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Edexcel IGCSE 4MA1

Paper 2F (Foundation Tier) – June 2024

100 marks · 2 hours · Calculator allowed

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

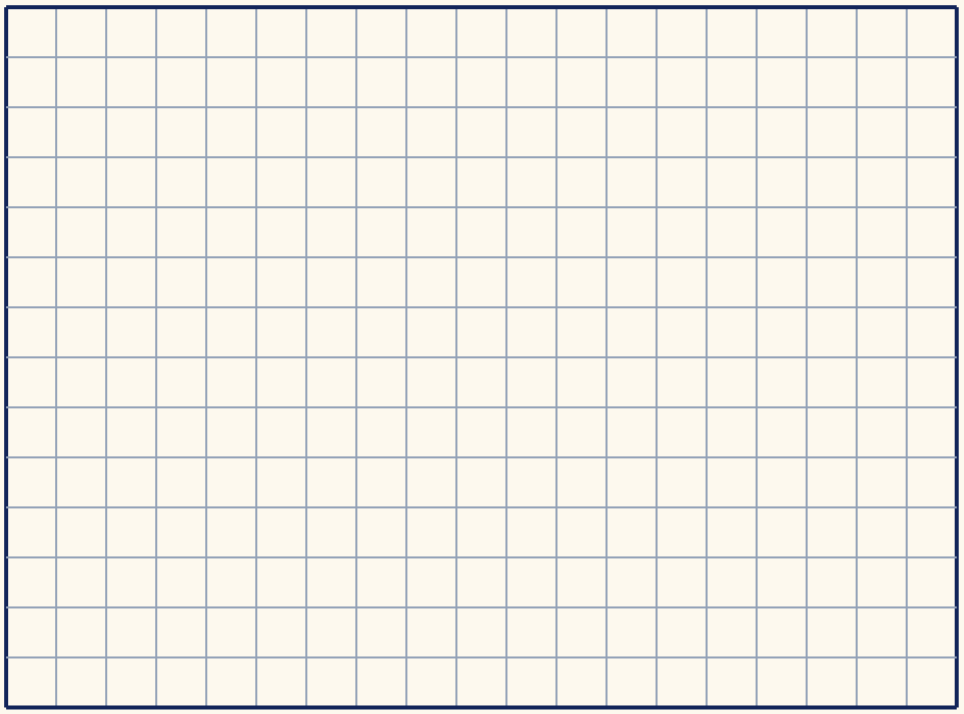
Original worked solutions for Edexcel International GCSE Mathematics A (4MA1), Paper 2F (Foundation Tier), June 2024 – 100 marks, 2 hours, calculator allowed. The questions have been reworded; all numerical values match the original paper. The official question paper and mark scheme are published by 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. The table shows the distance, in kilometres, each of 6 volunteers travelled to get to a beach clean-up.

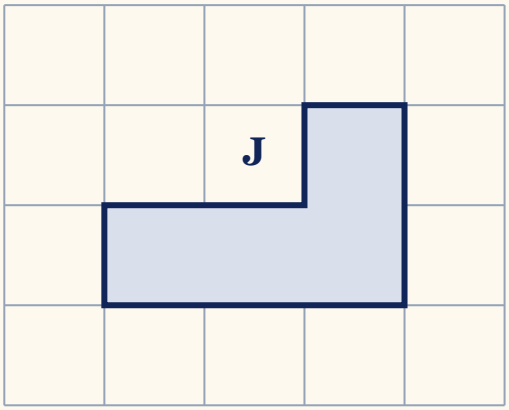


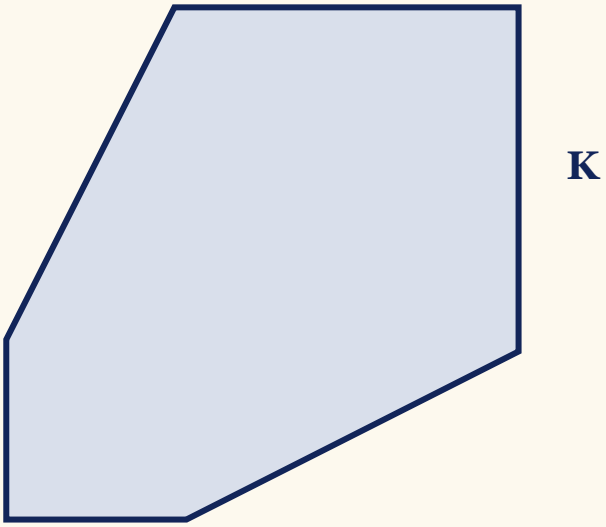
Name	Clive	Aoi	Rufus	Hinata	Cedric	Nora
Distance (km)	7	12	10	5	4	9

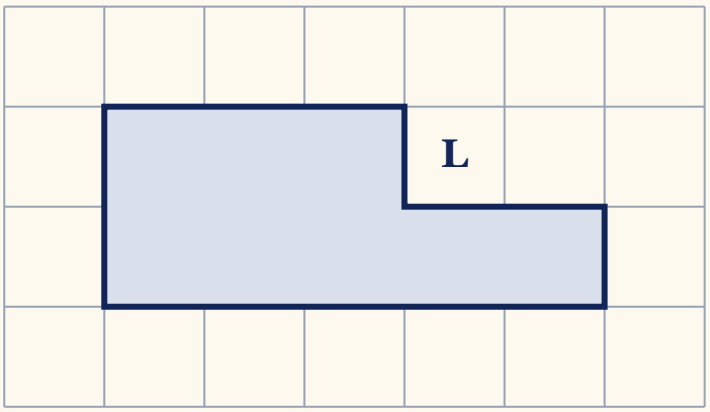
On the grid, draw a bar chart to show this information. *[3 marks]*

[Total 3 marks]

2. The diagram below shows shape J on a square grid, then shape K, then shape L on a centimetre grid.







(a) Draw a shape on the grid that is congruent to shape J *[1 mark]*

(b) Draw a shape on the grid that is an enlargement of shape J with scale factor 2 *[2 marks]*

Shape K has exactly one line of symmetry.
(c) Draw that line of symmetry on shape K *[1 mark]*

(d) Work out the perimeter of shape L *[1 mark]*

(e) Work out the area of shape L *[1 mark]*

(d) cm .....

(e) cm^2 .....

[Total 6 marks]

3. (a) Write these numbers in order of size.
Start with the smallest number.

$-77, 39, -89, 43, -6$ *[1 mark]*

(b) Write these decimals in order of size.
Start with the smallest decimal.

$0.134, 0.12, 0.145, 0.017, 0.3$ *[1 mark]*

(c) Change 0.7 into a percentage. *[1 mark]*

(d) Change $\frac{27}{100}$ into a decimal. *[1 mark]*

There are 60 cupcakes on a cake stall.
$\frac{7}{10}$ of the cupcakes are chocolate cupcakes.

(e) Work out how many of the cupcakes are not chocolate cupcakes. *[2 marks]*

(a) .....

(b) .....

(c) % .....

(d) .....

(e) .....

[Total 6 marks]

4. The first five terms of a number sequence are shown below.

106 99 92 85 78

(a) (i) Write down the next term of the sequence.
[1 mark]
(ii) Explain how you found your answer to part (a)(i). *[1 mark]*

The 9th term of the sequence is 50

(b) Work out the 12th term of the sequence. *[1 mark]*

Lorenzo says 7 is a term in the sequence.
Lorenzo is wrong.

(c) Explain why. *[1 mark]*

(a)(i) .....

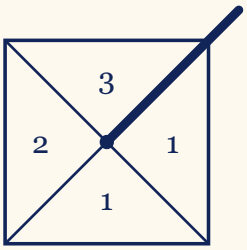
(a)(ii) .....

(b) .....

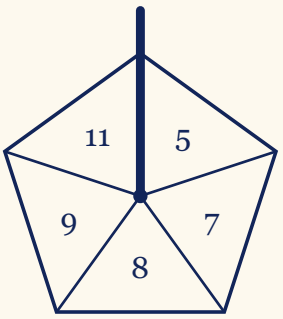
(c) .....

[Total 4 marks]

5. Duncan has made two fair spinners for a game at his school fair.
Spinner A has 4 sides and can land on 1, 1, 2 or 3
Spinner B has 5 sides and can land on 5, 7, 8, 9 or 11



Spinner A



Spinner B

Duncan spins each spinner once.
He subtracts the number that spinner A lands on from the number that spinner B lands on to get his score.

(a) Complete the table to show all the possible scores.
The spinner A numbers run across the top row and the spinner B numbers run down the first column.

	1	1	2	3
5	4	4		
7			5	4
8		7		5
9		8		
11		10	9	8

[2 marks]

(b) Find the probability that
(i) Duncan's score is an even number
[1 mark]
(ii) Duncan's score is greater than 7 *[1 mark]*

(b)(i) .....

(b)(ii) .....

[Total 4 marks]

6. There are 150 vehicles in a car park.

Of these vehicles
19 are vans
32 are motorbikes
3 are lorries

The rest of the vehicles are cars.

Write the number of cars as a fraction of the total number of vehicles.
Give your fraction in its simplest form. *[3 marks]*

.....

[Total 3 marks]

7. 2 flasks each contain 350 millilitres of apple juice.
5 cartons each contain y millilitres of apple juice.

Martin pours all the juice from the 2 flasks and the 5 cartons into a pan.
The total amount of juice that Martin pours into the pan is 2.8 litres.

Work out the value of y *[4 marks]*

y = ...

[Total 4 marks]

8. Craft Corner and Palette House each have a special offer on pots of paint.

Craft Corner	Palette House
Paint pots $4.20 per pot	Pack of 5 paint pots for $18
Special offer	**Special offer**
Pay for 2 pots get 1 pot free	25% off each pack of 5 pots

Ingrid buys 30 pots of paint from Craft Corner using the special offer.
Bilal buys 30 pots of paint from Palette House using the special offer.

Work out the difference between the amount that Ingrid pays and the amount that Bilal pays. *[4 marks]*

$ .....

[Total 4 marks]

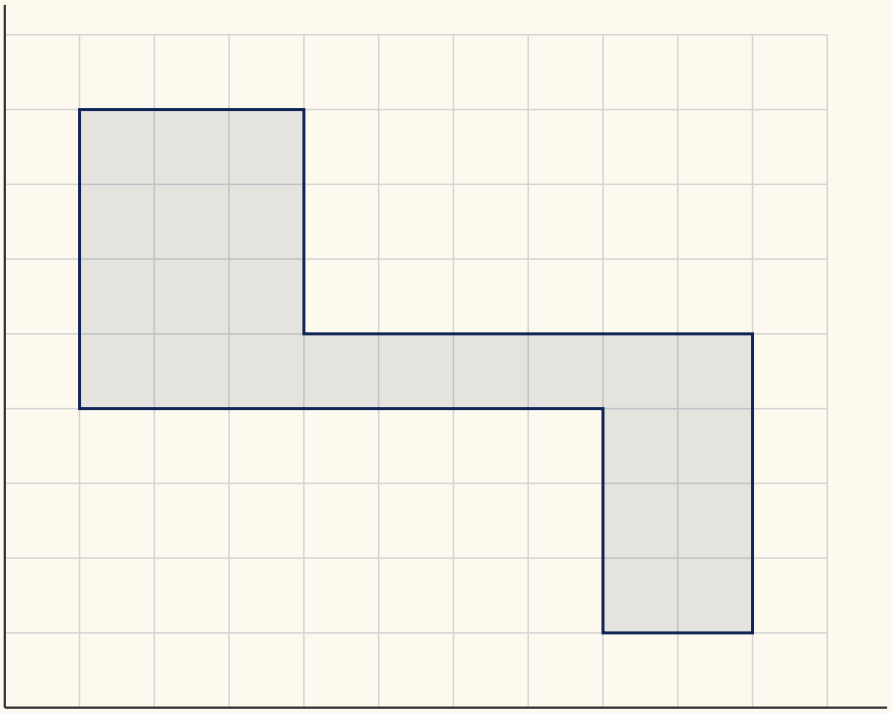
9. A circle has a radius of 9 cm.

Work out the area of the circle.
Give your answer correct to 3 significant figures. *[2 marks]*

..... cm^2

[Total 2 marks]

10. Shape A is drawn on the centimetre grid below.



On the second centimetre grid, draw a rectangle that has the same area as shape A. *[2 marks]*

[Total 2 marks]

11. (a) Simplify $e \times e \times e \times e \times e$

[1 mark]

(b) Simplify $m + m + m$

[1 mark]

(c) Simplify $3g^2 + 7g^2 - 4g^2$

[1 mark]

(d) Expand $a(a + 8)$

[1 mark]

(e) Factorise $15x + 20$ *[1 mark]*

Bridget sells d packs of greetings cards and h boxes of greetings cards.

Each pack contains 3 greetings cards.
Each box contains 5 greetings cards.

The total number of greetings cards that Bridget sells is T

(f) Write down a formula for T in terms of d and h *[3 marks]*

(a) .....

(b) .....

(c) .....

(d) .....

(e) .....

(f) .....

[Total 8 marks]

12. Duncan buys a telescope in Australia.

The telescope costs 232 Australian dollars.
In India, an identical telescope costs 12 420 Indian rupees.

The exchange rate is 1 Australian dollar for 54 Indian rupees.

The telescope costs more in Australia than in India.

Work out how much more.
You must give the units of your answer. *[3 marks]*

.....

[Total 3 marks]

13. Owen wants to knit a gift for a newborn baby.

He can knit a jacket (J) or a blanket (B) or a hat (H) or a scarf (S)
He can knit using white wool (W) or using yellow wool (Y)

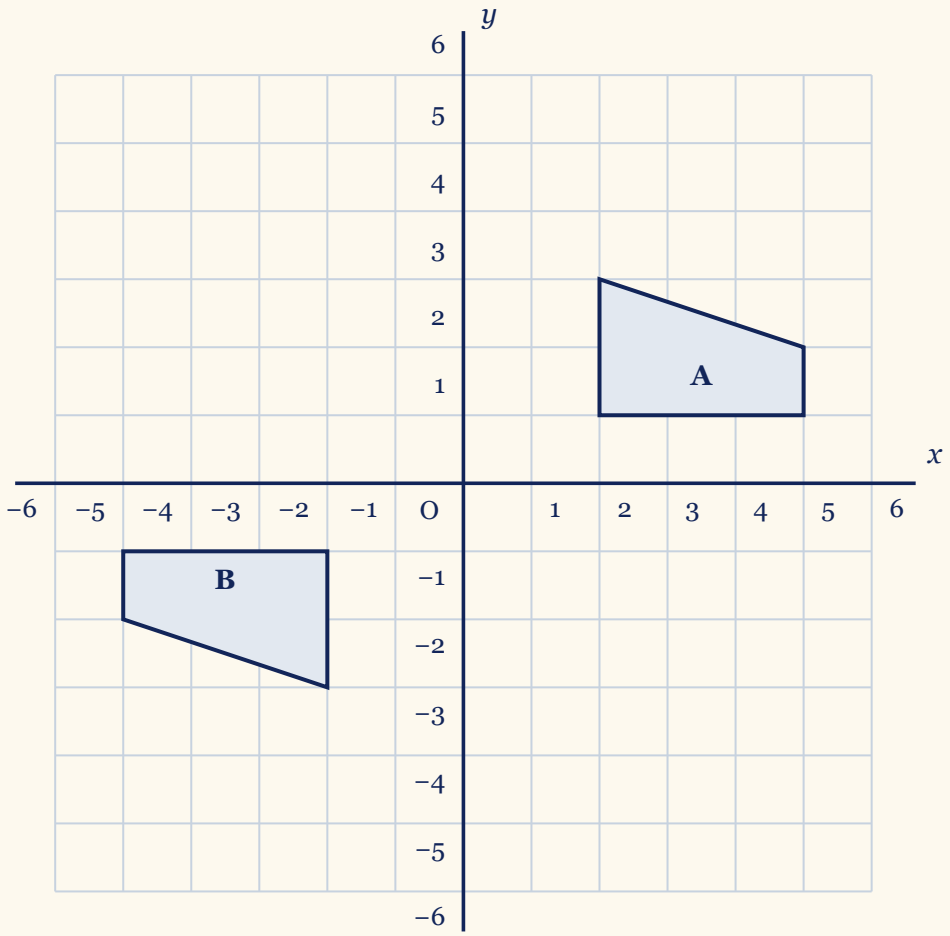
Owen chooses one item to knit and chooses one colour of wool.

Write down all the possible combinations for the item that Owen could knit. *[2 marks]*

.....

[Total 2 marks]

14. Shape A and shape B are drawn on the grid below.



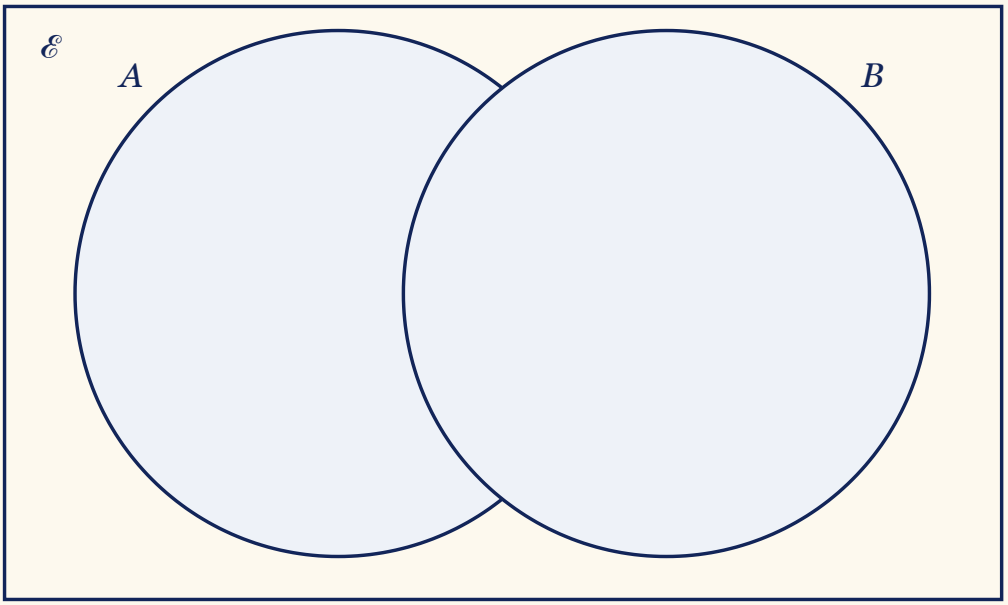
(a) Shape A is mapped onto shape B by a single transformation.
Describe this transformation fully. *[2 marks]*

(b) On the grid, draw the reflection of shape A in the line with equation $y = -1$ *[2 marks]*

(a) .....

[Total 4 marks]

15. $\mathcal{E} = \{11, 12, 13, 14, 15, 16, 17, 18, 19, 20\}$



$A = \{11, 14, 16, 19\}$
$B = \{12, 14, 15, 16, 18, 20\}$

Show this information on the Venn diagram below. *[3 marks]*

[Total 3 marks]

16. Use a calculator to find the value of

$$\frac{17.9}{8.61 + 2.36} - 1.2^2$$

Write your answer as a decimal.
Copy down every figure shown on your calculator display. *[2 marks]*

.....

[Total 2 marks]

17. Eight numbers are listed in order of size, from smallest to largest.

h 6 7 8 j 16 k k

Each of h, j and k is an integer.

The median of the eight numbers is 10
The mode of the eight numbers is 18
The range of the eight numbers is 13

Work out the value of h, the value of j and the value of k. *[3 marks]*

h = ...

j = ...

k = ...

[Total 3 marks]

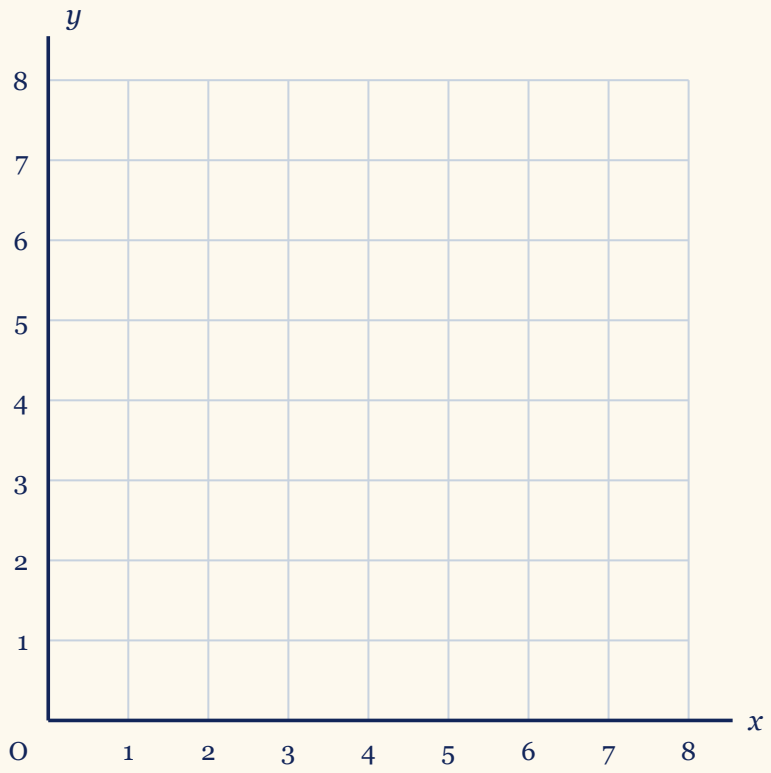
18. (a) On the grid, draw the straight line with equation

(i) $y = 2$

(ii) $x = 6$

(iii) $y = x + 1$

Write the equation beside each line you draw. *[3 marks]*



(b) Show, by shading on the grid, the region that satisfies all three of these inequalities

$y \geq 2$ $x \leq 6$ $y \leq x + 1$

Label this region R *[1 mark]*

[Total 4 marks]

19. An aircraft takes 9 hours 36 minutes to fly from Doha to Cape Town.

The aircraft flies at an average speed of 820 km/h.

Work out the total distance the aircraft flies. *[3 marks]*

..... km

[Total 3 marks]

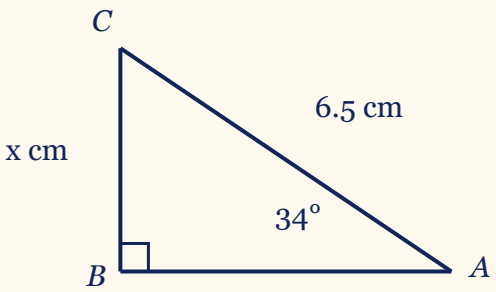
20. Show that $2\frac{4}{7} \times 3\frac{1}{9} = 8$

You must show all your working. *[3 marks]*

[Total 3 marks]

21. Triangle ABC is shown in the diagram below.
The angle at B is a right angle.

Diagram NOT accurately drawn



Calculate the value of x.
Give your answer correct to one decimal place. *[3 marks]*

x = ...

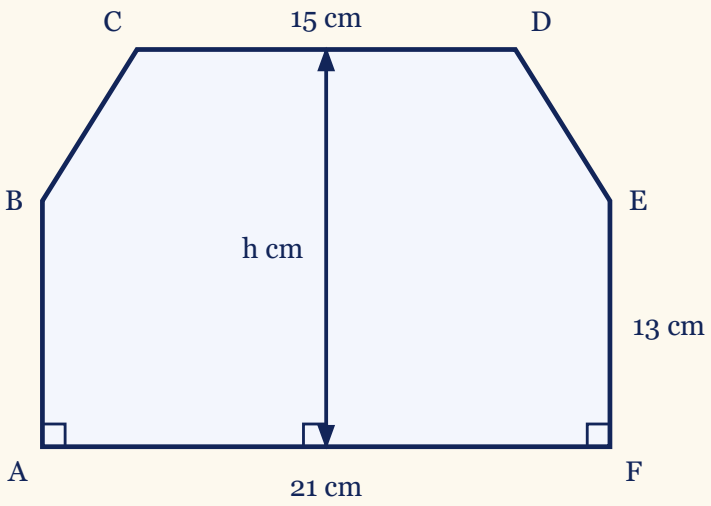
[Total 3 marks]

22. A moving walkway at an airport carries passengers at a steady speed of w metres per second.
Change this speed to a speed in kilometres per hour.
Give your answer in terms of w in its simplest form. *[3 marks]*

..... kilometres per hour

[Total 3 marks]

23. The diagram shows a hexagon $ABCDEF$



Not drawn accurately

$AF = 21$ cm, $CD = 15$ cm, $AB = FE = 13$ cm

CD is parallel to AF
The perpendicular height of the hexagon is h cm

The area of the hexagon is 390 cm²

Work out the value of h *[4 marks]*

h = ...

[Total 4 marks]

24. Rohan buys 600 balloons for a school fair.
He buys round balloons, heart balloons and star balloons so that

number of round balloons : number of heart balloons : number of star balloons $= 9 : 4 : 2$

45% of the round balloons are red.

$\frac{5}{8}$ of the heart balloons are red.

All of the star balloons are red.

Work out the number of balloons that are red. *[5 marks]*

.....

[Total 5 marks]

25. Lorenzo invests 4500 koruna in a savings bond for 4 years.
The bond pays 2.4% per year compound interest.

Work out how much money Lorenzo will have in the savings bond at the end of 4 years.
Give your answer correct to the nearest koruna. *[3 marks]*

..... koruna

[Total 3 marks]

26. Solve the simultaneous equations

$6x + 4y = 1$
$3x + 5y = 8$

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

x = ...

y = ...

[Total 3 marks]

27. (i) Write $x^2 + 9x - 22$ as a product of two brackets. *[2 marks]*

(ii) Hence solve the equation $x^2 + 9x - 22 = 0$ *[1 mark]*

(i) .....

(ii) .....

[Total 3 marks]

28. Bilal uses a smartwatch to count the number of steps he walks each day for 7 days.

For the first 4 days, his mean number of steps is 11 800
For the next 3 days, his mean number of steps is 13 207

Work out his mean number of steps for the 7 days. *[3 marks]*

.....

[Total 3 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

Six distances, in kilometres, one for each volunteer: 7, 12, 10, 5, 4, 9.
A blank square grid to draw the chart on.

Find

A bar chart showing the six distances.

Plan the Solution

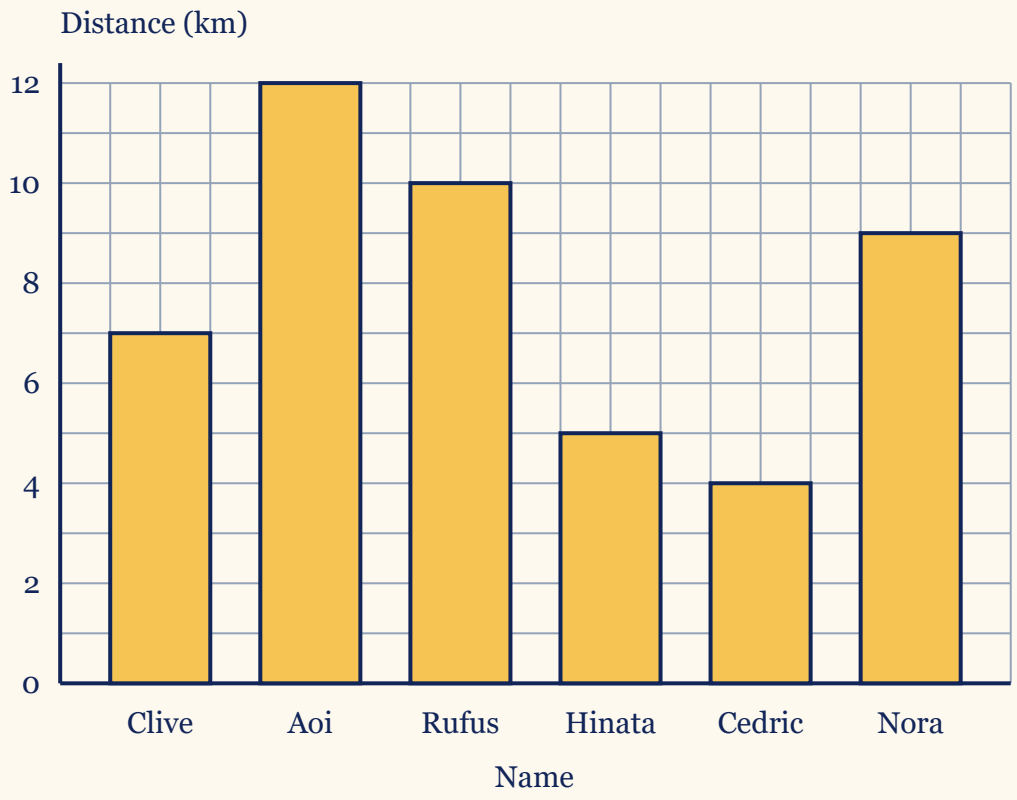
- Read the six heights straight from the table - a bar chart of raw data shows the numbers that are already there, so nothing has to be worked out.
- Choose a scale for the vertical axis that reaches the tallest distance, 12 km, and keep it linear so that equal steps stand for equal distances.
- Draw six bars of equal width, then label the scale and every bar.

Worked Solution [3 marks]

> Rule - Bar chart: each bar's height is the value it stands for, the scale rises in equal steps, and every bar carries its own label.

Step 1: read the six distances from the table

7, 12, 10, 5, 4, 9



(Reason: these six numbers are the bar heights, so the tallest bar is Aoi's at 12 km and the shortest is Cedric's at 4 km)

Step 2: choose a scale for the vertical axis

1 square $=$ 1 km

$12 \times 1 = 12$ squares

(Reason: one square standing for 1 km keeps the scale linear and makes every bar as many squares tall as its distance, so the axis has to run at least as high as the tallest bar)

Step 3: draw the bars and label the chart

Clive 7 Aoi 12 Rufus 10

Hinata 5 Cedric 4 Nora 9

(Reason: equal widths and equal gaps keep the bars comparable, and the marks are for the heights and the labels, not for the width chosen)

A fully correct bar chart: bars of height 7, 12, 10, 5, 4, 9 km

a linear scale on the distance axis, and every bar labelled with its name

Verification

✓ **Check 1:** Read the finished chart back against its scale. One square is 1 km, so count the squares in each bar and compare with the table. Clive 7, Aoi 12, Rufus 10, Hinata 5, Cedric 4, Nora 9 - all six agree with the table.

✓ **Check 2:** Add the six bar heights and compare that total with the total of the six distances in the table. A bar read wrongly would change one total and not the other. $7 + 12 + 10 + 5 + 4 + 9 = 47$ km both ways.

✓ **Check 3:** The tallest bar should stand above the shortest by the range of the data. $12 - 4 = 8$ squares between the top of Aoi's bar and the top of Cedric's, which is what the chart shows.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
Bars drawn to the correct heights	**B2**	All six bars at the correct height for the scale used - 7, 12, 10, 5, 4, 9. Gaps or no gaps between the bars, and bars of different widths, are condoned.	✓
Partial credit for the bars	**B1**	Three, four or five bars at the correct height, or all six heights marked but no bars drawn.	✓
Labelling	**B1**	All labels correct: a linear scale on the distance axis, and an individual label for each of the six names.	✓

Full marks: 3/3

Question 2 - Exam Solution

Understanding the Question

Given

Shape J on a square grid: an L-shape 3 squares wide and 2 squares tall, with a 2 by 1 rectangle missing from its top left corner.
Shape K: a six-sided shape that has exactly one line of symmetry.
Shape L on a centimetre grid: an L-shape 5 cm wide and 2 cm tall, with a 2 cm by 1

Find

(a) a shape congruent to shape J; (b) an enlargement of shape J with scale factor 2; (c) the one line of symmetry of shape K; (d) the perimeter of shape L, in cm; (e) the area of shape L, in square centimetres.

cm rectangle missing from its top right corner.

Plan the Solution

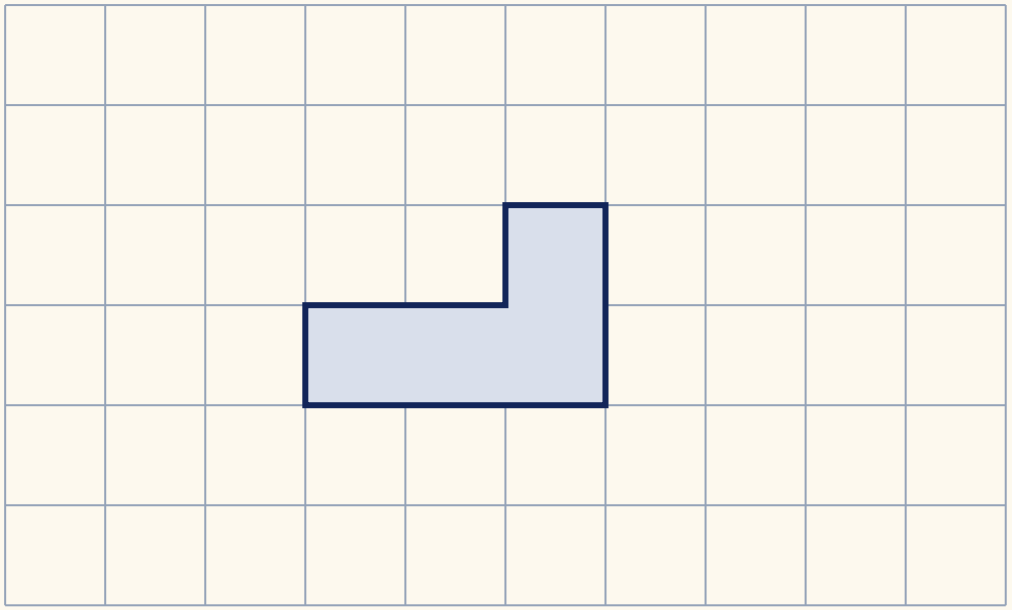
- Congruent means same size and same shape, so part (a) asks only for a copy: count the squares that make shape J and lay them out again somewhere else on the grid.
- Scale factor 2 doubles every length, so for part (b) work round the outline of shape J and draw each side twice as long.
- A line of symmetry is a fold line. Shape K has its two shortest sides meeting at one corner and its two medium sides meeting at the opposite corner, so for part (c) try the diagonal that joins those two corners.
- For part (d), travel once round the outside of shape L and add every side, the short ones at the step included.
- For part (e), count the centimetre squares shape L covers, or split it into two rectangles and add their areas.

Worked Solution [6 marks]

> Rule - Congruent shapes have identical side lengths and identical angles, so only their position or their turn may differ. An enlargement of scale factor 2 multiplies every length by 2 and every area by 2^2. A line of symmetry folds a shape exactly onto itself. Perimeter is the total distance round the outside; area is the number of unit squares covered.

Step 1 - Part (a): copy shape J without changing its size

$3 \times 1 + 1 \times 1 = 4$



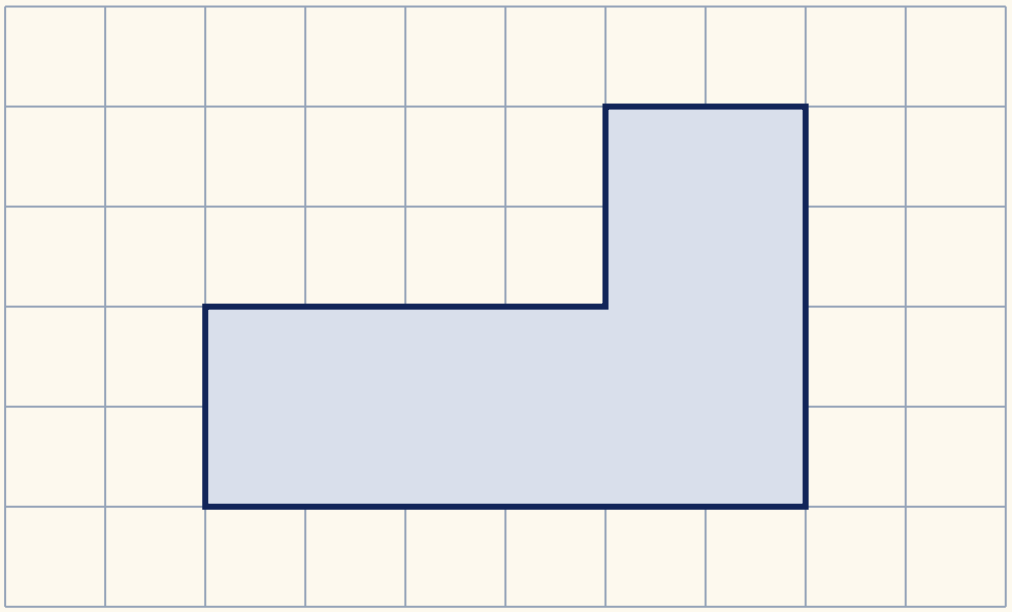
(Reason: Shape J is a row of 3 squares with 1 more square sitting on the right-hand end, so it covers 4 squares altogether. A congruent shape has the same sides and the same angles, so drawing those 4 squares in the same arrangement anywhere on the grid earns the mark. Turning it or flipping it is allowed; making it bigger or smaller is not.)

Step 2 - Part (b): double every side of shape J

$3 \times 2 = 6$

$2 \times 2 = 4$

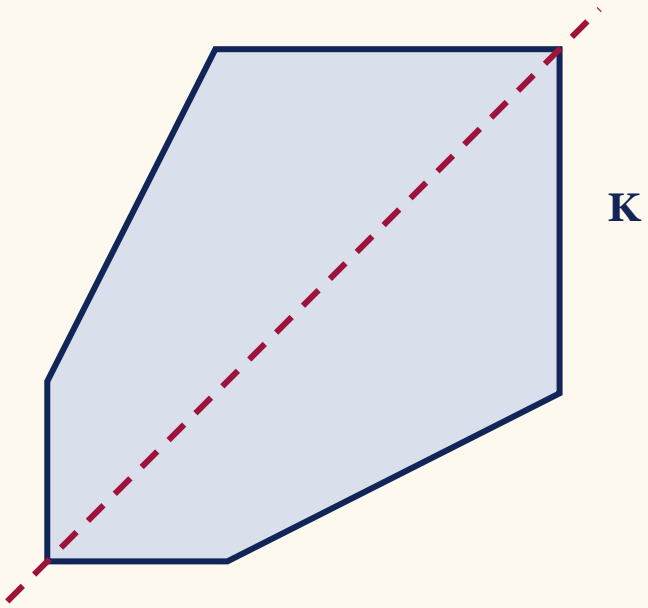
$1 \times 2 = 2$



(Reason: Scale factor 2 multiplies every length by 2, so the side of 3 squares becomes 6, the side of 2 squares becomes 4 and each side of 1 square becomes 2. The angles are unchanged, so the drawing is the same L-shape stretched equally in both directions.)

Step 3 - Part (c): find the fold line of shape K

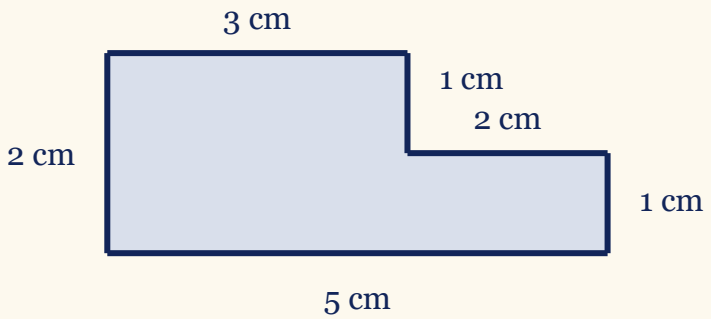
$$6 = 2 + 2 \times 2$$



(Reason: Shape K has 6 vertices. A fold line has to leave the shape looking the same, so it passes through 2 of them and swaps the other 4 in 2 matching pairs. The two shortest sides meet at the bottom left vertex and the two medium sides meet at the opposite vertex, so the fold line is the diagonal joining those two. Every other line leaves the shape looking different, so draw that one and no others.)

Step 4 - Part (d): add the sides of shape L

$$5 + 1 + 2 + 1 + 3 + 2 = 14$$



(Reason: Start at the bottom left corner of shape L and travel once round the outside, writing down every side you walk along. Each square of the grid is 1 cm, and the two short sides at the step count in exactly the same way as the long ones.)

Step 5 - Part (e): count the centimetre squares of shape L

$5 \times 1 = 5$

$3 \times 1 = 3$

$5 + 3 = 8$

(Reason: Split shape L into two rectangles: the bottom row is 5 cm by 1 cm and the row above it is 3 cm by 1 cm. Adding the two gives the number of centimetre squares the shape covers, which is its area.)

(a) a shape of the same size and shape as shape J

(b) an L-shape with every side of shape J doubled

(c) the diagonal joining the two opposite vertices where the equal sides meet

(d) 14 cm

(e) 8 cm^2

Verification

✓ **Check 1:** Shape L fits exactly inside a 5 cm by 2 cm rectangle, and the piece that is missing is cut from a corner, so the outline is exactly as long as the rectangle's.

$2 \times (5 + 2) = 14$

✓ **Check 2:** Count the centimetre squares of shape L one row at a time: a row of 5 with a row of 3 above it. $5 + 3 = 8$

✓ **Check 3:** Enlarging by scale factor 2 multiplies area by 2^2, so the shape drawn in part (b) should cover 4 times as many squares as shape J. $4 \times 2^2 = 16$

✓ **Check 4:** Fold shape K along the drawn diagonal: the two shortest sides swap with each other, the two long slanting sides swap, and the two medium sides swap. every vertex lands on a vertex, so the fold works, and no other line does the same

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a) A shape drawn with the same side lengths and the same angles as shape J	**B1**	A shape of the same size and shape as the one given. It may be reflected or rotated.	✓
(b) An L-shape drawn with every side of shape J doubled	**B2**	A shape that is an enlargement of the given shape. Any orientation is satisfactory. B1 for 2 correctly enlarged sides.	✓
(c) The correct line of symmetry drawn on shape K	**B1**	The correct line, with no other lines drawn.	✓
(d) Perimeter of shape L	**B1**	14	✓
(e) Area of shape L	**B1**	8	✓

Full marks: 6/6

Question 3 - Exam Solution

Understanding the Question

Given

Five numbers: -77, 39, -89, 43, -6. Two of them are negative.
Five decimals: 0.134, 0.12, 0.145, 0.017, 0.3. They do not all have the same number of decimal places.

Find

(a) the five numbers written in order, smallest first; (b) the five decimals written in order, smallest first; (c) 0.7 written as a percentage; (d) $\frac{27}{100}$ written

The decimal 0.7 and the fraction $\frac{27}{100}$.

A cake stall holding 60 cupcakes, of which $\frac{7}{10}$ are chocolate cupcakes.

as a decimal; (e) how many of the cupcakes are not chocolate cupcakes.

Plan the Solution

- For part (a), picture a number line. Everything negative sits to the left of 0, so both negative numbers come first, and among negatives the one furthest from zero is the smallest.
- For part (b), give every decimal the same number of decimal places by filling the gaps with zeros. Once they all have three decimal places they can be compared as whole numbers of thousandths.
- For part (c), a percentage counts hundredths, so multiply the decimal by 100.
- For part (d), a fraction with denominator 100 is already a number of hundredths, so the numerator gives the digits after the decimal point.
- For part (e), the whole stall is 1 whole. Subtract the fraction that are chocolate to get the fraction that are not, then take that fraction of 60.

Worked Solution [6 marks]

> Rule - On a number line, further left means smaller, so a negative number with a bigger digit is worth less. Decimals are compared place by place from the left, and writing them all to the same number of decimal places makes that comparison safe. To turn a decimal into a percentage, multiply by 100; a fraction over 100 is already a percentage, and its numerator gives the hundredths digits of the decimal. To find a fraction of an amount, divide by the denominator and multiply by the numerator.

Step 1 - Part (a): put the two negative numbers first

$$-89 < -77 < -6 < 0 < 39 < 43$$

(Reason: Every negative number is to the left of 0, so -89, -77 and -6 all come before 39 and 43. Among the negatives the order is the other way round from the digits: 89 is bigger than 77, so -89 is further left and therefore smaller. The two positive numbers keep their usual order.)

Step 2 - Part (b): give every decimal three decimal places, then compare

$$0.017,\ 0.120,\ 0.134,\ 0.145,\ 0.300$$

$$17 < 120 < 134 < 145 < 300$$

$$0.017 < 0.12 < 0.134 < 0.145 < 0.3$$

(Reason: Filling the short decimals with zeros does not change their value: 0.12 is the same as 0.120 and 0.3 is the same as 0.300. Now every decimal is a number of thousandths, so they can be ordered as whole numbers. Without the zeros it is easy to be tricked by the length of a decimal and think 0.134 beats 0.3.)

Step 3 - Part (c): multiply the decimal by one hundred

$$0.7 \times 100 = 70$$

(Reason: Per cent means out of 100, so a percentage counts hundredths. 0.7 is 7 tenths, and each tenth is 10 hundredths, so 0.7 is 70 hundredths.)

Step 4 - Part (d): read the hundredths straight off the fraction

$$\frac{27}{100} = 0.27$$

(Reason: The denominator 100 says the fraction counts hundredths, and the second place after the decimal point is the hundredths place. 27 hundredths is 2 tenths and 7 hundredths, which is written 0.27.)

Step 5 - Part (e): take the fraction that are not chocolate, then find it of sixty

$$1 - \frac{7}{10} = \frac{3}{10}$$

$$\frac{3}{10} \times 60 = 18$$

(Reason: The whole stall is 1 whole, so the cupcakes that are not chocolate make up the rest of it once the chocolate ones are taken away: $\frac{3}{10}$ of the stall. To take tenths of 60, split the 60 cupcakes into 10 equal groups of 6 and count three of those groups. The question asks for the cupcakes that are not chocolate, so it is the $\frac{3}{10}$ that is wanted, never the $\frac{7}{10}$.)

(a) $-89,\ -77,\ -6,\ 39,\ 43$

(b) $0.017,\ 0.12,\ 0.134,\ 0.145,\ 0.3$

(c) 70%

(d) 0.27

(e) 18 **cupcakes**

Verification

✓ **Check 1:** Walk along the answer to part (a) from left to right and subtract each number from the one after it. Every gap must come out positive, or two numbers are the wrong way

round. $12,\ 71,\ 45,\ 4$

✓ **Check 2:** Multiply each decimal in the answer to part (b) by 1000 to clear the decimal point, and check the whole numbers climb. $17 < 120 < 134 < 145 < 300$

✓ **Check 3:** Work parts (c) and (d) backwards. A percentage is a count of hundredths, so put 70 over 100; and read 0.27 as hundredths. $\frac{70}{100} = 0.7$ and $0.27 = \frac{27}{100}$

✓ **Check 4:** The chocolate cupcakes and the ones that are not chocolate are the whole stall between them, so the two counts must add back to 60. The chocolate ones number $\frac{7}{10} \times 60$. $42 + 18 = 60$

✓ **Check 5:** Do part (e) a different way, as a percentage: $\frac{3}{10}$ is 30%, and 30% of 60 is 0.3×60. $0.3 \times 60 = 18$

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a) The five numbers written in order, smallest first	**B1**	$-89,\ -77,\ -6,\ 39,\ 43$	✓
(b) The five decimals written in order, smallest first	**B1**	$0.017,\ 0.12,\ 0.134,\ 0.145,\ 0.3$. Allow extra zeros, eg $0.017,\ 0.120,\ 0.134,\ 0.145,\ 0.300$.	✓
(c) 0.7 written as a percentage	**B1**	70	✓
(d) $\frac{27}{100}$ written as a decimal	**B1**	0.27	✓
(e) A complete method to reach the cupcakes that are not chocolate	**M1**	$1 - \frac{7}{10}$ ($= \frac{3}{10} = 0.3$, that is 30%) or $\frac{7}{10} \times 60$ ($= 42$) oe.	✓
(e) The number of cupcakes that are not chocolate	**A1**	18. A correct answer scores full marks, unless it comes from obvious incorrect working.	✓

Full marks: 6/6

Question 4 - Exam Solution

Understanding the Question

Given

The first five terms of the sequence are $106,\ 99,\ 92,\ 85,\ 78$.
The 9th term is 50.
Lorenzo claims that 7 appears somewhere in the sequence.

Find

The next term, which is the 6th term, and the rule used to get it. The 12th term, starting from the 9th term. A reason why 7 cannot be a term.

Plan the Solution

- Subtract each term from the one after it. If every gap is the same, the sequence is linear and that gap is the common difference d.
- Add d to the last printed term for part (a)(i). The value of d is itself the explanation asked for in part (a)(ii).
- For part (b), count the gaps between the 9th term and the 12th term, then apply d that many times to 50.
- For part (c), build the nth term rule, then list the terms on either side of 7 to show that the sequence steps straight over it.

Worked Solution [4 marks]

> Rule, linear sequence: every term is the one before it plus a fixed common difference d, and the nth term is $dn + (a - d)$, where a is the first term.

Step 1: find the common difference

$$99 - 106 = -7$$
$$92 - 99 = -7$$
$$85 - 92 = -7$$
$$78 - 85 = -7$$

(Reason: (Reason: every gap comes to the same number, so the sequence is linear with $d = -7$. One gap on its own could be a coincidence, so all four are checked.))

Step 2: part (a)(i), take one more step

$$78 - 7 = 71$$

(Reason: (Reason: 78 is the 5th term, so taking away 7 once gives the 6th term.))

Step 3: part (a)(ii), say what the rule was

$d = -7$

(Reason: (Reason: the explanation the examiner wants is the common difference itself. Subtracting 7, or adding -7, is what turns each term into the next one.))

Step 4: part (b), count the gaps, not the terms

$12 - 9 = 3$

(Reason: (Reason: the 9th term is the starting point, so it is not a step. Only the moves to the 10th, 11th and 12th terms count.))

Step 5: part (b), step on from the 9th term to the 12th

$50 - 3 \times 7 = 29$

(Reason: (Reason: the 9th term is 50, and each further term takes away another 7, so the number of gaps found in Step 4 is how many sevens come off.))

Step 6: part (c), build the nth term rule

$a = 106$

$d = -7$

$dn + (a - d) = -7n + (106 + 7)$

$n\text{th term} = -7n + 113$

(Reason: (Reason: the rule turns a question about a list into a question about one equation, which can then be tested for any value at all.))

Step 7: part (c), test whether 7 can be a term

$-7n + 113 = 7$

$7n = 106$

$n = \dfrac{106}{7}$

(Reason: (Reason: $7 \times 15 = 105$ and $7 \times 16 = 112$, so 106 is not a multiple of 7 and n is not a whole number. A term position has to be a whole number.))

Step 8: part (c), show it in the list as well

$29,\ 22,\ 15,\ 8,\ 1$

(Reason: (Reason: after 15 the sequence goes to 8 and then to 1, so it steps straight over 7 and never lands on it.))

(a)(i) 71

(a)(ii) subtract 7 **from the term before**

(b) 29

(c) the sequence runs $15,\ 8,\ 1$**, stepping over** 7

Verification

- ✓ **Check 1:** Put $n = 1$, $n = 5$ and $n = 9$ into $-7n + 113$. 106, 78 and 50, which are the first term, the last printed term and the 9th term the question gives
- ✓ **Check 2:** Run part (b) backwards: add 7 three times to the 12th term and the 9th term should come back. $29 + 3 \times 7 = 50$
- ✓ **Check 3:** Divide by 7 and compare remainders. $106 = 15 \times 7 + 1$, and taking 7 away never changes a remainder. every term leaves remainder 1, while 7 leaves remainder 0, so no term can equal 7

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a)(i) 71	**B1**	cao	✓
(a)(ii) -7	**B1**	oe, for example 'take 7', 'subtract 7', 'each number is going down by 7', $78 - 7$, $-7n + 113$, $-7 \times 6 + 113$. If words are used, accept incorrect spelling where the meaning is clear.	✓
(b) 29	**B1**	cao	✓
(c) correct reason	**B1**	oe, for example the sequence is $-7n + 113$, or it goes $15,\ 8,\ 1$, or the terms are not in the 7 times table, or 8 is in the sequence but 7 is not. Not enough on its own: '7 is not in the sequence', 'it will pass 7', or 'Lorenzo is wrong'.	✓

Full marks: 4/4

Question 5 - Exam Solution

Understanding the Question

Given

Spinner A lands on 1, 1, 2 or 3, each section equally likely
Spinner B lands on 5, 7, 8, 9 or 11, each section equally likely
Score $= B - A$, the spinner B number minus the spinner A number

Find

(a) the ten missing scores in the two-way table (b)(i) $P(\text{score is even})$ (b)(ii) $P(\text{score} > 7)$

Plan the Solution

- Every cell of the table is one subtraction: the number at the start of the row minus the number at the top of the column, so fill each empty cell with $B - A$.
- The table has 4 columns and 5 rows, so there are 20 equally likely outcomes. That 20 is the denominator of both probabilities.
- For each probability, count the cells that fit the description and put that count over the total. Count from the completed table, never from the spinners.
- Read part (b)(ii) carefully: greater than 7 does not include a score of 7 itself.

Worked Solution [4 marks]

> Rule - Equally likely outcomes: $P(\text{event}) = \dfrac{\text{number of successful outcomes}}{\text{total number of outcomes}}$

Step 1: fill one cell, so the rule is clear

$\text{score} = B - A$

$5 - 1 = 4$

(Reason: The top left cell is spinner B on 5 with spinner A on 1, and the table already prints 4 there. The same subtraction fills every other cell.)

Step 2: complete every cell of the table

	1	1	2	3
5	4	4	3	2
7	6	6	5	4
8	7	7	6	5
9	8	8	7	6
11	10	10	9	8

(Reason: The two missing values on the top row are $5 - 2 = 3$ and $5 - 3 = 2$. Across a row the score falls as the spinner A number rises; down a column it rises with the spinner B number. Both patterns are a quick way to spot a slip.)

Step 3: count the equally likely outcomes

$4 \times 5 = 20$

(Reason: Each of the 4 sections on spinner A can pair with each of the 5 sections on spinner B, so the completed table holds 20 outcomes and every one of them is equally likely.)

Step 4: part (b)(i), count the even scores

Even scores : $4,\ 4,\ 2,\ 6,\ 6,\ 4,\ 6,\ 8,\ 8,\ 6,\ 10,\ 10,\ 8 \implies 13$ cells

$$P(\text{even}) = \frac{13}{20}$$

(Reason: Work through the completed table one row at a time and count every even score. 13 of the 20 cells hold an even number, and $\frac{13}{20}$ will not cancel.)

Step 5: part (b)(ii), count the scores greater than 7

Scores > 7 : $8,\ 8,\ 10,\ 10,\ 9,\ 8 \implies 6$ cells

$$P(\text{score} > 7) = \frac{6}{20} = \frac{3}{10}$$

(Reason: Greater than 7 means 8 and above, so a cell holding 7 does not count. Only the last two rows of the table reach that high.)

(a) the completed table above, with the ten missing scores in place

(b)(i) $\frac{13}{20}$

(b)(ii) $\frac{6}{20} = \frac{3}{10}$

Verification

- ✓ **Check 1 - the scores the paper already printed:** Test the printed cells against $B - A$. Three of them: $5 - 1 = 4$, $8 - 1 = 7$ and $11 - 3 = 8$. All ten printed cells agree with the completed table, so the rule filling the empty cells is the right one.
- ✓ **Check 2 - the even count, without the table:** A difference is even only when both numbers are odd or both are even. Spinner B shows 4 odd numbers and 1 even one; spinner A shows 3 odd and 1 even. $4 \times 3 + 1 \times 1 = 13$, the same count as reading the table.
- ✓ **Check 3 - the high scores, counted from the other end:** Count the cells holding 7 or less instead. There are 14 of them, and the two counts must fill the table between them.

$20 - 14 = 6$, which is the count part (b)(ii) needs.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a) All ten missing scores correct in the table	**B2**	All correct. (B1 for 5, 6, 7, 8 or 9 values completed correctly.)	✓
(b)(i) $\frac{13}{20}$	**B1ft**	Or any equivalent: 0.65 or 65%. Follow through from a completed table.	✓
(b)(ii) $\frac{6}{20}$	**B1ft**	Or any equivalent: $\frac{3}{10}$, 0.3 or 30%. Follow through from a completed table.	✓
Note on parts (b)(i) and (b)(ii)	**note**	Penalise incorrect notation only once. Penalise an incorrect denominator only once, as long as that denominator is greater than 13 and is the same in both parts.	✓

Full marks: 4/4

Question 6 - Exam Solution

Understanding the Question

Given

There are 150 vehicles in the car park altogether.
19 are vans, 32 are motorbikes and 3 are lorries.
Every vehicle that is left over is a car.

Find

The number of cars written as a fraction of 150. The fraction must be given in its simplest form, so it has to be cancelled down.

Plan the Solution

- Add the three groups that are not cars, so the vehicles already accounted for are known.
- Subtract that total from 150 to find how many cars there are.
- Write the number of cars over the total number of vehicles.
- Cancel the fraction by the highest common factor of its numerator and its denominator.

Worked Solution [3 marks]

> Rule - a part as a fraction of a whole: $\frac{\text{part}}{\text{whole}}$, then divide the numerator and the denominator by their highest common factor.

Step 1: Count the vehicles that are not cars

$19 + 32 + 3 = 54$

(Reason: The vans, the motorbikes and the lorries are the three groups the question counts for you, so adding them gives the 54 vehicles that are already accounted for.)

Step 2: Subtract from the total to find the number of cars

$150 - 54 = 96$

(Reason: Every vehicle is a van, a motorbike, a lorry or a car, so whatever is left of the 150 after the other three groups are taken away must be the 96 cars.)

Step 3: Write the cars as a fraction of the total

$$\frac{96}{150}$$

(Reason: A fraction of a total puts the part on top and the whole underneath, so the number of cars goes over 150 and not over any smaller group.)

Step 4: Cancel down to the simplest form

$$\frac{96}{150} = \frac{6 \times 16}{6 \times 25} = \frac{16}{25}$$

(Reason: The highest common factor of 96 and 150 is 6, so writing each of them as 6 times something lets that whole factor cancel in one go. Always test the result: 16 and 25 share no factor other than 1, so nothing further will cancel and the fraction is genuinely in its simplest form.)

$$\frac{16}{25}$$

Verification

- ✓ **Check 1:** Add all four groups back together. They must rebuild the 150 vehicles the car park started with. $19 + 32 + 3 + 96 = 150$
- ✓ **Check 2:** Turn the fraction before cancelling and the fraction after cancelling into decimals. Cancelling changes how a fraction is written, never how big it is, so the two decimals must be identical. $\frac{96}{150} = 0.64$ and $\frac{16}{25} = 0.64$

✓ **Check 3:** Cross-multiply the two fractions. If $\frac{96}{150}$ and $\frac{16}{25}$ are equal then 96×25 and 150×16 must come to the same number. $96 \times 25 = 2400$ and $150 \times 16 = 2400$

✓ **Check 4:** Break the final numerator and denominator into prime factors. If they have no prime factor in common, no further cancelling is possible and the fraction really is in its simplest form. $16 = 2^4$ and $25 = 5^2$, with no prime factor in common

Mark Scheme Breakdown

Step	Mark	Description	Got it?
$19 + 32 + 3 = 54$ or $150 - 19 - 32 - 3 = 96$	**M1**	For the number of vehicles that are not cars, or for the number of cars. Award also for the fraction $\frac{54}{150}$.	✓
$\frac{150 - 54}{150} = \frac{96}{150}$	**M1**	This mark assumes the first one. Award also for any correct fraction that is not in its simplest form, or for $\frac{9}{25}$.	✓
$\frac{16}{25}$	**A1**	A correct answer scores full marks, unless it comes from obviously incorrect working.	✓
Special case	**SC**	B2 for 0.64 or 64% if no other marks are scored - the right quantity, but given as a decimal or a percentage instead of as a fraction in its simplest form. B1 for 0.36 or 36% if no other marks are scored - the fraction of the vehicles that are not cars, so the wrong part of the total.	✓

Full marks: 3/3

Question 7 - Exam Solution

Understanding the Question

Given

2 flasks, each holding 350 millilitres
5 cartons, each holding y millilitres
Poured together they make 2.8 litres

Find

The value of y, the number of millilitres in one carton

Plan the Solution

- Change the total into millilitres, so that every amount is measured in the same unit.
- Work out the juice that came from the 2 flasks and take it off the total.
- Share whatever is left equally between the 5 cartons.

Worked Solution [4 marks]

> Total juice $= 2 \times 350 + 5y$, with every volume measured in millilitres.

Step 1: Put both amounts into the same unit

$2.8 \text{ litres} = 2.8 \times 1000 = 2800 \text{ ml}$

(Reason: One litre is 1000 millilitres. Litres and millilitres cannot be mixed in one calculation, and this conversion is worth a mark on its own.)

Step 2: Work out the juice from the two flasks

$2 \times 350 = 700 \text{ ml}$

(Reason: Each flask holds 350 millilitres and there are 2 of them.)

Step 3: Take the flasks' juice off the total

$2800 - 700 = 2100 \text{ ml}$

(Reason: Everything in the pan came from either the flasks or the cartons, so whatever is left once the flasks are accounted for is the juice from the cartons.)

Step 4: Share what is left between the five cartons

$5y = 2100$

$$y = \frac{2100}{5} = 420$$

(Reason: The 5 cartons all hold the same amount, so divide the remaining juice by 5.)

$$y = 420$$

Verification

✓ **Check 1:** Put $y = 420$ back into the pan: $2 \times 350 + 5 \times 420 = 700 + 2100$. $2800 \text{ ml} = 2.8 \text{ litres}$, which is the total the question gives.

✓ **Check 2:** Work the whole question in litres instead: $2 \times 0.35 = 0.7$, then $2.8 - 0.7 = 2.1$, then $\frac{2.1}{5} = 0.42$ litres. 0.42 litres is 420 millilitres, so a different unit gives the same answer.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
Convert so that both amounts are in one unit, e.g. 2.8 litres $= 2800$ ml or 350 ml $= 0.35$ litres	**B1**	One correct conversion. It may be implied by later working that is consistently in one unit.	✓
$2800 - 2 \times 350 = 2100$, or forming the equation $2 \times 350 + 5y = 2800$	**M1**	Method for the amount left for the five cartons, or an equivalent equation. Working in litres, $2.8 - 2 \times 0.35 = 2.1$, earns the same mark.	✓
$\frac{2100}{5}$	**M1**	Divide their remaining amount by 5. Also earned by an answer of 0.42, which is the value in litres left unconverted.	✓
$y = 420$	**A1**	A correct answer scores full marks, unless it comes from obviously incorrect working.	✓

Full marks: 4/4

Question 8 - Exam Solution

Understanding the Question

Given

Craft Corner sells paint pots at $\$4.20$ each, and its offer gives 1 free pot for every 2 pots paid for.
Palette House sells a pack of 5 paint pots for $\$18$, and its offer takes 25% off the price of each pack.
Ingrid and Bilal each buy 30 pots, each using their own shop's offer.

Find

The difference between the amount Ingrid pays at Craft Corner and the amount Bilal pays at Palette House.

Plan the Solution

- Treat the two shops as two separate calculations, and only subtract at the very end.
- Craft Corner first. The offer is really a 3 for 2 deal, so the useful question is how many of the 30 pots are actually paid for.
- Palette House next. Work out the full price of the packs, then reduce it by 25%.
- Finally subtract the smaller total from the larger one.

Worked Solution [4 marks]

> Rule - a 3 for 2 offer: every group of 3 pots costs the price of 2, so the number paid for is $\frac{2}{3}$ of the number taken home. A reduction of 25% leaves 75% still to pay, so the amount paid is 0.75 of the full price.

Step 1: how many pots Ingrid actually pays for

$$\frac{30}{3} = 10$$

$$10 \times 2 = 20$$

(Reason: (Reason: the free pot comes with every 2 bought, so the pots come in groups of 3. Thirty pots make 10 groups, and Ingrid pays for 2 pots in each group.))

Step 2: the amount Ingrid pays

$$20 \times 4.20 = 84$$

(Reason: (Reason: the 10 free pots cost nothing, so only the 20 paid-for pots are charged, at $\$4.20$ each. Ingrid pays $\$84$.))

Step 3: the full price of Bilal's packs

$$\frac{30}{5} = 6$$

$$6 \times 18 = 108$$

(Reason: (Reason: Palette House only sells packs of 5, and 30 pots is exactly 6 packs. Before the offer those packs would cost $\$108$.))

Step 4: the amount Bilal pays after the reduction

$$108 \times 0.75 = 81$$

(Reason: (Reason: taking 25% off leaves 75% of the price still to pay, and 75% written as a decimal is 0.75. Multiplying by the decimal that is LEFT is quicker than working out the saving and subtracting it.))

Step 5: the difference between the two amounts

$$84 - 81 = 3$$

(Reason: (Reason: Ingrid pays the larger amount, so subtract Bilal's total from hers. The question asks for the difference, so the answer is the gap between them, not either total.))

$3

Verification

✓ **Check 1:** Cost Ingrid's pots a completely different way. Every 3 pots cost 2×4.20, so on average one pot costs $\dfrac{2 \times 4.20}{3}$, and all 30 pots cost thirty times that. $\dfrac{2 \times 4.20}{3} = 2.80$, and $30 \times 2.80 = 84$, which is Step 2 again.

✓ **Check 2:** Cost Bilal's pots from the saving instead of the multiplier. Work out 25% of one pack, take it off the pack price, then multiply by the 6 packs. $0.25 \times 18 = 4.50$, so a pack costs $18 - 4.50 = 13.50$, and $6 \times 13.50 = 81$, which is Step 4 again.

✓ **Check 3:** Is the size sensible? Both offers bring the price of one pot down to somewhere under $\$3$, so two totals in the eighties and a small gap between them is what we should expect. Ingrid pays $\$84$, Bilal pays $\$81$, and the gap is $\$3$ - under 4% of either total, which is the sort of margin two rival offers should sit within.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
A method that uses one of the two offers	**M1**	For working with the Craft Corner 3 for 2 offer, for example $\dfrac{2}{3} \times 30$ $(= 20)$ or $\dfrac{2}{3} \times 4.20$ $(= 2.80)$, or for at least two multiples of 8.40 listed against the number of pots bought. Or for working with the 25% off offer at Palette House, for example 0.75×18 $(= 13.50)$ or $\dfrac{30}{5} \times 18 \times 0.75$ $(= 81)$.	✓
One of the two amounts, correct	**A1**	For 84 at Craft Corner, or 81 at Palette House. Either one earns this mark on its own.	✓
A fully correct method for the difference	**M1**	For $84 - 81$, where both amounts have come from correct working. Subtracting two values that were themselves wrong does not earn this.	✓

Step	Mark	Description	Got it?
The difference	**A1**	For 3. The scheme also allows -3, since a candidate who subtracts the other way round has still found the difference.	✓
A correct answer with no working shown	**Note**	A correct answer scores full marks, unless it has come from obviously incorrect working.	✓

Full marks: 4/4

Question 9 - Exam Solution

Understanding the Question

Given

A circle whose radius is 9 cm.

Find

The area of the circle, correct to 3 significant figures.

Plan the Solution

- The radius is known, so use the area formula $A = \pi r^2$.
- Square the radius first, then multiply by π on the calculator.
- Round only at the very end, so the third significant figure is safe.

Worked Solution [2 marks]

> Area of a circle: $A = \pi r^2$, where r is the radius.

Step 1: Write down the rule

$A = \pi r^2$

(Reason: The question gives the radius, so the version of the formula written in terms of r is the one to reach for.)

Step 2: Square the radius

$r = 9$

$r^2 = 9 \times 9 = 81$

(Reason: Squaring a length means multiplying it by itself, and it is the radius that is squared in the formula, never the whole of πr.)

Step 3: Multiply by pi

$A = \pi \times 81$

$A \approx 254.4690$

(Reason: Use the calculator's own π key and keep every digit on the display. Rounding here instead of at the end can move the third significant figure.)

Step 4: Round to 3 significant figures

$254.4690 \approx 254$

(Reason: The first three significant figures are 2, 5 and 4. The digit after them is 4, which is below 5, so the last figure kept stays as it is.)

254 cm^2 (to 3 significant figures)

Verification

✓ **Check 1:** Run the calculation backwards: divide the unrounded area by π and square-root the result. It must give the radius back. $\sqrt{\dfrac{254.4690}{\pi}} \approx 9$, the radius the question gives.

✓ **Check 2:** Trap the circle between two squares. The square drawn inside it has area $2r^2$ and the square drawn round it has area $4r^2$, so the circle must sit between them. $2 \times 81 = 162$ and $4 \times 81 = 324$, and $162 < 254 < 324$.

✓ **Check 3:** Repeat the working with the approximations for π that the mark scheme allows, 3.14 and $\dfrac{22}{7}$. $3.14 \times 81 = 254.34$ and $\dfrac{22}{7} \times 81 \approx 254.57$, which round to 254 and 255, both inside the accepted band.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
$\pi \times 9^2$ or equivalent	**M1**	Any use of π, 3.14, 3.142 or $\dfrac{22}{7}$ multiplied by the radius squared. Writing $\pi \times 81$ earns it just as well.	✓
254	**A1**	Accept anything from 254 to 255, which covers the approximations for π allowed above. A correct answer scores full marks unless it comes from obviously incorrect working.	✓

Full marks: 2/2

Question 10 - Exam Solution

Understanding the Question

Given

Shape A is drawn on a centimetre grid, so every small square measures 1 cm by 1 cm and covers an area of $1\ \text{cm}^2$.
Shape A has eight sides, and every one of them runs along a grid line.

Find

A rectangle whose area is equal to the area of shape A.

Plan the Solution

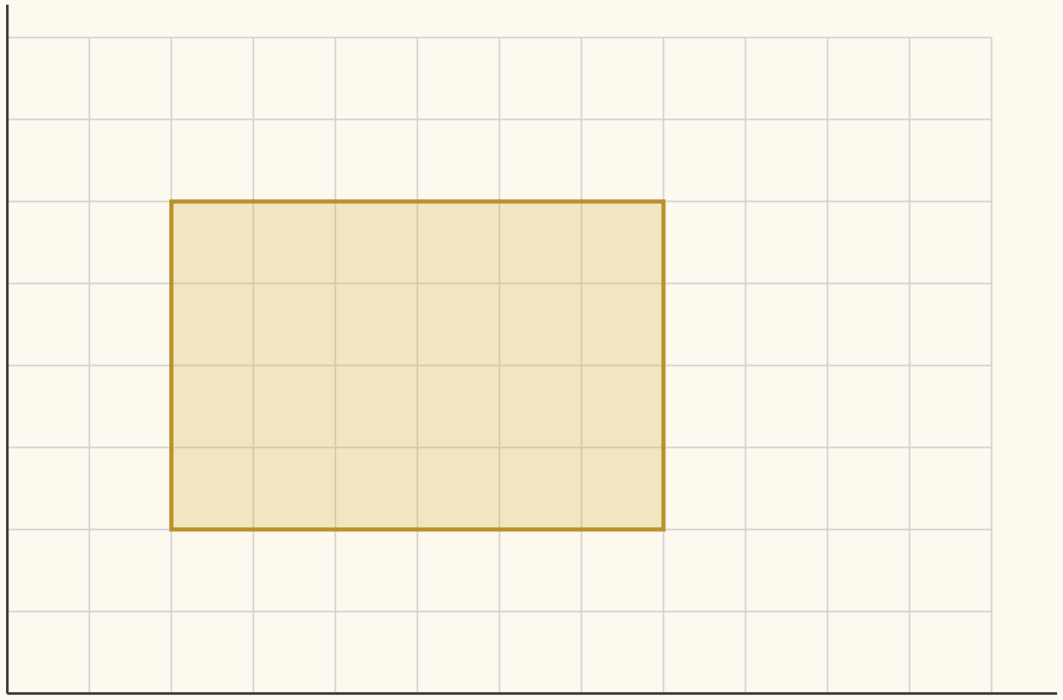
- Cut shape A into rectangles whose sides lie along the grid lines.
- Work out the area of each rectangle and add them, to get the area of shape A.
- Choose two side lengths whose product is that area, and draw that rectangle on the second grid.

Worked Solution [2 marks]

> area of a rectangle $=$ length $\times$ width

Step 1: cut shape A into three rectangles

left arm $= 3 \times 4 = 12\ \text{cm}^2$
middle bar $= 6 \times 1 = 6\ \text{cm}^2$
lower arm $= 2 \times 3 = 6\ \text{cm}^2$



(Reason: The tall arm on the left, the bar across the middle and the short arm at the lower right meet edge to edge and do not overlap. Each small square has area 1 cm^2, so a piece's area is its width in squares multiplied by its height in squares.)

Step 2: add the three areas

$$12 + 6 + 6 = 24$$

(Reason: Together the three pieces make up the whole of shape A and nothing else, so shape A has area 24 cm^2.)

Step 3: choose a rectangle with the same area

$$6 \times 4 = 24$$

(Reason: Any two lengths whose product is 24 will do: 12 by 2, 8 by 3, or 6 by 4. A rectangle 6 cm by 4 cm sits comfortably inside the second grid.)

Step 4: draw the rectangle on the grid

$$6 \text{ squares across} \times 4 \text{ squares down} = 24 \text{ squares}$$

(Reason: Draw along the grid lines, counting 6 squares across and 4 squares down, so the finished rectangle really does cover 24 centimetre squares.)

A rectangle measuring 6 cm by 4 cm, drawn on the centimetre grid, area 24 cm^2

Verification

✓ **Check 1:** Count the whole centimetre squares inside shape A one row at a time, working down from the top. $3 + 3 + 3 + 9 + 2 + 2 + 2 = 24$

✓ **Check 2:** Take the smallest rectangle that surrounds shape A, which is 9 cm by 7 cm, then subtract the two rectangular pieces missing from it: 6 by 3 at the top right and 7 by 3 at the bottom left. $63 - 18 - 21 = 24$

✓ **Check 3:** Multiply the drawn rectangle's own side lengths and compare the result with the area of shape A. $6 \times 4 = 24$

Mark Scheme Breakdown

Step	Mark	Description	Got it?
A rectangle of area 24 cm^2 drawn on the centimetre grid	**B2**	For a correct rectangle, for example 2 squares by 12 squares, 3 squares by 8 squares, 4 squares by 6 squares, or 5 squares by 4.8 squares. The sides need not be whole numbers of squares.	✓
The area of shape A stated as 24, or any rectangle drawn	**B1**	Partial credit, awarded independently: 1 mark for stating 24, or for drawing any rectangle, where the two are not brought together into a correct rectangle of area 24 cm^2.	✓

Full marks: 2/2

Question 11 - Exam Solution

Understanding the Question

Given

Five expressions to work on: $e \times e \times e \times e \times e$, $m + m + m$, $3g^2 + 7g^2 - 4g^2$, $a(a + 8)$ and $15x + 20$.
For part (f): a pack holds 3 greetings cards and a box holds 5 greetings cards, and d packs and h boxes are sold.

Find

The simplest form of each expression in parts (a) to (e). A formula for the total number of cards, T, written in terms of d and h.

Plan the Solution

- Part (a) is a product of powers of one letter, so add the indices. Parts (b) and (c) are sums of like terms, so combine the coefficients and leave the letter part alone.
- Part (d) multiplies out: the term outside the bracket multiplies each term inside it.
- Part (e) is the reverse of part (d): take out the highest common factor of 15 and 20.
- Part (f) counts the two kinds of container separately and adds the results, so the formula has one term for the packs and one for the boxes.

Worked Solution [8 marks]

> Index law and the distributive law: $x^m \times x^n = x^{m+n}$ and $p(q + r) = pq + pr$. Like terms are added by adding their coefficients only.

Step 1 (a): count how many times e is multiplied

$$e \times e \times e \times e \times e = e^{1+1+1+1+1} = e^5$$

(Reason: Every plain e means e^1, and multiplying powers of the same base adds the indices. There are 5 of them, so the index is 5. Multiplying is not adding: $e \times e$ is e^2, not $2e$.)

Step 2 (b): add the like terms m

$$m + m + m = (1 + 1 + 1)m = 3m$$

(Reason: There are three lots of the same term, so the coefficients 1, 1 and 1 are added and the letter is unchanged. Adding is not multiplying: $m + m + m$ is $3m$, while $m \times m \times m$ would be m^3.)

Step 3 (c): combine the coefficients of g^2

$$3g^2 + 7g^2 - 4g^2 = (3 + 7 - 4)g^2 = 6g^2$$

(Reason: All three terms are lots of g^2, so they are like terms and only the numbers in front are combined. The letter part stays as g^2 and is never squared again or doubled.)

Step 4 (d): multiply each term inside the bracket by a

$$a(a + 8) = a \times a + a \times 8 = a^2 + 8a$$

(Reason: The distributive law reaches both terms in the bracket, not just the first. $a \times a$ is a^2 and $a \times 8$ is $8a$, so the a must still be there in the second term. The two terms are not like terms, so nothing further can be collected.)

Step 5 (e): take out the highest common factor of 15 and 20

$$15x + 20 = 5 \times 3x + 5 \times 4 = 5(3x + 4)$$

(Reason: The highest common factor of 15 and 20 is 5, so 5 comes outside and what is left, $3x$ and 4, goes inside. The letter x appears in only one of the two terms, so it cannot be taken out as well.)

Step 6 (f): write one term for the packs and one for the boxes

cards in the packs $= 3 \times d = 3d$

cards in the boxes $= 5 \times h = 5h$

$T = 3d + 5h$

(Reason: Each of the d packs holds 3 cards, giving $3d$ cards, and each of the h boxes holds 5 cards, giving $5h$ cards. Every card sold is in a pack or in a box, so the two amounts are added. A formula is asked for, so the answer must start $T =$ and not stop at the expression.)

(a) e^5

(b) $3m$

(c) $6g^2$

(d) $a^2 + 8a$

(e) $5(3x + 4)$

(f) $T = 3d + 5h$

Verification

✓ **Check 1:** Put numbers in. With $e = 2$, $m = 4$ and $g = 2$, work out each original expression and each answer, and compare the two. $2 \times 2 \times 2 \times 2 \times 2 = 32 = 2^5$, $4 + 4 + 4 = 12 = 3 \times 4$, $12 + 28 - 16 = 24 = 6 \times 4$

✓ **Check 2:** Run parts (d) and (e) backwards. Factorise the answer to (d) and expand the answer to (e); each should give back the expression it came from. $a^2 + 8a = a(a + 8)$ and $5(3x + 4) = 15x + 20$

✓ **Check 3:** Test that 5 really is the highest common factor in part (e) by looking at what is left inside the bracket. $15 = 3 \times 5$ and $20 = 4 \times 5$, and 3 and 4 have no common factor left

✓ **Check 4:** Test the formula on a case that can be counted by hand: 4 packs and 2 boxes hold $4 \times 3 = 12$ cards and $2 \times 5 = 10$ cards. $T = 3 \times 4 + 5 \times 2 = 22$, and counting gives $12 + 10 = 22$

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a) e^5	**B1**	For e^5. The index must be written as a power of e; $5e$ earns nothing.	✓
(b) $3m$	**B1**	For $3m$. m^3 earns nothing.	✓

Step	Mark	Description	Got it?
(c) $6g^2$	**B1**	For $6g^2$. The power must stay as g^2.	✓
(d) $a^2 + 8a$	**B1**	For $a^2 + 8a$. $a^2 + 8$ earns nothing.	✓
(e) $5(3x + 4)$	**B1**	For $5(3x + 4)$. A partial factorisation such as $5(3x + 20)$ or an unfactorised answer earns nothing.	✓
(f) $T = 3d + 5h$	**B3**	Allow $T = d3 + h5$ or $T = d \times 3 + h \times 5$.	✓
(f) partial credit: the right expression without $T =$, or one coefficient right	**B2**	For $3d + 5h$ with no $T =$ in front, or for $T = 3d + xh$ or $T = yd + 5h$ or $T = 5d + 3h$, where $x \neq 0$ and $y \neq 0$ and either may be negative. The last of these is the swap: 5 attached to the packs and 3 to the boxes.	✓
(f) partial credit: one coefficient right with no $T =$, or any expression in d and h	**B1**	For $3d + xh$ or $yd + 5h$ where $x \neq 0$ and $y \neq 0$ and either may be negative, or for $5d + 3h$, or for $T =$ an incorrect expression in d and h, for example $T = d + h$ or $T = d \times h$, or for $T = 3d$ with or without a constant, or $T = 5h$ with or without a constant.	✓

Full marks: 8/8

Question 12 - Exam Solution

Understanding the Question

Given

In Australia the telescope costs 232 Australian dollars.
In India the identical telescope costs 12 420 Indian rupees.
The exchange rate is 1 Australian dollar for 54 Indian rupees.
Australia is the dearer of the two.

Find

How much more the telescope costs in Australia than in India, with the units written beside the number.

Plan the Solution

- The two prices are in different currencies, so they cannot be compared yet. Turn the Indian price into Australian dollars by dividing by 54.
- Subtract the smaller price from the larger one, now that both are in the same currency.
- Write the units beside the number, because the question asks for them and the final mark is for them.

Worked Solution [3 marks]

> Two prices can only be compared once they are in the same currency. Multiplying by the rate 54 turns Australian dollars into rupees, and dividing by 54 turns rupees back into Australian dollars.

Step 1: put the Indian price into Australian dollars

$$\frac{12\,420}{54} = 230$$

(Reason: Every Australian dollar is worth 54 rupees, so the number of dollars is found by dividing the rupee price by 54. The telescope in India costs 230 Australian dollars.)

Step 2: subtract, now that both prices are in the same currency

$$232 - 230 = 2$$

(Reason: Both prices are Australian dollar prices, so subtracting the Indian one from the Australian one gives the extra amount Duncan pays by buying in Australia.)

Step 3: write the units beside the number

2 Australian dollars

(Reason: A bare number would not say which currency the difference is in, and the same difference is 108 in rupees. The question asks for the units, so the currency must be written down.)

2 Australian dollars

Verification

✓ **Check 1:** Work the whole question in rupees instead. The Australian price in rupees is $232 \times 54 = 12\,528$, and the gap between the two rupee prices is $12\,528 - 12\,420 = 108$ rupees. Turning that gap back into Australian dollars gives $\frac{108}{54} = 2$, the same difference reached the other way round.

✓ **Check 2:** Undo Step 1: multiply the Indian price in Australian dollars back by the rate, and add the difference back on to the Indian price. $230 \times 54 = 12\,420$, which is the rupee price the question gives, and $230 + 2 = 232$, which is the Australian price.

✓ **Check 3:** Is the size sensible? Both telescopes cost about 230 Australian dollars, so the gap between them should be small. A gap of 2 Australian dollars on a price of 232 is under one per cent, which is what two almost equal prices should give.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
Convert so that both prices are in one currency	**M1**	A complete method for one conversion, either way round: $\frac{12\,420}{54}$ $(= 230)$ or 232×54 $(= 12\,528)$.	✓
Subtract to find the difference	**M1**	Subtracting in whichever currency was chosen, using the candidate's own converted value: $232 - 230 = 2$ or $12\,528 - 12\,420 = 108$. The quotation marks in the official scheme mark the converted value as the candidate's own.	✓
The answer, with its units	**A1**	cao 2 Australian dollars, or 108 rupees. The answer must carry the correct units, which may be shortened, for example \$ for dollars or r for rupees, and an incorrect spelling is allowed if the meaning is clear. A correct answer scores full marks unless it comes from obviously incorrect working.	✓

Full marks: 3/3

Question 13 - Exam Solution

Understanding the Question

Given

Four items to choose from: J (jacket), B (blanket), H (hat), S (scarf)
Two wool colours to choose from: W (white) and Y (yellow)
Exactly one item is chosen, and exactly one colour is chosen.

Find

Every possible combination of one item with one colour, written as a list The list must be complete: no combination missing, none repeated, and nothing in it that is not a real pair

Plan the Solution

- Work out how many combinations there should be before listing any, so the list can be checked against a target: $4 \times 2 = 8$.
- Be systematic. Take the items in the order they are given, and for each item write its white pair first and its yellow pair second.
- Write the item letter first and the colour letter second every time, so no pair can accidentally be written twice in two different ways.

Worked Solution [2 marks]

> Rule - Systematic listing: if there are m choices of one kind and n choices of another, then pairing every choice with every other choice gives $m \times n$ combinations.

Step 1: work out how many combinations to expect

$4 \times 2 = 8$

(Reason: (Reason: each of the 4 items can be knitted in either of the 2 colours, so there are 8 pairs altogether. Knowing the target first is what stops the list being cut short.))

Step 2: pair the first item with each colour

$J : JW, JY$

(Reason: (Reason: the jacket J can be knitted in white W or in yellow Y, and there is no third choice, so the jacket contributes exactly 2 combinations.))

Step 3: repeat for the other three items

$B : BW, BY$

$H : HW, HY$

$S : SW, SY$

(Reason: (Reason: the same two colours are available whatever the item is, so each of the remaining 3 items contributes 2 more combinations, giving 6 here.))

Step 4: collect the four rows into one list

$JW, JY, BW, BY, HW, HY, SW, SY$

(Reason: (Reason: reading the rows in order gives 8 combinations, which matches Step 1. Because every row was built the same way, no pair is repeated and every pair is a real item-with-colour choice.))

$$JW, JY, BW, BY, HW, HY, SW, SY$$

Verification

✓ **Check 1:** Count the entries in the finished list and compare with $4 \times 2 = 8$. The list holds 8 entries and all 8 are different, so nothing is missing and nothing is repeated.

✓ **Check 2:** Count how many times each colour letter appears in the list. W appears 4 times and Y appears 4 times - once with each of the 4 items, as it must be.

✓ **Check 3:** Read the list the other way round: count how many times each item letter appears. J, B, H and S each appear 2 times, once in white and once in yellow, so no item has been given a colour twice or left out.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
All 8 combinations written down: $JW, JY, BW, BY, HW, HY, SW, SY$	**B2**	All correct combinations, with no repeats and no incorrect combinations. Any order is accepted.	✓
At least 4 correct combinations written down	**B1**	Partial credit: at least 4 correct combinations, ignoring any repeats and ignoring any incorrect combinations.	✓

Full marks: 2/2

Question 14 - Exam Solution

Understanding the Question

Given

Shape A has vertices $(2,\ 3)$, $(5,\ 2)$, $(5,\ 1)$ and $(2,\ 1)$.
Shape B has vertices $(-2,\ -3)$, $(-5,\ -2)$, $(-5,\ -1)$ and $(-2,\ -1)$.
Both axes run from -6 to 6, so the whole grid is available for the image.

Find

(a) the single transformation that maps A onto B, described fully. (b) the reflection of shape A in the line $y = -1$, drawn on the grid.

Plan the Solution

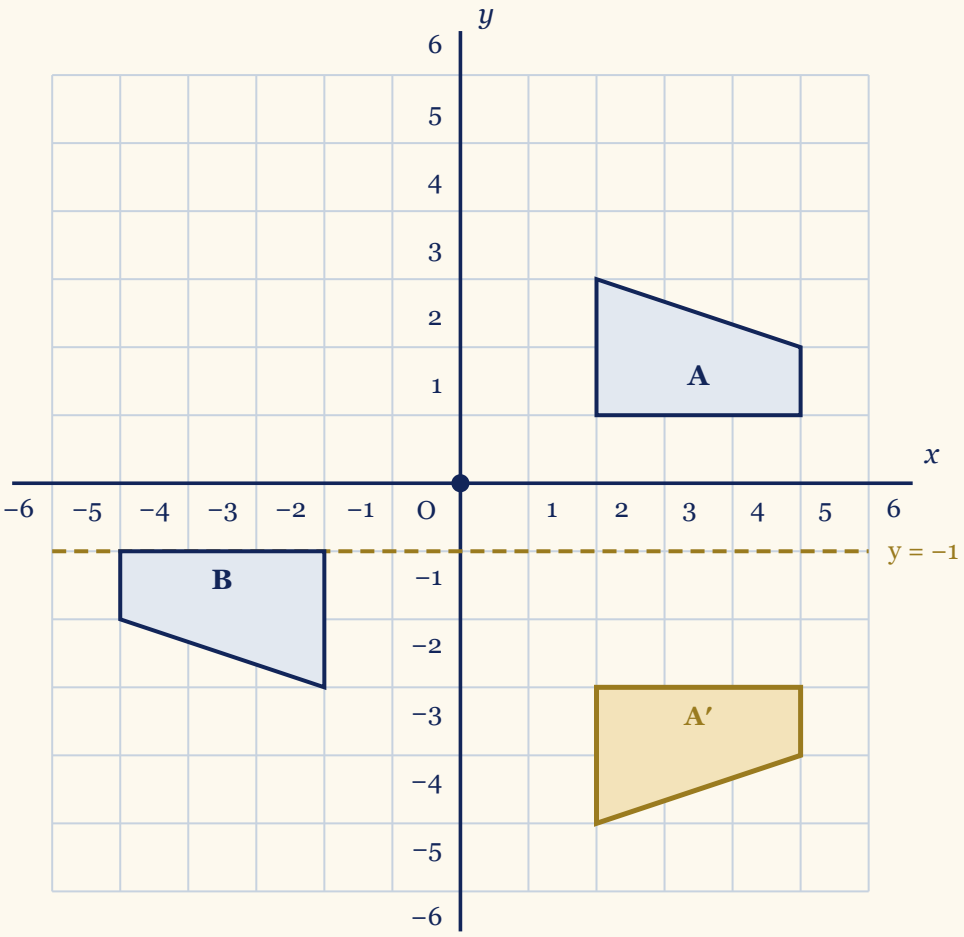
- Pair each vertex of A with the vertex of B it maps onto, and look for the pattern in the coordinates.
- A full description needs THREE things for a rotation: the word rotation, the angle, and the centre. Two of the three earns only half the marks.
- Find the centre from the data, not by eye: for a half turn it is the midpoint of every vertex and its image.
- For (b), reflect one vertex at a time in the horizontal line $y = -1$, then join the images in the same order round the shape.

Worked Solution [4 marks]

> A rotation of 180° about the centre $(a,\, b)$ maps $(x,\, y)$ onto $(2a - x,\, 2b - y)$, and the centre is the midpoint of every point and its image. A reflection in the horizontal line $y = c$ maps $(x,\, y)$ onto $(x,\, 2c - y)$.

Step 1: pair up the vertices of A and B

$(2,\, 3) \to (-2,\, -3)$
$(5,\, 2) \to (-5,\, -2)$
$(5,\, 1) \to (-5,\, -1)$
$(2,\, 1) \to (-2,\, -1)$



(Reason: Go round each shape in the same direction. The sloping side of A joins $(2,\ 3)$ to $(5,\ 2)$ and the sloping side of B joins $(-2,\ -3)$ to $(-5,\ -2)$, so those vertices correspond.)

Step 2: read the rule that links every pair

$$(x,\ y) \to (-x,\ -y)$$

(Reason: Both coordinates change sign, and nothing else changes. A slide would add the same amount to every point, and a flip in one of the axes would change one coordinate only, so this is a turn.)

Step 3: find the centre of the turn

$$\frac{2 + (-2)}{2} = 0$$

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

(Reason: The centre of a half turn is the midpoint of each point and its image. Working the midpoint of $(2,\ 3)$ and $(-2,\ -3)$ coordinate by coordinate gives $(0,\ 0)$, and the other three pairs give the same point, so the centre is the origin.)

Step 4: describe the transformation in full

$180°$ rotation about $(0,\ 0)$

(Reason: Three things are needed and all three are now known: the type (rotation), the angle $(180°)$ and the centre $((0,\ 0))$. A half turn is the one angle where the direction does not matter, so clockwise or anticlockwise need not be stated.)

Step 5: reflect each vertex of A in the line $y = -1$

$(x,\ y) \to (x,\ -2 - y)$
$(2,\ 3) \to (2,\ -5)$
$(5,\ 2) \to (5,\ -4)$
$(5,\ 1) \to (5,\ -3)$
$(2,\ 1) \to (2,\ -3)$

(Reason: A reflection in a horizontal line leaves every x where it is and sends y to $2c - y$. Here the mirror is $y = -1$, so $2c$ is -2 and each new y is $-2 - y$.)

Step 6: check the distances, then join the four image points

$3 - (-1) = 4$
$-1 - 4 = -5$
$1 - (-1) = 2$
$-1 - 2 = -3$

(Reason: The top vertex is 4 above the mirror line, so its image is 4 below it, at $(2,\ -5)$. The bottom left vertex is 2 above, so its image is 2 below, at $(2,\ -3)$. Join the four images in the same order round the shape and the reflection is drawn.)

(a) Rotation of $180°$ about the origin $(0,\ 0)$

(b) Image drawn with vertices $(2,\ -3)$, $(2,\ -5)$, $(5,\ -3)$ and $(5,\ -4)$

Verification

- ✓ **Check 1:** Turn shape B through $180°$ about the origin and see where it lands: $(-2,\ -3)$ goes to $(2,\ 3)$ and $(-5,\ -2)$ goes to $(5,\ 2)$. Shape B maps back onto shape A, so the same rotation works in both directions.
- ✓ **Check 2:** Compare the side lengths. Shape A has a horizontal side of 3, a vertical side of 2 and a short vertical side of 1, and shape B has exactly the same three. The two shapes are congruent, so the description is a rotation. An enlargement of scale factor -1 about the origin sends the points to the same places, which is why the mark scheme allows that wording only as a special case.
- ✓ **Check 3:** Test the reflection the other way round. Each image should sit as far below $y = -1$ as its object sits above it, with the x-coordinate unmoved: $(5,\ 2)$ is 3 above the

line and $(5, -4)$ is 3 below it. All four x-coordinates are unchanged and all four distances match, so the drawn shape is a true reflection of A in $y = -1$.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a) Name the transformation	**B1**	rotation, or an equivalent word, with no mention of reflection, translation, enlargement, move, flip or any similar word	✓
(a) Give the angle and the centre	**B1**	$180°$, or a half turn, about $(0, 0)$, or O, or 'the origin'. Ignore any reference to clockwise or anticlockwise.	✓
(a) Special case	**SC B2**	an answer of 'enlargement, centre the origin, scale factor -1' scores SC B2, because it moves every point to the right place but is not the description asked for	✓
(b) Draw the reflected shape	**B2**	a correct shape, with vertices $(2, -3)$, $(2, -5)$, $(5, -3)$ and $(5, -4)$	✓
(b) Partial credit	**B1**	a 'correct' shape reflected in any horizontal line, or a correct reflection in the line $x = -1$, or shape B reflected in $y = -1$	✓

Full marks: 4/4

Question 15 - Exam Solution

Understanding the Question

Given

The universal set $\mathcal{E} = \{11, 12, 13, 14, 15, 16, 17, 18, 19, 20\}$ - the ten whole numbers from 11 to 20 inclusive
$A = \{11, 14, 16, 19\}$ and
$B = \{12, 14, 15, 16, 18, 20\}$

Find

Which of the four regions each of the ten numbers belongs to Every member of $\mathcal{E}$ is written on the diagram exactly once, so the region outside both circles has to be filled in as well - it is one of the four parts being marked.

A Venn diagram with two overlapping circles inside a rectangle, so there are four regions to fill: circle A alone, the overlap, circle B alone, and the space inside the rectangle but outside both circles.

Plan the Solution

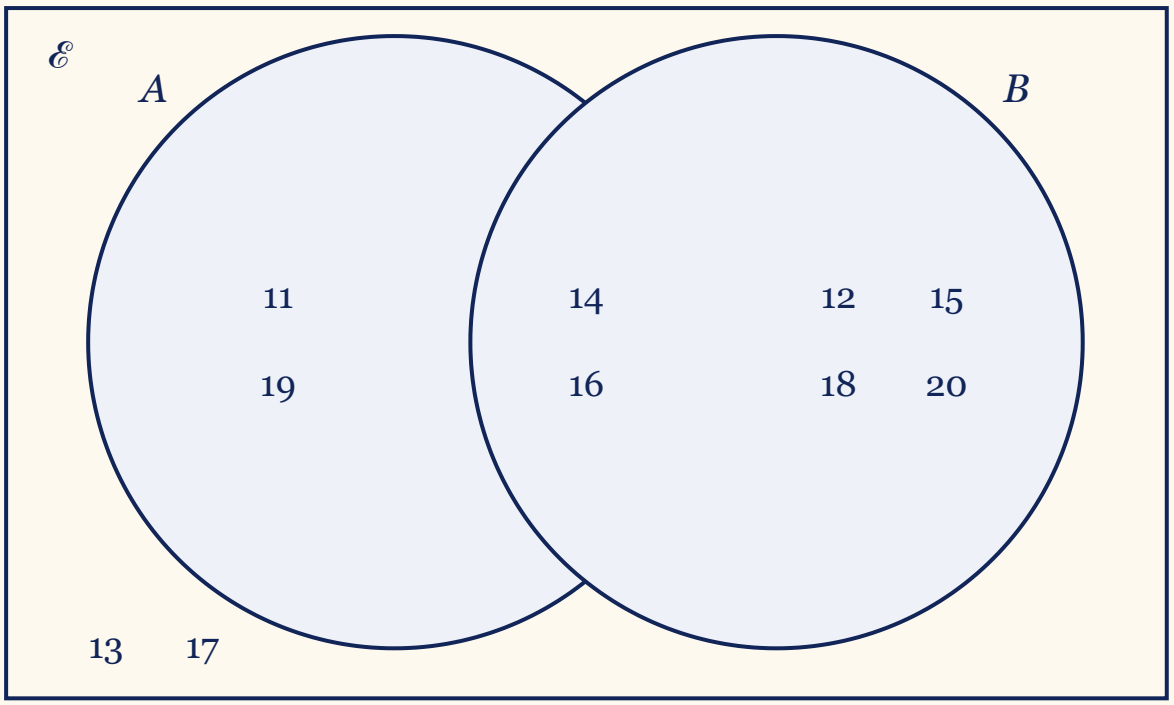
- Start with the overlap. A number is written once only, so the numbers that are in A and in B have to be settled before anything else is placed.
- Then take the overlap away from each circle in turn: what is left of A goes in the left crescent, and what is left of B goes in the right crescent.
- Anything in $\mathcal{E}$ that has not been used yet goes in the rectangle, outside both circles.
- Finish by counting. The four regions must hold 10 numbers between them, because that is how many members $\mathcal{E}$ has.

Worked Solution [3 marks]

> Rule - Every member of $\mathcal{E}$ goes in exactly one of the four regions: in both sets, in A only, in B only, or in neither set.

Step 1: find the numbers that are in both sets

$A = \{11, 14, 16, 19\}$
$B = \{12, 14, 15, 16, 18, 20\}$
$A \cap B = \{14, 16\}$



(Reason: (Reason: 14 and 16 are the only numbers that appear in both lists, so they belong in the overlap where the two circles cross. Settling the overlap first is what stops a number being written twice.))

Step 2: take the overlap out of circle A

$A \text{ only} = \{11, 19\}$

(Reason: (Reason: A has 4 members and 2 of them are already in the overlap, so 2 are left for the crescent of A that lies outside B.))

Step 3: take the overlap out of circle B

$B = \{12, 14, 15, 16, 18, 20\}$

$B \text{ only} = \{12, 15, 18, 20\}$

(Reason: (Reason: 14 and 16 have already been placed in the overlap, so they are not written a second time in the crescent that belongs to B alone.))

Step 4: place what is left outside both circles

$4 + 6 - 2 = 8$

$10 - 8 = 2$

$\text{Outside both circles} = \{13, 17\}$

(Reason: (Reason: the two circles hold 8 different numbers between them, because the 2 shared numbers would otherwise be counted twice. That leaves 2 members of $\mathcal{E}$ in neither set - 13 and 17 - and they go inside the rectangle but outside both circles.))

In A only: $11, 19$

In both A and B: $14, 16$

In B only: $12, 15, 18, 20$

Outside both circles: $13, 17$

Verification

✓ **Check 1:** Count the numbers written in the four regions and compare the total with the size of $\mathcal{E}$. The regions hold 2, 2, 4 and 2 numbers, and $2 + 2 + 4 + 2 = 10$, which is exactly how many members $\mathcal{E}$ has - nothing missing and nothing written twice.

✓ **Check 2:** Read circle A back off the finished diagram - the crescent and the overlap together - and compare it with the given set. $11, 19$ from the crescent and $14, 16$ from the overlap give $\{11, 14, 16, 19\}$, which is A exactly.

✓ **Check 3:** Do the same for circle B: its crescent and the overlap together must rebuild B. $12, 15, 18, 20$ from the crescent and $14, 16$ from the overlap give $\{12, 14, 15, 16, 18, 20\}$, which is B exactly.

✓ **Check 4:** Scan the ten numbers on the diagram for a repeat, and check that every member of the universal set appears somewhere. Each of 11 to 20 appears once and once only, so no number has been left out and none has been placed in two regions.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
All four parts of the Venn diagram correct: $11, 19$ in A only, $14, 16$ in the overlap, $12, 15, 18, 20$ in B only, and $13, 17$ outside both circles	**B3**	Full marks for a completely correct Venn diagram - all 4 parts right, including the numbers outside both circles.	✓
Two or three of the four parts of the Venn diagram correct	**B2**	Partial credit. A candidate who fills the two circles correctly but leaves 13 and 17 off the diagram has three parts right, so this is where that answer lands.	✓
Exactly one of the four parts of the Venn diagram correct	**B1**	Partial credit. Writing the whole of B into the B crescent and the whole of A into the A crescent - that is, never	✓

Step	Mark	Description	Got it?
		removing the shared numbers - typically leaves only one region right.	

Full marks: 3/3

Question 16 - Exam Solution

Understanding the Question

Given

The calculation $\dfrac{17.9}{8.61 + 2.36} - 1.2^2$, to be worked out on a calculator.
A fraction bar, so the whole of $8.61 + 2.36$ is the divisor.

Find

The value as a decimal, written with every figure the calculator display shows.

Plan the Solution

- Total the denominator first: $8.61 + 2.36$.
- Divide 17.9 by that total, keeping the full display.
- Square 1.2, then subtract it.
- Copy the display figure for figure. The question asks for all of them, so nothing is rounded.

Worked Solution [2 marks]

> Rule - order of operations: a fraction bar groups like a bracket, so the whole of $8.61 + 2.36$ is worked out before dividing, and the power 1.2^2 is worked out before the subtraction.

Step 1: total the denominator

$$8.61 + 2.36 = 10.97$$

(Reason: The fraction bar acts as a bracket, so everything under it is added before any dividing is done.)

Step 2: divide

$$\frac{17.9}{10.97} = 1.631722880583\ldots$$

(Reason: The full display is kept. Rounding to 1.63 here would change the figures the final answer is judged on.)

Step 3: work out the power 1.2^2

$1.2^2 = 1.44$

(Reason: A power is evaluated before the subtraction, so this value is ready to take away in the next step.)

Step 4: subtract

$1.631722880583\ldots - 1.44 = 0.191722880583\ldots$

(Reason: Taking the square away from the quotient completes the calculation.)

Step 5: read the display

0.1917228806

(Reason: A ten-figure display rounds the last figure it can show, so it reads 0.1917228806. Every figure is written down, exactly as it appears.)

$$0.1917228806$$

Verification

✓ **Check 1:** Do it as one fraction instead. Take $1.44 \times 10.97 = 15.7968$ from 17.9, then divide by 10.97. $\dfrac{2.1032}{10.97} = 0.191722880583\ldots$, the same figures as Step 4.

✓ **Check 2:** Work it exactly, as a fraction with no decimals: $\dfrac{1790}{1097} - \dfrac{36}{25}$. $\dfrac{5258}{27425} = 0.191722880583\ldots$, which agrees to every figure shown.

✓ **Check 3:** Reverse the calculation: add 1.44 back on, then multiply by 10.97. $(0.191722880583\ldots + 1.44) \times 10.97 = 17.9$, the numerator we started from.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
A start to the calculation, for example $8.61 + 2.36 = 10.97$ or $1.63(17\ldots)$ or $1.43(17\ldots)$, or an answer given as the fraction $\dfrac{5258}{27425}$, or an answer rounded too soon, such as 0.19, 0.191, 0.192 or 0.1917.	**M1**	Method: the denominator totalled, or the division carried out, or the value left as a fraction or rounded before the answer line.	✓

Step	Mark	Description	Got it?
0.19172(28806)	A1	The value written to at least 5 decimal places. A correct answer scores both marks unless it follows obviously incorrect working.	✓

Full marks: 2/2

Question 17 - Exam Solution

Understanding the Question

Given

Eight numbers, already in order of size:
$h \quad 6 \quad 7 \quad 8 \quad j \quad 16 \quad k \quad k$
h, j and k are integers, so no fractions or decimals are involved.
Median $= 10$, mode $= 18$, range $= 13$.

Find

The value of h, the value of j and the value of k.

Plan the Solution

- Take the three clues one at a time, and start with the clue that pins down a letter on its own.
- The mode is the value written most often. Every number in the list appears once except k, which appears twice, so the mode has to be k. That gives k straight away.
- With 8 numbers there is no single middle number, so the median is the mean of the 4th and 5th numbers, which are 8 and j. That gives j.
- The list is in order of size, so the largest number is k and the smallest is h. The range clue then gives h.

Worked Solution [3 marks]

> Rule - For a list already in order of size: the mode is the value written most often; the median of 8 values is $\dfrac{\text{4th value} + \text{5th value}}{2}$; and the range is $\text{largest} - \text{smallest}$.

Step 1: Use the mode to find k

$$\text{mode} = k$$

$$k = 18$$

(Reason: The mode is the value that occurs most often. The numbers 6, 7, 8 and 16 are each written once, so the only value that can occur twice is k. The mode is 18, so k must be 18.)

Step 2: Use the median to find j

$$\frac{8 + j}{2} = 10$$

$$8 + j = 2 \times 10 = 20$$

$$j = 20 - 8 = 12$$

(Reason: There are 8 numbers, an even amount, so the median is the mean of the middle two. Counting along the list, the 4th number is 8 and the 5th number is j. Their mean is given as 10, so their total must be 20.)

Step 3: Use the range to find h

$$k - h = 13$$

$$18 - h = 13$$

$$h = 18 - 13 = 5$$

(Reason: The eight numbers are already written in order of size, so the largest is k and the smallest is h. The range is largest minus smallest, and k was found to be 18 in Step 1.)

$$h = 5$$

$$j = 12$$

$$k = 18$$

Verification

- ✓ **Check 1:** Put the three values back into the list and work out all three statistics from scratch. The eight numbers become $5,\ 6,\ 7,\ 8,\ 12,\ 16,\ 18,\ 18$, whose middle two are 8 and 12. Median $\frac{8 + 12}{2} = 10$, mode 18 (the only repeat), range $18 - 5 = 13$ - all three given facts come back out.
- ✓ **Check 2:** Check the answers keep the list in order of size, which the question states it is in. Reading along: $5 \leq 6$ at the start, $8 \leq 12 \leq 16$ in the middle, and $16 \leq 18$ at the end. Every number sits where the question places it, so $h = 5$, $j = 12$ and $k = 18$ are allowed values and not just arithmetic that happens to work.
- ✓ **Check 3:** Check no other set of integers fits. A search over every integer triple that keeps the list in order gives exactly one that has median 10, a single mode of 18 and range 13.

Only $(h, j, k) = (5, 12, 18)$ survives, so the answer is unique - each clue pins down exactly one letter.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
Finds one of the three letters, or writes a correct statement for one of them, e.g. $k = 18$ or $\frac{8 + j}{2} = 10$ or $k - h = 13$.	M1	For a correct value for h, j or k, or for a correct statement for one of these.	✓
Finds a second letter, e.g. both $k = 18$ and $j = 12$, or both correct statements for them.	M1	For 2 correct values from h, j or k , or for 2 correct statements for them.	✓
All three values correct: $h = 5$, $j = 12$, $k = 18$.	A1	All correct. A correct answer scores full marks unless it comes from obviously incorrect working.	✓

Full marks: 3/3

Question 18 - Exam Solution

Understanding the Question

Given

A square grid running from 0 to 8 on the x-axis and from 0 to 8 on the y-axis.
Three lines to draw: $y = 2$, $x = 6$ and $y = x + 1$.
Three inequalities to satisfy at the same time: $y \geq 2$, $x \leq 6$ and $y \leq x + 1$.

Find

(a) the three straight lines, drawn on the grid, each with its equation written beside it. (b) the one region that satisfies all three inequalities at once, shaded and labelled R.

Plan the Solution

- Draw the two easy lines first. $y = 2$ is horizontal and $x = 6$ is vertical, so neither needs a table.
- For $y = x + 1$, work out two points that are far apart, plot them, join them with a ruler, and keep a third point as a check that the line is straight.

- Turn each inequality into a side of its own line, and test a single point to settle which side that is.
- The region wanted is the part of the grid on the correct side of all three lines at once. Its corners are where the boundary lines cross, so work those out before shading, and label the region R.

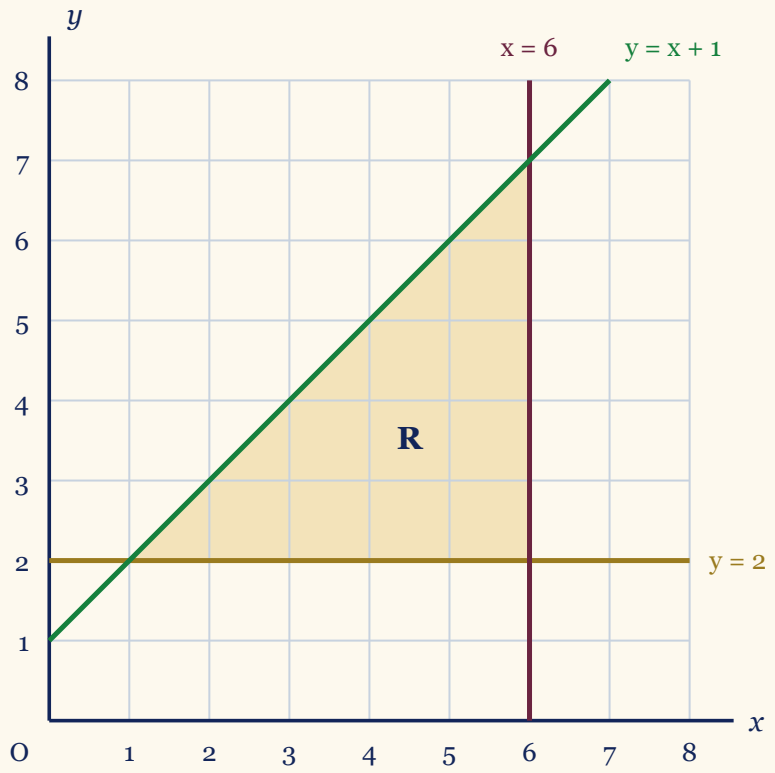
Worked Solution [4 marks]

> A line $y = a$ is horizontal and a line $x = b$ is vertical. A line $y = mx + c$ has gradient m and passes through $(0,\ c)$. A set of inequalities is satisfied by the OVERLAP of the regions the separate inequalities allow, and the corners of that overlap are the points where the boundary lines cross.

Step 1: draw $y = 2$

$y = 2$

$(0,\ 2)$ and $(8,\ 2)$



(Reason: Every point on this line has y-coordinate 2, whatever x is, so it is a horizontal line 2 squares above the x-axis. Rule it right across the grid, from $(0,\ 2)$ to $(8,\ 2)$.)

Step 2: draw $x = 6$

$x = 6$

$(6,\ 0)$ and $(6,\ 8)$

(Reason: Here it is the x-coordinate that is fixed and y that is free, so the line is vertical, 6 squares to the right of the y-axis. It runs from $(6,\ 0)$ up to $(6,\ 8)$.)

Step 3: draw $y = x + 1$

$x = 0:\ y = 0 + 1 = 1$

$x = 7:\ y = 7 + 1 = 8$

$x = 3:\ y = 3 + 1 = 4$

(Reason: Two points far apart give the most accurate line, so use the ends of the grid: at $x = 0$ the line is at $(0,\ 1)$, and it reaches the top of the grid at $(7,\ 8)$. The third point $(3,\ 4)$ should land exactly on the ruler - if it does not, one of the three is plotted wrongly.)

Step 4: decide which side of each line to keep

$y \geq 2:$ on or above $y = 2$

$x \leq 6:$ on or left of $x = 6$

$y \leq x + 1:$ on or below $y = x + 1$

(Reason: Test one point rather than guessing. Take $(6,\ 2)$: it gives $2 \geq 2$ (true), $6 \leq 6$ (true) and $2 \leq 6 + 1$ (true), so $(6,\ 2)$ is on the correct side of all three lines and the region is the one containing it.)

Step 5: find the corners of the region

$y = 2$ and $y = x + 1:\ x + 1 = 2 \Rightarrow x = 1 \Rightarrow (1,\ 2)$

$y = 2$ and $x = 6:\ (6,\ 2)$

$x = 6$ and $y = x + 1:\ y = 6 + 1 = 7 \Rightarrow (6,\ 7)$

(Reason: A corner is a point where two of the boundaries cross, so take the lines two at a time and solve them as a pair. The three corners are what tell you the shape to shade is a triangle rather than a strip that runs off the grid.)

Step 6: shade the triangle and label it R

corners $(1,\ 2),\ (6,\ 2),\ (6,\ 7)$

(Reason: The three lines cut exactly one region out of the grid that is on the right side of all of them at once. Shade that triangle and write R inside it, so it is clear which region has been chosen.)

(a) $y = 2$ horizontal through $(0,\ 2)$; $x = 6$ vertical through $(6,\ 0)$; $y = x + 1$ through $(0,\ 1)$ and $(7,\ 8)$

(b) R is the shaded triangle with corners $(1,\ 2)$, $(6,\ 2)$ and $(6,\ 7)$

Verification

✓ **Check 1:** Take a point well inside the shaded triangle, $(5,\ 4)$, and put it into all three inequalities: $4 \geq 2$, $5 \leq 6$ and $4 \leq 5 + 1$. All three are true, so $(5,\ 4)$ really does lie in the region.

✓ **Check 2:** Step just across each boundary in turn. $(5,\ 1)$ is below $y = 2$; $(7,\ 4)$ is to the right of $x = 6$; $(2,\ 5)$ is above $y = x + 1$. Each of the three points breaks exactly one inequality and keeps the other two, so every boundary is being used, and on the correct side.

✓ **Check 3:** Each corner must satisfy BOTH equations that meet there. $(1,\ 2)$: $y = 2$ and $1 + 1 = 2$. $(6,\ 2)$: $y = 2$ and $x = 6$. $(6,\ 7)$: $x = 6$ and $6 + 1 = 7$. Every corner lies on both of the lines that cross there, so the triangle drawn is the overlap of the three regions.

✓ **Check 4:** Measure the triangle two ways. Its horizontal side runs from $(1,\ 2)$ to $(6,\ 2)$ and its vertical side from $(6,\ 2)$ to $(6,\ 7)$, so $\frac{1}{2} \times 5 \times 5 = 12.5$ square units; counting whole and part squares on the grid gives the same. Both give 12.5 square units, which is what a triangle with two sides of 5 squares at right angles must have.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a)(i) The line y = 2 drawn	**B1**	a horizontal line through $(0,\ 2)$ and $(8,\ 2)$. It may be solid, dotted or dashed, must be at least 2 cm long, and need not be labelled	✓
(a)(ii) The line x = 6 drawn	**B1**	a vertical line through $(6,\ 0)$ and $(6,\ 8)$. It may be solid, dotted or dashed, must be at least 2 cm long, and need not be labelled	✓
(a)(iii) The line y = x + 1 drawn	**B1**	a straight line of gradient 1 through $(0,\ 1)$ and $(7,\ 8)$. It may be solid, dotted or dashed, must be at least 2 cm long, and need not be labelled	✓
(b) Correct region indicated	**B1ft**	the triangle with corners $(1,\ 2)$, $(6,\ 2)$ and $(6,\ 7)$, shaded and labelled R. Follow through on the candidate's own lines, dependent on at least B2 already scored in part (a) and on there being a vertical line, a horizontal line and a diagonal line with a positive gradient	✓
(b) Special case	**SC B1**	the lines $y = x + 1$, $y = 6$ and $x = 2$ with the matching area shaded scores SC B1. That is the candidate who has swapped the letters over on the two simple lines, drawing $y = 6$ for $x = 6$ and $x = 2$ for $y = 2$, and then shaded correctly for the lines drawn	✓

Step	Mark	Description	Got it?
Note on part (a)	**note**	the mark scheme awards the three marks in (a) for the lines alone - they need not be labelled - although the question does ask for a label on each line	✓

Full marks: 4/4

Question 19 - Exam Solution

Understanding the Question

Given

Time for the flight: 9 hours 36 minutes

Average speed: 820 km/h

Find

The total distance the aircraft flies, in kilometres.

Plan the Solution

- The speed is given in kilometres per HOUR, so the time has to be in hours before anything is multiplied. 9 hours 36 minutes is not 9.36 hours.
- Turn the 36 minutes into a part of an hour by dividing by 60, then add it to the 9 whole hours.
- Then use $\text{distance} = \text{speed} \times \text{time}$ and write the answer in kilometres.

Worked Solution [3 marks]

> Speed, distance and time: $\text{distance} = \text{speed} \times \text{time}$, where the time is measured in hours because the speed is in kilometres per hour.

Step 1: Change the minutes into hours

$$\frac{36}{60} = 0.6$$

$$9 \text{ hours } 36 \text{ minutes} = 9.6 \text{ hours}$$

(Reason: There are 60 minutes in an hour, so 36 minutes is $\frac{36}{60}$ of an hour, which is 0.6 of an hour. Adding that to the 9 whole hours gives 9.6 hours.)

Step 2: Multiply the speed by the time in hours

$$\text{distance} = 820 \times 9.6 = 7872$$

(Reason: Distance is speed multiplied by time. The speed counts kilometres for every hour, so multiplying by the number of hours gives the number of kilometres.)

Step 3: Write the distance in kilometres

distance $= 7872$ km

(Reason: The speed was in kilometres per hour and the time was in hours, so the distance comes out in kilometres and the unit on the answer line is already km.)

7872 km

Verification

✓ **Check 1:** Split the journey. Work out the distance for the 9 whole hours and the distance for the 36 minutes separately, then add them. $820 \times 9 = 7380$ and $\frac{820}{60} \times 36 = 492$, and $7380 + 492 = 7872$

✓ **Check 2:** Work backwards. Dividing the distance by the time must give the speed back. $\frac{7872}{9.6} = 820$, which is the speed the question gives.

✓ **Check 3:** Work in minutes instead of hours. The flight is $9 \times 60 + 36 = 576$ minutes, and the aircraft flies $\frac{820}{60}$ km each minute. $576 \times \frac{820}{60} = 7872$, the same distance from a method that never forms 9.6.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
Convert the time into hours (or into minutes)	M1	For a correct conversion of the time into hours or into minutes, eg 9.6 hours, $9\frac{36}{60}$ hours, $9\frac{3}{5}$ hours or 576 minutes.	✓
Use distance $=$ speed $\times$ time with the time in hours	M1	eg 820×9.6, $820 \times \frac{576}{60}$, $576 \times \frac{820}{60}$ or $576 \times \frac{41}{3}$ (allow 13.7 for $\frac{41}{3}$) or equivalent. Use of 9.36 is allowed for this mark only. Award M2 for $820 \times 9 + \frac{820}{60} \times 36$ $(= 7380 + 492)$, or for $\frac{34\,560}{60 \times 60} \times 820$ or equivalent.	✓

Step	Mark	Description	Got it?
Correct answer	**A1**	7872. A correct answer scores full marks unless it comes from obviously incorrect working.	✓
Special case: the time read as a decimal	**SCB1**	An answer of 7675.2 earns SCB1 if no other marks are awarded. It comes from treating 9 hours 36 minutes as 9.36 hours instead of 9.6 hours, so the 36 minutes is never divided by 60.	✓

Full marks: 3/3

Question 20 - Exam Solution

Understanding the Question

Given

The two mixed numbers $2\frac{4}{7}$ and $3\frac{1}{9}$.

The result that has to be proved:

$2\frac{4}{7} \times 3\frac{1}{9} = 8$.

Find

A complete piece of working that ends at 8. The answer is printed in the question, so the marks are for the working, not for the number.

Plan the Solution

- Write each mixed number as an improper fraction: multiply the whole number by the denominator, then add the numerator.
- Look for common factors across the multiplication sign. The 9 underneath cancels with the 18 on top, and the 7 underneath cancels with the 28 on top.
- Multiply the numerators together and the denominators together.
- Simplify and state that the result is 8, as required.

Worked Solution [3 marks]

> Rule - Mixed numbers and fractions: $n\frac{p}{q} = \frac{n \times q + p}{q}$, and $\frac{a}{b} \times \frac{c}{d} = \frac{a \times c}{b \times d}$.

Step 1: Write each mixed number as an improper fraction

$$2\frac{4}{7} = \frac{2 \times 7 + 4}{7} = \frac{18}{7}$$

$$3\frac{1}{9} = \frac{3 \times 9 + 1}{9} = \frac{28}{9}$$

(Reason: Multiply the whole number by the denominator and then add the numerator on top. The denominator itself never changes, so the 7 and the 9 stay where they are.)

Step 2: Cancel the common factors before multiplying

$$\frac{18}{7} \times \frac{28}{9} = \frac{18 \times 28}{7 \times 9}$$

$$\frac{18 \times 28}{7 \times 9} = \frac{2 \times 4}{1 \times 1}$$

(Reason: A factor on top may be cancelled with a factor underneath, whichever fraction it came from. Here 9 goes into 18 exactly 2 times and 7 goes into 28 exactly 4 times, so both denominators cancel away completely.)

Step 3: Multiply the cancelled fractions

$$\frac{2 \times 4}{1 \times 1} = \frac{8}{1} = 8$$

(Reason: The numerators multiply to 8 and the denominators multiply to 1, and a fraction whose denominator is 1 is just its numerator. This is the required result.)

Step 4: The same answer without cancelling first

$$\frac{18}{7} \times \frac{28}{9} = \frac{504}{63} = 8$$

(Reason: Multiplying straight across gives $\frac{504}{63}$, and since $63 \times 8 = 504$ that fraction is exactly 8. Either route earns all three marks, so cancelling is a shortcut rather than a requirement.)

$$2\frac{4}{7} \times 3\frac{1}{9} = \frac{18}{7} \times \frac{28}{9} = 8 \textbf{ as required}$$

Verification

✓ **Check 1:** Work backwards. If the product really is 8, then dividing 8 by $3\frac{1}{9}$ must give back $2\frac{4}{7}$. Dividing by a fraction means multiplying by its reciprocal.

$$8 \times \frac{9}{28} = \frac{72}{28} = \frac{18}{7} = 2\frac{4}{7}$$

✓ **Check 2:** Do it without improper fractions at all. Treat it as two brackets, $(2+\frac{4}{7})(3+\frac{1}{9})$, and expand, putting every term over 63.

$$6+\frac{2}{9}+\frac{12}{7}+\frac{4}{63}=\frac{378+14+108+4}{63}=\frac{504}{63}=8$$

✓ **Check 3:** A decimal check on the calculator, which is allowed on this paper:

$\frac{18}{7}\approx 2.571428571$ and $\frac{28}{9}\approx 3.111111111$. $2.571428571\times 3.111111111\approx 8$

Mark Scheme Breakdown

Step	Mark	Description	Got it?
Write both mixed numbers as improper fractions: $\frac{18}{7}$ and $\frac{28}{9}$.	**M1**	for correct improper fractions	✓
Cancel fully, eg $\frac{18}{7}\times\frac{28}{9}=\frac{2\times 4}{1\times 1}$, or multiply without cancelling, eg $\frac{18\times 28}{7\times 9}=\frac{504}{63}$.	**M1dep**	for cancelling fractions fully, or for cancelling partially with a clear intention to multiply, or for not cancelling but with a clear intention to multiply. An arithmetic error in the multiplication is allowed here.	✓
Reach the printed result from fully correct working, eg $\frac{504}{63}=8$ or $2\times 4=8$.	**A1**	Shown. Dependent on both method marks, for a correct answer from fully correct working.	✓
Alternative presentation the scheme also accepts	**note**	A candidate may write $8=\frac{8}{1}$ underneath the printed 8, and then need only show that the given product comes to $\frac{8}{1}$.	✓

Full marks: 3/3

Question 21 - Exam Solution

Understanding the Question

Given

Triangle ABC with a right angle at B
The angle at A is $34°$
The side $AC = 6.5$ cm, which is the hypotenuse
The side $BC = x$ cm

Find

The value of x, correct to one decimal place

Plan the Solution

- Stand at the $34°$ angle and name the two sides that matter: BC faces that angle, so it is the opposite; AC faces the right angle, so it is the hypotenuse.
- Opposite and hypotenuse together means the sine ratio, not the cosine and not the tangent.
- Write the ratio, rearrange it to make x the subject, then evaluate with the calculator in degree mode.
- Round only at the very end, to one decimal place.

Worked Solution [3 marks]

> Rule - Sine ratio in a right-angled triangle: $\sin\theta = \dfrac{\text{opposite}}{\text{hypotenuse}}$

Step 1: Name the sides from the marked angle

$\text{opposite} = BC = x$

$\text{hypotenuse} = AC = 6.5$

(Reason: (Reason: the hypotenuse is always the side facing the right angle, and the opposite is the side facing the angle you are using, here the $34°$ angle at A.))

Step 2: Choose the ratio and write it down

$$\sin 34° = \frac{x}{6.5}$$

(Reason: (Reason: the two sides in play are the opposite and the hypotenuse, and that pair belongs to sine. This single line is worth the first method mark.))

Step 3: Rearrange to make x the subject

$$x = 6.5 \times \sin 34°$$

(Reason: (Reason: multiplying both sides by 6.5 clears the fraction and leaves x alone. This is the fully correct method the second mark is for.))

Step 4: Evaluate on the calculator

$x = 6.5 \times \sin 34^\circ = 3.63475\ldots$

(Reason: (Reason: the calculator must be in degree mode, or the answer will be wildly out. Keep the full display and do not round yet.))

Step 5: Round to one decimal place

$x \approx 3.6$

(Reason: (Reason: the digit after the first decimal place is 3, which is below 5, so the 6 stays as it is. The mark scheme accepts anything that rounds to 3.6.))

$x = 3.6$ cm (to 1 decimal place)

Verification

✓ **Check 1:** Find the third side and test Pythagoras. $AB = 6.5\cos 34^\circ = 5.38874\ldots$, so $AB^2 + BC^2 = 29.0385\ldots + 13.2114\ldots$. $AB^2 + BC^2 = 42.25 = 6.5^2$, exactly the square of the hypotenuse

✓ **Check 2:** Come at it from the other acute angle instead. The angles give $180 - 90 - 34 = 56$, and BC is adjacent to the 56° angle, so $x = 6.5 \times \cos 56^\circ$. $6.5 \times \cos 56^\circ = 3.63475\ldots$, the same value, reached without using sine at all

✓ **Check 3:** A size check. The hypotenuse is the longest side of any right-angled triangle, so x must be smaller than 6.5. Also 34° is less than 45°, so the side facing it must be the shorter of the two legs. $3.6 < 5.4 < 6.5$, so the answer sits where it should

Mark Scheme Breakdown

Step	Mark	Description	Got it?
A correct trig statement for x	M1	$\sin 34 = \frac{x}{6.5}$ or $\frac{x}{\sin 34} = \frac{6.5}{\sin 90}$ or $6.5^2 - (6.5 \times \cos 34)^2$ or $\cos 56 = \frac{x}{6.5}$ oe	✓
A fully correct method to find x	M1	$(x =)\ 6.5 \times \sin 34$ or $x = \frac{6.5 \times \sin 34}{\sin 90}$ or $(x =)\sqrt{6.5^2 - (6.5 \times \cos 34)^2}$ or $(x =)\ 6.5 \times \cos 56$ oe	✓
The value of x	A1	awrt 3.6	✓

Step	Mark	Description	Got it?
Note	**note**	A correct answer scores full marks unless it comes from obvious incorrect working.	✓

Full marks: 3/3

Question 22 - Exam Solution

Understanding the Question

Given

A speed of w metres per second.
There are 60 seconds in a minute and 60 minutes in an hour.
There are 1000 metres in a kilometre.

Find

The same speed written in kilometres per hour, in terms of w, as simply as possible.

Plan the Solution

- A speed in kilometres per hour is a distance in kilometres travelled in one hour, so start by finding how far the walkway carries you in 1 hour.
- Turn that distance from metres into kilometres by dividing by 1000.
- Tidy the number that is multiplying w, because the question asks for the simplest form.

Worked Solution [3 marks]

> Rule - to change metres per second into kilometres per hour, multiply by 3600 to turn seconds into hours and divide by 1000 to turn metres into kilometres.

Step 1: how far does it travel in one hour?

$60 \times 60 = 3600$

$3600 \times w = 3600w$

(Reason: (Reason: one hour is 60 minutes and each minute is 60 seconds, so one hour is 3600 seconds. The walkway covers w metres in every one of them, so in an hour it covers $3600w$ metres.))

Step 2: change those metres into kilometres

$3600w$ metres

$\frac{3600w}{1000}$ kilometres

(Reason: (Reason: a kilometre is 1000 metres, so a distance in metres is divided by 1000 to give the same distance in kilometres. The speed is now a number of kilometres in one hour, which is exactly what kilometres per hour means.))

Step 3: simplify the number in front of w

$$\frac{3600}{1000} = 3.6$$

$$\frac{3600w}{1000} = 3.6w$$

(Reason: (Reason: the 3600 and the 1000 are just numbers, so they can be worked out on their own. Dividing 3600 by 1000 gives the multiplier that turns any speed in metres per second into kilometres per hour. In fraction form it is $\frac{18}{5}$, which is the same number.))

$3.6w$ kilometres per hour

Verification

- ✓ **Check 1 - put a number in:** Take $w = 5$, a speed of 5 metres per second. In one hour that is $5 \times 3600 = 18000$ metres, and $\frac{18000}{1000} = 18$ kilometres. The formula gives $3.6 \times 5 = 18$ kilometres per hour, the same speed
- ✓ **Check 2 - convert back the other way:** A speed of 3.6 kilometres per hour is 3600 metres travelled in 3600 seconds, so it should come back to 1 metre per second. $\frac{3600}{3600} = 1$, so the conversion undoes itself
- ✓ **Check 3 - is the size sensible?** Kilometres are long and hours are long, but an hour is 3600 times a second while a kilometre is only 1000 times a metre, so the number counting kilometres per hour must come out bigger than the number counting metres per second. The multiplier 3.6 is greater than 1, so the speed in kilometres per hour is the larger number, as expected

Mark Scheme Breakdown

Step	Mark	Description	Got it?
One correct conversion step	**M1**	For any one of $\frac{w}{1000}$, $w \times 10^{-3}$, $0.001w$, $w \times 60 \times 60$ or $w \times 3600$ oe. Also award this mark for $\frac{3600}{1000}$, $\frac{18}{5}$ or 3.6 oe written on its own, without a link to w.	✓
A fully correct method, including w	**M1**	For $\frac{w \times 60 \times 60}{1000}$ oe, for example $w \times \frac{3600}{1000}$. Both conversions must be present and applied to w.	✓
The simplified answer	**A1**	For $3.6w$. Accept $\frac{18}{5}w$ or $3\frac{3}{5}w$; allow $3.6 \times w$.	✓
Note	**note**	A correct answer scores full marks unless it comes from obviously incorrect working.	✓

Full marks: 3/3

Question 23 - Exam Solution

Understanding the Question

Given

A hexagon $ABCDEF$ with $AF = 21$ cm, $CD = 15$ cm and $AB = FE = 13$ cm
CD is parallel to AF, and the angles at A and at F are right angles
The area of the whole hexagon is 390 cm², and its perpendicular height is h cm

Find

The value of h, the perpendicular height of the hexagon in cm

Plan the Solution

- Cut the hexagon along BE into two familiar shapes: a rectangle underneath and a trapezium on top.
- Find the rectangle's area from the numbers given, then subtract it from 390 to leave the trapezium's area.

- Write the trapezium's area with the trapezium formula. Its parallel sides are known, so the only unknown left is its height, $h - 13$.
- Solve that equation, then add the 13 cm of the rectangle back on to reach the full height h.

Worked Solution [4 marks]

> Rule - Composite shape: the total area is the sum of its parts, and a trapezium with parallel sides a and b a distance d apart has area $\frac{1}{2}(a + b)d$.

Step 1: Split the hexagon and find the rectangle underneath

$BE = AF = 21$ cm

Area of $ABEF = 21 \times 13 = 273$ cm^2

(Reason: The angles at A and F are right angles and $AB = FE$, so $ABEF$ is a rectangle. That makes BE the same length as AF, and a rectangle's area is its length times its width.)

Step 2: Find the area left over for the trapezium

Area of $BCDE = 390 - 273 = 117$ cm^2

(Reason: The rectangle and the trapezium together make the whole hexagon, so whatever is left of the 390 cm² after the rectangle belongs to the trapezium $BCDE$.)

Step 3: Write the trapezium's area in terms of h

$$\frac{1}{2} \times (21 + 15) \times (h - 13) = 117$$

$$18(h - 13) = 117$$

(Reason: The trapezium's parallel sides are $BE = 21$ cm and $CD = 15$ cm. It sits on top of the 13 cm rectangle, so its own height is $h - 13$ cm, and $\frac{1}{2} \times (21 + 15) = 18$.)

Step 4: Solve for h

$$h - 13 = \frac{117}{18} = 6.5$$

$$h = 6.5 + 13 = 19.5$$

(Reason: Dividing both sides by 18 gives the trapezium's height, 6.5 cm. That is only the part above BE, so the 13 cm of the rectangle is added back to give the height of the whole hexagon.)

$$h = 19.5$$

Verification

✓ **Check 1:** Put $h = 19.5$ back into the original split. The trapezium's height is $19.5 - 13 = 6.5$ cm, so its area is $18 \times 6.5 = 117$ cm², and the rectangle is 273 cm². $273 + 117 = 390$ cm², which is the area the question gives

✓ **Check 2:** Cut the shape a different way. Start from the whole 21 cm by 19.5 cm rectangle that encloses it and take off the two corner triangles, each with base $\dfrac{21 - 15}{2} = 3$ cm and height 6.5 cm, so $2 \times \dfrac{1}{2} \times 3 \times 6.5 = 19.5$ cm². $409.5 - 19.5 = 390$ cm², the same area from a completely different split

✓ **Check 3:** Expand instead of dividing. From $273 + 18(h - 13) = 390$ the left side becomes $18h - 234 + 273 = 18h + 39$, which is one of the equations the mark scheme lists. $18h + 39 = 390$, so $18h = 351$ and $h = 19.5$

Mark Scheme Breakdown

Step	Mark	Description	Got it?
A correct area for one part of the shape, eg the rectangle $ABEF$: $13 \times 21 = 273$	**M1**	A correct calculation for an area linked to the shape. $h - 13$ may be written as x or y, and even as h; brackets may be missing for this mark only.	✓
$390 - 273 = 117$, or 13×21 together with $\dfrac{1}{2}(15 + 21)(h - 13)$	**M1**	For considering the area of all parts of the shape. The parts need not be added or subtracted, but the brackets must be used correctly.	✓
$\dfrac{117}{0.5 \times (15 + 21)} = 6.5$, or the equation $273 + 18(h - 13) = 390$	**M1**	A correct calculation for the height of the trapezium or for the height of the shape, or a correct equation involving either. Typical equations simplify to $18y = 117$, $18h - 234 = 117$ or $18h + 39 = 390$.	✓
$h = 19.5$	**A1**	oe, eg $\dfrac{39}{2}$. A correct answer scores full marks unless it comes from obviously incorrect working.	✓

Full marks: 4/4

Question 24 - Exam Solution

Understanding the Question

Given

A total of 600 balloons.
Round : heart : star $= 9 : 4 : 2$.
45% of the round balloons are red.
$\frac{5}{8}$ of the heart balloons are red.
Every one of the star balloons is red.

Find

The total number of balloons that are red.

Plan the Solution

- Add the ratio parts to see how many equal parts the 600 balloons are split into.
- Divide to find the size of one part, then multiply to find how many balloons there are of each shape.
- Take the red fraction of each shape separately - a percentage for the round, a fraction for the heart, all of the star.
- Add the three red amounts to get the total.

Worked Solution [5 marks]

> Rule - Sharing in a ratio: one part is $\frac{\text{total amount}}{\text{sum of the ratio parts}}$, and each share is that one part multiplied by its own number of parts.

Step 1: Add the ratio parts

$$9 + 4 + 2 = 15$$

(Reason: (Reason: the ratio $9 : 4 : 2$ splits the whole order into 15 equal parts, so the parts must be added before anything can be shared.))

Step 2: Work out one part

$$\frac{600}{15} = 40$$

(Reason: (Reason: the 600 balloons are shared equally between the 15 parts, so one part is 40 balloons.))

Step 3: Work out how many of each shape

$$\text{round} = 9 \times 40 = 360$$
$$\text{heart} = 4 \times 40 = 160$$
$$\text{star} = 2 \times 40 = 80$$

(Reason: (Reason: each shape gets its own number of parts. As a check, $360 + 160 + 80 = 600$, which is the whole order.))

Step 4: Work out how many of each shape are red

$0.45 \times 360 = 162$

$\frac{5}{8} \times 160 = 100$

star: all 80

(Reason: (Reason: 45% is the same as 0.45, so multiply the round balloons by 0.45; multiply the heart balloons by their red fraction; and every one of the 80 star balloons is red, so all of them count.))

Step 5: Add the three red amounts

$162 + 100 + 80 = 342$

(Reason: (Reason: the red balloons are the red round ones, the red heart ones and the star ones together - no balloon is counted twice, because each balloon has only one shape.))

342 balloons are red

Verification

✓ **Check 1:** Work out what fraction of the whole order is red in one go: $0.45 \times \frac{9}{15} = \frac{27}{100}$ for the round, $\frac{5}{8} \times \frac{4}{15} = \frac{1}{6}$ for the heart, and $\frac{2}{15}$ for the star.

$\left(\frac{27}{100} + \frac{1}{6} + \frac{2}{15}\right) \times 600 = \frac{57}{100} \times 600 = 342$

✓ **Check 2:** Count the balloons that are NOT red instead: $0.55 \times 360 = 198$ round and $\frac{3}{8} \times 160 = 60$ heart, with none of the star balloons left out. $198 + 60 + 0 = 258$ are not red, and $600 - 258 = 342$ are red.

✓ **Check 3:** Work in ratio parts rather than balloons: $0.45 \times 9 = 4.05$ parts of round, $\frac{5}{8} \times 4 = 2.5$ parts of heart and 2 parts of star are red, out of 15 parts.

$4.05 + 2.5 + 2 = 8.55$, and $\frac{8.55}{15} \times 600 = 342$

Mark Scheme Breakdown

Step	Mark	Description	Got it?
A correct method to find one share	**M1**	e.g. $\frac{600}{9+4+2} = 40$, or any one of 360, 160 or 80 seen. Also allow 45% of 600, or $\frac{5}{8}$ of 600, or the fraction of the share that is round balloons.	✓
A correct method to find the number of star balloons	**M1**	e.g. $2 \times 40 = 80$ or $\frac{2}{15} \times 600 = 80$, or the fraction of the share that is heart balloons. This implies the first M1.	✓
A correct method to find the number of red round balloons	**M1**	e.g. $0.45 \times (9 \times 40) = 162$ or $0.45 \times 600 \times \frac{9}{15} = 162$, or the total of the parts that are red, $4.05 + 2.5 + 2 = 8.55$. This implies the first M1.	✓
A correct method to find the number of red heart balloons	**M1**	e.g. $\frac{5}{8} \times (4 \times 40) = 100$ or $\frac{5}{8} \times 600 \times \frac{4}{15} = 100$, or multiplying the total of the correct red parts by 600, e.g. $\frac{8.55}{9+4+2} \times 600$, which implies all previous M marks.	✓
Correct answer	**A1**	342 cao. A correct answer scores full marks unless it comes from obviously incorrect working.	✓

Full marks: 5/5

Question 25 - Exam Solution

Understanding the Question

Given

Amount invested: 4500 koruna
Time in the bond: 4 years
Compound interest at 2.4% per year - the interest is added to the bond, so the next

Find

The value of the bond at the end of 4 years, to the nearest koruna

year's interest is worked out on a bigger amount

Plan the Solution

- Turn the yearly increase into a single multiplier: $100\% + 2.4\% = 102.4\%$, which is 1.024.
- Compound interest applies that multiplier once for every year, so 4 years means the multiplier is used 4 times - that is 1.024^4.
- Multiply the 4500 koruna by that power, then round the result to the nearest whole koruna.

Worked Solution [3 marks]

> Rule - Compound growth: $A = P \times \left(1 + \frac{r}{100}\right)^n$, where P is the starting amount, r is the percentage rate per year and n is the number of years.

Step 1: Write the yearly increase as one multiplier

$$100\% + 2.4\% = 102.4\%$$

$$102.4\% = \frac{102.4}{100} = 1.024$$

(Reason: Adding 2.4% to an amount leaves you with 102.4% of it, so one multiplication by 1.024 does a whole year in a single step.)

Step 2: Raise the multiplier to the power of the number of years

$$1.024^4 = 1.099511627776$$

(Reason: Interest is added at the end of each of the 4 years, and every time the running total is multiplied by 1.024, so the four multiplications collapse into one power.)

Step 3: Multiply the amount invested by that power

$$4500 \times 1.099511627776 = 4947.802324992$$

(Reason: The starting amount is scaled by the same factor every year, so multiplying the 4500 koruna by the power gives the value of the bond at the end.)

Step 4: Round to the nearest koruna

$$4947.802324992 \approx 4948$$

(Reason: The first digit after the decimal point is 8, which is 5 or more, so the whole-number part rounds up from 4947 to 4948.)

4948 koruna

Verification

✓ **Check 1:** Build the total up one year at a time instead of using a power: multiply by 1.024 four separate times, starting from 4500. The year-end totals are 4608, 4718.592, 4831.838208 and 4947.802324992 - the same final amount, so the power method agrees with the year-by-year method.

✓ **Check 2:** Work backwards. Dividing the final amount by the multiplier four times must return the amount that was invested. $\dfrac{4947.802324992}{1.024^4} = 4500$, which is exactly what Lorenzo put in.

✓ **Check 3:** Compare with simple interest, which would pay $4500 \times 0.024 \times 4 = 432$ koruna. Compound interest must pay a little more, because later years earn interest on the earlier interest. The interest here is $4947.802324992 - 4500 = 447.802324992$ koruna, which is more than 432 but not by much over 4 years - exactly the size of gap to expect.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
$4500 \times 1.024\ (= 4608)$ or equivalent, or $4500 \times 0.024\ (= 108)$	**M1**	One year of compound growth started correctly - either the multiplier method, or working out one year's interest of 108 koruna.	✓
4608×1.024 $(= 4718.592)$ and 4718.592×1.024 $(= 4831.838208)$ and 4831.838208×1.024 $(= 4947.802324992)$	**M1**	The growth carried through all four years, each year multiplying the previous total. The mark scheme prints these figures in quotation marks, which means the candidate's own running totals are followed through.	✓
4948	**A1**	Accept anything from 4947 to 4948. A correct answer scores full marks unless it comes from obviously incorrect working.	✓
Single-step alternative: 4500×1.024^4	**M2**	Doing all four years in one power earns both method marks together, with no year-by-year working needed.	✓

Step	Mark	Description	Got it?
If no other mark has been awarded	SCB1	Award 1 mark for any of $4500 \times 0.024 \times 4 = 432$ or $0.096 \times 4500 = 432$ (simple interest instead of compound), $4500 + 4500 \times 0.024 \times 4 = 4932$ or $4500 \times 1.096 = 4932$ (the simple-interest total), $0.976 \times 4500 = 4392$ (a decrease of 2.4% for one year), $0.904 \times 4500 = 4068$ (a simple decrease over 4 years), $0.976^4 \times 4500 = 4083.304660992$ (a compound decrease), or $4500 \times 1.024^3 = 4831.838208$ (stopping a year early).	✓

Full marks: 3/3

Question 26 - Exam Solution

Understanding the Question

Given

Equation 1: $6x + 4y = 1$

Equation 2: $3x + 5y = 8$

Two linear equations in the same two unknowns, so exactly one pair of values fits both.

Find

The value of x and the value of y that satisfy both equations at the same time. Algebraic working is demanded, so a pair found by trial and improvement earns nothing.

Plan the Solution

- The coefficient of x is 6 in equation 1 and 3 in equation 2, so doubling equation 2 makes both of them $6x$.
- Subtract the two equations to remove x and leave one equation in y alone.
- Put that value of y back into one of the original equations to get x.
- Test the pair in both original equations, and repeat the solve by eliminating y instead, as an independent check.

Worked Solution [3 marks]

> Rule - Elimination: multiply one or both equations until one letter has the same coefficient in both, then subtract when those coefficients have the same sign, or add when they have opposite signs, to remove that letter.

Step 1: Match the x terms

$3x + 5y = 8$

$2 \times (3x + 5y) = 2 \times 8$

$6x + 10y = 16$

(Reason: Multiplying every term of equation 2 by 2 turns its $3x$ into $6x$, matching equation 1. The right-hand side must be doubled as well, so 8 becomes 16.)

Step 2: Subtract to eliminate x

$(6x + 10y) - (6x + 4y) = 16 - 1$

$6y = 15$

$y = \frac{15}{6} = \frac{5}{2} = 2.5$

(Reason: Both equations now begin with $6x$, so subtracting removes x completely. That leaves $10y - 4y = 6y$ on the left and $16 - 1 = 15$ on the right, and dividing by 6 gives y.)

Step 3: Substitute back to find x

$6x + 4 \times 2.5 = 1$

$6x + 10 = 1$

$6x = 1 - 10 = -9$

$x = \frac{-9}{6} = -\frac{3}{2} = -1.5$

(Reason: Putting $y = 2.5$ into the first original equation leaves x as the only unknown. Take the 10 across to the right, then divide by 6.)

$$x = -\frac{3}{2} = -1.5$$

$$y = \frac{5}{2} = 2.5$$

Verification

✓ **Check 1:** Put $x = -1.5$ and $y = 2.5$ into the left-hand side of equation 1, $6x + 4y$.
$6 \times (-1.5) + 4 \times 2.5 = -9 + 10 = 1$, which is the right-hand side of equation 1.

✓ **Check 2:** Put the same pair into the left-hand side of equation 2, $3x + 5y$. A pair that only fits one equation is not a solution. $3 \times (-1.5) + 5 \times 2.5 = -4.5 + 12.5 = 8$, which is the right-hand side of equation 2.

✓ **Check 3:** Solve it again the other way round, eliminating y first: 5 times equation 1 gives $30x + 20y = 5$, and 4 times equation 2 gives $12x + 20y = 32$. Subtract.

$18x = 5 - 32 = -27$, so $x = \dfrac{-27}{18} = -1.5$, the same value reached by a different elimination.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
Multiply equation 2 by 2 to give $6x + 10y = 16$, then subtract equation 1 from it.	**M1**	A correct method to eliminate x or y: multiplying one or both equations so that one value can be eliminated, and the correct operation to eliminate it, which can be shown by 2 out of 3 terms correct for subtraction or addition (allow one arithmetic error in multiplying). Or a correct substitution of one variable into the other equation. Note: the mark is for the method and not for the result, although a correct result also earns it.	✓
Substitute the letter already found back into either original equation to reach the other letter.	**M1**	A correct method to calculate the value of the other letter: substitution of the found variable into an equation (the equation does not need to be solved), or starting again with elimination or substitution.	✓
Both values stated, with algebraic working shown.	**A1**	Working required. $x = -1.5$ and $y = 2.5$, or equivalent: the answer must be a vulgar fraction, a mixed number or a decimal, so an unsimplified $y = \dfrac{12.5}{5}$ is not accepted.	✓

Full marks: 3/3

Question 27 - Exam Solution

Understanding the Question

Given

The expression $x^2 + 9x - 22$
The equation $x^2 + 9x - 22 = 0$, which is the same expression set equal to zero
A quadratic with no coefficient in front of x^2, so it factorises into two simple brackets if it factorises at all

Find

(i) The two brackets whose product is the given expression (ii) The values of x that make the expression zero. A quadratic can have two, so expect two.

Plan the Solution

- Compare with $x^2 + bx + c$: here $b = 9$ and $c = -22$.
- Hunt for two numbers whose product is -22 and whose sum is 9. Because the product is negative, one number is positive and the other is negative.
- List the factor pairs of -22 and test each one on the sum. Every pair passes the product test, so the sum is what decides.
- Drop the winning pair straight into $(x + p)(x + q)$.
- For part (ii), the word "hence" means use those brackets: a product is zero only when one of its factors is zero, so set each bracket to 0 in turn.

Worked Solution [3 marks]

> Rule - Factorising $x^2 + bx + c$: find two numbers p and q with $pq = c$ and $p + q = b$. Then $x^2 + bx + c = (x + p)(x + q)$.

Step 1: Read off the product and the sum

$x^2 + 9x - 22$ gives $b = 9$ and $c = -22$

(Reason: The two numbers in the brackets must multiply to give $c = -22$ and add to give $b = 9$.)

Step 2: Test the factor pairs of -22

$1 \times (-22) = -22$ and $1 + (-22) = -21$
$2 \times (-11) = -22$ and $2 + (-11) = -9$
$(-2) \times 11 = -22$ and $(-2) + 11 = 9$

(Reason: Every pair here multiplies to -22, so the product test cannot separate them. Only -2 and 11 also add to 9, so that is the pair to use.)

Step 3: Write the two brackets

$x^2 + 9x - 22 = (x + (-2))(x + 11)$
$x^2 + 9x - 22 = (x - 2)(x + 11)$

(Reason: The winning pair goes straight into $(x + p)(x + q)$, and $x + (-2)$ is tidied to $x - 2$.)

Step 4: Use the factorisation on the equation

$(x - 2)(x + 11) = 0$

$x - 2 = 0$ or $x + 11 = 0$

(Reason: Two numbers multiply to zero only when at least one of them is zero, so each bracket is taken in turn.)

Step 5: Solve each bracket

$x = 2$ or $x = -11$

(Reason: Add 2 to both sides of the first bracket, and subtract 11 from both sides of the second.)

(i) $(x - 2)(x + 11)$

(ii) $x = 2$ or $x = -11$

Verification

✓ **Check 1:** Expand the brackets again and collect the two x terms.
$(x - 2)(x + 11) = x^2 + 11x - 2x - 22 = x^2 + 9x - 22$

✓ **Check 2:** Put $x = 2$ back into $x^2 + 9x - 22$. Squaring the 2 gives 4. $4 + 18 - 22 = 0$

✓ **Check 3:** Put $x = -11$ into the same expression. Squaring the -11 gives 121, and $9 \times (-11)$ is -99. $121 - 99 - 22 = 0$

✓ **Check 4:** The two solutions of $x^2 + bx + c = 0$ must add to $-b$ and multiply to c, which tests both answers at once without expanding anything.
$2 - 11 = -9$ and $2 \times (-11) = -22$

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(i) Brackets of the form $(x \pm 2)(x \pm 11)$	**M1**	Or $(x + a)(x + b)$ where $ab = -22$ or $a + b = 9$. The method mark is for finding the right pair of numbers, even if the signs are not yet settled.	✓
(i) $(x - 2)(x + 11)$	**A1**	Correct answer scores full marks, unless it comes from obvious incorrect working.	✓
(ii) $2, -11$	**B1ft**	Must follow through from the candidate's own factors in part (i): a candidate who wrote $(x + 2)(x - 11)$ in part (i) earns this mark for $-2, 11$.	✓

Full marks: 3/3

Question 28 - Exam Solution

Understanding the Question

Given

A step count for each of 7 days, split into a block of 4 days and a block of 3 days
Mean for the first 4 days $= 11\,800$
Mean for the next 3 days $= 13\,207$

Find

The mean number of steps for all 7 days
Note: this is a weighted mean, so it is not the halfway value $\dfrac{11\,800 + 13\,207}{2}$

Plan the Solution

- A mean on its own cannot be added to another mean. Turn each mean back into a total first.
- Multiply each block's mean by the number of days in that block to get the steps in that block.
- Add the two block totals to get the steps for the whole 7 days.
- Divide that grand total by 7 to get the mean for the 7 days.

Worked Solution [3 marks]

> Mean: $\text{mean} = \dfrac{\text{total}}{\text{number of values}}$, which rearranges to $\text{total} = \text{mean} \times \text{number of values}$. Totals can be added; means cannot.

Step 1: turn the first mean back into a total

$4 \times 11\,800 = 47\,200$

(Reason: A mean of $11\,800$ over 4 days means those four days add up to $4 \times 11\,800$ steps.)

Step 2: turn the second mean back into a total

$3 \times 13\,207 = 39\,621$

(Reason: The same rearrangement for the shorter block: 3 days at a mean of $13\,207$ steps come to $3 \times 13\,207$ steps altogether.)

Step 3: add the two block totals

$47\,200 + 39\,621 = 86\,821$

(Reason: Totals may be added because every one of the 7 days is counted exactly once: 4 days from the first block and 3 from the second.)

Step 4: divide the grand total by the number of days

$$\frac{86\,821}{7} = 12\,403$$

(Reason: Back to the mean itself: 86 821 steps shared over 7 days. The division is exact, so the mean is a whole number of steps.)

12 403 steps

Verification

✓ **Check 1:** Work backwards. If the mean for the 7 days is 12 403, the seven days must add up to $7 \times 12\,403$, and that must be the grand total from Step 3. $7 \times 12\,403 = 86\,821$, which is $47\,200 + 39\,621$

✓ **Check 2:** Reach the answer a different way. Start at the lower mean and add the share of the gap that belongs to the 3 busier days: the gap between the two means is $13\,207 - 11\,800 = 1407$. $11\,800 + \frac{3}{7} \times 1407 = 11\,800 + 603 = 12\,403$

✓ **Check 3:** Sense check the position of the answer. It must lie between 11 800 and 13 207, and nearer the first because more days are in that block. The two gaps should be in the reverse ratio of the day counts, $3 : 4$. $12\,403 - 11\,800 = 603$ and $13\,207 - 12\,403 = 804$, and $603 : 804 = 3 : 4$

Mark Scheme Breakdown

Step	Mark	Description	Got it?
One correct block total, or the total for all 7 days	**M1**	$4 \times 11\,800$ $(= 47\,200)$ or $3 \times 13\,207$ $(= 39\,621)$ or 86 821	✓
A fully correct method for the mean of the 7 days	**M1**	$\frac{47\,200 + 39\,621}{7}$, that is $\frac{86\,821}{7}$. Their two block totals may be followed through here.	✓
The mean for the 7 days	**A1**	12 403. A correct answer scores full marks, unless it comes from obviously incorrect working.	✓

Full marks: 3/3

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