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Edexcel IGCSE 4MA1

4MA1/2FR (Foundation Tier) – Wednesday 4 June 2025

100 marks · 2 hours · Calculator allowed

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Full original worked solutions and mark schemes for every question on this paper.

Original worked solutions for Edexcel International GCSE Mathematics A, Paper 4MA1/2FR (Foundation Tier), June 2025 series, sat Wednesday 4 June 2025 –100 marks, 2 hours, calculator allowed. The questions have been reworded; all numerical values match the original paper. The official question paper and mark scheme are published by Pearson Edexcel. This resource reproduces neither the exam paper nor the official mark scheme.

Both are PDF files hosted by Pearson: **official question paper (PDF)** and **official mark scheme (PDF)**.

Practice Questions

Try each question on paper first. Full worked solutions and mark schemes follow in the next section.

1. (a) Put these numbers in order of size, starting with the smallest.

83 148 46 229 99 *[1 mark]*

(b) Put these decimals in order of size, starting with the smallest.

0.25 0.5 0.46 0.08 0.417 *[1 mark]*

(c) Express 0.81 as a fraction. *[1 mark]*

(d) Work out the number that is exactly halfway between 0.2 and 0.3 *[1 mark]*

(a) .....

(b) .....

(c) .....

(d) .....

[Total 4 marks]

2. Marina recorded the ages, in years, of the seven cats at an animal rescue centre.
Here are her results.

2 9 10 6 7 9 4

(a) Write down the mode of the ages. *[1 mark]*

(b) Work out the median age. *[2 marks]*

(c) Find the range of the ages. *[1 mark]*

(a) .....

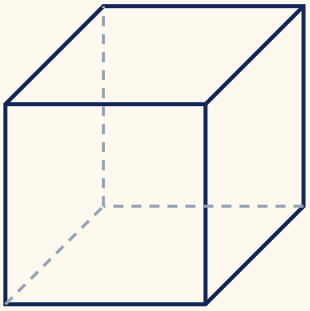
(b) .....

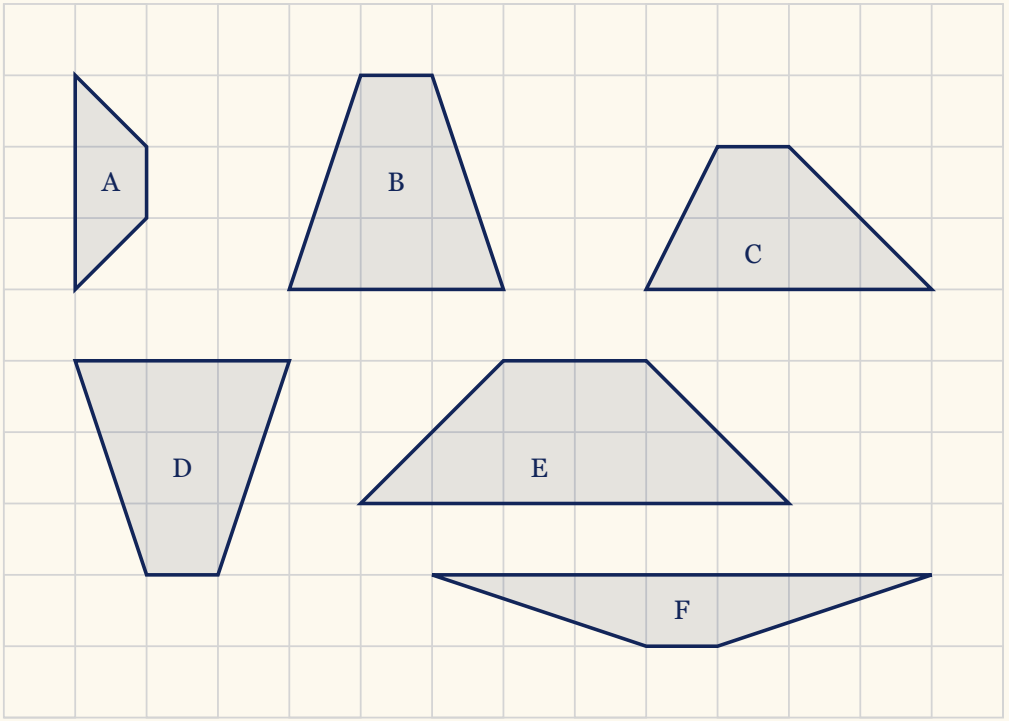
(c) .....

[Total 4 marks]

3. The diagram shows a 3-D shape.

Diagram NOT
accurately drawn





(a) (i) Write down the mathematical name of this shape.
[1 mark]
(ii) Write down the number of edges of this shape. *[1 mark]*

The grid below shows six quadrilaterals.
Two of the quadrilaterals are congruent.

(b) Write down the letters of these two quadrilaterals.
[1 mark]

(c) Write down the letter of the quadrilateral that has no lines of symmetry. *[1 mark]*

(a) (i) .....

(a) (ii) .....

(b) .....

(c) .....

[Total 4 marks]

4. (a) Convert 5 000 millilitres into litres. *[1 mark]*

(b) Work out the difference between a length of 3 metres and a length of 85 centimetres.
Give your answer in centimetres. *[2 marks]*

(a) litres .....

(b) centimetres .....

[Total 3 marks]

5. (a) Simplify the expression $a + a + a + a + a$ *[1 mark]*

(b) Simplify the expression $b \times c \times 7$ *[1 mark]*

(c) Solve the equation $5d = 40$ *[1 mark]*

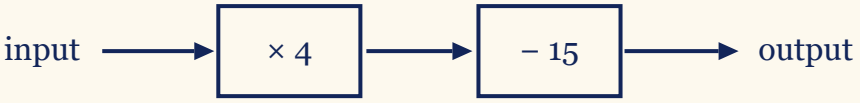
(a) .....

(b) .....

(c) d = ...

[Total 3 marks]

6. The diagram shows a number machine.



(a) Work out the output when the input is 10 *[1 mark]*

(b) Work out the output when the input is -2 *[1 mark]*

(a) .....

(b) .....

[Total 2 marks]

7. Douglas sells 80 pies for a total of £176

$\frac{1}{5}$ of the pies are large.

Each large pie costs £3

The remaining pies are small.

Work out the cost of one small pie. *[4 marks]*

£ .....

[Total 4 marks]

8. Gordon is going to book an apartment at a holiday resort for 7 nights.

An apartment at the resort costs the same amount for each night.
Gordon knows that the apartment costs 150 euros for 2 nights.

The resort also charges an additional tourist tax of 5 euros for each night.

Work out the total cost of the apartment and the tax for 7 nights. *[3 marks]*

..... euros

[Total 3 marks]

9. Pierre chooses one food item and one drink at a hotel breakfast bar.

He can choose one food item from croissant (C) or fruit (F) or porridge (P)
He can choose one drink from milk (M) or juice (J) or tea (T)

(a) List all the possible combinations that Pierre can choose. *[2 marks]*

Yusuf and Rhys share some cherries in the ratio $3 : 4$

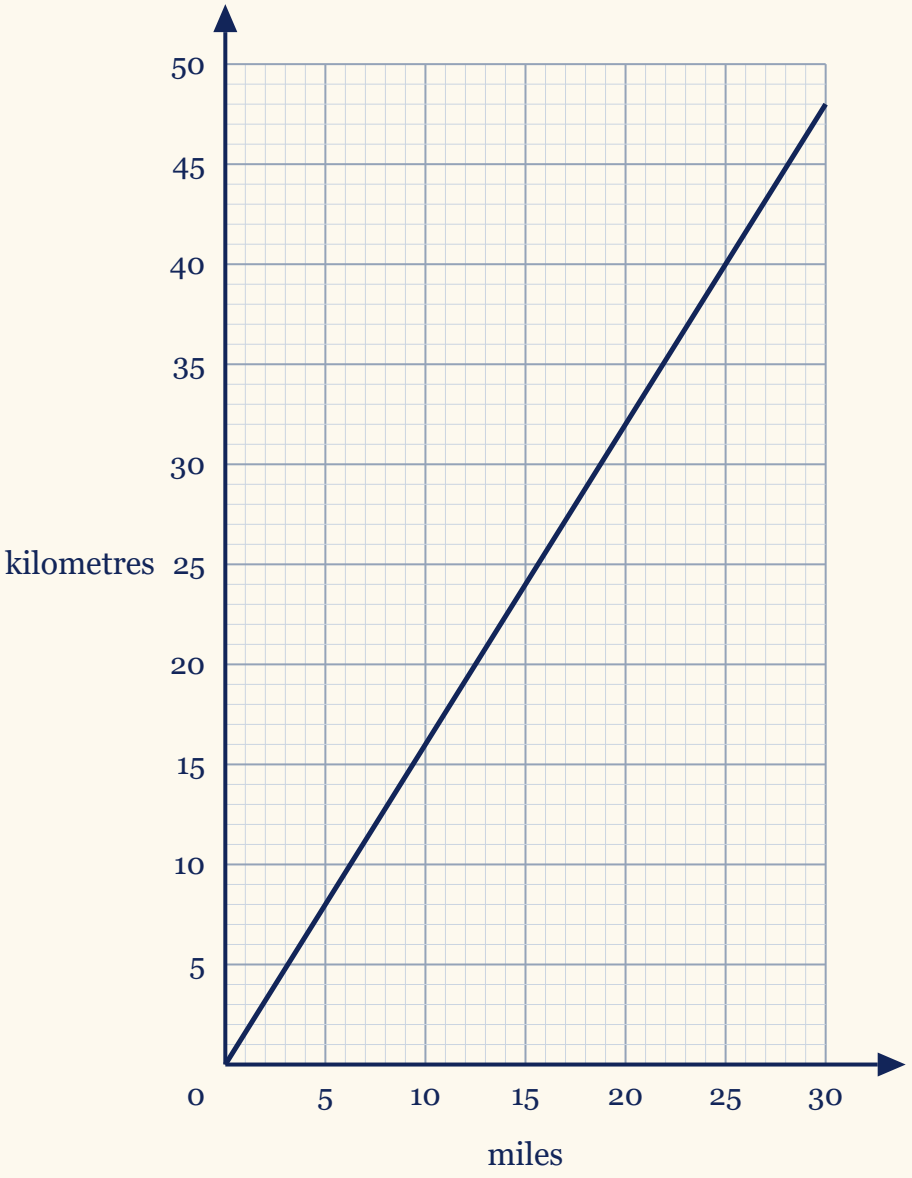
(b) What fraction of the cherries does Rhys get? *[1 mark]*

(a) .....

(b) .....

[Total 3 marks]

10. The conversion graph below can be used to change between miles and kilometres.



(a) Use the graph to change 25 miles into kilometres. *[1 mark]*

Claire delivers parcels for a courier firm.
She is paid \$0.80 for every kilometre she drives.

For one delivery round Claire was paid \$19.20 in total.

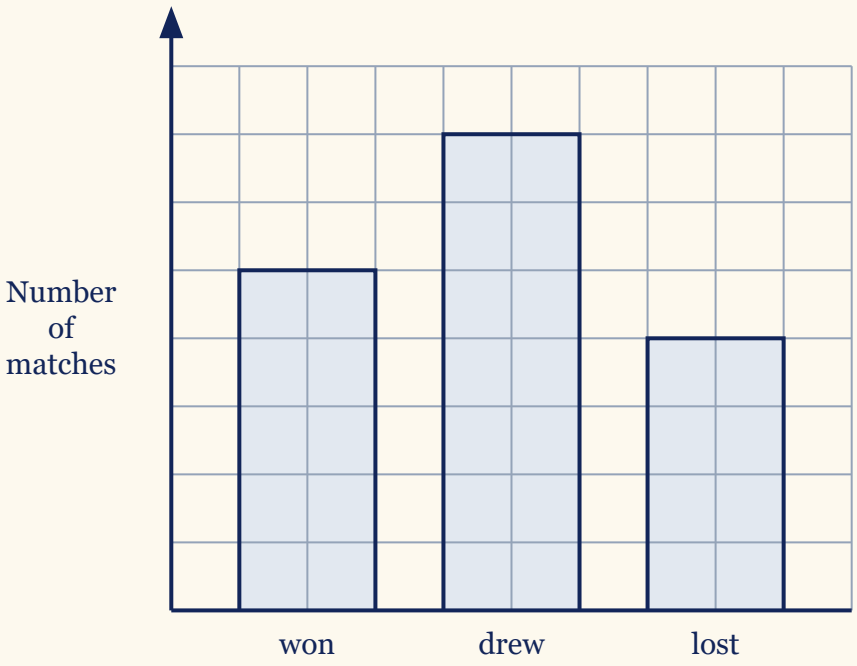
(b) Work out the number of miles she drove. *[2 marks]*

(a) .....

(b) .....

[Total 3 marks]

11. The bar chart gives information about the results of the matches played by a youth club's five-a-side football team.



The team gained
3 points for each match it won
1 point for each match it drew
0 points for each match it lost

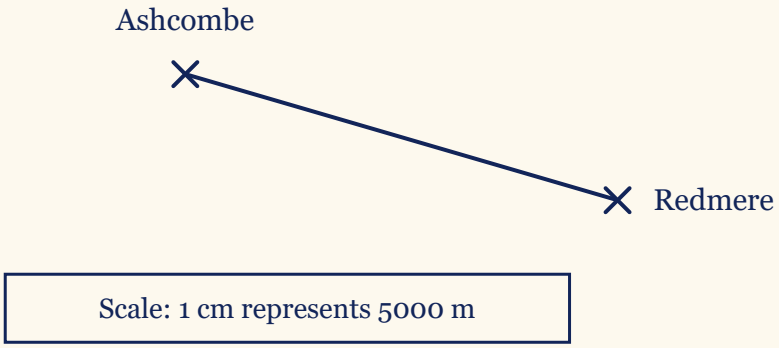
The team drew 14 matches.

Work out the total number of points the team gained. *[3 marks]*

.....

[Total 3 marks]

12. The scale drawing shows the positions of two towns, Ashcombe and Redmere.



Scale: 1 cm represents 5000 m

(a) Work out the real distance, in kilometres, between Ashcombe and Redmere. *[3 marks]*

On Sunday, Carla cycles directly from Ashcombe to Redmere.

Carla leaves Ashcombe at 12 50
She arrives at Redmere at 17 15

(b) Work out the time Carla takes to cycle directly from Ashcombe to Redmere. *[2 marks]*

(a) kilometres .....

(b) hours .....

minutes .....

[Total 5 marks]

13. (a) Factorise $15 - 5x$ *[1 mark]*

$d = 5p + 7r$

(b) Work out the value of p when $d = 35$ and $r = 2$ *[3 marks]*

Beads are sold in small tubs and large tubs.

There are 12 beads in a small tub.
There are 25 beads in a large tub.

Oliver buys m small tubs of beads and n large tubs of beads.

(c) (i) Write an expression, in terms of m and n, for the total number of tubs of beads Oliver buys. *[1 mark]*

(ii) Write an expression, in terms of m and n, for the total number of beads Oliver buys. *[2 marks]*

(a) .....

(b) p = ...

(c)(i) .....

(c)(ii) .....

[Total 7 marks]

14. Here is a list of the ingredients needed to make 6 muffins.

Chocolate muffins
Makes 6 muffins
60 g sugar
75 g butter
1 egg
90 g flour
65 g chocolate

Meera makes some of these muffins.
She uses 450 g of flour.

(a) How many muffins does Meera make? *[2 marks]*

Claire makes 84 of these muffins.

(b) What weight of butter does Claire use? *[2 marks]*

Meera and Claire pay a total of 624 rupees for the ingredients.
The ratio of the amount Meera pays to the amount Claire pays is 3 : 5

(c) How much does Claire pay? *[2 marks]*

(a) .....

(b) g .....

(c) rupees .....

[Total 6 marks]

15. Marcus has some wooden beads in a tin.

7 of the beads are yellow
5 of the beads are white
The rest of the beads are purple

Marcus is going to take at random a bead from the tin.

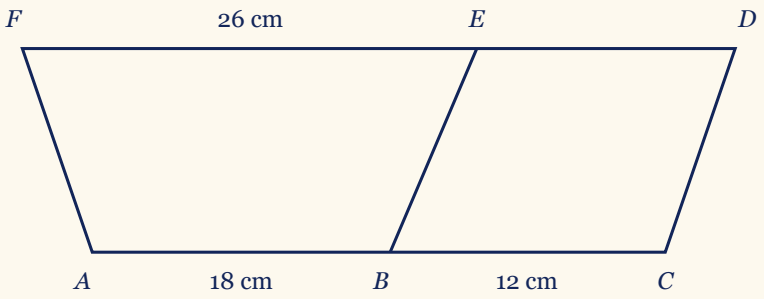
The probability that the bead is purple is $\frac{2}{5}$

Work out the number of purple beads in the tin. *[3 marks]*

.....

[Total 3 marks]

16. The diagram shows a quadrilateral $ACDF$.



Not drawn accurately

In this quadrilateral, $ABEF$ is a trapezium and $BCDE$ is a parallelogram.

$FE = 26$ cm, $AB = 18$ cm, $BC = 12$ cm

Parallelogram $BCDE$ has an area of 96 cm².

Find the area of trapezium $ABEF$. *[3 marks]*

..... cm²

[Total 3 marks]

17. (a) Factorise fully $18c - 45cd$ *[2 marks]*

(b) Solve the equation $\frac{5 - 2x}{6} = 3x - 4$

You must show clear algebraic working. *[3 marks]*

(a) .....

(b) x = ...

[Total 5 marks]

18. Express 1400 as a product of powers of its prime factors.
Show your working clearly. *[3 marks]*

.....

[Total 3 marks]

19. Work out the values of x and y that satisfy both of the simultaneous equations below.

$3x + 2y = 10$
$3x - 4y = 16$

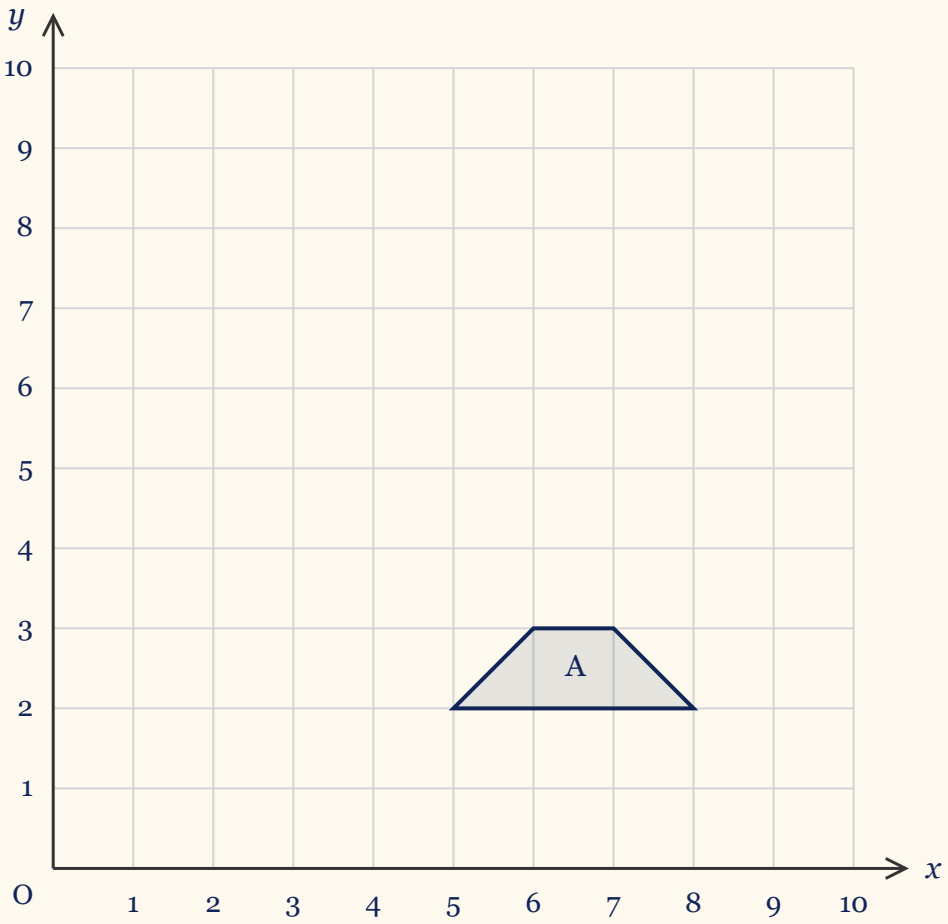
You must show clear algebraic working. *[3 marks]*

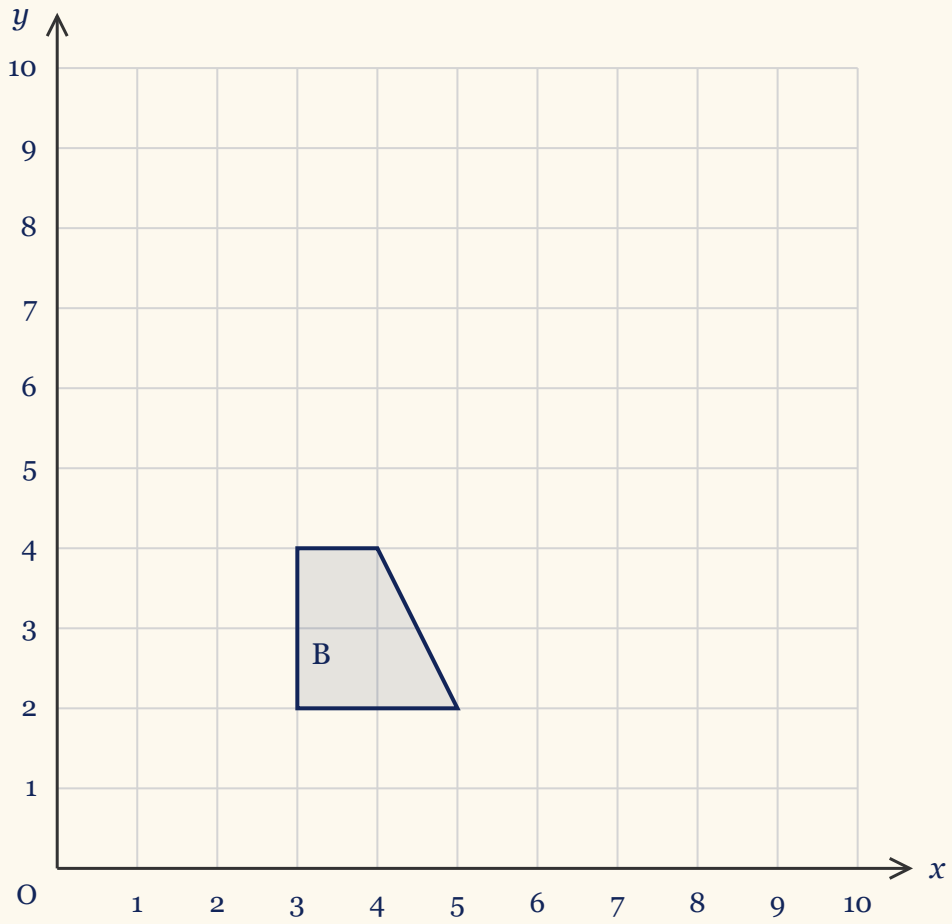
x = ...

y = ...

[Total 3 marks]

20. (a) On the grid above, draw the reflection of shape A in the line $y = x$ *[2 marks]*





(b) On the grid above, draw the enlargement of shape B with scale factor 2 and centre $(1, 1)$ *[2 marks]*

[Total 4 marks]

21. Nathan is going to lay paving slabs on a patio for a customer.
The area of the patio is 45 m²

Nathan buys one pack of paving slabs for each 1.5 m² of patio area.
Each pack of paving slabs costs £64

Nathan also buys 5 bags of jointing sand.
Each bag of jointing sand costs £12

Nathan charges the customer £$3\,000$

Work out his percentage profit.
Give your answer correct to one decimal place. *[5 marks]*

..... %

[Total 5 marks]

22. (a) Write down the value of 5^0 *[1 mark]*

$$\frac{5^9 \times 5^{-3}}{5^{-2}} = 5^k$$

(b) Work out the value of k *[2 marks]*

(c) Simplify fully $\left(2d^4e^5\right)^3$ *[2 marks]*

(a) .....

(b) k = ...

(c) .....

[Total 5 marks]

23. A silver pendant has a mass of 48.3 g
Silver has a density of 10.5 g/cm³

Calculate the volume of the pendant. *[2 marks]*

..... cm³

[Total 2 marks]

24. A list of 7 numbers has a mean of 60

A group of 3 of these numbers has a mean of 46

Work out the mean of the remaining 4 numbers. *[3 marks]*

.....

[Total 3 marks]

25. In its winter sale, a kitchen shop in Lucerne reduces the normal price of every appliance by 15%

The sale price of an espresso machine is 612 Swiss francs.

Work out the normal price of the espresso machine. *[3 marks]*

..... Swiss francs

[Total 3 marks]

26. The straight line L is parallel to the line with equation $y = 2 - 5x$
L passes through the point $(0, 6)$

Work out an equation of L *[2 marks]*

.....

[Total 2 marks]

27. The diagram shows triangle ADE and triangle CDB.

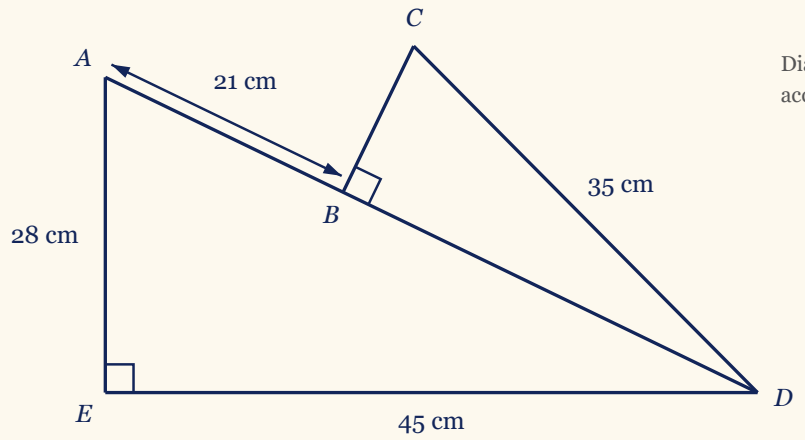


Diagram NOT accurately drawn

ABD is a straight line.
$AE = 28$ cm, $ED = 45$ cm, $AB = 21$ cm, $CD = 35$ cm
angle AED = angle $CBD = 90°$

Calculate the area of triangle CDB
Give your answer correct to 3 significant figures. *[5 marks]*

..... cm²

[Total 5 marks]

Worked Solutions & Mark Schemes

Every mark (M for method, A for accuracy) is shown, just like a real examiner.

Question 1 - Exam Solution

Understanding the Question

Given

Five whole numbers: 83, 148, 46, 229, 99
Five decimals: 0.25, 0.5, 0.46, 0.08, 0.417
The decimal 0.81
The two decimals 0.2 and 0.3
None of the five whole numbers is repeated and no two of the five decimals are equal, so each list has one order and one order only.

Find

(a) the five whole numbers written out smallest first (b) the five decimals written out smallest first (c) 0.81 written as a fraction (d) the number exactly halfway between 0.2 and 0.3

Plan the Solution

- Count the digits first. A three-digit number is bigger than any two-digit number, so that splits the list before a single digit is compared.
- Fill the shorter decimals out with zeros until all five have three decimal places, the longest one there. Once they are all the same length they can be compared like whole numbers.
- Count the decimal places in 0.81. Two places means hundredths, so the denominator is 100.
- Halfway between two numbers is the midpoint: add the two numbers and halve the total.

Worked Solution [4 marks]

> Rule - Place value: compare two numbers column by column from the left, and the first column where they differ decides which one is larger. Zeros written on the end of a decimal change nothing, and a decimal with two decimal places is a number of hundredths.

Step 1: (a) split the whole numbers by how many digits they have

$46 < 83 < 99$

$148 < 229$

$46 < 83 < 99 < 148 < 229$

(Reason: Every two-digit number is smaller than every three-digit number, so 46, 83 and 99 all come before 148 and 229. Inside each group the leading digit settles it: 4, then 8, then 9 in the tens column, and 1 before 2 in the hundreds column.)

Step 2: (b) give every decimal the same number of decimal places

$0.25 = 0.250$

$0.5 = 0.500$

$0.46 = 0.460$

$0.08 = 0.080$

$0.417 = 0.417$

(Reason: 0.417 has the most decimal places, three, so every decimal is filled out to three places. A zero written on the end of a decimal adds nothing to its value - it only records that there are no thousandths.)

Step 3: (b) compare the decimals as whole numbers of thousandths

$80 < 250 < 417 < 460 < 500$

$0.08 < 0.25 < 0.417 < 0.46 < 0.5$

(Reason: With three decimal places each decimal is a whole number of thousandths: 0.080 is 80 of them and 0.500 is 500. Whole numbers are easy to put in order, and the order they come in is the order the decimals come in.)

Step 4: (c) read the decimal as a number of hundredths

$$0.81 = \frac{8}{10} + \frac{1}{100}$$

$$0.81 = \frac{80}{100} + \frac{1}{100} = \frac{81}{100}$$

(Reason: The 8 sits in the tenths column and the 1 in the hundredths column, so together they make 81 hundredths. Two decimal places always give a denominator of 100, and since 81 and 100 share no factor, that fraction is already as simple as it goes.)

Step 5: (d) take the midpoint of the two decimals

$$\frac{0.2 + 0.3}{2} = \frac{0.5}{2} = 0.25$$

(Reason: Halfway between two numbers means the midpoint, and the midpoint is what you reach by adding the two numbers together and halving the total. That works whatever the two numbers are.)

(a) 46, 83, 99, 148, 229

(b) 0.08, 0.25, 0.417, 0.46, 0.5

(c) $\frac{81}{100}$

(d) 0.25

Verification

✓ **Check 1:** Read the answer to (a) backwards. If the list really runs smallest to largest, then read the other way it must run largest to smallest, and it must still hold the same five numbers the question printed. Backwards it reads 229, 148, 99, 83, 46 - largest first, the same five numbers, none repeated and none missing.

✓ **Check 2:** Order the decimals a second way, without lining up any decimal places. Compare each one against a landmark instead: 0.08 is less than a tenth, 0.25 is a quarter, 0.417 is a little over four tenths, 0.46 is just under a half and 0.5 is exactly a half. Those landmarks fall in that same order, so the list matches the one the padding method gave.

✓ **Check 3:** Turn the fraction back into a decimal. Dividing by 100 moves every digit two columns to the right. $\frac{81}{100} = 0.81$, which is the decimal the question printed.

✓ **Check 4:** Measure the distance from the answer to each end of the pair. $0.25 - 0.2$ and $0.3 - 0.25$ should come out the same size as each other. Both gaps come to 0.05, so 0.25 sits the same distance from 0.2 as it does from 0.3, which is what halfway means.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a) 46, 83, 99, 148, 229	**B1**	Correct answer only.	✓
(b) 0.08, 0.25, 0.417, 0.46, 0.5	**B1**	Correct answer only.	✓
(c) $\frac{81}{100}$	**B1**	Any equivalent fraction is accepted.	✓
(d) 0.25	**B1**	Allow $\frac{1}{4}$ or any equivalent.	✓

Full marks: 4/4

Question 2 - Exam Solution

Understanding the Question

Given

The seven ages, in the order they were recorded:

2 9 10 6 7 9 4

Seven values, and 7 is odd, so once they are written in order of size exactly one of them sits in the middle.

Find

(a) the mode of the ages (b) the median age (c) the range of the ages

Plan the Solution

- Write the seven ages in order of size first. The median cannot be read off until they are ordered, and ordering them also puts equal ages side by side for the mode and the smallest and largest ages at the two ends for the range.
- The mode is the age that appears most often, so count how many times each age appears. The counts have to add back up to 7.
- With 7 ages in order, the middle one is the 4th, because 3 ages sit below it and 3 sit above it.
- The range is one subtraction: the largest age take away the smallest age.

Worked Solution [4 marks]

> Rule - Mode, median and range: the mode is the value that appears most often, the median is the middle value once the data is written in order of size, and the range is largest − smallest. Only the median needs the data ordered, but ordering it once serves all three.

Step 1: put the seven ages in order of size

2 4 6 7 9 9 10

(Reason: The same seven ages the question printed, smallest first, with nothing added, dropped or altered. Part (b) awards a method mark for this ordering on its own, and it sets the other two parts up as well: the two 9s now sit side by side for part (a), and the smallest and largest ages sit at the two ends for part (c).)

Step 2: (a) count how many times each age appears

9 appears twice

$$\text{mode} = 9$$

(Reason: Reading along the ordered list, the two 9s are the only pair: 2, 4, 6, 7 and 10 each appear once and 9 appears twice, which accounts for all 7 ages. The mode is the age that appears most often, so it is the age 9 itself, never the 2 that says how many times it was recorded.)

Step 3: (b) take the middle value of the ordered list

$$\text{middle position} = \frac{7+1}{2} = 4$$

$$2 \quad 4 \quad 6 \quad 7 \quad 9 \quad 9 \quad 10$$

$$\text{median} = 7$$

(Reason: There are 7 ages, an odd number, so one of them sits exactly in the middle. Counting in from both ends at once, 2, 4 and 6 lie below it and 9, 9 and 10 lie above it, which leaves the 4th value of the ordered list on its own in the middle. The ordering has to come first: the middle of the list as it was recorded is not the median.)

Step 4: (c) take the smallest age from the largest

$$\text{range} = 10 - 2 = 8$$

(Reason: The ordered list has the largest age, 10, at one end and the smallest, 2, at the other, and the range is the gap between them. It measures how spread out the ages are, so it is a single number, 8, and not the pair 2 to 10.)

(a) 9

(b) 7

(c) 8

Verification

- ✓ **Check 1:** Go back to the list as the question printed it and tally the ages there, with nothing put in order. If the mode is right, one age appears more often than any other and the tallies add back up to seven. 9 appears twice and 2, 4, 6, 7 and 10 appear once each, which is $2 + 5 = 7$ ages altogether, so 9 is the only age recorded more than once.
- ✓ **Check 2:** Write the ages in order the other way round, largest first, and count to the same position. The mark scheme accepts either ordering, so the middle value has to come out the same counting from either end. Largest first the list reads $10 \quad 9 \quad 9 \quad 7 \quad 6 \quad 4 \quad 2$, and the 4th value from that end is 7, with 3 ages on each side of it.
- ✓ **Check 3:** Find the range without subtracting. Count up in ones from the smallest age to the largest, and separately add up the gaps between neighbouring ages in the ordered list, which must come to the same total. Counting 2 up to 10 takes 8 steps, and the six gaps $2 + 2 + 1 + 2 + 0 + 1$ also come to 8.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a) 9	**B1**	Correct answer only.	✓
(b) 2 4 6 7 9 9 10 or 10 9 9 7 6 4 2	**M1**	For ordering the numbers. Allow one error or one omission.	✓
(b) 7	**A1**	A correct answer scores full marks, unless it comes from obviously incorrect working.	✓
(c) 8	**B1**	Correct answer only.	✓

Full marks: 4/4

Question 3 - Exam Solution

Understanding the Question

Given

A 3-D shape drawn in perspective, with the three edges at its hidden corner dashed.
Six quadrilaterals, A to F, drawn on a square grid.

Find

The mathematical name of the 3-D shape.
The number of edges the 3-D shape has.
The two quadrilaterals that are congruent.
The quadrilateral that has no lines of symmetry.

Plan the Solution

- Read the solid off the drawing: two equal square faces joined by four equal edges.
- Count the edges in groups, so that the dashed ones are not left out.
- Congruent means the same shape and the same size, so measure the sides of each quadrilateral and look for two that match.
- A line of symmetry folds a shape exactly onto itself, so test each quadrilateral for a fold line.

Worked Solution [4 marks]

A cube has 6 square faces, 8 vertices and 12 edges. Congruent shapes have exactly the same size and shape, so one can be turned, or turned over, to fit exactly on the other. A line of symmetry folds a shape exactly onto itself.

Step 1: name the solid

(Reason: Every face of the drawing is a square and every edge is the same length, so the solid is a cube. A cube is the cuboid whose length, width and height are all equal, which is why a mark scheme will also accept cuboid or square prism here.)

Step 2: count the edges

$4 + 4 = 8$

$8 + 4 = 12$

(Reason: Count in groups so that none is missed. The square face at the front has 4 edges and the square face behind it has 4 more, which is 8. Then 4 edges join the two faces, one at each corner. Only three of those four are drawn solid: the fourth runs back to the hidden corner and is dashed, so it is the one that gets forgotten.)

Step 3: find the congruent pair

$\sqrt{1^2 + 3^2} = \sqrt{10}$

(Reason: B and D both have parallel sides of 3 squares and 1 square, a height of 3 squares, and two sloping sides that each run 1 square across and 3 squares up. Every side of one matches a side of the other, and D is simply B turned over, which changes nothing about its size. F has sloping sides of $\sqrt{10}$ squares as well, but its parallel sides are 7 and 1, so it is not congruent to either of them.)

Step 4: look for a line of symmetry

$\sqrt{1^2 + 2^2} = \sqrt{5}$

$\sqrt{2^2 + 2^2} = \sqrt{8}$

(Reason: Each of the six is a trapezium, and a trapezium folds onto itself only when its two sloping sides are equal. In C the left side rises 2 squares over 1 square, so it measures $\sqrt{5}$ squares, while the right side falls 2 squares over 2 squares, so it measures $\sqrt{8}$ squares. Those are not equal, so there is no fold line. The other five all have equal sloping sides, so each of them has one line of symmetry.)

(a) (i) cube

(a) (ii) 12

(b) B and D

(c) C

Verification

✓ **Check 1:** Count something else about the same solid. A cube has 8 corners and 6 faces, and for any solid of this kind $V - E + F = 2$. $8 - 12 + 6 = 2$, so 12 edges is right.

✓ **Check 2:** Move B onto D instead of measuring. Turn B over in a horizontal line, then slide it 3 squares to the left, so that every corner (x, y) goes to $(x - 3, 11 - y)$. $(5, 9) \to (2, 2)$, $(6, 9) \to (3, 2)$, $(7, 6) \to (4, 5)$, $(4, 6) \to (1, 5)$ and those four points are exactly the corners of D.

✓ **Check 3:** Test C a second way. A fold line of a trapezium has to pass through the midpoint of both parallel sides, so compare the two midpoints. The long side runs from 9 to 13, with midpoint 11; the short side runs from 10 to 11, with midpoint 10.5. They are not above one another, so no fold line exists.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a) (i) Cube	**B1**	Allow a misspelling. Allow cuboid. Allow prism or square prism or rectangular prism.	✓
(a) (ii) 12	**B1**	cao	✓
(b) B and D	**B1**	Allow D and B (or b and d etc).	✓
(c) C	**B1**	Allow c.	✓

Full marks: 4/4

Question 4 - Exam Solution

Understanding the Question

Given

(a) A volume of $5\,000$ millilitres.
(b) A length of 3 metres and a length of 85 centimetres.

Find

(a) That same volume written in litres. (b) The difference between the two lengths, given in centimetres.

Plan the Solution

- One litre is $1\,000$ millilitres, so part (a) is a single division.

- Part (b) gives the two lengths in different units, and lengths can only be subtracted once they are in the same unit.
- The answer is wanted in centimetres, so change the metres into centimetres and do the subtraction there.

Worked Solution [3 marks]

> Metric conversions: 1 litre is 1 000 millilitres, and 1 metre is 100 centimetres. Multiply when moving to the smaller unit, divide when moving to the larger one.

Step 1: divide the millilitres by $1\,000$

$$1 \text{ litre} = 1\,000 \text{ ml}$$

$$\frac{5\,000}{1\,000} = 5$$

(Reason: A litre is the larger unit, so the number must come out smaller. $5\,000$ millilitres fills five one-litre bottles exactly.)

Step 2: write the 3 metres in centimetres

$$1 \text{ m} = 100 \text{ cm}$$

$$3 \times 100 = 300$$

(Reason: A centimetre is the smaller unit, so the number must come out bigger. Multiplying by 100 carries the metres into centimetres.)

Step 3: subtract the shorter length from the longer one

$$300 \text{ cm} - 85 \text{ cm} = 215 \text{ cm}$$

(Reason: Both lengths are now in centimetres, so they subtract directly and the difference is already in the unit the question asks for.)

(a) 5 litres

(b) 215 centimetres

Verification

✓ **Check 1:** Turn the answer to part (a) back into millilitres by multiplying by $1\,000$. $5 \times 1\,000 = 5\,000$ millilitres, which is the volume the question gives.

✓ **Check 2:** Do part (b) in metres instead. 85 centimetres is 0.85 metres, so subtract in metres and convert the difference afterwards. $3 - 0.85 = 2.15$ metres, and $2.15 \times 100 = 215$ centimetres, the same answer.

✓ **Check 3:** Add the difference back on to the shorter length and see whether the longer length comes back. $85 + 215 = 300$ centimetres, which is the 3 metres the question gives.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a) 5	**B1**	For the correct answer.	✓
(b) $3 \times 100\ (= 300)$ or $3 - 0.85\ (= 2.15)$ or, with digits 300, either $300 - 85$ or $85 - 300$	**M1**	For conversion to centimetres, or a method to work out the difference in metres, or a method to find the difference in centimetres using their converted 300. For digits 300, allow 30, 300, 3 000, 0.3, 0.03 and so on, but not 3.	✓
215	**A1**	Allow -215. A correct answer scores full marks unless it comes from obvious incorrect working.	✓

Full marks: 3/3

Question 5 - Exam Solution

Understanding the Question

Given

(a) The sum $a + a + a + a + a$, which adds the same letter over and over.
(b) The product $b \times c \times 7$, which multiplies two letters and a number.
(c) The equation $5d = 40$.

Find

(a) That sum written in its simplest form.
(b) That product written in its simplest form.
(c) The value of d that makes the equation true.

Plan the Solution

- Part (a) adds one letter to itself several times, so count how many lots of a there are and write that count in front of the letter.
- Part (b) only multiplies, and multiplying can be done in any order, so move the 7 to the front and write the letters straight after it.
- Part (c) has d multiplied by 5, so undo that multiplication by dividing both sides by 5.

Worked Solution [3 marks]

> Algebra shorthand: repeated addition of one letter is written as a count in front of that letter, so $a + a = 2a$; a product is written with its number first and its letters after it, so $3 \times p \times q$ is written $3pq$; and an equation stays balanced when the same thing is done to both sides.

Step 1: count the a terms in part (a)

$$a + a + a + a + a = 5a$$

(Reason: There are five separate lots of a being added. Adding a letter to itself is counted, not multiplied, so the count is written in front of the letter, where it is called the coefficient.)

Step 2: put the 7 in front in part (b)

$$b \times c \times 7 = 7 \times b \times c$$

$$7 \times b \times c = 7bc$$

(Reason: Multiplying can be done in any order, so the 7 moves to the front. A number multiplying letters is written next to them, so no multiplication signs are needed. Writing the letters the other way round, as $7cb$, is equally correct.)

Step 3: divide both sides by 5 in part (c)

$$5d = 40$$

$$\frac{5d}{5} = \frac{40}{5}$$

$$d = 8$$

(Reason: $5d$ means five lots of d, so dividing both sides by 5 leaves d on its own and keeps the two sides equal.)

(a) $5a$

(b) $7bc$

(c) $d = 8$

Verification

✓ **Check 1:** Put $a = 3$ into the sum the question gives, and into the answer, and see whether the two agree. $3 + 3 + 3 + 3 + 3 = 15$ and $5 \times 3 = 15$, so the simplified form gives the same value as the sum it came from.

✓ **Check 2:** Put $b = 2$ and $c = 4$ into the product the question gives, and into the answer. $2 \times 4 \times 7 = 56$ and $7 \times 2 \times 4 = 56$, so reordering the factors has not changed the

value.

✓ **Check 3:** Put $d = 8$ back into the equation the question gives. $5 \times 8 = 40$, which is the right-hand side, so $d = 8$ is the solution.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a) $5a$	**B1**	For the correct answer.	✓
(b) $7bc$	**B1**	Or equivalent, for example $7cb$.	✓
(c) 8	**B1**	For the correct answer.	✓

Full marks: 3/3

Question 6 - Exam Solution

Understanding the Question

Given

A number machine with two boxes: the first multiplies by 4, the second subtracts 15.
The input enters the first box, and whatever leaves the second box is the output.

Find

(a) the output when the input is 10 (b) the output when the input is -2

Plan the Solution

- Follow the arrows from left to right. The number that leaves the first box is the number that enters the second.
- Multiply by 4 first, then subtract 15. The machine fixes that order, so the two boxes cannot be swapped.
- Part (b) starts below zero, so carry the minus sign through the multiplication before subtracting.

Worked Solution [2 marks]

> Rule - Read a number machine left to right: each box acts on the number that reaches it, so the output is $4 \times \text{input} - 15$.

Step 1: (a) The first box multiplies by 4

$10 \times 4 = 40$

(Reason: the input 10 reaches the first box, so that box acts on it before anything else happens)

Step 2: (a) The second box subtracts 15

$40 - 15 = 25$

(Reason: the number leaving the first box, 40, is the number entering the second)

Step 3: (b) The first box multiplies by 4 again

$-2 \times 4 = -8$

(Reason: four lots of a negative number is negative, so the minus sign travels through the multiplication)

Step 4: (b) The second box subtracts 15

$-8 - 15 = -23$

(Reason: taking 15 away from a number that is already below zero moves it further below zero)

(a) 25

(b) -23

Verification

✓ **Check 1:** Run part (a) backwards through the machine: undo the subtraction by adding 15, then undo the multiplication by dividing by 4. $\dfrac{25 + 15}{4} = 10$, the input part (a) started from

✓ **Check 2:** Do the same for part (b), starting from -23. $\dfrac{-23 + 15}{4} = -2$, the input part (b) started from

✓ **Check 3:** Treat the whole machine as one calculation, $4n - 15$, and substitute each input into it. $4 \times 10 - 15 = 25$ and $4 \times (-2) - 15 = -23$

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a)	**B1**	25 cao	✓
(b)	**B1**	-23 cao	✓

Full marks: 2/2

Question 7 - Exam Solution

Understanding the Question

Given

Douglas sells 80 pies altogether and takes £176 for them.
$\frac{1}{5}$ of the pies are large, and every large pie is priced at £3 on its own.
The pies that are left over are the small ones, and they are all the same price as each other.

Find

the cost of one small pie, in pounds

Plan the Solution

- Count the large pies first: $\frac{1}{5}$ of 80 says how many there are, and every pie that is not large is small.
- Work out what the large pies bring in on their own, then take that away from the total takings to leave what the small pies brought in.
- Share the small pies' takings equally between the small pies. That is a division, and the divisor is the number of SMALL pies, not the number of pies on the stall.

Worked Solution [4 marks]

Rule - The takings split into two lots that make the whole:
large takings + small takings = 176, so taking one lot away leaves the other.
Sharing a lot equally is a division: $\text{price of one pie} = \frac{\text{takings}}{\text{number of those pies}}$.

Step 1: How many of the pies are large

$$\frac{1}{5} \times 80 = 16$$

(Reason: one fifth means splitting the 80 pies into five equal groups of 16 and taking one of those groups)

Step 2: How many of the pies are small

$$80 - 16 = 64$$

(Reason: every pie is either large or small, so the small ones are whatever is left of the 80)

Step 3: What the large pies bring in

$$16 \times 3 = 48$$

(Reason: 16 large pies at £3 each, so this part of the takings can be worked out without knowing anything about the small pies)

Step 4: What the small pies bring in

$$176 - 48 = 128$$

(Reason: the two lots together make the whole £176, so taking the large pies' £48 away leaves the small pies' share of the takings)

Step 5: Share those takings between the small pies

$$\frac{128}{64} = 2$$

(Reason: the 64 small pies are all the same price, so the £128 they brought in divides equally between them)

£2

Verification

✓ **Check 1:** Rebuild the takings from the two prices. If one small pie really costs £2, the 16 large pies and the 64 small pies must together bring in the total Douglas took.
$16 \times 3 + 64 \times 2 = 48 + 128 = 176$, the total on the paper

✓ **Check 2:** Use the average price instead of the counts. Douglas takes £176 for 80 pies, so the average pie costs $\frac{176}{80} = 2.2$, and each large pie sits 0.8 above that average.
$16 \times 0.8 = 12.8$ above average altogether, spread over the 64 small pies gives $\frac{12.8}{64} = 0.2$ below average each, so $2.2 - 0.2 = 2$

✓ **Check 3:** Work in batches of five pies, which is the smallest batch with the right mix: one large and four small. The 80 pies make 16 such batches. $\frac{176}{16} = 11$ per batch, and $11 - 3 = 8$ of that is the four small pies, so $\frac{8}{4} = 2$

Mark Scheme Breakdown

Step	Mark	Description	Got it?
$\frac{1}{5} \times 80\ (= 16)$ or $\left(1 - \frac{1}{5}\right) \times 80\ (= 64)$ oe	M1	for a method to find the number of large pies or the number of small pies	✓
"16" $\times 3\ (= 48)$	M1	for a method to find the total cost of the large pies. The quotation marks are the scheme's own: the candidate's number of large pies from the row above may be used here.	✓
176 – "48" $(= 128)$	M1	for a method to find the total cost of the small pies. The quotation marks are the scheme's own: the candidate's total cost of the large pies from the row above may be used here.	✓
Correct answer scores full marks (unless from obvious incorrect working)	A1	2	✓

Full marks: 4/4

Question 8 - Exam Solution

Understanding the Question

Given

Gordon is booking the apartment for 7 nights, and every night costs the same as every other night.

Find

the total cost of the apartment and the tax for 7 nights, in euros

The apartment on its own costs 150 euros for 2 nights.
A tourist tax of 5 euros is charged for each night, on top of what the apartment costs.

Plan the Solution

- The 150 euros pays for 2 equal nights, so halving it gives what one night of the apartment costs. That is the only rate the question does not hand you.
- Scale that nightly cost up to 7 nights to get what the apartment costs on its own.
- The tax is a separate charge made once for every night, so work it out over 7 nights as well, then add the two amounts. Watch which count of nights each part uses: 2 belongs to the price Gordon was quoted, and 7 belongs to the stay.

Worked Solution [3 marks]

> Rule - A cost that is the same every night is shared out equally: $\text{cost of one night} = \dfrac{\text{cost of several nights}}{\text{number of those nights}}$. A charge made once per night is multiplied by the number of nights, and a total made of two separate charges is their sum.

Step 1: What the apartment costs for one night

$$\frac{150}{2} = 75$$

(Reason: the 150 euros pays for 2 nights that cost the same as each other, so one night is half of it)

Step 2: What the apartment costs for the whole stay

$$75 \times 7 = 525$$

(Reason: every night of the stay costs the same 75 euros, so 7 nights cost seven times as much)

Step 3: The tax for the whole stay

$$5 \times 7 = 35$$

(Reason: the tax is charged once for every night that Gordon stays, and the stay is 7 nights long, not the 2 nights the quoted price happens to cover)

Step 4: Add the two charges together

$$525 + 35 = 560$$

(Reason: Gordon pays for the apartment and pays the tax, so the total is the 525 euros for the apartment plus the 35 euros of tax)

560 euros

Verification

✓ **Check 1:** Price one whole night first, tax included, instead of keeping the two charges apart. One night costs $75 + 5 = 80$ euros, and the stay is 7 of those nights. $80 \times 7 = 560$, the same total by a route that never forms 525 or 35

✓ **Check 2:** Scale the quoted package instead of dividing it. Two nights cost $150 + 5 \times 2 = 160$ euros once the tax on those two nights is added, and 7 nights is 3.5 such packages. $160 \times 3.5 = 560$, so no nightly rate is needed to reach the total

✓ **Check 3:** Work backwards from the answer. Take the tax off the total, then share what is left between the nights and see whether it rebuilds the price the paper quotes. $560 - 35 = 525$, then $\frac{525}{7} = 75$ a night, and $75 \times 2 = 150$ euros for two nights, which is the figure Gordon was given

Mark Scheme Breakdown

Step	Mark	Description	Got it?
$\frac{150}{2}$ $(= 75)$ or 5×7 $(= 35)$ or $\frac{150 + 5 \times 2}{2}$ $(= 80)$	M1	for a method to find the cost of the apartment without tax for 1 night or for a method to find the total cost of the tax for 7 nights or for a method to find the total cost of the apartment and the tax for 1 night	✓
$7\times$ "75" + "35" $(= 525 + 35)$ or ("75" $+ 5) \times 7$ or "80" $\times 7$	M1	for a complete method to find the total cost of the apartment and the tax for 7 nights. The quotation marks are the scheme's own: the candidate's own 75, 35 or 80 from the row above may be used here.	✓
Correct answer scores full marks (unless from obvious incorrect working)	A1	560	✓

Full marks: 3/3

Question 9 - Exam Solution

Understanding the Question

Given

(a) One food item from C, F or P, and one drink from M, J or T.
(b) Cherries shared between Yusuf and Rhys in the ratio $3 : 4$.

Find

(a) Every possible food-and-drink combination, with none missing and none repeated. (b) The fraction of the cherries that Rhys gets.

Plan the Solution

- (a) Hold the food item fixed and run through all three drinks before moving on to the next food item. Working in that order is what stops a combination being missed.
- (a) Then count what the finished list ought to hold: 3 food items, each of them with 3 drinks.
- (b) Add the parts of the ratio to find how many equal shares the cherries are cut into, then put Rhys's parts over that total.

Worked Solution [3 marks]

Rule - Systematic listing: fix the first choice, run through every second choice, then move on to the next first choice. Rule - Ratio to fraction: in a share in the ratio $a : b$, the second person's fraction of the whole is $\dfrac{b}{a+b}$.

(a) Pair the croissant with each drink in turn

$CM,\ CJ,\ CT$

(Reason: The food item stays at C while only the drink changes, so all three croissant combinations come out together and none of them can be forgotten.)

(a) Repeat for the fruit, and then for the porridge

$FM,\ FJ,\ FT$

$PM,\ PJ,\ PT$

(Reason: The same three drinks are on offer whichever food item is picked, so every food item contributes 3 combinations of its own.)

(a) Check that nothing has been missed

$3 \times 3 = 9$

(Reason: There are 3 food items and, for each one of them, 3 drinks, so the finished list must hold that many combinations - with no repeats in it and nothing extra.)

(b) Count the equal parts in the ratio

$3 + 4 = 7$

(Reason: The ratio $3 : 4$ cuts the cherries into 3 parts for Yusuf and 4 parts for Rhys, which is 7 equal parts altogether.)

(b) Put Rhys's parts over the total number of parts

$$\frac{4}{3+4} = \frac{4}{7}$$

(Reason: Rhys takes 4 of the 7 equal parts. A fraction of the whole always carries the number of equal parts underneath, not the other person's share.)

(a) $CM, CJ, CT, FM, FJ, FT, PM, PJ, PT$

(b) $\frac{4}{7}$

Verification

✓ **Check 1:** Count the boxed list, and count how often each letter appears in it. The list holds 9 combinations, and each of C, F and P appears 3 times, as does each of M, J and T.

✓ **Check 2:** Rebuild the list the other way round, drink first: all the M combinations, then all the J combinations, then all the T combinations. CM, FM, PM, CJ, FJ, PJ, CT, FT, PT - the same nine pairs in a different order, so none was missed and none was written twice.

✓ **Check 3:** Test the fraction on a number of cherries that divides exactly: share 70 cherries in the ratio $3 : 4$. One part is 10, so Yusuf gets 30 and Rhys gets 40, and $\frac{40}{70} = \frac{4}{7}$.

✓ **Check 4:** Add the two shares. Yusuf's fraction of the cherries and Rhys's fraction of the cherries must make one whole between them. $\frac{3}{7} + \frac{4}{7} = 1$

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a) $CM, CJ, CT, FM, FJ, FT, PM, PJ, PT$	**B2**	for correct outcomes listed with no repeats and no extras	✓
(a) partial credit	**B1**	for 5, 6, 7 or 8 correct outcomes listed, ignore repeats and ignore extras or for 9 correct outcomes listed, ignore repeats and ignore extras	✓

Step	Mark	Description	Got it?
(b) $\frac{4}{7}$	**B1**	oe	✓
(b) what oe accepts here	**Note**	oe is short for or equivalent: any fraction equal to $\frac{4}{7}$ scores the mark, for example $\frac{8}{14}$ or $\frac{40}{70}$.	✓

Full marks: 3/3

Question 10 - Exam Solution

Understanding the Question

Given

(a) A conversion graph between miles and kilometres. The miles axis runs from 0 to 30 and the kilometres axis runs from 0 to 50, and every small square is one unit. (b) Claire is paid $0.80 for every kilometre she drives, and one delivery round paid her $19.20 altogether.

Find

(a) 25 miles, written in kilometres. (b) The number of miles Claire drove on that round.

Plan the Solution

- (a) Go up from the miles axis to the line, then turn and go straight across to the kilometres axis, and read the value there.
- (b) The money comes first. Every kilometre is worth the same $0.80, so the pay tells you how many kilometres she drove.
- (b) Then use the same graph the other way round: across from the kilometres axis to the line, then down to the miles axis.

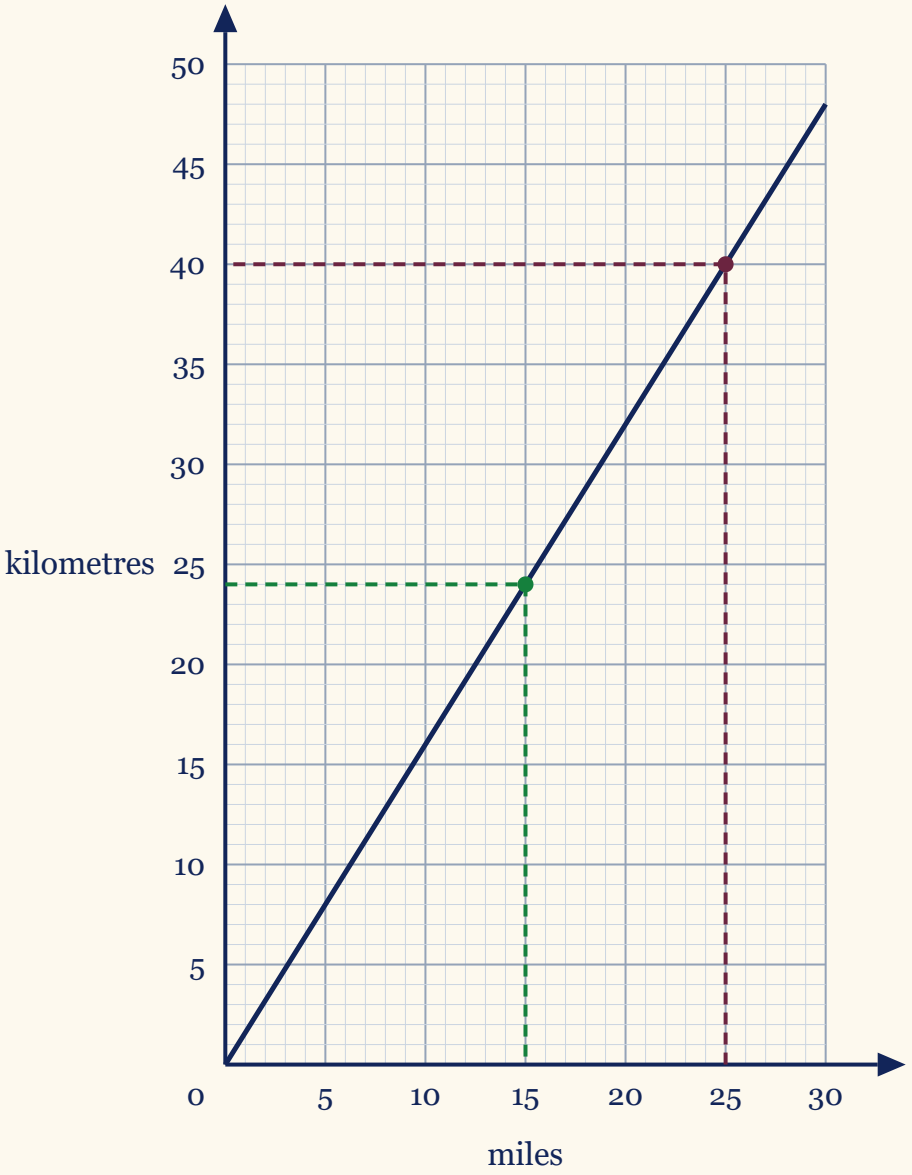
Worked Solution [3 marks]

Rule - Reading a conversion graph: start on the axis whose value you know, go to the line, then turn and go to the axis you want. Rule - A fixed rate: the number of kilometres is

$$\frac{\text{total pay}}{\text{pay for one kilometre}}.$$

(a) Find 25 on the miles axis and go straight up to the line

25 miles



(Reason: The miles axis is the horizontal one, so 25 miles is a point along the bottom. It is one of the numbered lines, so there are no squares to count before you start.)

(a) Turn and read across to the kilometres axis

$(25,\ 40)$

(Reason: Going straight across from the point on the line meets the kilometres axis at the numbered line 40, so the point on the line is $(25,\ 40)$ and 25 miles is 40 kilometres.)

(b) Turn the pay into kilometres

$$\frac{19.20}{0.80} = 24$$

(Reason: Every kilometre driven is worth $0.80, so the number of kilometres is how many lots of 0.80 there are in 19.20. That is a division, and it is the step the mark scheme gives the method mark for.)

(b) Go across from 24 on the kilometres axis to the line

24 km

(Reason: 24 is not one of the numbered lines. Each small square is 1 kilometre, so 24 is the line one square below 25. Go across from there until you meet the graph.)

(b) Read down to the miles axis

(15, 24)

(Reason: Dropping straight down from that point on the line lands on 15 on the miles axis, so 24 kilometres is 15 miles - the distance Claire drove.)

(a) 40 kilometres

(b) 15 miles

Verification

✓ **Check 1:** Build the pay back up from the kilometres: 24 kilometres at $0.80 for each one. $0.80 \times 24 = 19.20$, which is exactly what she was paid.

✓ **Check 2:** Convert the answer forwards instead of backwards. Part (a) reads 25 miles as 40 kilometres, so one mile is 1.6 kilometres. $1.6 \times 15 = 24$ kilometres, which is the number of kilometres the pay gave.

✓ **Check 3:** Compare the two readings. Both points sit on the same straight line through the origin, so the miles and the kilometres must be in the same ratio at both of them. $\frac{15}{25} = \frac{24}{40}$, and both sides come to 0.6.

✓ **Check 4:** Check the size of the answer. A mile is longer than a kilometre, so the same journey must come to fewer miles than kilometres. 15 miles against 24 kilometres, which is the way round it should be.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a) 40	**B1**	for 40	✓

Step	Mark	Description	Got it?
(b) $\frac{19.20}{0.80}$ $(= 24)$ oe	**M1**	for a method to find the number of kilometres she drove	✓
(b) 15	**A1**	cao	✓
(b) what the printed scheme adds beside the answer	**Note**	Correct answer scores full marks (unless from obvious incorrect working)	✓
(b) what oe and cao accept here	**Note**	oe is short for or equivalent, so any correct method for dividing the total pay by the pay for one kilometre earns the M1 - counting up in lots of 0.80 as far as 19.20 earns it just as the division does. cao is short for correct answer only, so the A1 needs 15 itself.	✓

Full marks: 3/3

Question 11 - Exam Solution

Understanding the Question

Given

The bar chart has three bars: won is 5 squares tall, drew is 7 squares tall and lost is 4 squares tall.
A win is worth 3 points, a draw is worth 1 point and a loss is worth 0 points.
The team drew 14 matches.
The vertical axis carries no numbers, so the scale is not given directly.

Find

The total number of points the team gained.

Plan the Solution

- The vertical axis has no numbers on it, so the scale has to come from the one bar the question tells us about.
- The drew bar is 7 squares tall and stands for 14 matches, which fixes what one square is worth.

- Use that scale to read the won bar and the lost bar.
- Multiply each number of matches by the points that result is worth, then add the three totals.

Worked Solution [3 marks]

> Rule - Reading an unnumbered scale: divide the value you are given by the height of its own bar in squares to find what one square stands for, then read every other bar with that same scale.

Step 1: find what one square on the vertical axis stands for

$$\frac{14}{7} = 2$$

(Reason: The drew bar is 7 squares tall and the team drew 14 matches, so 7 squares stand for 14 matches and one square stands for 2 matches.)

Step 2: read the won bar and the lost bar

won: $5 \times 2 = 10$

lost: $4 \times 2 = 8$

(Reason: The won bar is 5 squares tall and the lost bar is 4 squares tall, and every square is worth 2 matches.)

Step 3: turn each result into points

from wins: $10 \times 3 = 30$

from draws: $14 \times 1 = 14$

from losses: $8 \times 0 = 0$

(Reason: A win is worth 3 points, a draw is worth 1 point and a loss is worth 0 points, so each number of matches is multiplied by its own points value.)

Step 4: add the three totals

$30 + 14 + 0 = 44$

(Reason: Adding the points from the wins, the draws and the losses gives the total the team gained.)

44 points

Verification

✓ **Check 1:** Count matches instead of points. The three bars are 5, 7 and 4 squares tall, which is 16 squares in all at 2 matches a square. $16 \times 2 = 32$ matches, and separately $10 + 14 + 8 = 32$

✓ **Check 2:** Price a whole square of each result instead. A square of wins is worth $3 \times 2 = 6$ points, a square of draws is worth $1 \times 2 = 2$ points, and a square of losses is worth nothing. $5 \times 6 + 7 \times 2 = 44$

✓ **Check 3:** Take the scale out of it, as the mark scheme allows. The won bar is $\frac{5}{7}$ of the drew bar, so the wins come straight from the 14 matches. $\frac{5}{7} \times 14 = 10$ wins, so $3 \times 10 + 14 = 44$

Mark Scheme Breakdown

Step	Mark	Description	Got it?
$\frac{14}{7}\ (= 2)$ or $\frac{5}{7} \times 14\ (= 10)$ or $\frac{4}{7} \times 14\ (= 8)$ or any correct value marked on the vertical axis	**M1**	for working with the scale	✓
their $10 \times 3\ (= 30)$ or $5 \times 3 + 7 \times 1\ (= 15 + 7 = 22)$ or $5 \times 3 + 14\ (= 15 + 14 = 29)$	**M1**	for a method to find the number of points won, or for a method to work out the total number of points using a vertical scale of 1 match per cm. The candidate's own value from the first mark may be used here - that is what the printed scheme's quotation marks mean.	✓
MoM1 is possible	**Note**	The second method mark can be earned even when the first is not.	✓
44	**A1**	Correct answer scores full marks (unless from obvious incorrect working).	✓

Full marks: 3/3

Question 12 - Exam Solution

Understanding the Question

Given

A scale drawing showing Ashcombe and Redmere, joined by a straight line.
Scale: 1 cm represents 5000 m.
Carla leaves Ashcombe at 12 50 and arrives at Redmere at 17 15.

Find

(a) The real distance between the two towns, in kilometres. (b) How long the journey takes, in hours and minutes.

Plan the Solution

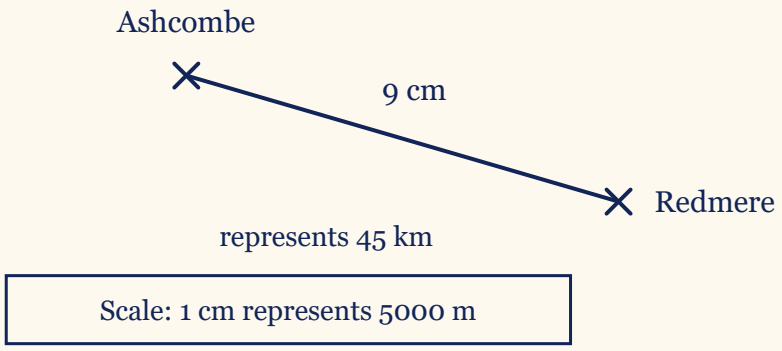
- Measure the line between the two crosses with a ruler. It is 9 cm long.
- Use the scale to turn that measurement into a real distance in metres.
- Change the metres into kilometres, because part (a) asks for kilometres.
- For part (b), count on from 12 50: first to the next whole hour, then in whole hours, then the last few minutes.

Worked Solution [5 marks]

> Rule - Scale drawing: multiply the measured length by whatever 1 cm represents, and the answer is the real distance. Rule - Elapsed time: count on from the start time in stages, never subtracting clock times as if they were ordinary numbers.

Step 1: Measure the line on the scale drawing

9 cm



(Reason: A ruler laid across the two crosses reads 9 cm. The mark scheme allows anything from 8.8 cm to 9.2 cm, so a reading a little either side of 9 still earns the mark.)

Step 2: Use the scale to get the real distance in metres

$9 \times 5000 = 45\,000$

(Reason: Every 1 cm on the drawing stands for 5000 m on the ground, so 9 cm stands for 9 lots of 5000 m.)

Step 3: Change the metres into kilometres

$$\frac{45\,000}{1000} = 45$$

(Reason: There are 1000 m in 1 km, so dividing the number of metres by 1000 turns the answer into kilometres, which is the unit part (a) asks for.)

Step 4: Count on from 12 50 to the next whole hour

$$60 - 50 = 10$$

(Reason: An hour is 60 minutes and the clock already reads 50 minutes past, so 10 more minutes reach 13 00.)

Step 5: Count on in whole hours to 17 00

$$17 - 13 = 4$$

(Reason: From 13 00 to 17 00 is 4 complete hours, with no odd minutes in them.)

Step 6: Add the minutes from each end

$$10 + 15 = 25$$

(Reason: The 10 minutes before 13 00 and the 15 minutes after 17 00 give 25 minutes, on top of the 4 whole hours.)

(a) 45 kilometres

(b) 4 hours 25 minutes

Verification

✓ **Check 1:** Take the other way through the scale. 5000 m is 5 km, so 1 cm on the drawing stands for 5 km, and the measured length is multiplied by that instead. $9 \times 5 = 45$ kilometres, the same answer.

✓ **Check 2:** Work backwards from the answer. 45 km is 45 000 m, and each centimetre on the drawing stands for 5000 m, so dividing must give back the length that was measured. $\frac{45\,000}{5000} = 9$ centimetres, which is the length on the drawing.

✓ **Check 3:** Count part (b) a different way: in minutes after midnight. 12 50 is 770 minutes after midnight and 17 15 is 1035 minutes after midnight. $1035 - 770 = 265$ minutes, and $4 \times 60 + 25 = 265$, so the two ways agree.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a) Measure the line and use the scale	**M1**	for measuring the line (a tolerance of ± 0.2 cm, so 8.8 cm to 9.2 cm) and using the scale, that is a measurement from 8.8 to 9.2 times 5000, giving $44\,000$ to $46\,000$, or $\frac{5000}{1000} = 5$, or $\frac{\text{any seen value}}{1000}$, or for an attempt to convert a value into kilometres. Do not allow $\frac{\text{any seen value}}{1000}$ if it is clearly linked to the wrong unit, eg mm.	✓
(a) Use of scale and conversion	**M1**	for use of scale and conversion: their $44\,000$ to $46\,000$ divided by 1000, or 8.8 to 9.2 times their 5. The printed scheme sets those values in quotation marks, which means the candidate's own earlier values may be used here.	✓
(a) The answer	**A1**	for 45. Allow 44 to 46, and it must agree with their measurement. A correct answer scores full marks unless it comes from obviously incorrect working.	✓
(b) The time from 12 50 to 17 15	**B2**	for 4 (hours) and 25 (minutes).	✓
(b) Partial credit	**(B1)**	for 4 (hours) or 25 (minutes).	✓

Full marks: 5/5

Question 13 - Exam Solution

Understanding the Question

Given

The expression $15 - 5x$.
The formula $d = 5p + 7r$, with $d = 35$ and $r = 2$.
12 beads in a small tub, and 25 beads in a large tub.

Find

(a) $15 - 5x$ written as a factor outside a bracket. (b) The value of p. (c)(i) An expression for the total number of tubs. (c)(ii) An expression for the total number of beads.

Oliver buys m small tubs and n large tubs.

Plan the Solution

- For part (a), find the largest number that divides both 15 and $5x$, and take it outside a bracket.
- For part (b), put $d = 35$ and $r = 2$ into the formula, then undo the operations around p one at a time.
- For part (c)(i), count the tubs themselves: a tub counts once whether it is small or large, so the sizes play no part.
- For part (c)(ii), count the beads instead: each small tub carries 12 and each large tub carries 25, so multiply first and add afterwards.
- Both answers to part (c) stay as expressions, because m and n are never given a value.

Worked Solution [7 marks]

> Rule - Factorising: take the highest common factor outside the bracket, so that $ab + ac = a(b + c)$. Rule - Substituting: replace every letter whose value is known, then rearrange until the letter you want stands alone. Rule - Forming an expression: an amount for each item is a multiplication, and separate groups are added.

Step 1: Find the highest common factor of 15 and $5x$

$$15 = 5 \times 3$$

$$5x = 5 \times x$$

(Reason: Both terms contain a factor of 5, and no larger number divides 15, so 5 is the highest common factor of the two terms.)

Step 2: Write that common factor outside a bracket

$$15 - 5x = 5(3 - x)$$

(Reason: Dividing each term by 5 leaves 3 and $-x$, and those go inside the bracket in the same order and with the same signs. The subtraction sign stays where it was.)

Step 3: Substitute $d = 35$ and $r = 2$ into the formula

$$35 = 5p + 7 \times 2$$

$$35 = 5p + 14$$

(Reason: Putting the two known values into $d = 5p + 7r$ turns the formula into an equation containing p alone, and $7 \times 2 = 14$ is a number that can be worked out straight away.)

Step 4: Take the known number away from both sides

$$5p = 35 - 14 = 21$$

(Reason: The 14 is added to $5p$ on the right-hand side, so subtracting it from both sides leaves $5p$ on its own.)

Step 5: Divide both sides by 5

$$p = \frac{21}{5}$$

$$p = 4.2$$

(Reason: $5p$ means 5 times p, so dividing both sides by 5 leaves p. The fraction $\frac{21}{5}$ does not cancel, and as a decimal it is 4.2. The mark scheme accepts either form.)

Step 6: Count the tubs for part (c)(i)

$$m + n$$

(Reason: Every tub counts as one tub whatever its size, so the m small tubs and the n large tubs give $m + n$ tubs altogether. The 12 and the 25 are not used in this part.)

Step 7: Count the beads each size of tub contributes

$$12 \times m = 12m$$

$$25 \times n = 25n$$

(Reason: Each small tub holds 12 beads, so m of them hold $12m$ beads; each large tub holds 25 beads, so n of them hold $25n$ beads.)

Step 8: Add the two amounts together

$$12m + 25n$$

(Reason: The two sizes of tub are separate groups, so their bead counts add. Nothing further can be collected, because $12m$ and $25n$ are not like terms.)

(a) $5(3 - x)$

(b) $p = \frac{21}{5}$**, that is** 4.2

(c)(i) $m + n$

(c)(ii) $12m + 25n$

Verification

✓ **Check 1:** Multiply the bracket in part (a) back out. Multiplying the 5 by each term inside must rebuild the expression the question printed. $5(3 - x) = 15 - 5x$, which is the original expression.

✓ **Check 2:** Put $p = 4.2$ and $r = 2$ back into $d = 5p + 7r$. If the value of p is right, the formula must return the $d = 35$ the question gave. $5 \times 4.2 + 7 \times 2 = 21 + 14 = 35$, the value the question gave.

✓ **Check 3:** Reach p the other way round. Rearrange the formula first, giving $p = \dfrac{d - 7r}{5}$, and only then put the numbers in, so the arithmetic happens in a different order. $p = \dfrac{35 - 14}{5} = \dfrac{21}{5} = 4.2$, the same value.

✓ **Check 4:** Test part (c) on a case. If Oliver buys 4 small tubs and 3 large tubs, count directly: that is $4 + 3$ tubs, holding $4 \times 12 = 48$ beads and $3 \times 25 = 75$ beads. The direct count gives 7 tubs and $48 + 75 = 123$ beads, and the expressions give $m + n = 7$ and $12 \times 4 + 25 \times 3 = 123$.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a) The factorised expression	**B1**	for $5(3 - x)$.	✓
(b) A correct substitution, or a correct first step in rearranging	**M1**	for $35 = 5 \times p + 7 \times 2$, or for $5p = d - 7r$, or for $\dfrac{d}{5} = p + \dfrac{7}{5}r$, or equivalent. The mark is for a correct substitution in an equation, or for a correct first step in re-arranging.	✓
(b) Rearranging to reach $5p$, $-5p$, or a complete method for p	**M1**	for $5p = 35 -$ "14" or $5p = 21$, or for $-5p = -35 +$ "14" or $-5p = -21$, or for $(p =)\dfrac{35 -$ "14"$}{5}$ or $(p =)\dfrac{-35 +$ "14"$}{-5}$, or equivalent. The mark is for rearranging to find the value of $5p$, or the value of $-5p$, or for a complete method to find the value of p. The printed scheme sets 14 in quotation marks, which means the candidate's own earlier value may be used here.	✓
(b) The value of p	**A1**	for $\dfrac{21}{5}$, or equivalent, eg 4.2. A correct answer scores full marks unless it comes from obviously incorrect working.	✓
(c)(i) The expression for the	**B1**	for $m + n$, or equivalent. Condone $s + l$.	✓

Step	Mark	Description	Got it?
total number of tubs			
(c)(ii) The expression for the total number of beads	**B2**	for the final answer $12m + 25n$ or $25n + 12m$.	✓
(c)(ii) Partial credit	**(B1)**	for $12m$ or $25n$. For B2 or B1, condone use of s and l for m and n respectively.	✓

Full marks: 7/7

Question 14 - Exam Solution

Understanding the Question

Given

One recipe makes 6 muffins from 60 g sugar, 75 g butter, 1 egg, 90 g flour and 65 g chocolate.
Meera uses 450 g of flour.
Claire makes 84 muffins.
Together they pay 624 rupees, shared in the ratio $3 : 5$, Meera to Claire.

Find

(a) The number of muffins Meera makes. (b) The weight of butter Claire uses. (c) The amount Claire pays.

Plan the Solution

- Part (a) works from an ingredient, so count the recipes first: divide the flour used by the flour in one recipe, then multiply by the 6 muffins each recipe makes.
- Part (b) works the other way round, from the muffins. Divide by 6 to count the recipes, then multiply by the butter in one recipe. Only the butter line of the card is needed.
- Part (c) is a ratio share, not a recipe. Add the parts to see how many equal parts the money is cut into, find one part, then take Claire's parts.
- In every part the same idea is doing the work: multiply or divide two matching quantities by the same number and they stay in proportion.

Worked Solution [6 marks]

> Rule - Scaling a recipe: divide the amount used by the amount in one recipe to find the number of recipes, then multiply any other ingredient by that same number. Rule - Sharing in a ratio: add the parts to find how many equal parts there are, divide the total by that number to find one part, then multiply by the number of parts wanted, so that $a : b$ shares a total T as $\dfrac{T}{a+b}$ for each part.

Step 1: Work out how many recipes 450 g of flour makes

$$\frac{450}{90} = 5$$

(Reason: One recipe uses 90 g of flour, so dividing the flour used by the flour in one recipe counts the recipes. It divides exactly, giving 5 whole recipes, so nothing is left over and no rounding is needed.)

Step 2: Multiply by the 6 muffins one recipe makes

$$5 \times 6 = 30$$

(Reason: Every recipe makes the same 6 muffins, so 5 recipes make 5 lots of 6. The other four ingredients play no part in this answer.)

Step 3: Work out how many recipes 84 muffins is

$$\frac{84}{6} = 14$$

(Reason: Part (b) starts from the muffins rather than from an ingredient, so this time divide by the 6 muffins in one recipe. Again it divides exactly, so Claire makes a whole number of recipes.)

Step 4: Multiply by the butter in one recipe

$$14 \times 75 = 1\,050$$

(Reason: Each recipe uses 75 g of butter, so 14 recipes use 14 lots of 75 g. The answer is a weight, so it is measured in grams.)

Step 5: Split the 624 rupees into equal parts

$$3 + 5 = 8$$

$$\frac{624}{8} = 78$$

(Reason: A ratio of $3 : 5$ means the money is cut into 8 equal parts, 3 of them Meera's and 5 of them Claire's. Dividing the total by 8 gives the value of one part, in rupees.)

Step 6: Take Claire's share of those parts

$$5 \times 78 = 390$$

(Reason: Claire's share is 5 of the 8 equal parts, so her payment is that many lots of the value of one part. The question asks for Claire's amount, not Meera's.)

(a) 30 muffins

(b) 1 050 g

(c) 390 rupees

Verification

✓ **Check 1:** Scale part (a) back the other way. If 30 muffins is right, then it must be a whole number of recipes, and those recipes must use exactly the flour the question gave. $\frac{30}{6} = 5$ recipes, and $5 \times 90 = 450$ g of flour, the amount the question gives.

✓ **Check 2:** Redo parts (a) and (b) per muffin instead of per recipe, so the arithmetic happens in a different order. One muffin takes $\frac{90}{6} = 15$ g of flour and $\frac{75}{6} = 12.5$ g of butter. $\frac{450}{15} = 30$ muffins, and $84 \times 12.5 = 1\,050$ g of butter, the same two answers.

✓ **Check 3:** Work out Meera's payment instead and add the two together. Meera has 3 of the 8 parts, and the two payments must rebuild the total the question gave. $624 \times \frac{3}{8} = 234$ rupees for Meera, and $234 + 390 = 624$, the total the question gives.

✓ **Check 4:** Test that the two payments really are in the ratio the question states, by dividing each of them by the value of one part. $\frac{234}{78} = 3$ and $\frac{390}{78} = 5$, so the payments are in the ratio $3 : 5$, Meera to Claire.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a) A method to find the number of recipes, or the flour needed for one muffin	**M1**	for $\frac{450}{90}$ $(= 5)$, or equivalent, or for $\frac{90}{6}$ $(= 15)$, or equivalent. The mark is for a method to find the number of batches of 6 muffins made, or the amount of flour needed per muffin.	✓
(a) The number of muffins	**A1**	for 30. A correct answer scores full marks unless it comes from obviously incorrect working.	✓
(b) A method to find the number of recipes, or the butter	**M1**	for $\frac{84}{6}$ $(= 14)$, or equivalent, or for $\frac{75}{6}$ $(= 12.5)$, or equivalent. The mark is for a method to find the	✓

Step	Mark	Description	Got it?
needed for one muffin		number of batches of 6 muffins made, or the amount of butter needed per muffin.	
(b) The weight of butter	A1	for 1 050. A correct answer scores full marks unless it comes from obviously incorrect working.	✓
(c) A method to find one part of the ratio, three parts, or a complete method	M1	for $\frac{624}{3+5}$ $(=78)$, or equivalent, or for $624 \times \frac{3}{3+5}$ $(=234)$, or equivalent, or for $624 \times \frac{5}{3+5}$, or equivalent. The mark is for a method to find the value of one part of the ratio, or for a method to find the value of three parts, or for a complete method.	✓
(c) The amount Claire pays	A1	for 390. A correct answer scores full marks unless it comes from obviously incorrect working.	✓

Full marks: 6/6

Question 15 - Exam Solution

Understanding the Question

Given

7 of the beads are yellow and 5 of them are white. Every other bead in the tin is purple.
One bead is taken at random, and the probability that it is purple is $\frac{2}{5}$.
The total number of beads in the tin is not given.

Find

The number of purple beads in the tin. It is a whole number, so the working should land on one - here it comes out at 8.

Plan the Solution

- Add the yellow and the white beads. That gives 12 beads whose colour is already known, and they are exactly the beads that are not purple.

- Turn the probability round. If $\frac{2}{5}$ of the tin is purple, work out what fraction of the tin is not purple.
- Use that fraction to scale the known count up to the whole tin: find one fifth of the beads first, then all five fifths.
- Subtract the beads that are not purple to leave the purple ones, then check that the probability comes back out.

Worked Solution [3 marks]

> Rule - Probability of one random pick: $\frac{\text{number of beads of that colour}}{\text{total number of beads}}$. The probability that something happens and the probability that it does not happen always add to 1.

Step 1: Count the beads that are not purple

$$7 + 5 = 12$$

(Reason: (Reason: yellow and white are the only other colours in the tin, so those 12 beads are precisely the ones that are not purple.))

Step 2: Work out the fraction that is not purple

$$1 - \frac{2}{5} = \frac{3}{5}$$

(Reason: (Reason: purple and not purple are the only two outcomes, so their probabilities add to 1. Taking $\frac{2}{5}$ away leaves the share of the tin that is not purple.))

Step 3: Scale up to the whole tin

$$\frac{12}{3} = 4$$

$$4 \times 5 = 20$$

(Reason: (Reason: think of the tin as 5 equal parts. The 12 beads that are not purple fill 3 of them, so dividing by 3 gives one part, and all 5 parts together make the whole tin.))

Step 4: Subtract to leave the purple beads

$$20 - 12 = 8$$

(Reason: (Reason: the tin holds 20 beads and 12 of them are yellow or white, so everything left over is purple.))

8 purple beads

Verification

✓ **Check 1:** Put the answer back into the question. The tin would hold $8 + 12 = 20$ beads altogether, of which 8 are purple, so the probability of taking a purple bead is $\frac{8}{20}$. $\frac{8}{20} = \frac{2}{5}$, which is the probability the question gives.

✓ **Check 2:** Check the split a different way, as a ratio. The tin divides 8 purple to 12 not purple, and cancelling that ratio should give the $2 : 3$ split that sits behind $\frac{2}{5}$. $\frac{8}{4} = 2$ and $\frac{12}{4} = 3$, so the ratio is $2 : 3$ as expected.

✓ **Check 3:** Check the other colour instead. Out of 20 beads, 12 are not purple, and that share must be the fraction found in Step 2 and must complete the probability to 1. $\frac{12}{20} = \frac{3}{5}$ and $\frac{2}{5} + \frac{3}{5} = 1$.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
Proportion, ratio or equation	**M1**	For finding the proportion of the beads that are not purple (this may be a percentage or a decimal), $1 - \frac{2}{5}$ $\left(= \frac{3}{5}\right)$ oe, or for a correct ratio (allow the ratio in any order), (purple : yellow + white =) $2 : 3$ Values in a ratio do not need labels, but if labels are used they must be correct. This is implied by, for example, 12 beads being 3 parts. OR for forming a correct equation in terms of the number of purple beads or the total number of beads (allow the use of any letter), eg $\frac{n}{n + 12} = \frac{2}{5}$ or $\frac{t - 12}{t} = \frac{2}{5}$	✓
A method to reach one fifth of the beads, or the total	**M1**	For a method to find the value of one fifth of the beads, $\frac{7 + 5}{3}$ $(= 4)$ oe, or for a method to find the total number of beads in the tin, $\frac{7 + 5}{3} \times 5$ $(= 20)$ oe, or $\frac{7 + 5}{\frac{3}{5}}$ $(= 20)$ oe.	✓

Step	Mark	Description	Got it?
		The printed scheme puts the 3 and the $\frac{3}{5}$ in quotation marks, which means the candidate's own value from the first mark may be used here, so a follow-through on it is allowed. OR for a correct method to solve a correct equation, eg $n = \frac{12 \times 2}{5 - 2}$ or $t = \frac{5 \times 12}{5 - 2}$	
Answer 8	**A1**	cao. A correct answer scores full marks unless it comes from obvious incorrect working. Note: an answer of $\frac{8}{20}$ scores M1M1A0 - the total has been found but the question asked for the number of purple beads, not the probability.	✓

Full marks: 3/3

Question 16 - Exam Solution

Understanding the Question

Given

A quadrilateral $ACDF$ made of a trapezium $ABEF$ and a parallelogram $BCDE$, joined along BE.
$FE = 26$ cm, $AB = 18$ cm, $BC = 12$ cm.
Area of parallelogram $BCDE$ = 96 cm².

Find

The area of the trapezium $ABEF$, in cm².

Plan the Solution

- F, E and D sit on one straight line, and A, B and C sit on another. The two lines are parallel, so the trapezium and the parallelogram have the same perpendicular height.
- The parallelogram is the shape whose area is known, so use it to find that height first: its base is $BC = 12$ cm.
- Then feed that height into the trapezium, whose parallel sides are $AB = 18$ cm and $FE = 26$ cm.

- Watch which lengths belong to which shape: BC is a side of the parallelogram only, and never goes inside the trapezium formula.

Worked Solution [3 marks]

> Parallelogram: area $=$ base $\times$ h.
> Trapezium: area $= \frac{1}{2}(a+b)h$, where a and b are the two parallel sides and h is the perpendicular distance between them.
> Two shapes standing between the same pair of parallel lines share one value of h.

Step 1: Find the height from the parallelogram

$$12 \times h = 96$$

$$\frac{96}{12} = 8$$

(Reason: A parallelogram's area is base times perpendicular height, so 12 lots of h make 96, giving $h = 8$ cm. Because FED and ABC are parallel lines, this same 8 cm is the height of the trapezium.)

Step 2: Put that height into the trapezium formula

$$\frac{1}{2} \times (18 + 26) \times 8 = \frac{1}{2} \times 44 \times 8 = 176$$

(Reason: The trapezium's parallel sides are AB and FE, so those are the pair that goes inside the bracket. Half of $18 + 26$ is the average width of the trapezium, and multiplying that average width by the height gives the area.)

176 cm²

Verification

✓ **Check 1:** Compare the two shapes without finding the height at all. The trapezium's average width is $\frac{18+26}{2} = 22$ cm against the parallelogram's 12 cm, and both stand on the same height, so the areas are in the ratio $22 : 12$. $96 \times \frac{22}{12} = 176$ cm², which agrees.

✓ **Check 2:** Cut the trapezium up instead of using its formula. Sliding AB up to the top line leaves a parallelogram 18 cm by 8 cm, plus a triangle whose base is $26 - 18 = 8$ cm on the same height. $18 \times 8 + \frac{1}{2} \times 8 \times 8 = 144 + 32 = 176$ cm², which agrees.

✓ **Check 3:** Work out the whole quadrilateral a different way. ED equals BC, which is 12 cm, because $BCDE$ is a parallelogram. So FD is $26 + 12 = 38$ cm, AC is

$18 + 12 = 30$ cm, and $ACDF$ is itself a trapezium on the same height. $\frac{1}{2} \times (38 + 30) \times 8 = 272$ cm² for the whole quadrilateral, and taking the parallelogram off leaves $272 - 96 = 176$ cm², which agrees.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
$\frac{96}{12}$ $(= 8)$	**M1**	for a complete method to find the height of the parallelogram	✓
$\frac{1}{2}(18 + 26) \times [8]$	**M1**	for a method to find the area of the trapezium (do not allow missing brackets unless recovered), where $[8]$ is what they believe to be the height of the trapezium and must be positive. Do not allow $[8]$ to be 12 or 1	✓
176	**A1**	Correct answer scores full marks (unless from obvious incorrect working)	✓

Full marks: 3/3

Question 17 - Exam Solution

Understanding the Question

Given

Part (a): the expression $18c - 45cd$, which has two terms.

Part (b): the equation $\frac{5 - 2x}{6} = 3x - 4$, with a fraction on the left-hand side only.

Find

(a) $18c - 45cd$ written as a product, with the highest common factor outside the brackets. (b) The value of x, with the algebraic working shown.

Plan the Solution

- (a) Factorising fully means taking out the highest common factor, so deal with the numbers and the letters separately: first the HCF of 18 and 45, then any letter that appears in both terms.
- (a) Finish by checking that nothing inside the brackets could still come out. That is what the word fully is asking for.

- (b) The fraction is the awkward part, so clear it first: multiply both sides by 6. The whole of the right-hand side is multiplied, not just its first term.
- (b) Then gather the x terms on one side and the numbers on the other, and divide.

Worked Solution [5 marks]

> Factorising fully: take out the highest common factor of the numbers, together with every letter that appears in every term, then write what is left inside the brackets.
> Solving an equation that carries a fraction: multiply both sides by the denominator, so $\frac{a}{6} = b$ becomes $a = 6b$.
> Whatever is done to one side of an equation is done to the whole of the other side.

Step 1 (a): Find the highest common factor of the numbers

$18 = 2 \times 3 \times 3$

$45 = 3 \times 3 \times 5$

$3 \times 3 = 9$

(Reason: Writing each number as a product of primes shows what the two share: two threes, and nothing else. So the largest number that divides both 18 and 45 is 9.)

Step 2 (a): Take out the common letter, then divide each term

$\frac{18c}{9c} = 2$

$\frac{45cd}{9c} = 5d$

$18c - 45cd = 9c(2 - 5d)$

(Reason: c is in both terms, so it comes out alongside the 9, while d is in the second term only and has to stay inside. Dividing each term by $9c$ gives what goes in the brackets, and the minus sign between the two terms is kept. Nothing more can come out: 2 and 5 share no factor, and no letter is in both parts of the bracket.)

Step 3 (b): Multiply both sides by 6 to clear the fraction

$6 \times \frac{5 - 2x}{6} = 6(3x - 4)$

$5 - 2x = 18x - 24$

(Reason: Multiplying by 6 cancels the denominator on the left. On the right the bracket is multiplied by 6 as a whole, so every term inside it is multiplied, not just the first one.)

Step 4 (b): Collect the x terms on one side and the numbers on the other

$5 + 24 = 18x + 2x$

$29 = 20x$

(Reason: Adding $2x$ to both sides clears the $-2x$ from the left, and adding 24 to both sides clears the -24 from the right. The four terms are then sorted: numbers on one side, x terms on the other.)

Step 5 (b): Divide both sides by 20

$$x = \frac{29}{20}$$

$$x = 1.45$$

(Reason: 20 lots of x make 29, so one x is $\frac{29}{20}$. The mark scheme accepts that fraction, the mixed number $1\frac{9}{20}$ or the decimal 1.45.)

(a) $9c(2 - 5d)$

(b) $x = 1.45$

Verification

✓ **Check 1:** Part (a): multiply the brackets out again. Every term inside is multiplied by $9c$. $9c \times 2 = 18c$ and $9c \times (-5d) = -45cd$, giving $18c - 45cd$, the expression the question gives.

✓ **Check 2:** Part (a) again, with numbers instead of letters, which tests the factorising without repeating the algebra. Put $c = 2$ and $d = 3$ into each form.
$18 \times 2 - 45 \times 2 \times 3 = 36 - 270 = -234$, and
$9 \times 2 \times (2 - 15) = 18 \times (-13) = -234$. The two forms agree.

✓ **Check 3:** Part (b): put $x = 1.45$ back into each side of the original equation separately, and see whether they meet. Left-hand side $\frac{5 - 2.9}{6} = \frac{2.1}{6} = 0.35$, right-hand side $3 \times 1.45 - 4 = 4.35 - 4 = 0.35$. The two sides are equal.

✓ **Check 4:** Part (b) by a second method, never clearing the fraction at all. Split the left-hand side into $\frac{5}{6} - \frac{2}{6}x$, then collect: $\frac{5}{6} + 4 = 3x + \frac{1}{3}x$, so $\frac{29}{6} = \frac{10}{3}x$.
$x = \frac{29}{6} \times \frac{3}{10} = \frac{29}{20} = 1.45$, the same value, reached without multiplying through.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
$9c(2 - 5d)$	**B2**	for $9c(2 - 5d)$ or $-9c(5d - 2)$	✓

Step	Mark	Description	Got it?
$9(2c-5cd)$ or $c(18-45d)$ or $3c(6-15d)$ or $3(6c-15cd)$	B1	for $9(2c-5cd)$ or $c(18-45d)$ or $3c(6-15d)$ or $3(6c-15cd)$ or $9c(p+qd)$ where p and q are non-zero integers or $(2-5d)$ as a factor	✓
eg $5-2x=18x-24$ or $\frac{5}{6}-\frac{2}{6}x=3x-4$	M1	for removal of the fraction and correctly multiplying out RHS by 6 in an equation or separating fractions on the LHS in an equation	✓
$5+24=18x+2x$ oe or $29=20x$ oe or $\frac{5}{6}+4=\frac{2}{6}x+3x$ oe	M1ft	dep on 4 terms, for correctly rearranging their 4 term equation for terms in x on one side of the equation and number terms on the other	✓
1.45, working required	A1	dep on M1, oe eg $\frac{29}{20}$ or $1\frac{9}{20}$	✓

Full marks: 5/5

Question 18 - Exam Solution

Understanding the Question

Given

The number 1400.
Working is required, so an answer written down on its own earns nothing.

Find

1400 written as a product of powers of its prime factors.

Plan the Solution

- Divide by the smallest prime, 2, for as long as the result is a whole number.
- Move up through the primes - 3, then 5, then 7 - dividing whenever one goes exactly.
- Stop once what is left is prime, then write each repeated prime as a power.

Worked Solution [3 marks]

> Rule - Prime factorisation: keep dividing by the smallest prime that goes exactly until the quotient is 1. Every whole number greater than 1 is a product of primes in exactly one

way, so the order the factors are found in cannot change the answer.

Step 1: Take out every factor of 2

$$\frac{1400}{2} = 700$$

$$\frac{700}{2} = 350$$

$$\frac{350}{2} = 175$$

(Reason: 1400, 700 and 350 are all even, so 2 divides three times. 175 is odd, so 2 will not go again.)

Step 2: Move up to the next prime that divides, 5

$$\frac{175}{5} = 35$$

$$\frac{35}{5} = 7$$

(Reason: 175 is not a multiple of 3 - its digits add to 13 - but it ends in 5, so 5 goes twice. What is left is 7, which is prime, so the dividing stops there.)

Step 3: Collect the repeated factors into powers

$$1400 = 2 \times 2 \times 2 \times 5 \times 5 \times 7$$

$$1400 = 2^3 \times 5^2 \times 7$$

(Reason: The three 2s and the two 5s are written as powers; the single 7 needs no index.)

$$2^3 \times 5^2 \times 7$$

Verification

✓ **Check 1:** Multiply the powers back together: $2^3 = 8$ and $5^2 = 25$. $8 \times 25 \times 7 = 1400$

✓ **Check 2:** Start somewhere else entirely. Split 1400 as 14×100 and break each part down separately. $(2 \times 7) \times (2^2 \times 5^2) = 2^3 \times 5^2 \times 7$

✓ **Check 3:** Every base in the answer must itself be prime: 2, 5 and 7 divide by nothing except 1 and themselves. All three bases are prime, so the answer really is a product of primes.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
Prime factorisation started	**M1**	for finding 2 prime factors after at least 2 stages of prime factorisation with 0 incorrect stages, or for finding 2 prime factors after at least 3 stages of prime factorisation with no more than 1 incorrect stage. Examples of the amount of work needed: $2 \times 2 \times 350$, $2 \times 7 \times 100$, $2 \times 5 \times 140$, $5 \times 5 \times 56$, $7 \times 5 \times 40$, or $2 \times 7 \times 25 \times 4$ reached from $14 \times 100 = 14 \times 25 \times 4$.	✓
Note	**Note**	Each stage gives 2 factors and may be shown in a factor tree, a table or a list, but 2 prime factors must be seen. Example of finding 2 prime factors after at least 3 stages with 1 incorrect stage: $1400 = 10 \times 14 = 2 \times 5 \times 2 \times 7$.	✓
All six prime factors identified	**M1 dep**	dep on M1 - for the factors $2, 2, 2, 5, 5, 7$ identified with no others, in any form: listed, multiplied or added, for example $2 \times 2 \times 2 \times 5 \times 5 \times 7$. Ignore 1s. May be seen in a fully correct factor tree or ladder.	✓
The factorisation written in index form	**A1 dep on M2**	dep on M2 - for $2^3 \times 5^2 \times 7$. Working is required. May be in any order, and the multiplication signs may be written as dots.	✓

Full marks: 3/3

Question 19 - Exam Solution

Understanding the Question

Given

$3x + 2y = 10$
$3x - 4y = 16$
Two linear equations in the same two letters, and the x-terms are already identical.

Find

The one pair of values, x and y, that makes both equations true at once.

Plan the Solution

- Both equations begin with $3x$, so nothing has to be multiplied first: subtracting one equation from the other removes x straight away.
- Solve the single-letter equation that is left, to get y.
- Put that value back into one of the original equations, to get x.
- Test the pair in both original equations, not only the one used for the substitution.

Worked Solution [3 marks]

> Rule - Elimination: when one letter has the same coefficient in both equations, subtracting one equation from the other removes that letter and leaves a single-letter equation to solve.

Step 1: Label the equations and compare the x-terms

$$3x + 2y = 10 \qquad (1)$$
$$3x - 4y = 16 \qquad (2)$$

(Reason: Both equations contain $3x$, so the coefficients of x already match and one subtraction will remove it.)

Step 2: Subtract equation (2) from equation (1)

$$(3x + 2y) - (3x - 4y) = 10 - 16$$
$$6y = -6$$

(Reason: The x-terms cancel because $3x - 3x = 0$, and subtracting $-4y$ adds $4y$, so the left side is $6y$. On the right, $10 - 16 = -6$.)

Step 3: Divide by 6 to find y

$$y = \frac{-6}{6} = -1$$

(Reason: Dividing both sides of $6y = -6$ by 6 leaves y on its own.)

Step 4: Substitute $y = -1$ into equation (1) to find x

$$3x + 2 \times (-1) = 10$$
$$3x - 2 = 10$$
$$3x = 12$$
$$x = \frac{12}{3} = 4$$

(Reason: With y known, equation (1) has only one letter left in it. Adding 2 to both sides gives $3x = 12$, and dividing by 3 gives x.)

$$x = 4$$
$$y = -1$$

Verification

✓ **Check 1:** Put $x = 4$ and $y = -1$ into equation (1). $3 \times 4 + 2 \times (-1) = 12 - 2 = 10$

✓ **Check 2:** The same pair must also fit equation (2), which was not the equation used for the substitution. $3 \times 4 - 4 \times (-1) = 12 + 4 = 16$

✓ **Check 3:** Solve a second way: double equation (1) to give $6x + 4y = 20$, then add equation (2) so the y-terms cancel instead. $9x = 36$, so $x = 4$ again, and equation (2) then gives $y = -1$.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
eg $3x + 2y = 10$ subtract $3x - 4y = 16$ $(6y = -6)$ or eg $6x + 4y = 20$ add $3x - 4y = 16$ $(9x = 36)$ or eg $3\left(\frac{10 - 2y}{3}\right) - 4y = 16$ or $3\left(\frac{16 + 4y}{3}\right) + 2y = 10$ or eg $3x - 4\left(\frac{10 - 3x}{2}\right) = 16$ or $3x + 2\left(\frac{3x - 16}{4}\right) = 10$ or $6y = -6$ oe or $9x = 36$ oe	M1	a correct method to eliminate x or y: coefficients of x or y are the same and the correct operation to eliminate is selected; if operator not written, the correct operation can be implied by 2 out of 3 terms correct. Allow one arithmetic error if multiplying to equate coefficients, or for a correct substitution of one variable into the other equation. NB: the mark is for the method and not for the result of the method. However, if the correct result of this method is seen, the mark can be awarded.	✓

Step	Mark	Description	Got it?
$3x + 2 \times (-1) = 10$ or $3x - 4 \times (-1) = 16$ or $x = \dfrac{10 - 2 \times (-1)}{3}$ or $x = \dfrac{16 + 4 \times (-1)}{3}$ or $3 \times 4 + 2y = 10$ or $3 \times 4 - 4y = 16$ or $y = \dfrac{10 - 3 \times 4}{2}$ or $y = \dfrac{3 \times 4 - 16}{4}$	**M1**	dep on M1 a correct substitution to find the value of the second variable using their value, or for starting again with elimination or substitution (as above). The printed scheme puts the substituted value in quotation marks, so the candidate's own value from the first mark is accepted here, not only -1 and 4.	✓
$x = 4$ and $y = -1$, with working required	**A1**	dep on M1	✓

Full marks: 3/3

Question 20 - Exam Solution

Understanding the Question

Given

Shape A is the trapezium with vertices $(5, 2)$, $(8, 2)$, $(7, 3)$ and $(6, 3)$.
Shape B is the quadrilateral with vertices $(3, 2)$, $(5, 2)$, $(4, 4)$ and $(3, 4)$.
The mirror line for part (a) is $y = x$. The centre for part (b) is $(1, 1)$ and the scale factor is 2.

Find

(a) The image of shape A after a reflection in $y = x$, drawn on the grid.
(b) The image of shape B after an enlargement of scale factor 2 with centre $(1, 1)$, drawn on the grid.

Plan the Solution

- (a) Work vertex by vertex. Reflecting in $y = x$ swaps the two coordinates of a point, so map all four vertices and then join them up in the same order.
- (b) Work out from the centre. Count the steps across and up from $(1, 1)$ to a vertex, double both steps, and count that far again from the centre.

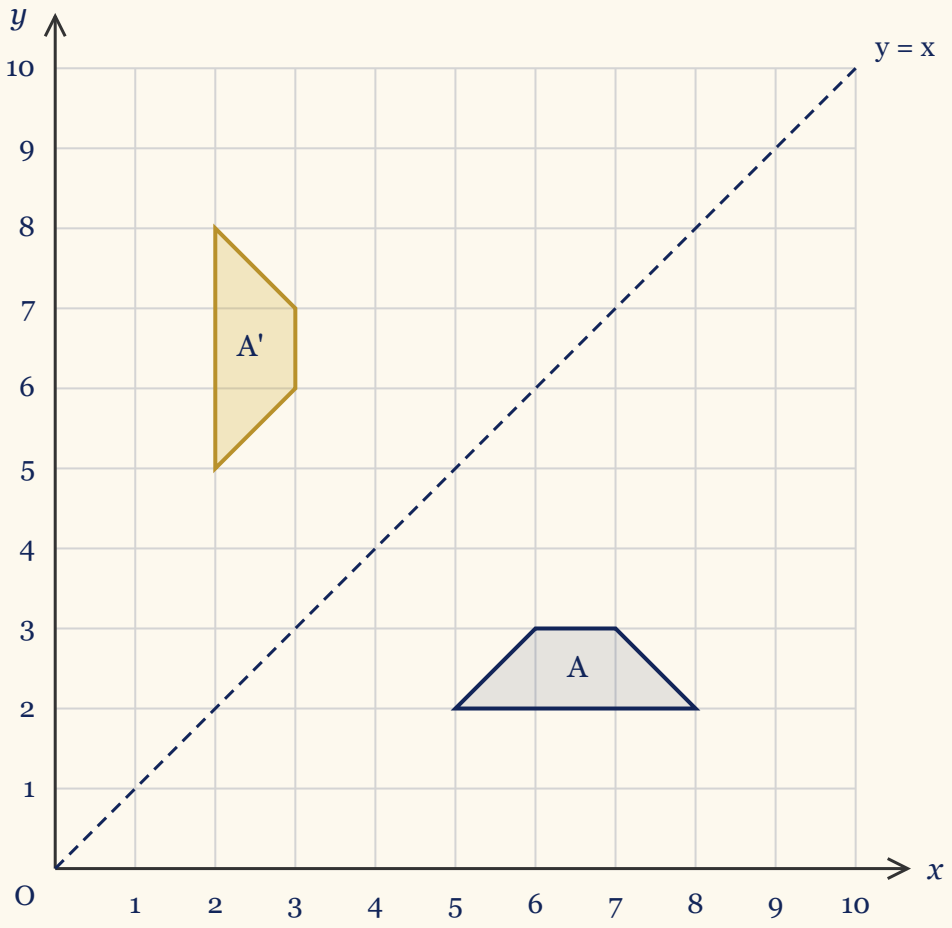
- Each answer is the drawing itself, so there is no answer line to fill in - the marks are for the shape on the grid.

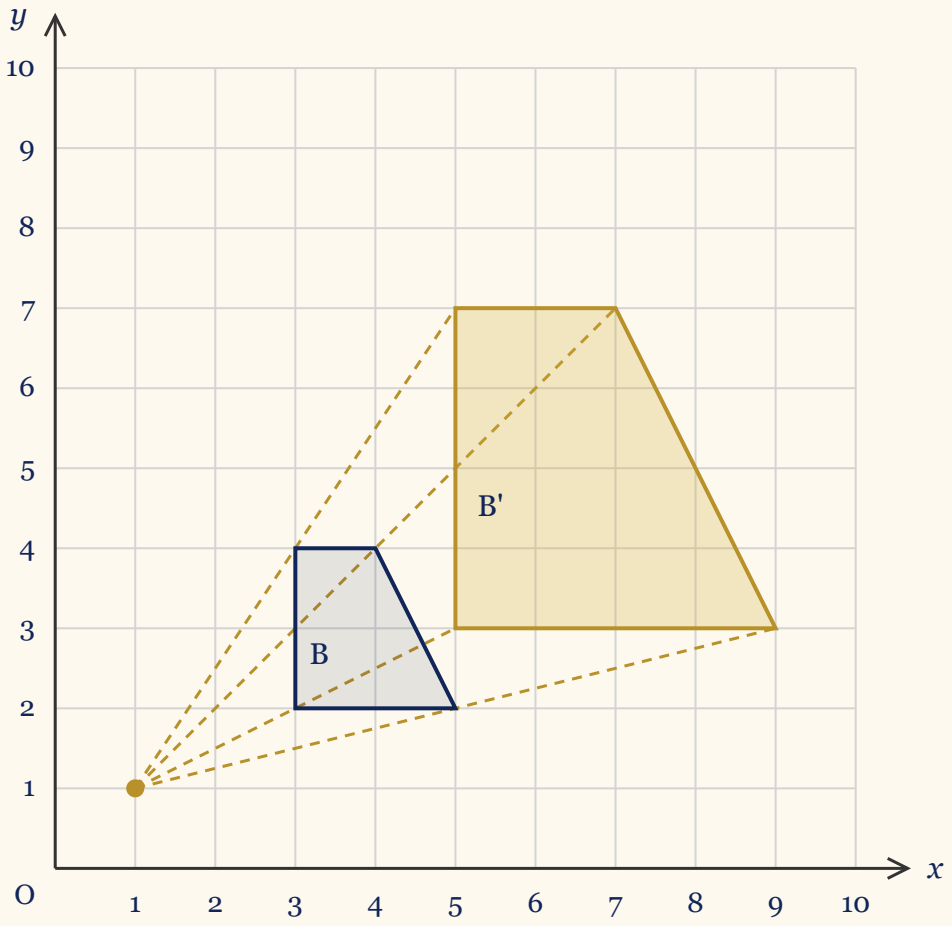
Worked Solution [4 marks]

> Reflection in $y = x$: $(a, b) \to (b, a)$. Enlargement of scale factor k with centre (p, q): $(a, b) \to (p + k(a - p), q + k(b - q))$.

Step 1: Read shape A off the grid

$(5, 2), (8, 2), (7, 3), (6, 3)$





(Reason: Every vertex sits on a grid intersection, so each coordinate can be counted straight off the axes. The trapezium has a base 3 squares long and a top edge 1 square long.)

Step 2: Swap the coordinates of every vertex

$(5, 2) \rightarrow (2, 5)$
$(8, 2) \rightarrow (2, 8)$
$(7, 3) \rightarrow (3, 7)$
$(6, 3) \rightarrow (3, 6)$

(Reason: The mirror line $y = x$ makes the two axes change places, so every point (a, b) lands on (b, a). Nothing is stretched, so the image is exactly the same size and shape as shape A.)

Step 3: Join the four image points in the same order

$(2, 5) \rightarrow (2, 8) \rightarrow (3, 7) \rightarrow (3, 6) \rightarrow (2, 5)$

(Reason: Going round the object and round the image in the same order keeps the trapezium the right way round. Drawing the mirror line first is worth a mark on its own, even if the image then goes wrong.)

Step 4: Read shape B off the grid

$(3, 2), (5, 2), (4, 4), (3, 4)$

(Reason: The centre of enlargement $(1, 1)$ lies outside shape B, so the image will sit further away from that point than the object does, on the same side of it.)

Step 5: Work out the image of the vertex (3, 4)

$3 - 1 = 2$

$4 - 1 = 3$

$1 + 2 \times 2 = 5$

$1 + 2 \times 3 = 7$

$(3, 4) \rightarrow (5, 7)$

(Reason: From the centre $(1, 1)$ this vertex is 2 squares across and 3 squares up. Scale factor 2 doubles both steps, to 4 across and 6 up, and those doubled steps are then counted from the centre itself.)

Step 6: Repeat for the other three vertices

$(3, 2) \rightarrow (5, 3)$

$(5, 2) \rightarrow (9, 3)$

$(4, 4) \rightarrow (7, 7)$

(Reason: The same counting works every time. The vertex $(5, 2)$ is 4 across and 1 up from the centre, so its image is 8 across and 2 up from the centre, at $(9, 3)$.)

Step 7: Join the image points and check along the ray lines

$(5, 3) \rightarrow (9, 3) \rightarrow (7, 7) \rightarrow (5, 7) \rightarrow (5, 3)$

(Reason: A straight line from the centre through any vertex of shape B carries on to that vertex's image, and the image is twice as far out. Every edge of the image is twice the length of the edge it came from.)

(a) Image of shape A drawn with vertices $(2, 5)$, $(2, 8)$, $(3, 6)$ and $(3, 7)$

(b) Image of shape B drawn with vertices $(5, 3)$, $(5, 7)$, $(7, 7)$ and $(9, 3)$

Verification

✓ **Check 1:** (a) A mirror line is the perpendicular bisector of the join, so the midpoint of $(5, 2)$ and its image $(2, 5)$ has to lie on $y = x$. $\frac{5 + 2}{2} = 3.5$ across and $\frac{2 + 5}{2} = 3.5$ up, so the midpoint $(3.5, 3.5)$ sits on the line

✓ **Check 2:** (a) A reflection cannot change the area. Both the trapezium and its image have parallel sides of 3 and 1, with those two sides 1 square apart. $\frac{1}{2} \times (3 + 1) \times 1 = 2$ square units for each of them

✓ **Check 3:** (b) The centre, a vertex and that vertex's image must lie on one straight line, with the image twice as far from the centre. Test it on $(5, 2)$. The vertex is 4 across and 1 up from $(1, 1)$, and the image $(9, 3)$ is 8 across and 2 up, so $\frac{8}{4} = 2$ agrees with $\frac{2}{1} = 2$

✓ **Check 4:** (b) An enlargement of scale factor k multiplies an area by k^2. Shape B covers 3 square units and its image covers 12 square units. $\frac{12}{3} = 4$ and $2^2 = 4$, so the two areas agree with a scale factor of 2

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a) Vertices at $(2, 5)$, $(2, 8)$, $(3, 6)$, $(3, 7)$	**B2**	for correct shape in correct position	✓
(a) Partial credit	**B1**	for correct orientation of shape but wrong position, or for 3 out of 4 vertices correct, or for $y = x$ drawn	✓
(b) Vertices at $(5, 3)$, $(5, 7)$, $(7, 7)$, $(9, 3)$	**B2**	for correct shape in correct position	✓
(b) Partial credit	**B1**	for correct size and orientation of shape but wrong position, or for 3 out of 4 vertices correct	✓

Full marks: 4/4

Question 21 - Exam Solution

Understanding the Question

Given

The patio has an area of 45 m².
One pack of paving slabs covers 1.5 m², and one pack costs £64.

Find

Nathan's percentage profit, correct to one decimal place.

5 bags of jointing sand are bought, and each bag costs £12.
The customer is charged £3 000.

Plan the Solution

- Count the packs first: divide the area of the patio by the area one pack covers.
- Turn everything bought into money and add it up, so the total cost is a single figure.
- Profit is the money charged less that total cost.
- Percentage profit measures the profit against what was spent, so divide the profit by the total cost - not by the amount charged - and multiply by 100.

Worked Solution [5 marks]

> Rule - Percentage profit: take the total cost away from the money charged to find the profit, then divide the profit by the total cost and multiply by 100. The cost is what the profit is being compared with, so the cost goes underneath in the fraction.

Step 1: Work out how many packs of slabs are needed

$$\frac{45}{1.5} = 30$$

(Reason: One pack covers 1.5 m², so the number of packs is the area of the patio divided by the area one pack covers. It divides exactly, giving 30 whole packs, so there is no part pack to round up.)

Step 2: Work out what the packs of slabs cost

$$30 \times 64 = 1\,920$$

(Reason: Every pack costs the same £64, so 30 packs cost 30 lots of £64.)

Step 3: Work out what the jointing sand costs

$$5 \times 12 = 60$$

(Reason: The sand is priced by the bag, so 5 bags at £12 each is 5 lots of £12. This cost does not depend on the area of the patio.)

Step 4: Add the two costs to find the total cost

$$1\,920 + 60 = 1\,980$$

(Reason: The slabs and the sand are the only things Nathan buys, so the two costs added together are everything he spends. This total is the figure the percentage will be measured against.)

Step 5: Take the total cost away from the money charged

$$3\,000 - 1\,980 = 1\,020$$

(Reason: Profit is what is left of the customer's money once everything Nathan has paid out has been taken off, so the whole of the total cost comes off the £3 000.)

Step 6: Write the profit as a percentage of the total cost

$$\frac{1\,020}{1\,980} \times 100 = 51.5151\ldots$$

(Reason: Percentage profit compares the profit with the money spent, so the profit goes on top and the total cost £1 980 goes underneath. Multiplying by 100 turns that fraction into a percentage. The division never stops: the digits 51 repeat for ever.)

Step 7: Round to one decimal place

51.5

(Reason: The question asks for one decimal place. The digit after the first decimal place is 1, which is below 5, so the 5 in the first decimal place stays as it is. The answer is a percentage, so it needs a per cent sign.)

$$51.5\%$$

Verification

✓ **Check 1:** Put the percentage back. The profit is $\frac{17}{33}$ of the cost, so adding that profit on to the total cost must rebuild the money the customer is charged. $1\,980 \times \frac{17}{33} = 1\,020$ of profit, and $1\,980 + 1\,020 = 3\,000$, the amount charged.

✓ **Check 2:** Cost the job a different way, by the square metre instead of by the pack. One pack covers 1.5 m² for £64, so one square metre of slabs costs $\frac{64}{1.5}$ pounds. $\frac{64}{1.5} \times 45 = 1\,920$ for the slabs, and $1\,920 + 60 = 1\,980$ altogether, the same total cost as before.

✓ **Check 3:** Compare the money charged with the money spent in one go. The charge is some percentage of the cost, and the first 100 per cent of that only replaces what was spent, so the rest is the profit. $\frac{3\,000}{1\,980} \times 100 - 100 = 51.5$ to one decimal place, the same answer by a different road.

✓ **Check 4:** Test the size of the answer. A profit of exactly 50 per cent would mean charging half as much again as the job cost. $1\,980 \times 1.5 = 2\,970$, and the customer is charged £ 3 000, a little more than that, so a percentage profit just above 50 is the right size.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
A method to find the number of packs needed, or the cost of the sand, or the cost of the slabs per square metre	M1	for $\frac{45}{1.5}\ (=30)$, or for $5\times 12\ (=60)$, or for $\frac{64}{1.5}\left(=\frac{128}{3}=42.6(6\ldots)\right)$. The mark is for a method to find the number of packs needed, or the cost of the jointing sand, or the cost of the slabs per m^2.	✓
A method to find the cost of the packs of slabs	M1	for their $30\times 64\ (=1\,920)$, or for their $42.6(6\ldots)\times 45\ (=1\,920)$. The printed scheme puts quotation marks round the 30 and the $42.6(6\ldots)$, so a candidate's own earlier value may be used here.	✓
A method to find the total cost, or the profit	M1	for their $1\,920+$ their $60\ (=1\,980)$, or for $3\,000-1\,920-60\ (=1\,020)$. The first alternative is printed in quotation marks, so a candidate's own two costs may be used; the second is printed without them.	✓
A method to find the percentage profit, or to be one step away from it	M1	for example $\frac{3\,000-\text{their }1\,980}{\text{their }1\,980}\ (=0.515\ldots)$, or $\frac{3\,000-\text{their }1\,980}{\text{their }1\,980}\times 100$, or $\frac{3\,000}{\text{their }1\,980}\ (=1.515\ldots)$, or $\frac{3\,000}{\text{their }1\,980}\times 100\ (=151.5\ldots)$, or $\frac{3\,000}{\text{their }1\,980}\times 100-100$. Every printed alternative puts the total cost in quotation marks, so the candidate's own total cost may be used throughout.	✓
The percentage profit	A1	for 51.5, awrt 51.5. A correct answer scores full marks unless it comes from obviously incorrect working.	✓
Special case - the jointing sand left out of the total cost: an answer of 56.3 or 56.25	SC	Special case B3 for an answer of 56.3 or 56.25, which comes from using $1\,920$ instead of $1\,980$ as the total cost.	✓

Full marks: 5/5

Question 22 - Exam Solution

Understanding the Question

Given

Part (a) gives the power 5^0, a base with index 0.

Part (b) gives $\frac{5^9 \times 5^{-3}}{5^{-2}} = 5^k$, so both sides are powers of the same base.

Part (c) gives $\left(2d^4e^5\right)^3$, a number and two letters multiplied together inside one bracket, and the whole bracket is cubed.

Find

The value of 5^0. The value of k. $\left(2d^4e^5\right)^3$ written in its simplest form.

Plan the Solution

- Part (a) is the zero-index rule on its own. Any base except 0 raised to the index 0 is 1.
- Part (b): tidy the top of the fraction first with the multiplication rule, then divide by the bottom with the division rule, so the left-hand side becomes one single power of 5.
- Once each side is a single power of the same base, the two indices must be equal, and that gives k without ever working out a large number.
- Part (c): a power outside a bracket reaches every factor inside it, so cube the 2 and multiply each letter's index by 3.

Worked Solution [5 marks]

> Rule - The index laws: $a^m \times a^n = a^{m+n}$, $\frac{a^m}{a^n} = a^{m-n}$, $(a^m)^n = a^{mn}$ and $a^0 = 1$ for every a that is not 0. A power outside a bracket applies to every factor inside it, so $(ab)^n = a^n b^n$.

Step 1: Part (a) - use the zero-index rule

$$\frac{5^3}{5^3} = 5^{3-3} = 5^0$$

$$\frac{125}{125} = 1$$

$$5^0 = 1$$

(Reason: A power divided by itself is 1, and the division rule turns that same division into an index of $3 - 3$. So an index of 0 has to mean 1. This is the value of the power, not the value of the base, so the 5 does not appear in the answer.)

Step 2: Part (b) - multiply the two powers on the top

$$5^{9} \times 5^{-3} = 5^{9+(-3)} = 5^{6}$$

(Reason: Multiplying powers of the same base adds the indices. Adding -3 is the same as taking 3 away, so the index on top becomes 6.)

Step 3: Part (b) - divide by the power underneath

$$\frac{5^{6}}{5^{-2}} = 5^{6-(-2)} = 5^{8}$$

(Reason: Dividing powers of the same base takes the bottom index away from the top index. The index underneath is negative here, and taking a negative number away is the same as adding it on, so watch the two minus signs meeting.)

Step 4: Part (b) - match the indices on the two sides

$$5^{8} = 5^{k}$$

$$k = 8$$

(Reason: Both sides are now a single power of the same base 5, and one power of 5 can only equal another when their indices are equal. The question asks for k itself, so the answer is the index, not the power.)

Step 5: Part (c) - give every factor inside the bracket the power 3

$$\left(2d^{4}e^{5}\right)^{3} = 2^{3} \times \left(d^{4}\right)^{3} \times \left(e^{5}\right)^{3}$$

(Reason: The bracket holds three factors multiplied together, and cubing the bracket cubes each one of them. Leaving the 2 untouched is the usual slip here, because it carries no visible index.)

Step 6: Part (c) - work out each of the three factors

$$2^{3} = 8$$

$$\left(d^{4}\right)^{3} = d^{4\times3} = d^{12}$$

$$\left(e^{5}\right)^{3} = e^{5\times3} = e^{15}$$

(Reason: The number is cubed, not multiplied by 3: $2 \times 2 \times 2 = 8$. A power raised to a power multiplies the indices, so 4 becomes 12 and 5 becomes 15.)

Step 7: Part (c) - write the three factors as one expression

$$\left(2d^{4}e^{5}\right)^{3} = 8d^{12}e^{15}$$

(Reason: The number and the two letters are all different, so nothing here will combine or cancel any further. That is what fully simplified means for an expression like this one.)

(a) 1

(b) $k = 8$

(c) $8d^{12}e^{15}$

Verification

✓ **Check 1:** Test part (a) without using the zero-index rule at all. Step down the powers of 5, where each step divides by 5: 125, 25, 5. One more step reaches 5^0. $\dfrac{5}{5} = 1$, so 5^0 is 1, the same as part (a).

✓ **Check 2:** Work the left-hand side of part (b) out as an ordinary number instead of as indices. 5^{-3} means $\dfrac{1}{125}$, and dividing by 5^{-2} is the same as multiplying by 25. $5^9 \times 5^{-3} = 15\,625$, then $15\,625 \times 25 = 390\,625$, and $5^8 = 390\,625$, so the index really is 8.

✓ **Check 3:** Reach part (b) a third way, by writing an equation in the indices alone and never touching a power. The top index is $9 - 3$ and the bottom index is -2. $9 - 3 = k - 2$, and $6 + 2 = 8$, so $k = 8$ again.

✓ **Check 4:** Test part (c) with numbers. Put $d = 1$ and $e = 2$ into the question and into the answer. Two different expressions cannot agree for every substitution, so agreement is real evidence, and this pair tests the index on e. $(2 \times 1 \times 32)^3 = 64^3 = 262\,144$, and $8 \times 1 \times 32\,768 = 262\,144$.

✓ **Check 5:** Now swap the two numbers over, $d = 2$ and $e = 1$, which tests the index on d and leaves e out of the way. $(2 \times 16 \times 1)^3 = 32^3 = 32\,768$, and $8 \times 4\,096 \times 1 = 32\,768$.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a) The value of 5^0	**B1**	for 1, cao.	✓
(b) One correct application of an index rule, or a correct equation in the indices, or a complete method for k	**M1**	for one correct application of an index rule (must be seen in powers of 5), eg $(5^9 \times 5^{-3} =)\ 5^6$ or $\left(\dfrac{5^9}{5^{-2}} =\right)\ 5^{11}$ or $\left(\dfrac{5^{-3}}{5^{-2}} =\right)\ 5^{-1}$ or $(5^k \times 5^{-2} =)\ 5^{k-2}$; this could be after an initial mistake - working will need to be clearly seen. Or for forming a correct equation in the indices alone,	✓

Step	Mark	Description	Got it?
		$9 - 3 = k - 2$ oe. Or for a complete method for the value of k, $9 - 3 - (-2)$ or $9 - 3 + 2$.	
(b) The value of k	**A1**	for 8, condone 5^8. A correct answer scores full marks unless it comes from obviously incorrect working.	✓
(c) The expression simplified fully	**B2**	for a correct answer, $8d^{12}e^{15}$.	✓
(c) Partial credit inside that B2	**(B1)**	(B1 for answer of the form kd^me^n where at least two of $k = 8$, $m = 12$ and $n = 15$ are correct)	✓

Full marks: 5/5

Question 23 - Exam Solution

Understanding the Question

Given

The pendant has a mass of 48.3 g
Silver has a density of 10.5 g/cm³
Density is the mass of one cubic centimetre of the material.

Find

The volume of the pendant, in cubic centimetres.

Plan the Solution

- Start from the density formula, $\text{density} = \dfrac{\text{mass}}{\text{volume}}$.
- Substitute the two values the question gives, then rearrange so the volume is on its own.
- Divide the mass by the density, then multiply back to check the mass returns to 48.3 g.

Worked Solution [2 marks]

> Rule - Density: $\text{density} = \dfrac{\text{mass}}{\text{volume}}$, so $\text{volume} = \dfrac{\text{mass}}{\text{density}}$.

Step 1: Write down the density formula

$$\text{density} = \frac{\text{mass}}{\text{volume}}$$

(Reason: Density compares mass with volume, so this formula is the link between the two values the question gives.)

Step 2: Put in the values given

$$10.5 = \frac{48.3}{v}$$

(Reason: The letter v stands for the volume in cm³. Substituting 10.5 and 48.3 correctly into a correct density formula is what earns the method mark.)

Step 3: Rearrange to make the volume the subject

$$10.5 \times v = 48.3$$

$$v = \frac{48.3}{10.5}$$

(Reason: Multiply both sides by v, then divide both sides by 10.5. The mark scheme accepts any one of these three forms for the method mark.)

Step 4: Work out the division

$$\frac{48.3}{10.5} = 4.6$$

(Reason: A calculator is allowed on this paper, so the volume is one division. The same value as a fraction is $\frac{23}{5}$, or $4\frac{3}{5}$ written as a mixed number.)

4.6 cm³

Verification

- ✓ **Check 1:** Multiply the volume back by the density: 10.5×4.6. This must return the mass the question states. $10.5 \times 4.6 = 48.3$, the mass in the question.
- ✓ **Check 2:** Estimate the size of the answer. 48.3 is close to 50 and 10.5 is close to 10. $\frac{50}{10} = 5$, so a volume a little under 5 cm³ is the right size.
- ✓ **Check 3:** Clear the decimals instead of using a calculator: multiply the top and the bottom of the fraction by 10. $\frac{483}{105} = \frac{23}{5} = 4.6$, one of the equivalent forms the mark scheme allows.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
$10.5 = \frac{48.3}{v}$ or $10.5v = 48.3$ or $(v =) \frac{48.3}{10.5}$	M1	oe for substituting 10.5 and 48.3 correctly into a correct formula for density; may use any letter for the volume	✓
4.6 (a correct answer scores full marks, unless it comes from obvious incorrect working)	A1	allow $\frac{23}{5}$ or $4\frac{3}{5}$ oe	✓

Full marks: 2/2

Question 24 - Exam Solution

Understanding the Question

Given

A list of 7 numbers has a mean of 60
A group of 3 of those numbers has a mean of 46
The two groups together make up the whole list, because $3 + 4 = 7$.

Find

The mean of the remaining 4 numbers.

Plan the Solution

- A mean is a total shared out equally, so a mean can be turned back into a total: $\text{total} = \text{mean} \times \text{how many}$.
- Turn both means into totals: the total of all 7 numbers, and the total of the 3 numbers.
- Subtract to leave the total of the other 4 numbers, then share that total between 4.

Worked Solution [3 marks]

Rule - Mean: $\text{mean} = \frac{\text{total}}{\text{how many}}$, so $\text{total} = \text{mean} \times \text{how many}$.

Step 1: Turn the overall mean back into a total

$60 \times 7 = 420$

(Reason: A mean of 60 across 7 numbers means the 7 numbers share out to 60 each, so together they come to 60×7. Either this total or the one in Step 2 earns the first method mark.)

Step 2: Turn the second mean back into a total the same way

$$46 \times 3 = 138$$

(Reason: The same rule applied to the smaller group: 3 numbers with a mean of 46 add up to 46×3.)

Step 3: Subtract to leave the total of the other 4 numbers

$$420 - 138 = 282$$

(Reason: The 3 numbers and the other 4 numbers together are the whole list, so taking the smaller total away from the whole total leaves exactly the total of the numbers that remain. This is the second method mark.)

Step 4: Share that total between the numbers that are left

$$\frac{282}{4} = 70.5$$

(Reason: There are 4 numbers left, so their total is divided by 4 to give their mean. A calculator is allowed on this paper, so this is one division; the same value written as a fraction is $\frac{141}{2}$, or $70\frac{1}{2}$ as a mixed number.)

$$70.5$$

Verification

✓ **Check 1:** Put the list back together. Add the total of the 3 numbers to the total of the other 4, then divide by 7. That must return the mean the question starts from.
$138 + 282 = 420$ and $\frac{420}{7} = 60$, the mean in the question.

✓ **Check 2:** Balance the list about its overall mean. The 3 numbers average 14 below 60, a shortfall of $3 \times 14 = 42$, and the other 4 numbers have to carry that whole shortfall between them. $\frac{42}{4} = 10.5$ above the overall mean, and $60 + 10.5 = 70.5$.

✓ **Check 3:** Write down a list that fits both statements. Take 44, 46, 48, whose mean is 46, and take 68, 70, 71, 73 as the other four. All seven add to 420, so their mean is 60, and the four that are left add to 282, giving a mean of 70.5.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
$60 \times 7\ (= 420)$ or $46 \times 3\ (= 138)$	M1	may be embedded within an equation	✓
"420" − "138" $(= 282)$	M1	for a method to find the sum of the 4 numbers. Allow this mark if they do further incorrect work using 282. The quotation marks mean the candidate's own earlier totals may be used.	✓
70.5 (a correct answer scores full marks, unless it comes from obvious incorrect working)	A1	allow $\frac{141}{2}$ oe eg $\frac{282}{4}$ or $70\frac{1}{2}$	✓

Full marks: 3/3

Question 25 - Exam Solution

Understanding the Question

Given

In the sale, the normal price of every appliance is reduced by 15%.
The sale price of the espresso machine is 612 Swiss francs.
The reduction is a percentage of the normal price, not of the sale price, and the normal price is the thing that has not been given.

Find

The normal price of the espresso machine, in Swiss francs.

Plan the Solution

- The normal price is the whole amount, so it counts as 100%. Taking 15% off leaves 85% of it, so the sale price is the normal price multiplied by 0.85.
- That multiplication has already happened, so it has to be undone. Dividing the sale price by 0.85 gets back to the price the shop started from.
- Finish by taking 15% off the answer and looking for 612 again.

Worked Solution [3 marks]

> Rule - Reverse percentage: sale price $=$ normal price $\times$ multiplier, so normal price $=\dfrac{\text{sale price}}{\text{multiplier}}$, where the multiplier for a reduction of 15% is 0.85.

Step 1: Work out what percentage of the normal price is left

$100\% - 15\% = 85\%$

$1 - 0.15 = 0.85$

(Reason: The normal price is the whole amount, so it is 100%. A reduction of 15% leaves 85% of it, and 85% written as a decimal is 0.85. Either form earns the first method mark, and so does going straight to $\dfrac{612}{85}$.)

Step 2: Say what the shop did to the normal price

normal price $\times\ 0.85 = 612$

(Reason: The shop started at the normal price and multiplied it by 0.85 to get the ticket in the window. This is the sentence the whole question turns on: the 15% is a share of the normal price, which is bigger than 612, so it is worth more than 15% of 612.)

Step 3: Undo the multiplication

$$\text{normal price} = \frac{612}{0.85}$$

(Reason: Dividing by 0.85 reverses multiplying by 0.85, so it takes the sale price back to the price it came from. Writing this down is the complete method, and it earns the second method mark.)

Step 4: Work out the division

$$\frac{612}{0.85} = 720$$

(Reason: A calculator is allowed on this paper, so this is one division. Dividing by 0.85 is the same as multiplying by $\dfrac{100}{85}$, which cancels to $\dfrac{20}{17}$, and $612 \times \dfrac{20}{17} = 720$ the same way.)

720 Swiss francs

Verification

✓ **Check 1:** Run the sale forwards. Take 15% off the answer; the sale price in the question must come back. $0.15 \times 720 = 108$ comes off, and $720 - 108 = 612$, the sale price the question gives.

✓ **Check 2:** Work the answer out a different way. The sale price is 85% of the normal price, so divide it by 85 to find 1%, then take 100 of those. $\frac{612}{85} = 7.2$ for 1%, and $7.2 \times 100 = 720$ for the whole price.

✓ **Check 3:** Is the size sensible? The money taken off is 15% of the larger normal price, so it has to be more than 15% of the smaller sale price. $0.15 \times 612 = 91.8$, while the money actually taken off is $720 - 612 = 108$, which is the larger of the two, as it has to be.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
$1 - 0.15\ (= 0.85)$ or $100(\%) - 15(\%)\ (= 85(\%))$ or $\frac{612}{85}\ (= 7.2)$ oe	**M1**	may be seen embedded. Do not allow $(1 - 15\%)$ unless processed correctly.	✓
$\frac{612}{\text{"}0.85\text{"}}$ oe or $\frac{612}{\text{"}85\text{"}} \times 100$ oe or $\text{"}7.2\text{"} \times 100$	**M1**	for a complete method. The quotation marks mean the candidate's own earlier value may be used here, so a wrong multiplier carried forward correctly still earns this mark.	✓
720	**A1**	A correct answer scores full marks, unless it comes from obvious incorrect working.	✓

Full marks: 3/3

Question 26 - Exam Solution

Understanding the Question

Given

The line with equation $y = 2 - 5x$.
L is parallel to that line.
L passes through $(0, 6)$.

Find

An equation of L.

Plan the Solution

- Rewrite the given line with the x term first, so its gradient can be read straight off.

- Parallel lines have equal gradients, so give L that same gradient.
- Substitute $(0, 6)$ into $y = mx + c$ to find the constant term.

Worked Solution [2 marks]

> Rule - Parallel lines: two lines are parallel exactly when their gradients are equal. In $y = mx + c$, m is the gradient and c is the y-intercept.

Step 1: Write the given line as $y = mx + c$

$y = 2 - 5x$

$y = -5x + 2$

(Reason: Swapping the two terms round does not change the line, and it puts the gradient in front of the x. The gradient of the given line is -5, because the minus sign belongs to the 5, and its y-intercept is 2.)

Step 2: Give L the same gradient

$m = -5$

(Reason: Parallel lines rise at exactly the same rate, so being parallel is the same statement as having equal gradients. L therefore takes the gradient of the line it is parallel to, and its equation so far is $y = mx + c$ with that gradient in place of m.)

Step 3: Substitute $(0, 6)$ to find c

$6 = -5 \times 0 + c$

$c = 6$

(Reason: The point lies on L, so $x = 0$ and $y = 6$ must fit the equation. $-5 \times 0 = 0$, which leaves $c = 6$. An x-coordinate of 0 puts the point on the y-axis, so here the constant is the y-intercept itself.)

Step 4: Write the equation of the line

$y = -5x + 6$

(Reason: Putting the gradient and the intercept into $y = mx + c$ gives the equation of L. Any equivalent rearrangement earns the mark, for example $y = 6 - 5x$ or $y + 5x = 6$.)

$$y = -5x + 6$$

Verification

✓ **Check 1:** Put $x = 0$ into the answer. $y = -5 \times 0 + 6 = 6$, so $(0, 6)$ does lie on L.

✓ **Check 2:** Compare the two lines written the same way round: $y = -5x + 2$ and $y = -5x + 6$. The gradients are both -5, so the lines are parallel, and the intercepts 2

and 6 differ, so L is not the line it is parallel to.

✓ **Check 3:** Measure the vertical gap between the two lines at $x = 1$ and again at $x = 4$. At $x = 1$ the gap is $1 - (-3) = 4$ and at $x = 4$ it is $-14 - (-18) = 4$. A gap that never changes is what parallel means.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
eg $y = -5x\ (+k)$ or $y - a = -5(x - b)$ or eg $y = mx + 6$ or $y - 6 = m(x - 0)$ or eg $-5x + 6$ or $L = -5x + 6$	M1	for the equation of any line with gradient -5 other than $y = 2 - 5x$ or for the equation of any line passing through the point $(0, 6)$ or the correct line missing $y =$ or with the wrong subject	✓
$y = -5x + 6$	A1	oe equation eg $y = 6 - 5x$ or $y - 6 = -5(x - 0)$ or $y + 5x = 6$ Correct answer scores full marks (unless from obvious incorrect working)	✓

Full marks: 2/2

Question 27 - Exam Solution

Understanding the Question

Given

ABD is a straight line, and B is the point on it with $AB = 21$ cm. Triangle ADE has a right angle at E, with $AE = 28$ cm and $ED = 45$ cm. Triangle CDB has a right angle at B, with $CD = 35$ cm.

Find

The area of triangle CDB, correct to 3 significant figures. Neither side of that triangle is given, so both have to be built out of the numbers that are.

Plan the Solution

- Triangle ADE is right-angled at E, so Pythagoras turns AE and ED into the hypotenuse AD.
- Because ABD is a straight line, BD is simply AD with AB taken off it.
- Triangle CDB is right-angled at B, so CD is its hypotenuse and Pythagoras gives the shorter side BC - a subtraction this time, not an addition.
- BD and BC meet at a right angle, so they are the base and the height of triangle CDB and the area is half their product.

Worked Solution [5 marks]

> Rule - Pythagoras: in a right-angled triangle $a^2 + b^2 = c^2$, where c is the hypotenuse, so a shorter side comes from $a^2 = c^2 - b^2$. Area of a right-angled triangle $= \frac{1}{2} \times \text{base} \times \text{height}$.

Step 1: Find AD with Pythagoras in triangle ADE

$$AD^2 = 28^2 + 45^2 = 784 + 2\,025 = 2\,809$$

$$AD = \sqrt{2\,809} = 53 \text{ cm}$$

(Reason: Angle AED is $90°$, so AD is the hypotenuse of triangle ADE and the two given sides are squared and added. $2\,809$ is a perfect square, so AD is exactly 53.)

Step 2: Take AB off AD to reach BD

$$BD = AD - AB = 53 - 21 = 32 \text{ cm}$$

(Reason: ABD is a straight line, so B lies on AD and $AB + BD = AD$. This is the step that joins the two triangles: BD belongs to both of them.)

Step 3: Find BC with Pythagoras in triangle CDB

$$BC^2 = 35^2 - 32^2 = 1\,225 - 1\,024 = 201$$

$$BC = \sqrt{201} = 14.177\ldots \text{ cm}$$

(Reason: Angle CBD is $90°$, so $CD = 35$ cm is the hypotenuse and BC is one of the shorter sides. A shorter side is found by subtracting the squares, not by adding them. Keep $\sqrt{201}$ exact so nothing is lost to rounding before the last line.)

Step 4: Work out the area of triangle CDB

$$\text{Area of } CDB = \frac{1}{2} \times BD \times BC = \frac{1}{2} \times 32 \times \sqrt{201} = 16\sqrt{201}$$

$$16 \times 14.177446 = 226.8391$$

$$\text{Area} = 227 \text{ cm}^2 \text{ to 3 significant figures}$$

(Reason: The right angle at B makes BD and BC the base and the height, so the area is half their product. $\frac{1}{2} \times 32 = 16$, which is why the exact answer is $16\sqrt{201}$; rounding $226.8391\ldots$ gives 227 .)

$$227 \text{ cm}^2$$

Verification

✓ **Check 1:** Reach the area by trigonometry instead. In triangle CDB, $\cos BDC = \frac{32}{35}$, so angle $BDC \approx 23.8955°$, and the area is $\frac{1}{2} \times CD \times BD \times \sin BDC$.
$\frac{1}{2} \times 35 \times 32 \times \sin 23.8955° = 226.839\ldots$, which is 227 to 3 significant figures.

✓ **Check 2:** Put BC back into Pythagoras. The squares of the two shorter sides of triangle CDB must add up to the square of the hypotenuse CD.
$32^2 + 201 = 1\,024 + 201 = 1\,225 = 35^2$

✓ **Check 3:** Test AD the same way: 28, 45 and 53 must be a Pythagorean triple.
$28^2 + 45^2 = 784 + 2\,025 = 2\,809 = 53^2$

Mark Scheme Breakdown

Step	Mark	Description	Got it?
A correct method to find AD^2, or angle EDA, or angle EAD	**M1**	For example $28^2 + 45^2 = 784 + 2\,025 = 2\,809$. Or, for angle EDA, $\tan^{-1}\frac{28}{45} = 31.8\ldots$. Or, for angle EAD, $\tan^{-1}\frac{45}{28} = 58.1\ldots$.	✓
A correct method to find AD	**M1**	For example $AD = \sqrt{28^2 + 45^2} = \sqrt{784 + 2\,025} = \sqrt{2\,809} = 53$, or equivalent. Or, from the angle above, $\frac{28}{\sin 31.8\ldots} = 53\ldots$ or $\frac{45}{\cos 31.8\ldots} = 53\ldots$ or $\frac{45}{\sin 58.1\ldots} = 53\ldots$ or $\frac{28}{\cos 58.1\ldots} = 53\ldots$.	✓

Step	Mark	Description	Got it?
A correct method to find BC, or angle BDC, or angle BCD	**M1**	For example $BC = \sqrt{35^2 - (53-21)^2} = \sqrt{1\,225 - 1\,024} = \sqrt{201} = 14.1\ldots$. Or, for angle BDC, $\cos^{-1}\dfrac{53-21}{35} = 23.8\ldots$. Or, for angle BCD, $\sin^{-1}\dfrac{53-21}{35} = 66.1\ldots$. The printed scheme puts the 53 in quotation marks, so the candidate's own value for AD may be used in its place.	✓
A correct method to find the area of triangle CDB	**M1**	For example $\dfrac{1}{2} \times 14.1\ldots \times (53-21)$, giving $16\sqrt{201}$. Or $\dfrac{1}{2} \times 35 \times (53-21) \times \sin 23.8\ldots$. Or $\dfrac{1}{2} \times 35 \times 14.1\ldots \times \sin 66.1\ldots$. The printed scheme puts each of these values in quotation marks, so the candidate's own AD, BC and angle may be used.	✓
The answer	**A1**	Anything which rounds to 227. Accept $16\sqrt{201}$.	✓
Guidance for the whole question	**Note**	A correct answer scores full marks, unless it comes from obviously incorrect working.	✓

Full marks: 5/5

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