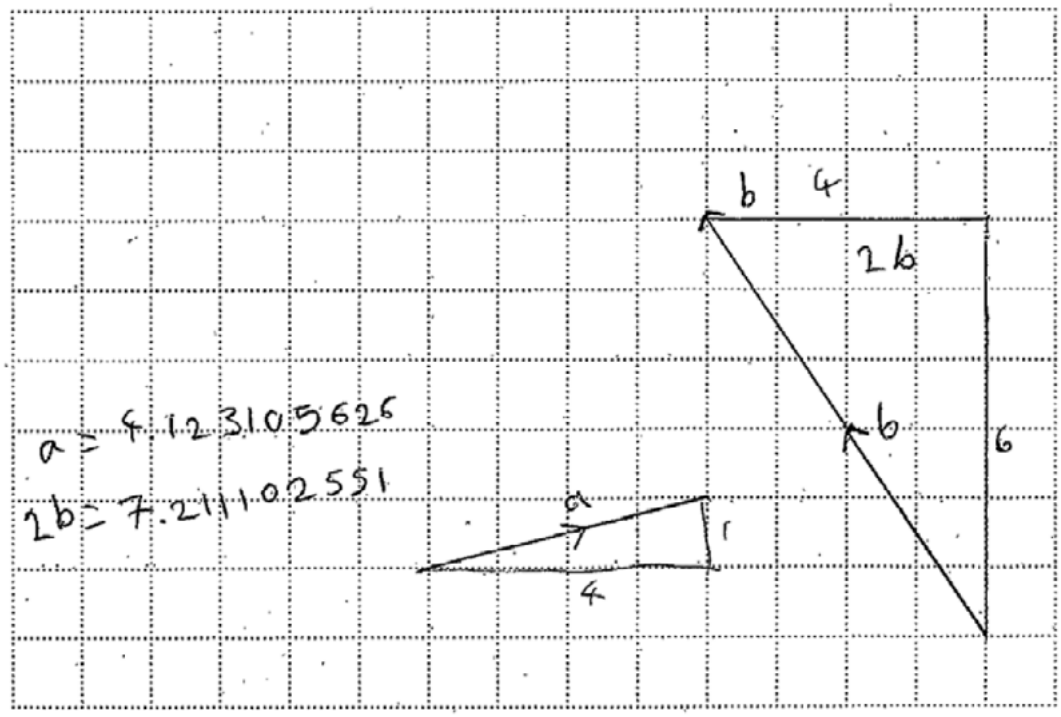


Examiner commentary

This response is equivalent to **a – 2b** and was very common. For the award of part marks, incorrect or missing arrows were condoned. A vector line correctly representing ± 2**b** scores M1. A second M1 is achieved when this is joined to the end of another vector line correctly representing **a**.

Exemplar 3

1 mark

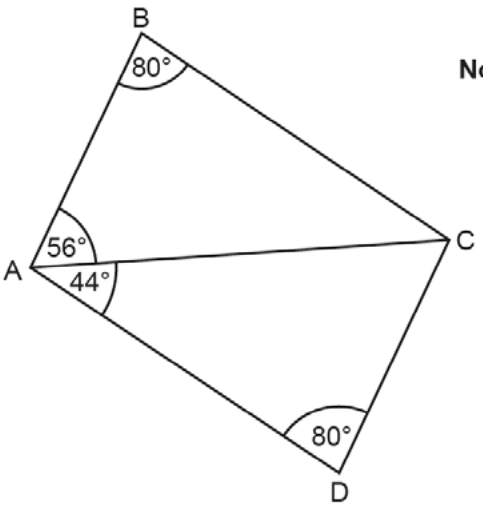


Examiner commentary

This scores M1 for a vector line correctly representing ± 2**b**. It is not joined to vector **a** so does not score the second mark.

Question 11

11 The diagram below shows two triangles.



Not to scale

Prove that triangle ABC is congruent to triangle ACD.

.....

.....

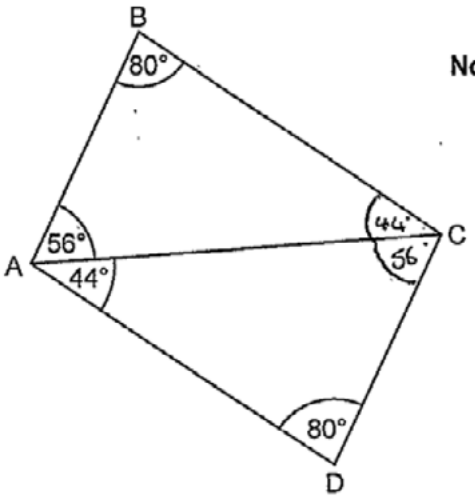
.....

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

Exemplar 1

4 marks

11 The diagram below shows two triangles.



~~RHS~~
ASA
SAS
SSS

Prove that triangle ABC is congruent to triangle ACD.

Line AC is common to both triangles
∠ACB = 44 (angles in a Δ)
∠ACD = 56 (angles in a Δ)

Line AC is common to both triangles.
∠BAC = ∠ACD (given in question) and angles in a triangle = 180°)
&
∠CAD = ∠BCA (given, and angles in a triangle = 180°).
Triangles ABC and ACD are ~~same~~ congruent because ASA [4]

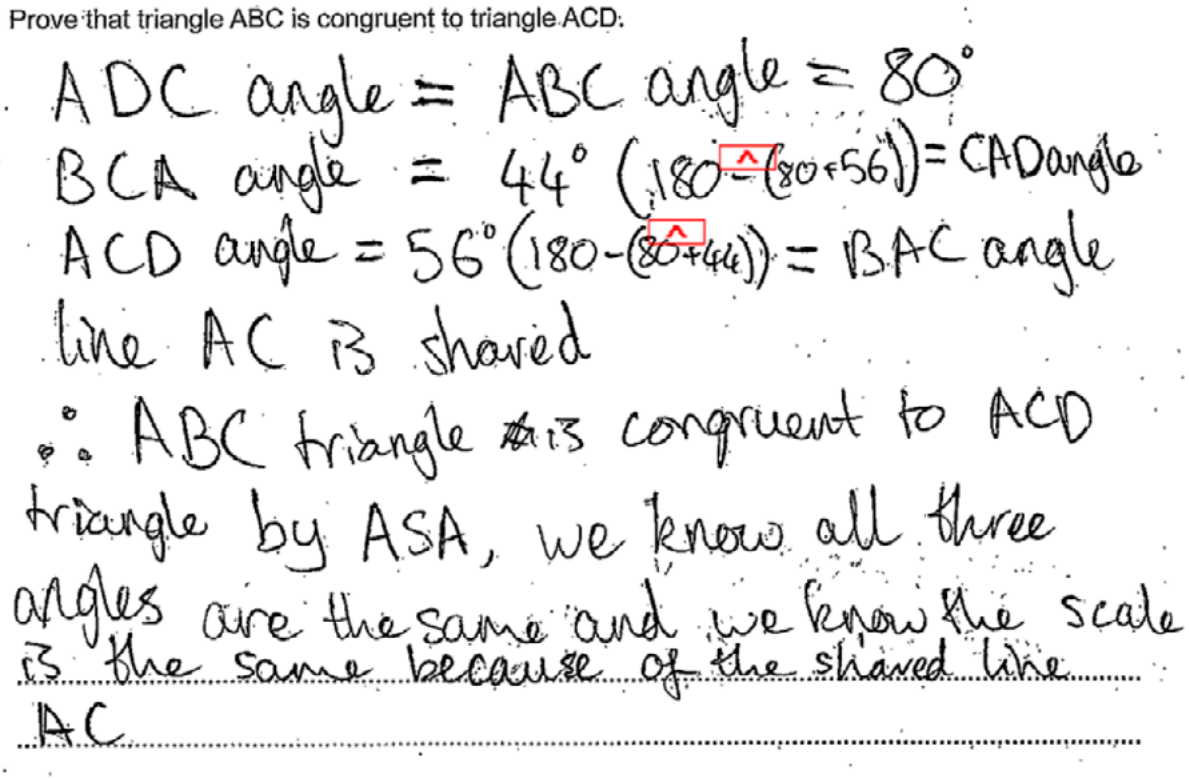
Examiner commentary

The response scores full marks. The remaining angles are found with the required reason of "angles in a triangle" for the first mark. Corresponding angles are matched, the common side is identified, and the concluding statement is correct for the approach used. All notation is concise and unambiguous.

Exemplar 2

3 marks

Prove that triangle ABC is congruent to triangle ACD:

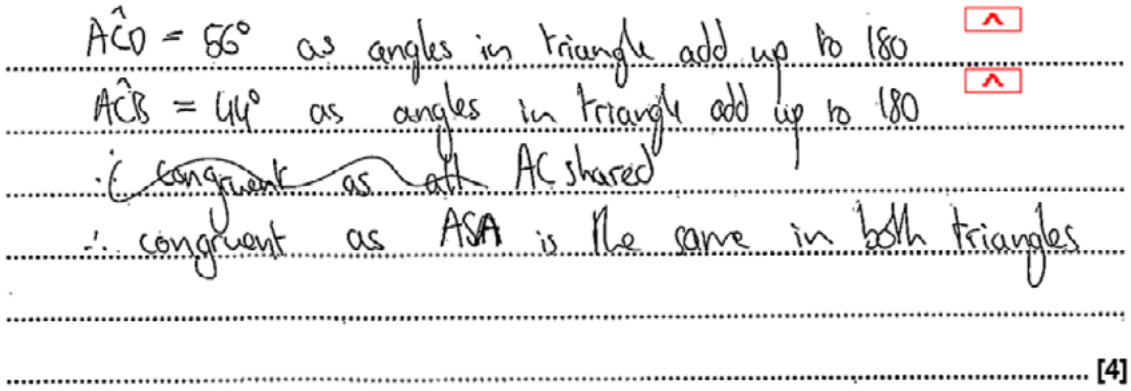


Examiner commentary

The response lacks the reason "angles in a triangle"; the arithmetic is insufficient for the first mark. The statements and conclusion are correct and so this scores 3 marks.

Exemplar 3

2 marks



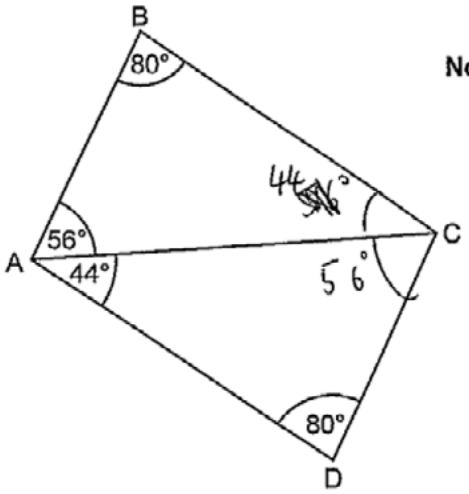
Examiner commentary

This response scores 2 marks. The remaining angles are found with the required reason of "angles in a triangle", scoring the first mark. "AC is shared" is sufficient to imply it is "common". This is the first statement mark on the mark scheme and scores B1. Other statements that match angles are absent and, therefore, the conclusion mark for ASA is not awarded.

Exemplar 4

2 marks

11 The diagram below shows two triangles.



Not to scale

Prove that triangle ABC is congruent to triangle ACD.

$180 - (80 + 44) = 56^\circ = \hat{A}CD$

$180 - (80 + 56) = 44^\circ = \hat{B}C\hat{A}$

These triangles are congruent through AAA as they have 3 of the same angle.

$\hat{A}B\hat{C} = A\hat{D}C$

$B\hat{A}C = D\hat{C}A$

$B\hat{C}A = D\hat{A}C$

[4]

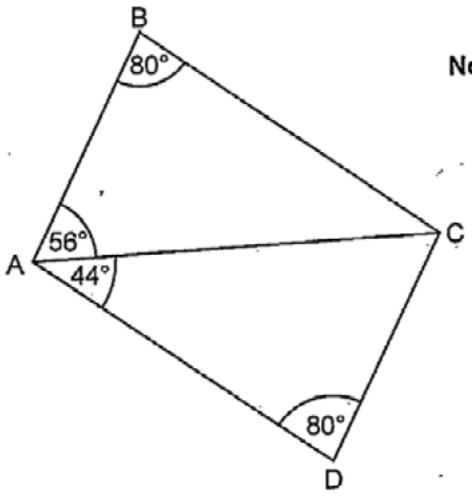
Examiner commentary

This response scores 2 marks. The remaining angles are found but the reason is not given. There are three correct statements matching the angles – two are sufficient to score the two statement marks. A third statement and conclusion are required for the final mark but the conclusion of AAA given here is not valid for showing congruency.

Exemplar 5

1 mark

11 The diagram below shows two triangles.



Prove that triangle ABC is congruent to triangle ACD.

∠B = ∠D 44 + 80 = 124 180

180 − 124 = 56 56 + 80 = 136 180 − 136 = 44

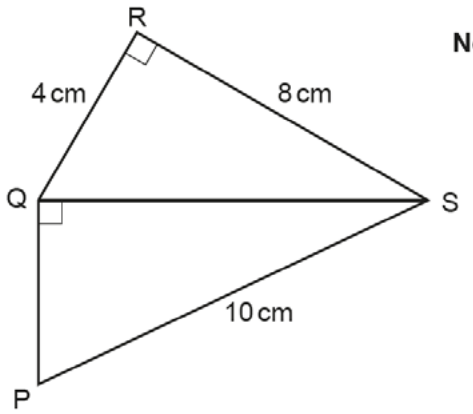
[4]

Examiner commentary

Angle B is matched with angle D and so a statement mark is scored. Although there is some calculation leading to angles of 44° and 56°, it is not clear which angles have been found. An SC1 would have been awarded alongside the statement mark if the angles had been labelled or shown on the diagram.

Question 12

12 The diagram below shows two right-angled triangles.



Not to scale

Prove that triangles PQS and QRS are similar.

.....

.....

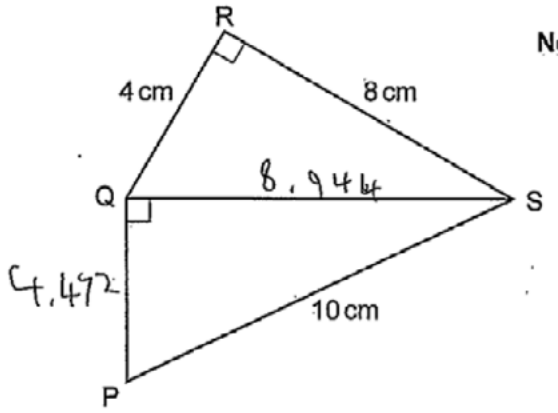
.....

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

Exemplar 1

5 marks

12 The diagram below shows two right-angled triangles.



Prove that triangles PQS and QRS are similar.

$\sqrt{8^2 + 4^2} = 8.944 = QS$ ($4\sqrt{5}$)

$\sqrt{10^2 - (2\sqrt{5})^2} = 4.472 = QP$

$QP \div 4 = 1.118$ ($\frac{\sqrt{5}}{2}$)

$QS \div 8 = 1.118$

$PS \div 8.944 = 1.118$

Each side from triangle QRS has been enlarged by the same factor to obtain the lengths for PQS showing that they are similar.

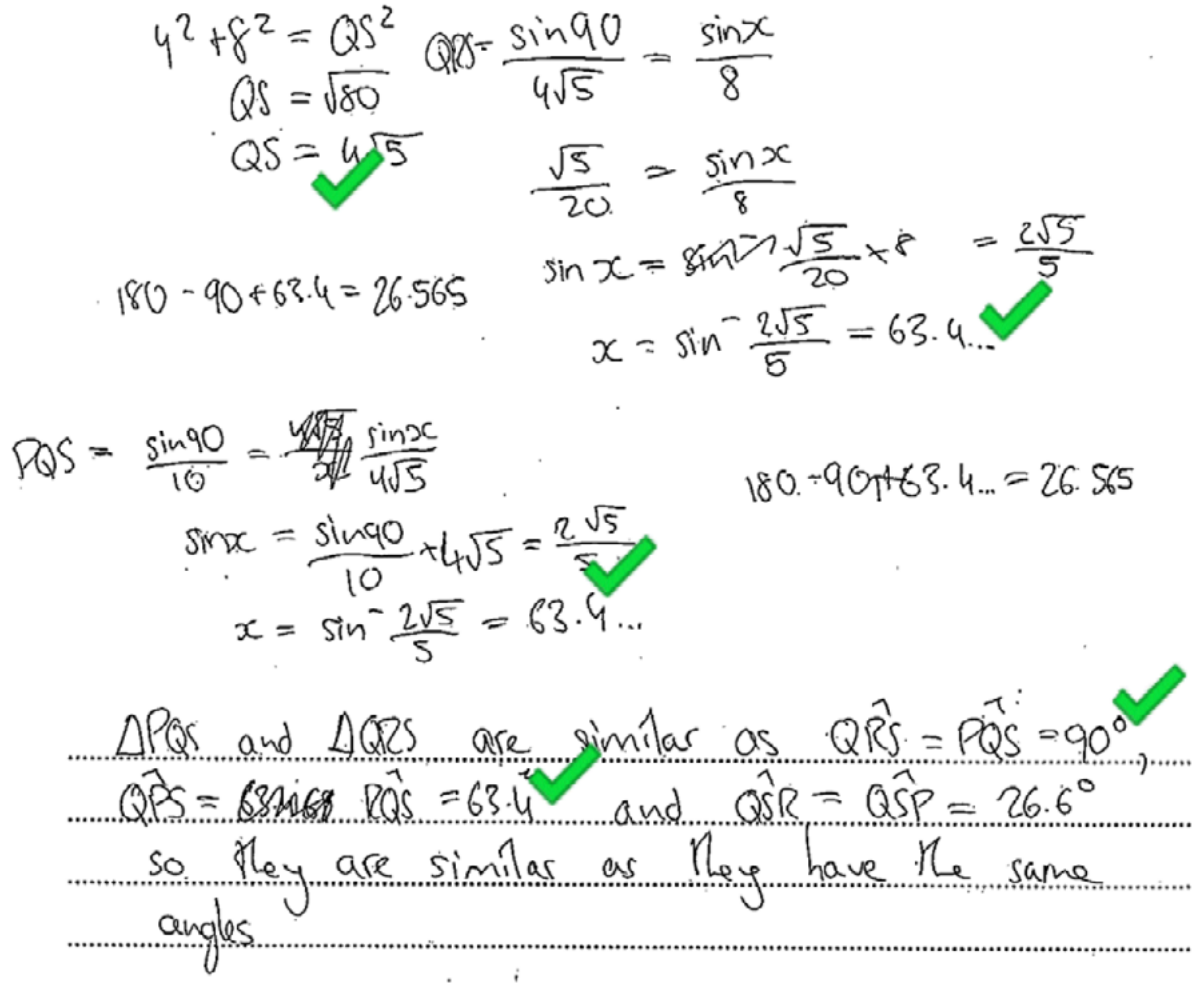
Examiner commentary

This question can be answered using different approaches. This response uses ratios/scale factors and scores full marks. The sides being used are either labelled or clear from the diagram, the calculations are correct and of sufficient accuracy, and the conclusion is clear. QS is found for two marks, they then show two pairs of corresponding sides are in the same ratio for one mark, and that the third pair are in the same ratio for another mark. They then have an appropriate conclusion for this approach.

Some candidates using this method rounded prematurely, leading to ratios that were not the same.

Exemplar 2

5 marks



Examiner commentary

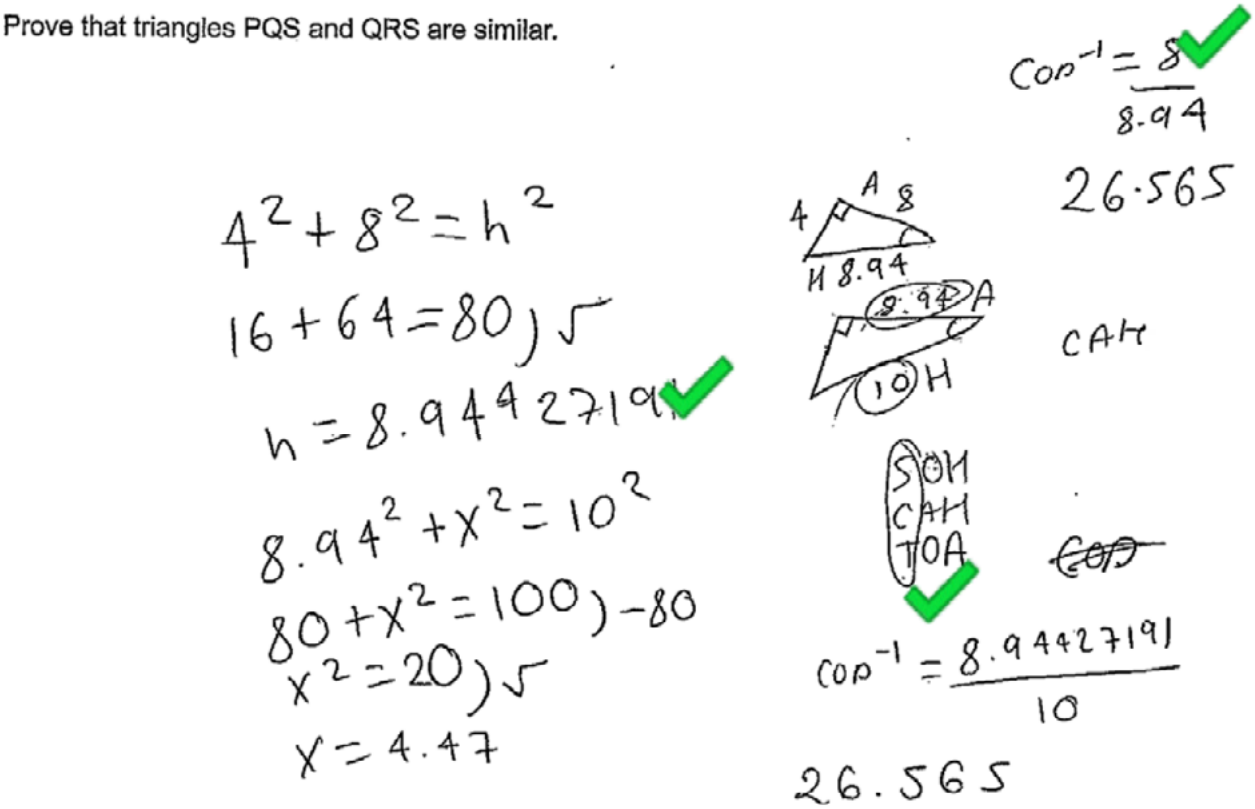
This question can be answered using different approaches. This response uses trigonometry and scores full marks. The calculations are correct and of sufficient accuracy, and the conclusion is clear. QS is found for two marks, and they then work out a missing angle in each triangle. Although it is not efficient to use the sine rule in a right-angled triangle, the working is still valid and so scores the mark. They then match angle QRS with PQS as their second pair of corresponding angles. They then give the appropriate conclusion for this approach.

Some candidates using this method rounded prematurely, leading to angles that were not equal.

Exemplar 3

3 marks

Prove that triangles PQS and QRS are similar.



I worked out the hypotenuse for triangle QRS and get a length for triangle PQS and used SOHCAHTOA to work out an angle using cos for each triangle and the angles both came to 26.565° and that means the triangles are similar

[5]

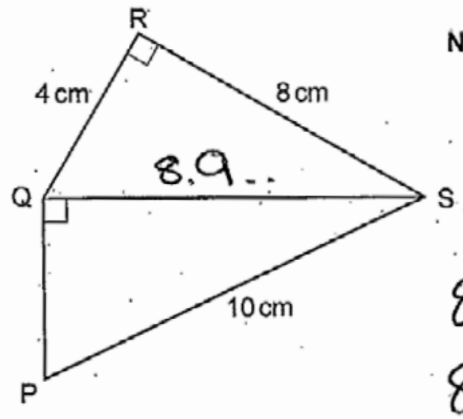
Examiner commentary

This question can be answered using different approaches. This response uses trigonometry but is incomplete. It scores 3 marks: 2 marks for QS and 1 mark for showing a pair of corresponding angles are equal.

Exemplar 4

2 marks

12 The diagram below shows two right-angled triangles.



Not to scale

Prove that triangles PQS and QRS are similar.

$8.9^2 + b^2 = 10^2$

$80 + b^2 = 100$

20^{2}

$4^2 + 8^2 = 80$

$16^2 + 64 = 80$

$100 - 80 = 20$

$\sqrt{80} = 8.944271911$

$\sqrt{20} = 4.4721$

35955

both triangles are right angled triangles.

PQS side lengths are slightly bigger than QRS

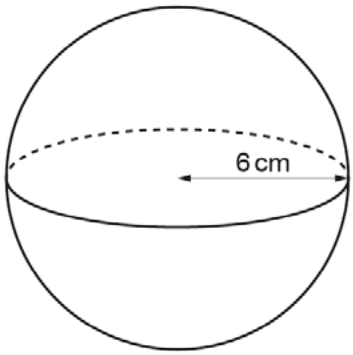
[5]

Examiner commentary

The response scores 2 marks for finding QS, even though this is not labelled. The candidate also finds PQ but there is no credit for doing so unless it is used in subsequent work.

Question 13 (a)

13 (a) Calculate the volume of a sphere with radius 6 cm.



[The volume V of a sphere with radius r is $V = \frac{4}{3}\pi r^3$.]

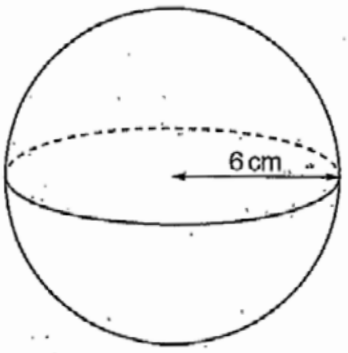
(a) ..... cm^3 **[2]**

Exemplar 1

2 marks

13 (a) Calculate the volume of a sphere with radius 6 cm.

MASS
O V



[The volume V of a sphere with radius r is $V = \frac{4}{3}\pi r^3$.]

$\frac{4}{3}\pi 6^3 = 288\pi$

$288\pi = 904.7786842$

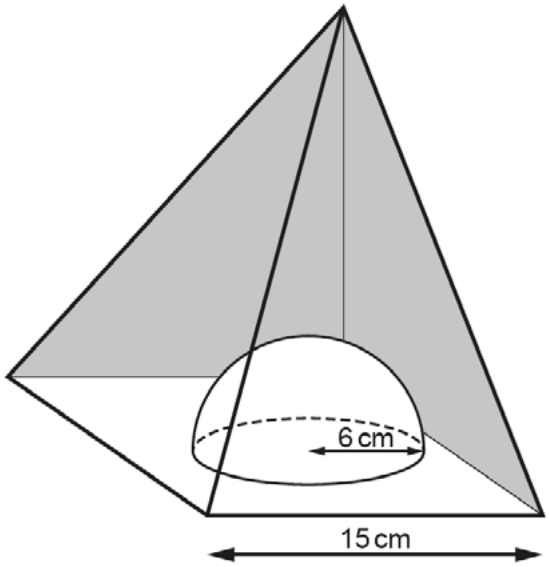
(a) 904.8 (1dp) cm^3 **[2]**

Examiner commentary

The answer line and working are correct. The response scores full marks. An incorrect answer with the correct working shown would score M1.

Question 13 (b)

(b) An ornament is made from a solid glass square-based pyramid.
The base has side length 15 cm.
A hemisphere with radius 6 cm is cut out of the base of the pyramid.
This reduces the volume of glass contained in the ornament by 30%.



Calculate the perpendicular height of the pyramid.

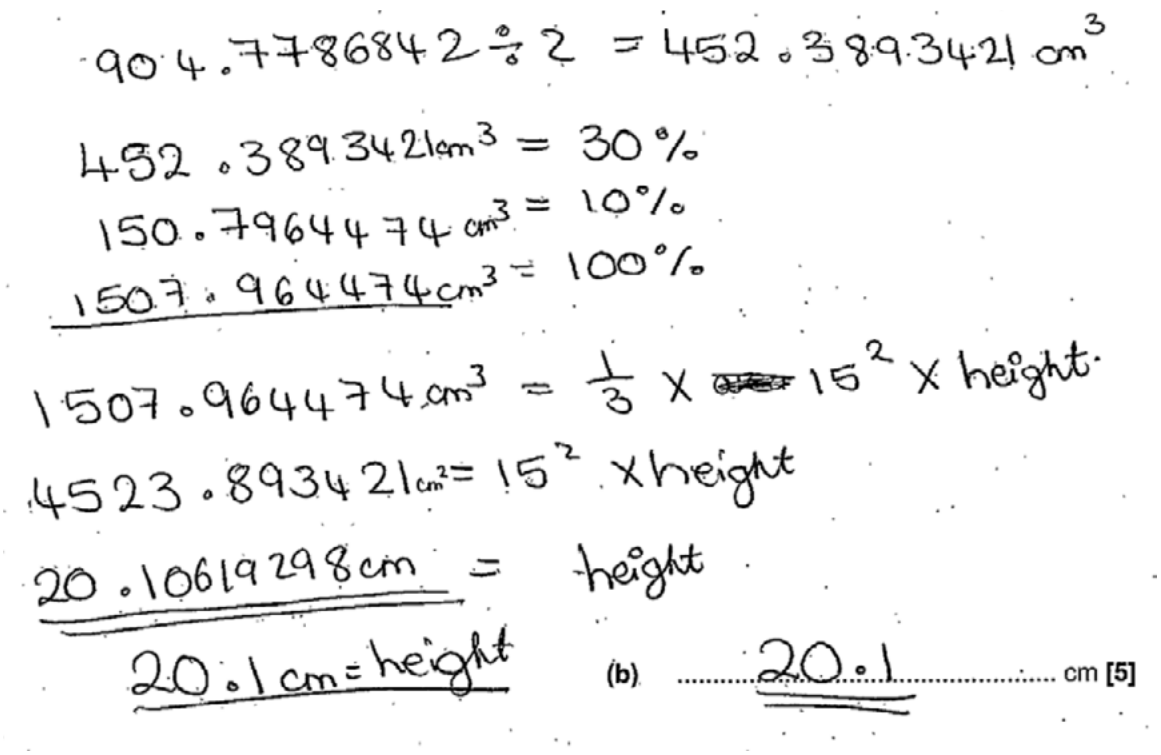
[The volume of a pyramid is $\frac{1}{3}\times$ area of base $\times$ perpendicular height.

A hemisphere is half a sphere.]

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

Exemplar 1

5 marks



Examiner commentary

To answer this question successfully, candidates needed to find the volume of a hemisphere, perform a reverse percentage calculation, equate to the volume of a pyramid and then solve to find the missing height. Candidates performed these processes in different orders, making errors along the way. Clear presentation is very helpful on questions like this.

In this response, both the answer and supporting work are correct and so full marks are awarded. Although a few words would aid the presentation, the working can still be easily followed. The candidate starts by halving the volume of the sphere found in part (a) to obtain the volume of the hemisphere, scoring M1. They then perform the reverse percentage step by setting the volume of the hemisphere to 30% of the pyramid, and then scaling up via 10% to reach 100%. This scores another M1. The right-hand side of their equation shows correct use of the volume of a pyramid formula, scoring M1, and the equation is solved via a correct method, scoring the final M1. The answer is correct and thus the final mark is also awarded.

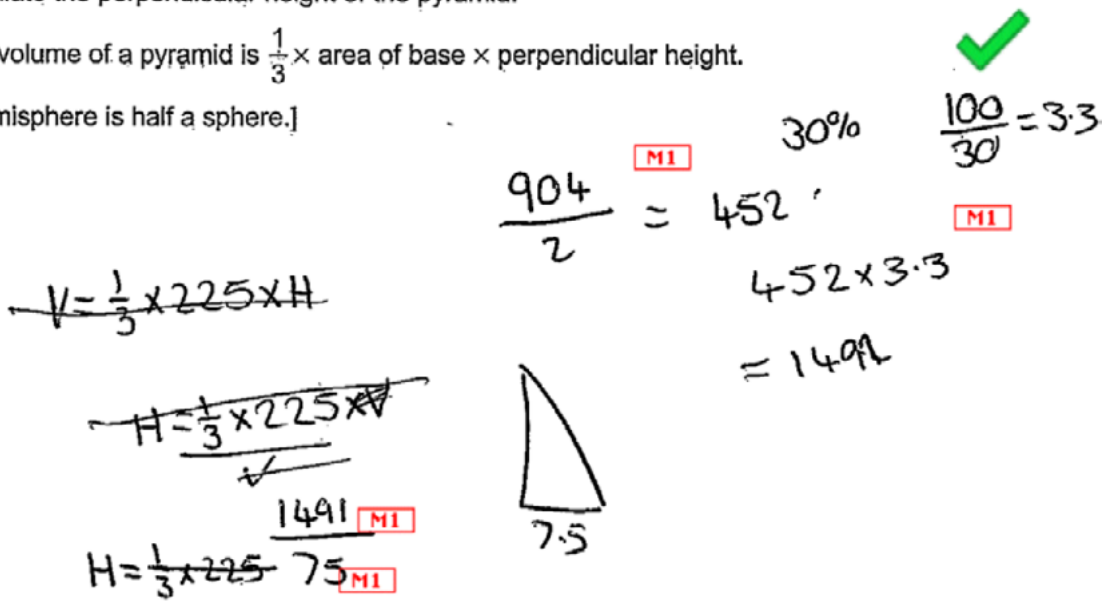
Exemplar 2

4 marks

Calculate the perpendicular height of the pyramid.

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

A hemisphere is half a sphere.]



(b) 19.88 cm [5]

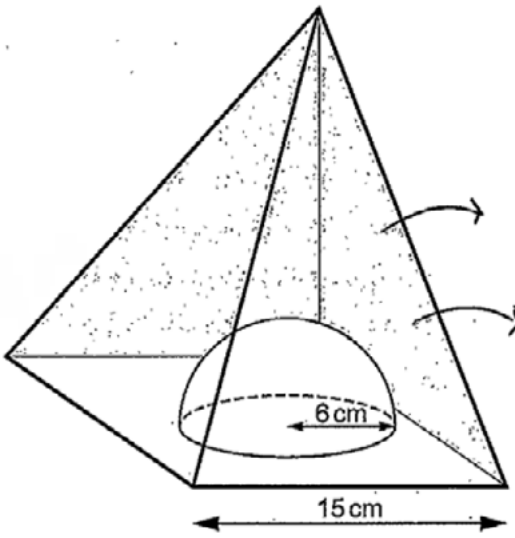
Examiner commentary

This response scores 4 marks and illustrates the importance of showing working. Their only error is using $\frac{100}{30}$ as 3.3 in their calculations. This leads to an inaccurate final answer but they still score the four method marks.

The presentation is not particularly good but is fairly typical of that shown by students on this paper. 904 is the inaccurate volume of their sphere found in part (a) and this is divided by 2 to find the volume of the hemisphere, scoring M1. The multiplication by 3.3 is seen to be intended as equivalent to dividing by 30 and multiplying by 100, which is a correct reverse percentage method, and so M1 is scored here. On the left, a 75 appears, which is $\frac{1}{3} \times 225$ and the relevant part of the pyramid formula, scoring M1. This is correctly used in the division for the final M1. Although Exemplar 1 gave an equation, it is not a requirement for the final method mark.

Exemplar 3

3 marks



1507.9 cm^2 of gas

1055.51 (B)

Calculate the perpendicular height of the pyramid.

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

A hemisphere is half a sphere.]

hemisphere volume = 452.3 (A)

volume inside = 30%

30% of x = 452.3 (A)

x = 452.3

30% 1508 = 452.4

30% 1507 = 452.1

30% x 1507.7 = 452.31

1507.9 is gas volume

$1055 = \frac{1}{3} \times 225 \times h$

$\div 225$

$\frac{1055}{225} = \frac{1}{3} \times h$

$h = 14.06$

$\frac{1055}{225} = \frac{1}{3} \times h$

$\frac{1055}{225} \div \frac{1}{3} = h$

(b) 14.06 cm [5]

Examiner commentary

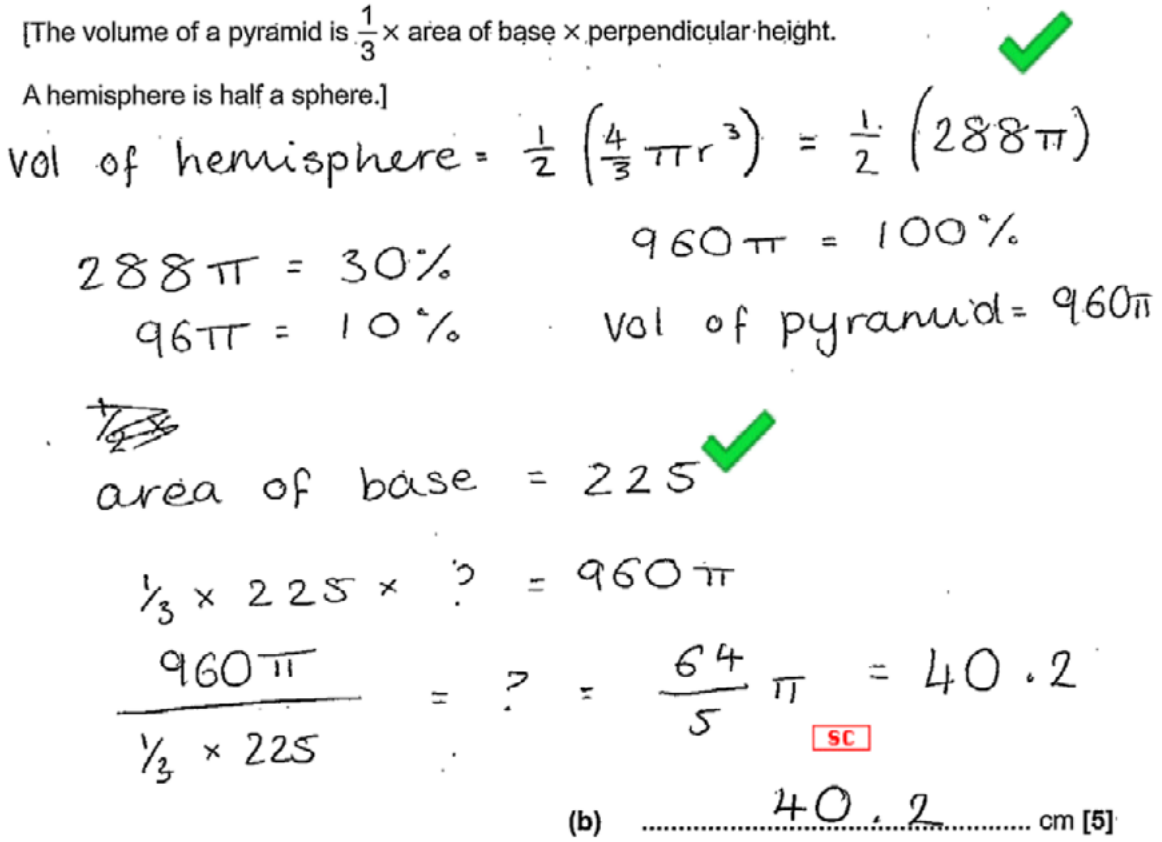
This response scores 3 marks. They find the volume of the hemisphere (M1) and, on the right-hand side, perform the reverse percentage step correctly (M1). On the left, they correctly use the volume of a pyramid formula (M1) but they equate this to an incorrect value, showing that they do not fully understand the context, and so the final method mark and answer mark are not awarded.

Exemplar 4

3 marks

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

A hemisphere is half a sphere.]



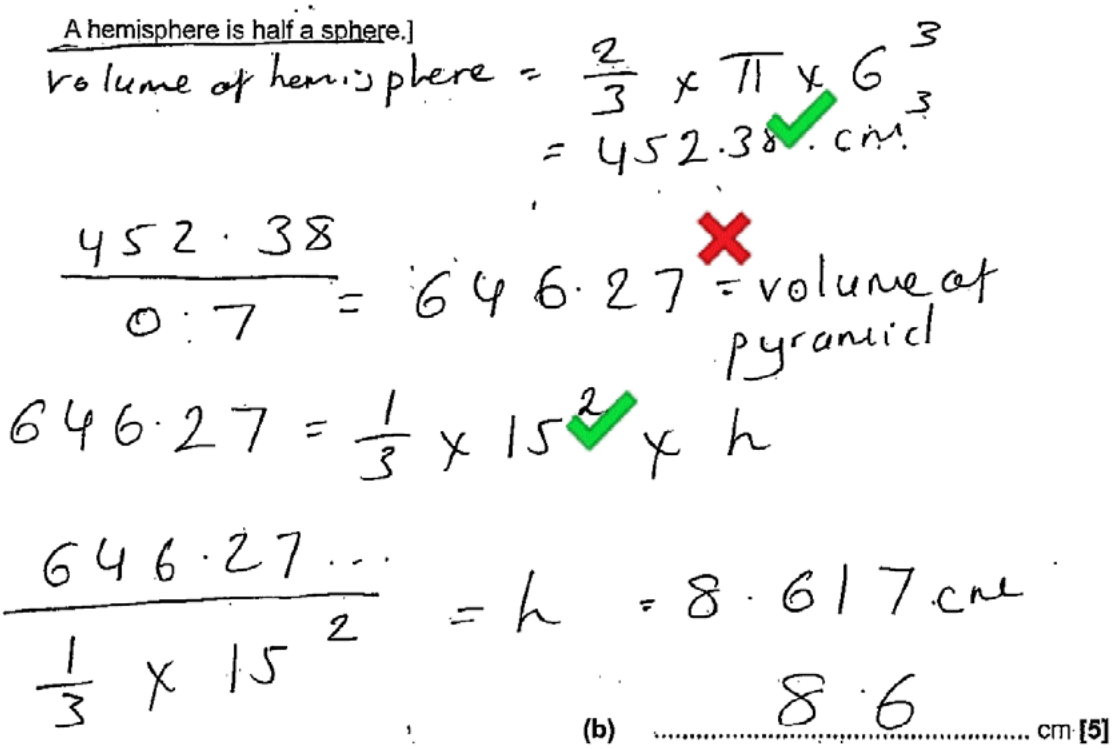
(b) 40.2 cm [5]

Examiner commentary

The candidate ignores their own first line and uses the volume of a sphere throughout. All working is otherwise correct. The mark scheme awards SC3 for this.

Exemplar 5

2 marks

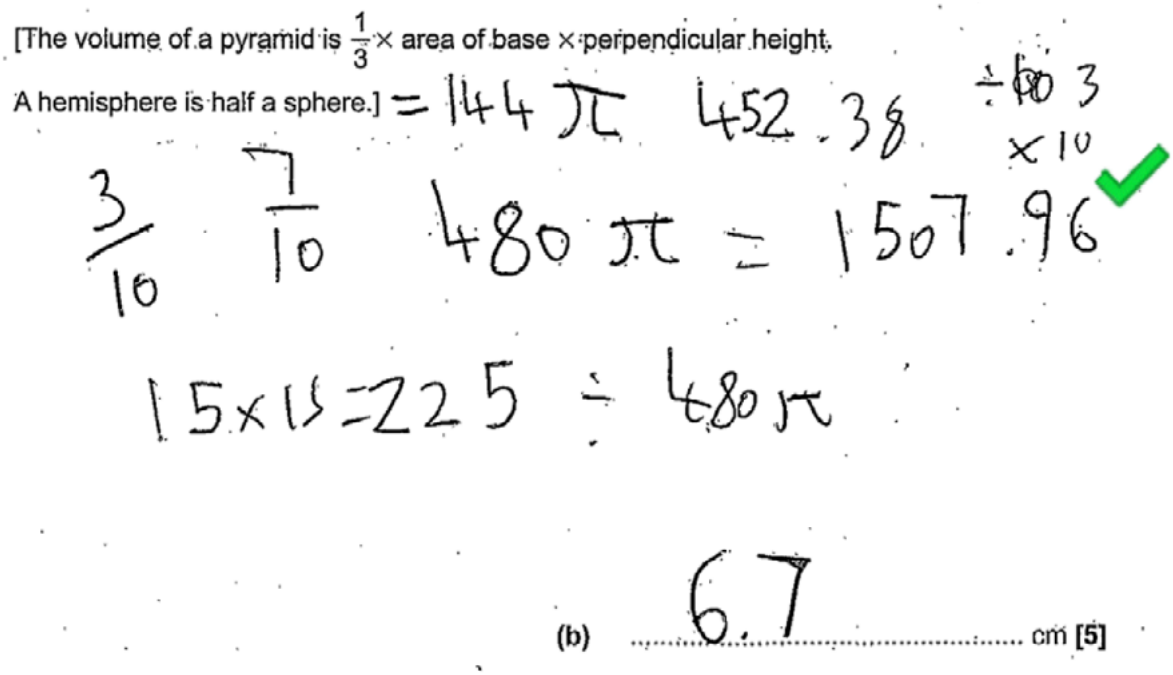


Examiner commentary

The response scores 2 marks for the volume of the hemisphere and the correct use of the volume of the pyramid formula. The attempt to perform the reverse percentage step is a common, invalid, method. Use of a correct method for the reverse percentage is necessary to score beyond 2 marks.

Exemplar 6

2 marks



Examiner commentary

The response scores 2 marks for the volume of the hemisphere and the reverse percentage step. However, they have not used the volume of the pyramid formula correctly so no more marks are earned.

Question 14 (a)

14 (a) Standard bricks have dimensions 21.5 cm by 10.3 cm by 6.5 cm, correct to 1 decimal place.

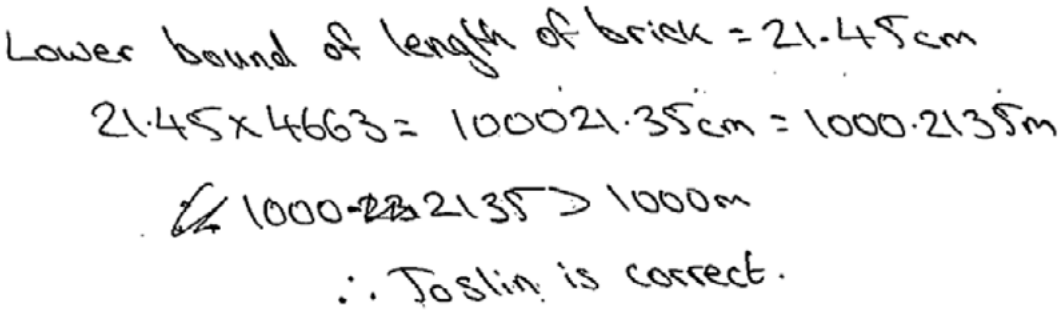
A house is built using 4663 standard bricks.

Joslin says

Placed end to end, the bricks from the house would definitely reach over 1 km.

Show that Joslin's statement is correct. **[4]**

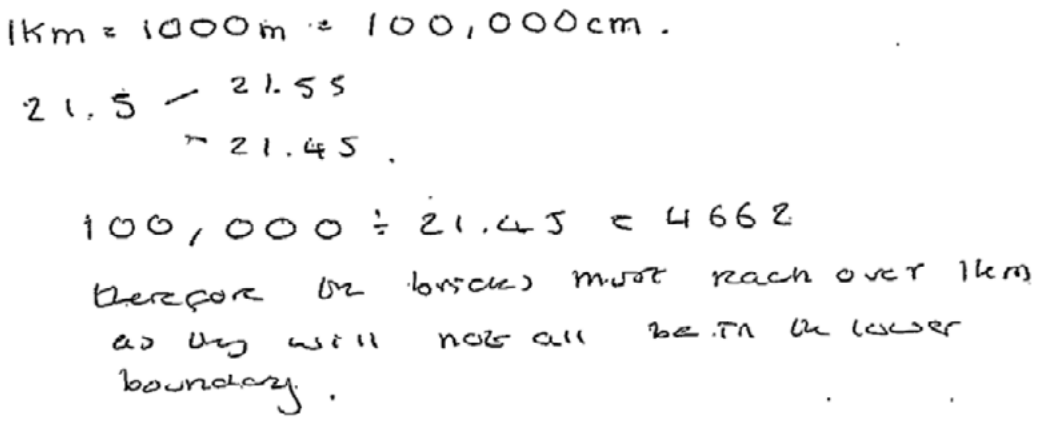
Exemplar 1 — 4 marks



Examiner commentary

The response scores full marks. They use the lower bound, perform an appropriate calculation to find the length of 4663 bricks, convert the lengths to a common unit, compare and conclude.

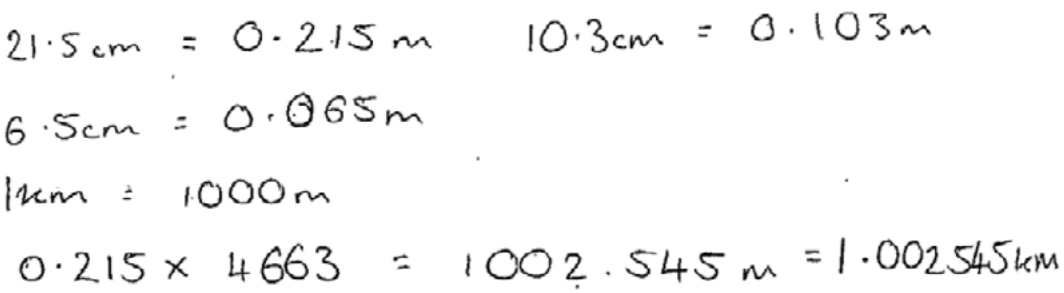
Exemplar 2 — 3 marks



Examiner commentary

This response shows the alternative approach of working out the number of bricks that will fit in 1 km. They use the lower bound, perform an appropriate calculation and convert the lengths to a common unit. However, they do not explicitly compare their answer against 4663 in making their conclusion and so score 3 marks only.

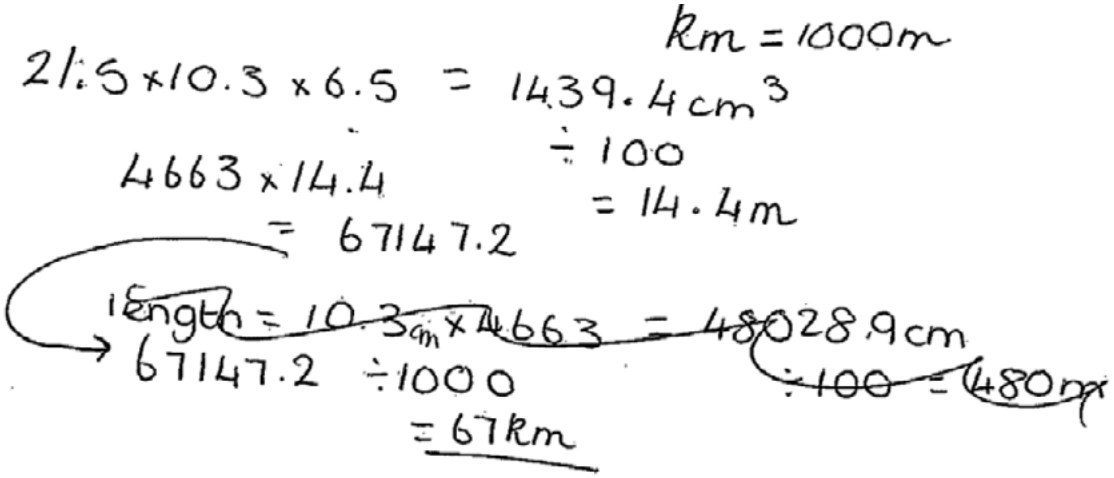
Exemplar 3 2 marks



Examiner commentary

This was a very common response which scores 2 marks. They do not use a lower bound but do perform an appropriate calculation and correct unit conversion.

Exemplar 4 1 mark

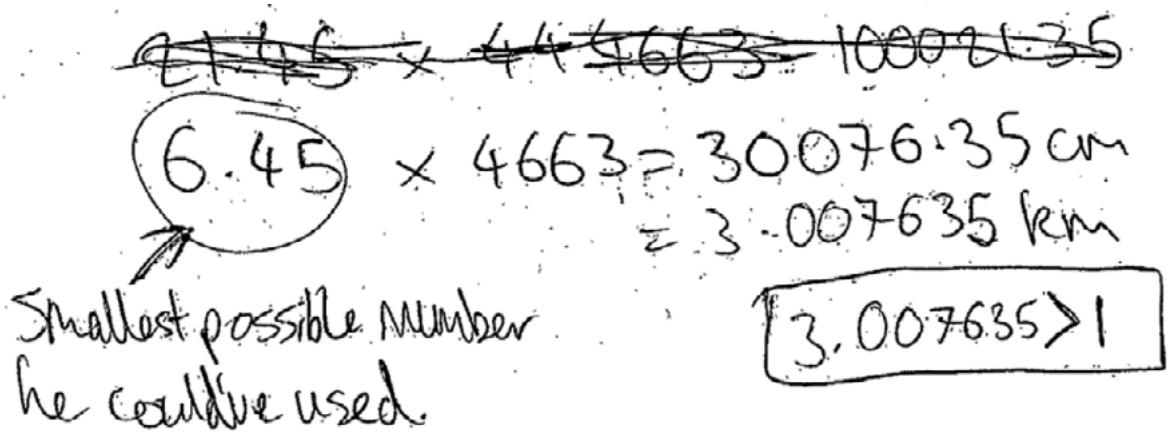


Examiner commentary

The candidate does not use a lower bound and their calculation uses volume rather than length. However, there is a correct unit conversion (67147.2 (m) into km) and so 1 mark is scored.

Exemplar 5

1 mark



Examiner commentary

This candidate uses the height of the brick rather than its length. The calculation is awarded SC1. A further B1 for the unit conversion is possible if correct, but here they have gone wrong.

Question 14 (b) (i)

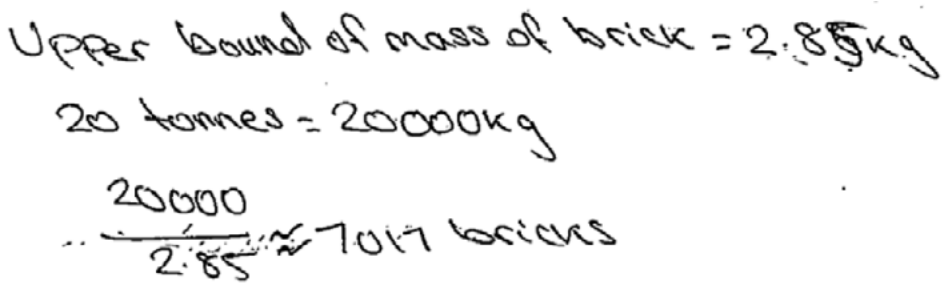
(b) A standard brick should weigh 2.8 kg, correct to 1 decimal place.
A truck can carry a maximum load of 20 tonnes.

(i) Calculate the maximum number of standard bricks that the truck should be able to carry.

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

Exemplar 1

3 marks



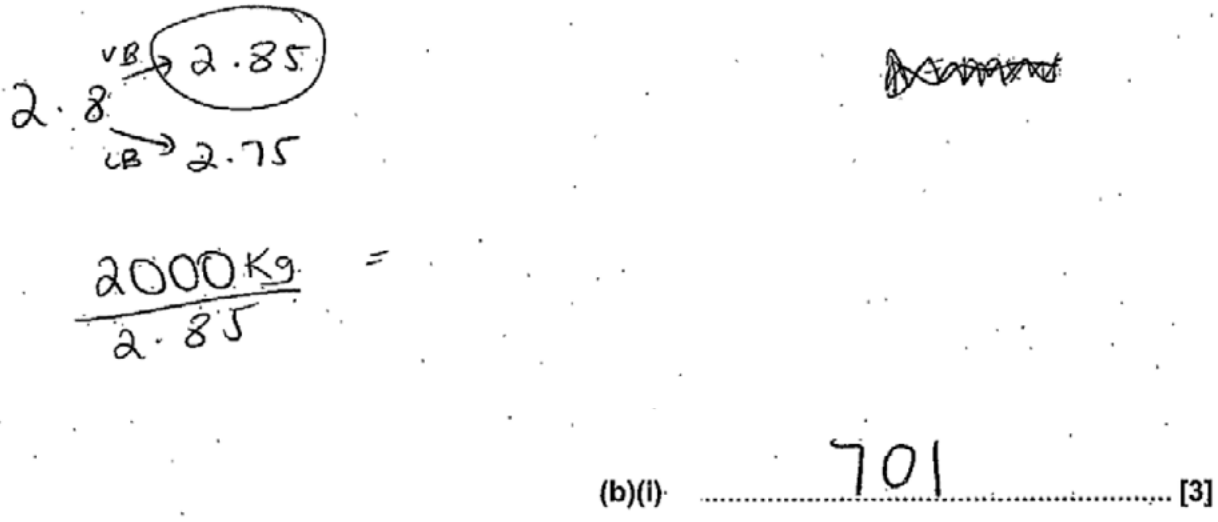
(b)(i) 7017 **[3]**

Examiner commentary

The response scores full marks. They use the upper bound for the mass of a brick, convert the mass of the bricks and maximum load to a common unit, and perform accurately the calculation to find the number of bricks.

Exemplar 2

2 marks



(b)(i) 701 **[3]**

Examiner commentary

The response scores 2 marks. They use the upper bound for the mass of a brick and perform an appropriate calculation to find the number of bricks. However, their unit conversion between tonnes and kg is incorrect.

Exemplar 3

2 marks

$\frac{20,000}{2.8} = 7142$

(b)(i) 7142 [3]

Examiner commentary

The response scores 2 marks. They convert the mass of the bricks and maximum load to a common unit, and perform accurately the calculation to find the number of bricks. However, they have not used the upper bound for the mass of the brick.

Exemplar 4

2 marks

1000 kg = 1 ton

$2.8\text{ kg} = 2.8 \times 10^{-3}$ ton

$\frac{20}{2.8 \times 10^{-3}} = 7142.9$

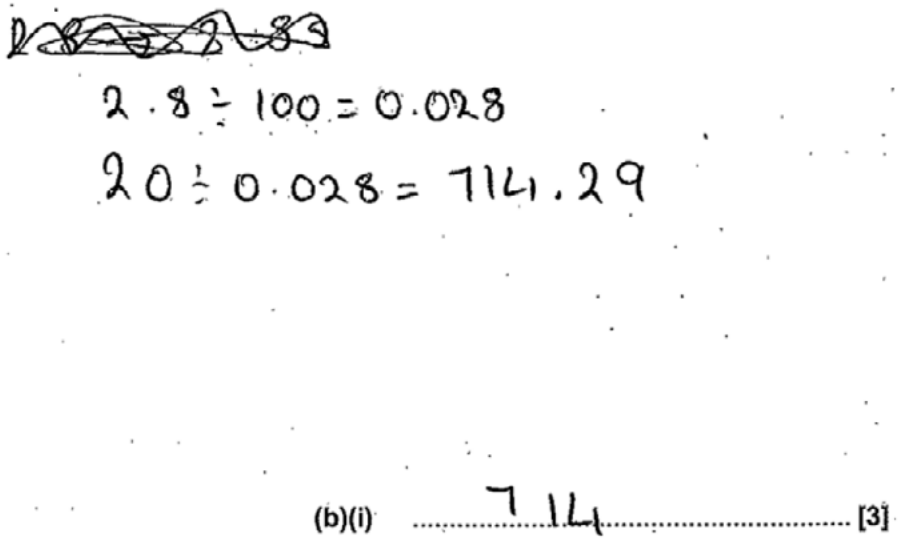
(b)(i) 7142 [3]

Examiner commentary

The response scores 2 marks. They convert the mass of the bricks and maximum load to a common unit (in this case tonnes), and perform accurately the calculation to find the number of bricks. However, they have not used the upper bound for the mass of the brick.

Exemplar 5

1 mark



Examiner commentary

The response scores 1 mark for the calculation to find the number of bricks. They do not use the upper bound for the mass of the brick and the unit conversion is incorrect.

Question 15

15 Ratna invests £1200 for 2 years in a bank account paying r % per year compound interest.
At the end of 2 years, the amount in the bank account is £1379.02.

Calculate r.

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

Exemplar 1

4 marks

$1200 \times r^2 = 1379.02$

$r^2 = \frac{1379.02}{1200}$

$r = \sqrt{\frac{1379.02}{1200}}$

$r = 1.072$

$1.072 - 1 =$

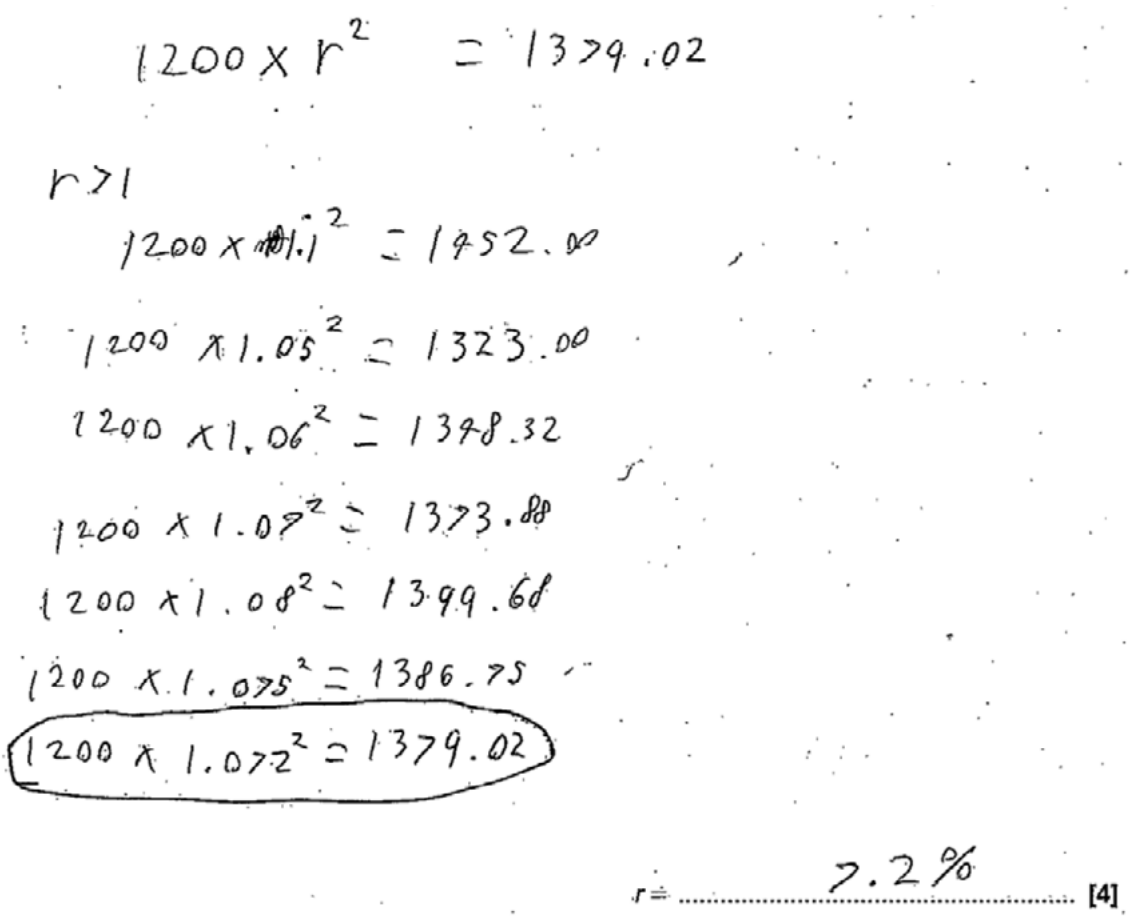
$r =$ 7.2% **[4]**

Examiner commentary

The response scores full marks. Both the answer and supporting working are correct. A correct compound interest equation is set-up in the opening line and the method for solving it is clear. The solution to the equation, 1.072, is then correctly interpreted as an interest rate of 7.2%.

Exemplar 2

4 marks

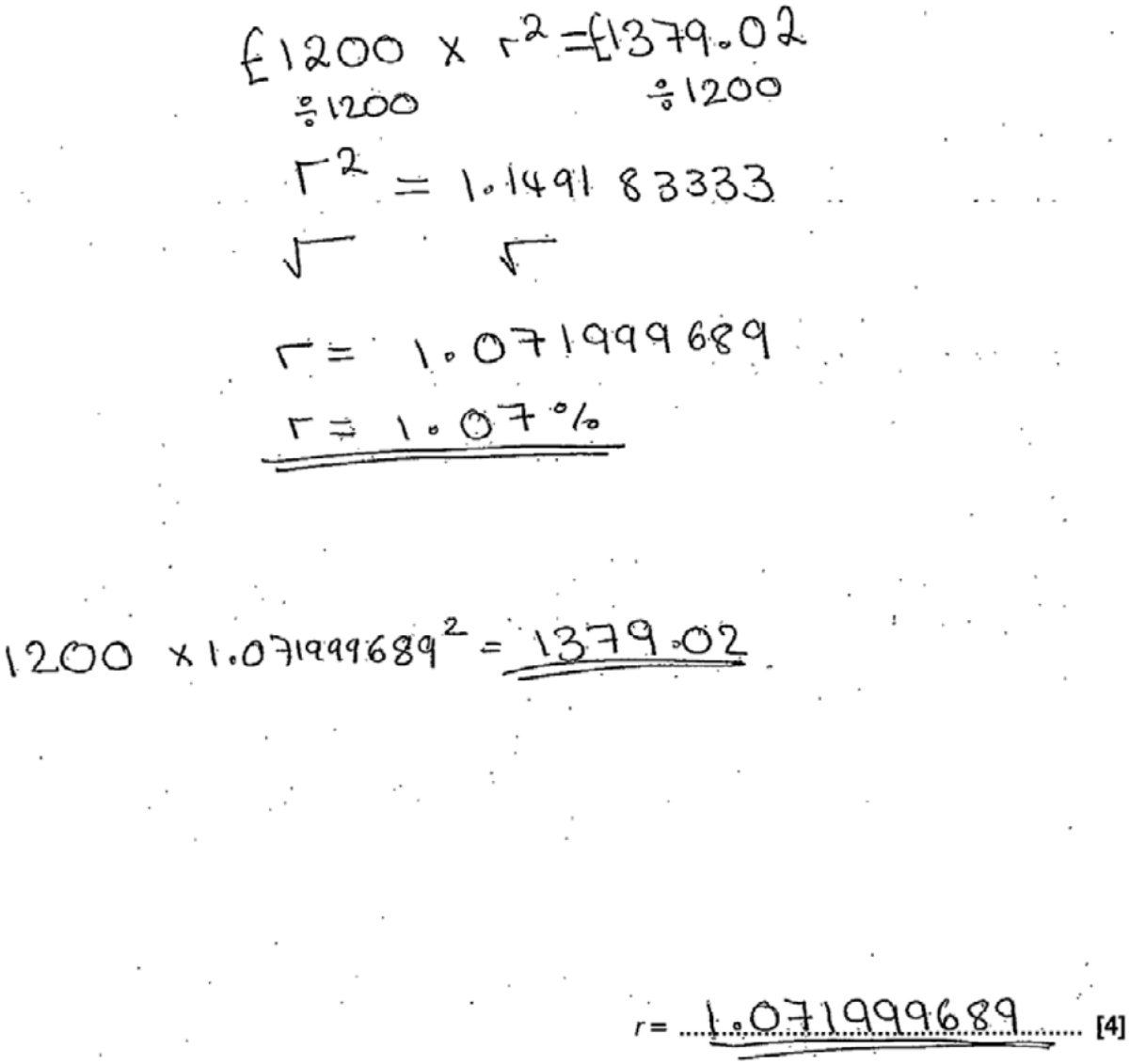


Examiner commentary

The response scores full marks. The question does not specify what working or method is required and this candidate has set-up a compound interest equation which is solved using trial and improvement. Using trials is often "all or nothing" but, here, the opening equation would score M1 if the correct answer had not been found.

Exemplar 3

3 marks

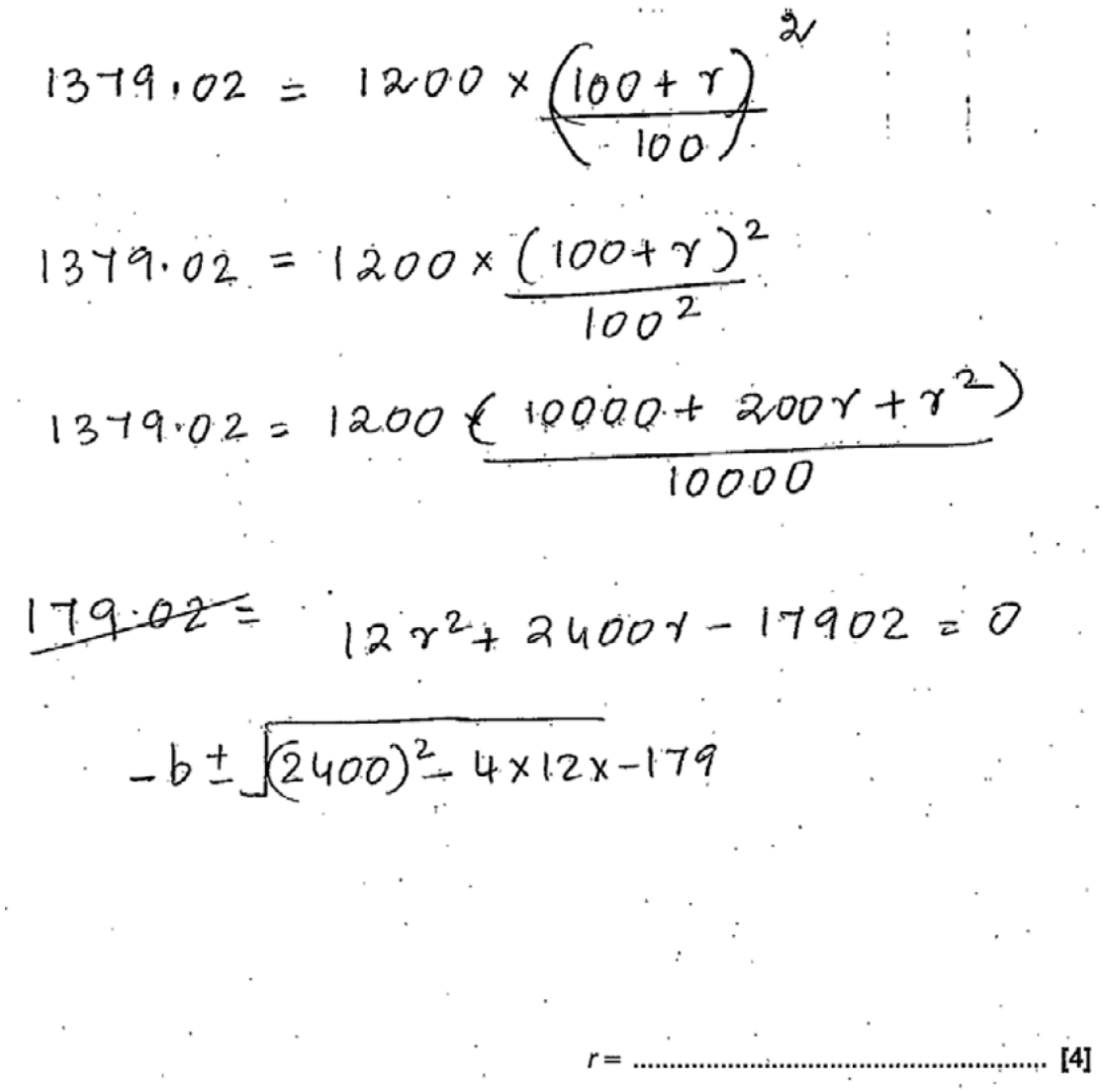


Examiner commentary

This response scores 3 marks. The compound interest equation and its solution are correct, scoring M3, but it is not interpreted correctly as a rate of interest.

Exemplar 4

1 mark

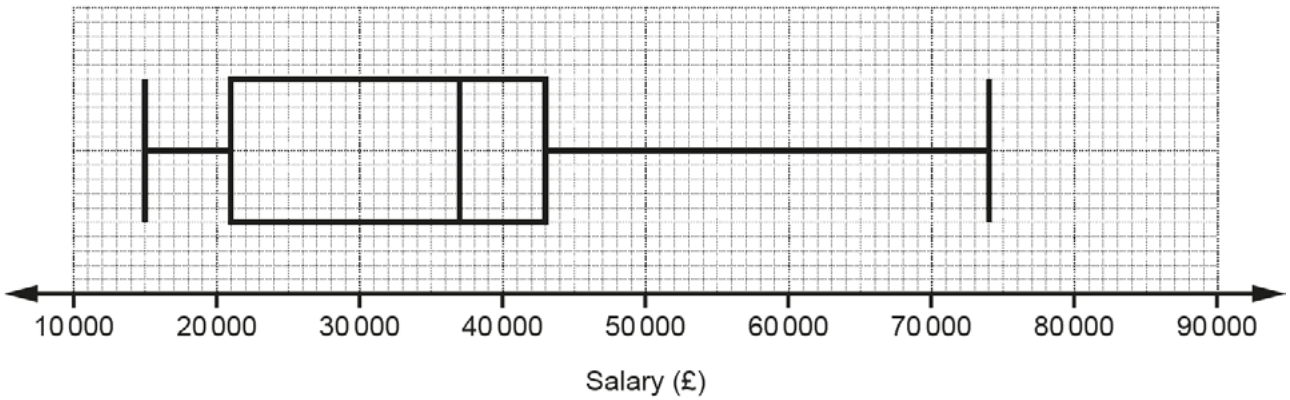


Examiner commentary

Some able candidates used an unnecessarily complicated form for their compound interest equation. As is the case here, it was rare for them to be able to make much progress. This example scores just 1 mark for the equation.

Question 16 (b)

16 The box plot shows the distribution of the salaries for the workers at Bexbridge Biscuits.



(b) Find the interquartile range.

(b) £ ..... **[2]**

Exemplar 1

2 marks

UQ = 43000 –
LQ = 21000
22000

(b) £ 22000 **[2]**

Examiner commentary

Correct, so 2 marks. One mark was available for figures 43 – figures 21 or an answer starting with figures 22.

Question 16 (c)

(c) The following salary information is true for workers at Camford Cookies.

- The highest paid worker earns £85 000.
- The lowest paid worker earns 20% of the salary of the highest paid worker.
- 25% of the workers earn more than £50 000.
- 25% of the workers earn less than £28 000.
- The median salary is £37 000.

Draw a box plot to show the salaries of the workers at Camford Cookies.

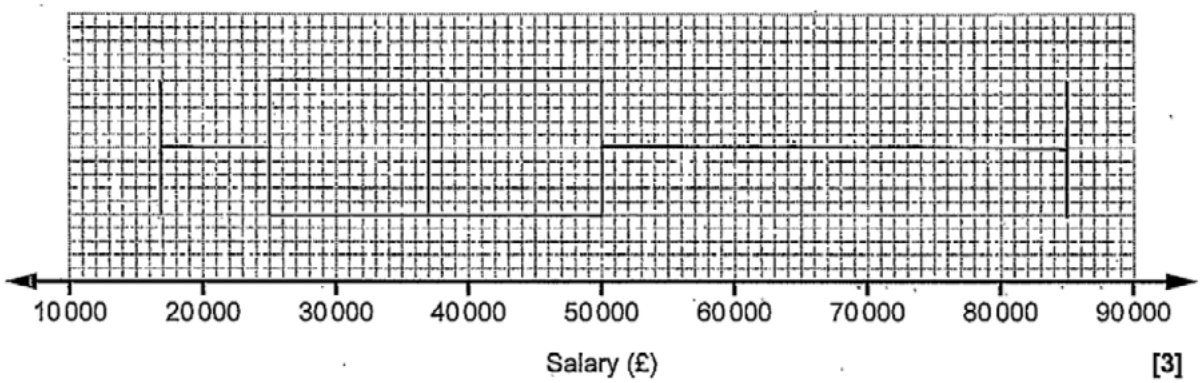
[3]

Exemplar 1

2 marks

Draw a box plot to show the salaries of the workers at Camford Cookies.

$85\,000 \div 100 \times 20 = 17\,000$



[3]

Examiner commentary

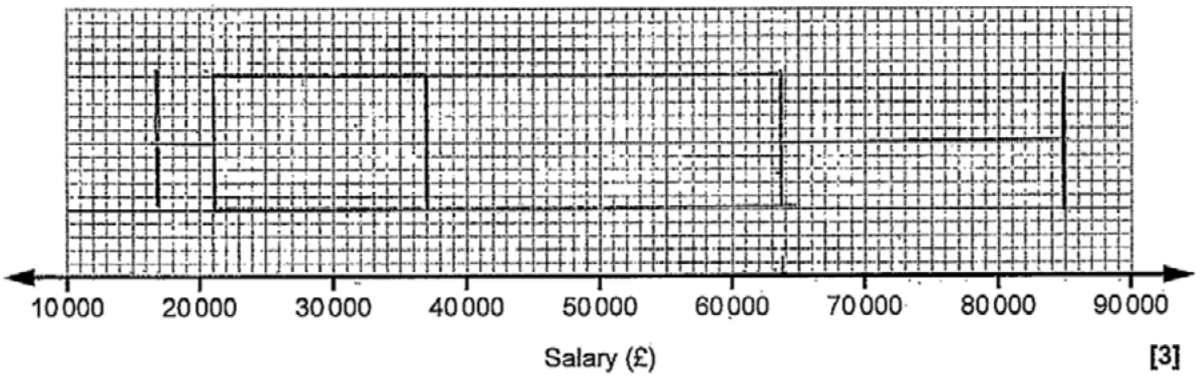
There are four correct markers, with the lower quartile being incorrect. Therefore, B2 is scored.

Exemplar 2

1 mark

Draw a box plot to show the salaries of the workers at Camford Cookies.

85000 ÷ 100 = 850
850 x 20 = 17000
85000 ÷ 2
42500 ÷ 2 = 21250
42500 + 21250 = 63750



[3]

Examiner commentary

There are three correct markers, with the lower quartile and upper quartile being incorrect. Therefore, B1 is scored. Alternatively, B1 could be awarded for working out the lowest paid worker earns £17 000.

Question 16 (d)

(d) Make two different comparisons between the distribution of the salaries at Bexbridge Biscuits and the salaries at Camford Cookies.

1:.....

.....

2:.....

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

Exemplar 1 2 marks

1: The average salaries at Bexbridge biscuits and Camford Cookies are the same

2: The IQR are also the same for both the factories, hence the results are spread out the same. [2]

IQR = 50,000 − 28,000 = 22,000

Examiner commentary

There is a correct statement about the averages and a correct statement about the IQRs. Therefore, 2 marks are awarded.

Exemplar 2 1 mark

1: The range of salary at Bexbridge biscuits is smaller than the range at camford cookies

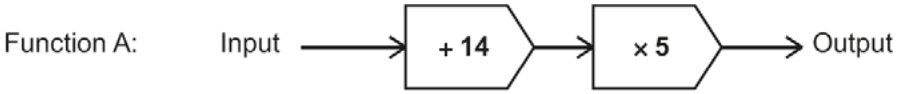
2: The ~~median salary~~ interquartile range is larger at camford cookies than at Bexbridge biscuits [2]

Examiner commentary

There is a correct statement about the range, scoring 1 mark. The IQR statement is wrong. Even if this had been correct, the overall response would still only score one mark because both comments are about the spread of the data.

Question 17 (a)

17 Here is a function.



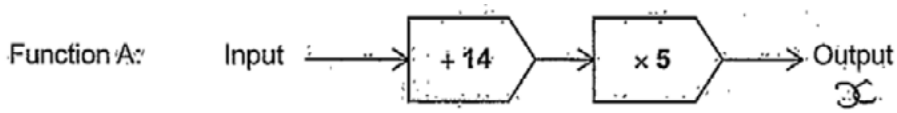
(a) The **output** of function A is x.

Write an algebraic expression, in terms of x, for the input of function A.

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

Exemplar 1

2 marks



(a) The **output** of function A is x.

Write an algebraic expression, in terms of x, for the input of function A.

$(x + 14) \times 5 = x$

$x \div 5 = \frac{x}{5}$

$\frac{x}{5} - 14 = \text{input}$

$\frac{x}{5} - 14 =$

(a) $\frac{x}{5} - 14$ **[2]**

Examiner commentary

Correct, so 2 marks. $\frac{x}{5}$ on its own would score M1.

Exemplar 2

1 mark

$$\frac{x-14}{5}$$

(a) $\frac{x-14}{5}$ ..... [2]

Examiner commentary

The operations are performed in the wrong order but an SC1 is awarded.

Exemplar 3

0 marks

(5c+14)x5

(a) (5c+14)x5 ..... [2]

Examiner commentary

The candidate finds an expression for the output rather than the input and so scores 0 marks.

Question 17 (b)

(b) A number, k, is put into function A.
The output is also k.

Find the value of k.

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

Exemplar 1

3 marks

$5(k+14) = k$

$5k + 70 = k$

$-k \quad -k$

$4k + 70 = 0$

$-70 \quad -70$

$4k = -70$

$k = -17.5$

(b) $k =$ -17.5 **[3]**

Examiner commentary

The working and the answer line are both correct, so this response scores full marks. The candidate sets up an equation using an expression for the input. The notation is correct throughout.

Some candidates omitted the brackets which then led them to solving an incorrect equation. Up to two follow through marks could be scored.

Exemplar 2

3 marks

inverse

$\frac{k}{5} - 14 = \text{input}$ k

$\frac{k}{5} - 14 = k$

$\frac{k}{5} = k + 14$

$k = 5k + 70$

$k - 5k = 70$

$-4k = 70$

$\frac{70}{-4} = -17.5$

(b) $k =$ −17·5 [3]

Examiner commentary

The working and the answer line are both correct, so this response scores full marks. This candidate sets up an equation using an expression for the output.

Exemplar 3

1 mark

$K + 14 \rightarrow K + 14 \times 5$ ✗ $\not{\times} K$

$K + 14 \times 5 = K$ (−14)

$5K = K - 14$ (−K) ✗

$\frac{4K}{4} = \frac{-14}{4}$ FT

$K = -3.5$

(b) $k =$ −3·5 [3]

Examiner commentary

The opening equation lacks brackets and then 14 × 5 is not performed. Therefore, neither of the first two marks are scored. However, their final step from 4k = –14 is correct and so the final follow through mark can be awarded.

Question 18 (b)

(b) The standard tin and the large tin are mathematically similar.
The **volume** of the large tin is 50% more than the volume of the standard tin.
Both tins are cylinders.
The radius of the standard tin is 10 cm.

Calculate the radius of the large tin.

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

Exemplar 1

4 marks

volume scale factor = 1.5

$\sqrt[3]{1.5}$ = scale factor

$10 \times \sqrt[3]{1.5} = 11.447\ldots$

(b) 11.45 cm **[4]**

Examiner commentary

The response is correct and concise. It is almost identical to the mark scheme and scores full marks. Few scripts were as clearly presented as this.

Exemplar 2

3 marks

(b) The standard tin and the large tin are mathematically similar.
The **volume** of the large tin is 50% more than the volume of the standard tin.
Both tins are cylinders.
The radius of the standard tin is 10 cm.

Calculate the radius of the large tin.

standard volume 10 x 1.5 = 15

large 15

radius factor $\sqrt[3]{1.5}$ 10 x $\sqrt[3]{1.5}$ = 1.144714243

10 x 1.5 = 15

Vol = 50% more than small

$\frac{60}{40} = 1.5$

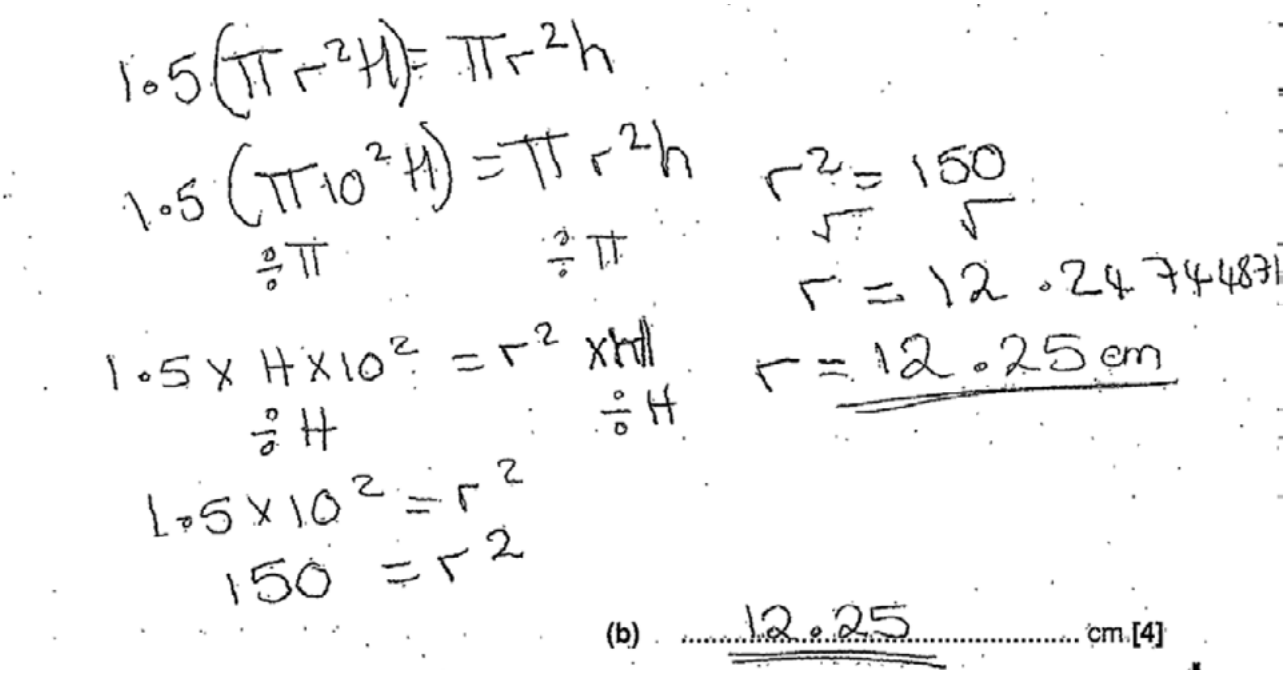
(b) 1.144714243 ..... cm **[4]**

Examiner commentary

The response scores B1 for 1.5 and M2 for $10 \times \sqrt[3]{1.5}$. However, this is not evaluated correctly either in the body of the script or on the answer line.

Exemplar 3

1 mark

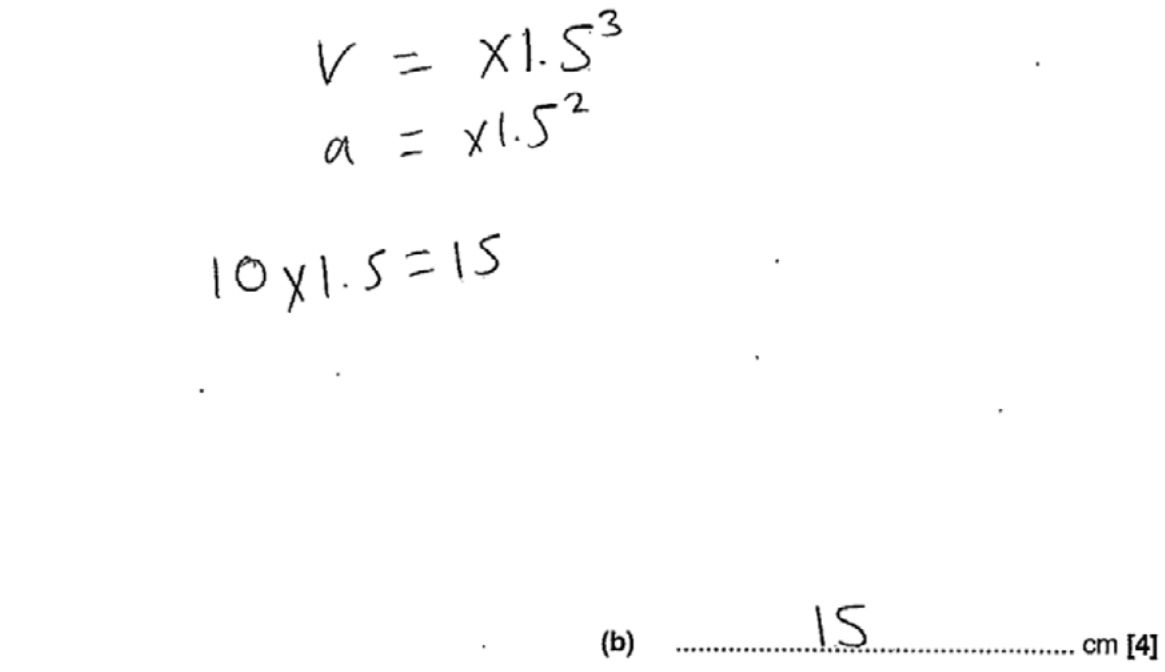


Examiner commentary

Responses similar to this were very common. The candidate sets up an equation showing that the volume of one cylinder is 1.5 times that of another. They score B1 for 1.5. However, when solving, they encounter a problem and so make the two heights equal to each other so that they cancel out. The remainder of the work is then based on a false assumption and is invalid (they are actually finding the radius that gives a 50% increase in surface area).

Exemplar 4

1 mark



Examiner commentary

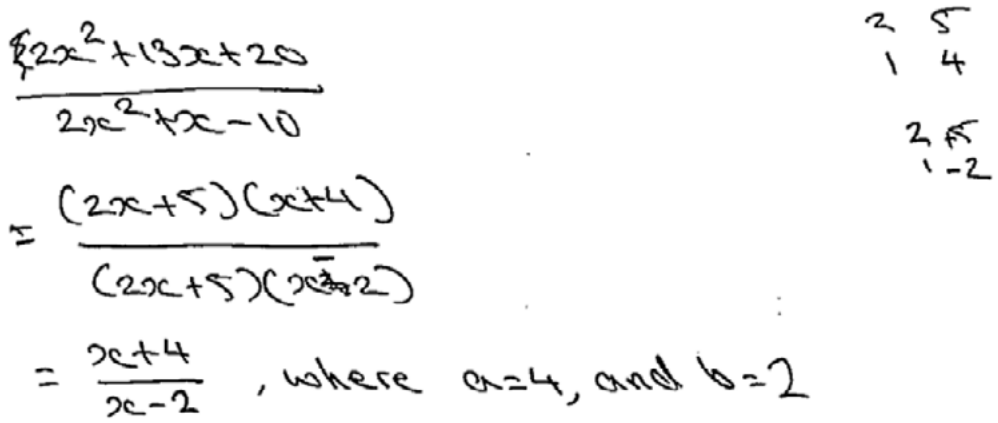
This is very minimal and incorrect but scores B1 for a scale factor of 1.5.

Question 19

19 Show that $\frac{2x^2+13x+20}{2x^2+x-10}$ simplifies to $\frac{x+a}{x-b}$ where a and b are integers. **[4]**

Exemplar 1

4 marks



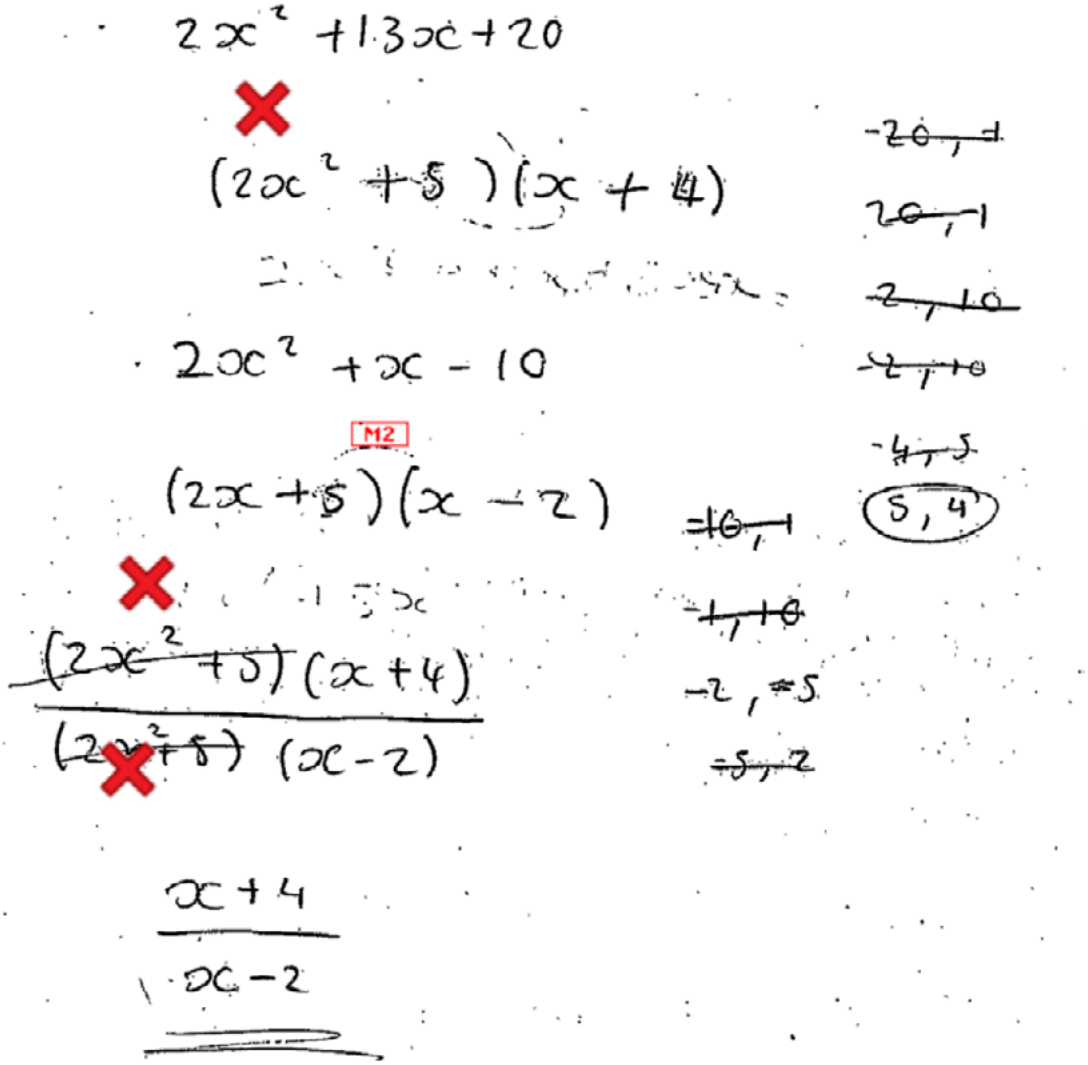
Examiner commentary

The answer is correct and follows from correct working. The response scores full marks.

M3 was available for factorising both the numerator and denominator correctly but was rarely awarded as almost all completed the cancelling step correctly for full marks.

Exemplar 2

2 marks



Examiner commentary

The denominator is seen to be factorised correctly even though it is subsequently changed in order to facilitate the simplification. This scores M2. However, the numerator is only seen as an incorrect factorisation. Although the final answer is correct, it has come after errors in the working and so is not awarded full marks.

Exemplar 3

0 marks

20

19 Show that $\frac{2x^2+13x+20}{2x^2+x-10}$ simplifies to $\frac{x+a}{x-b}$ where a and b are integers. [4]

$a = 2$

$b = 13$

$c = 20$

$\frac{-13 \pm \sqrt{13^2 - 4 \times 2 \times 20}}{2a = 4}$

$a = 2$

$b = 1$

$c = -10$

$\frac{-1 \pm \sqrt{1^2 - 4 \times 2 \times -10}}{2 \times 2}$

$\frac{-1 \pm \sqrt{81}}{4}$

$x_1 = -2.5$

$x_2 = 2$

$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

$= \frac{-13 \pm \sqrt{9}}{4}$

$\frac{-13 + 3}{4}$

$x_1 = -2.5$

$\frac{-13 - \sqrt{9}}{4}$

$x_2 = -4$

$x = 4$

$\frac{x + 4}{x - 2.5}$

$a = 4$

$b = 2.5$

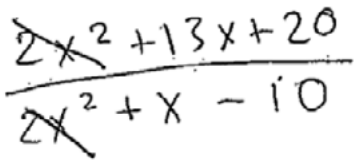
Examiner commentary

Candidates who used the quadratic formula rather than factorisation were rarely successful. Like here, candidates did not know what to do with the two pairs of roots obtained. Unless further correct progress was made towards a simplification, the responses scored 0 marks.

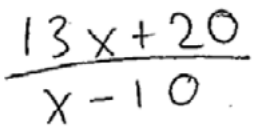
Simplification of algebraic fractions is unlikely to require the use of the quadratic formula, and candidates should routinely be thinking of factorising. Even a partially correct factorisation, giving two correct terms when expanded, would have scored M1.

Exemplar 4

0 marks



$$\frac{2x^2+13x+20}{2x^2+x-10}$$



$$\frac{13x+20}{x-10}$$

Examiner commentary

Invalid cancellation of terms was quite common and scored 0 marks.

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