

Edexcel IGCSE 4MA1

Paper 1F (Foundation Tier) – November 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 1F (Foundation Tier), November 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 lengths, in metres, of five long road bridges.



Bridge	Length (metres)
Corvale	13 972
Highmoor	12 940
Kelbrook	24 512
Ashlon	16 918
Denmoor	17 540

- (a) Write down the name of the longest bridge. [1 mark]
- (b) In the number 13 972, what is the value of the digit 9? [1 mark]
- (c) One of the bridge lengths rounds to 17 000 metres, correct to the nearest thousand. Name that bridge. [1 mark]
- (d) Write 12 940 in words. [1 mark]
- (e) Find the combined length of Corvale Bridge and Denmoor Bridge. [1 mark]

(a)

(b)

(c)

(d)

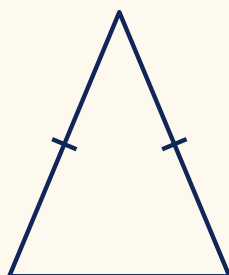
(e)

[Total 5 marks]

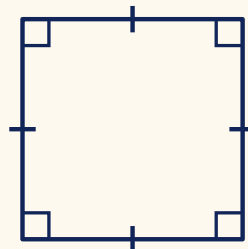
2. Two shapes are shown below.



Triangle



Quadrilateral



(a) Write down the mathematical name of

(i) the triangle, *[1 mark]*

(ii) the quadrilateral. *[1 mark]*

(b) Draw the line of symmetry of the triangle. *[1 mark]*

(c) Write down the order of rotational symmetry of the quadrilateral. *[1 mark]*

(a)(i)

(a)(ii)

(b)

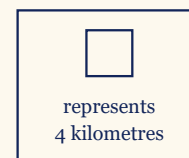
(c)

[Total 4 marks]

3. The pictogram shows the number of kilometres Daniel travelled on Monday, Tuesday, Wednesday and Thursday.



Monday	   
Tuesday	   
Wednesday	    
Thursday	  
Friday	



- (a) Write down the number of kilometres Daniel travelled on Tuesday. [1 mark]

On Wednesday, Daniel travelled further than he did on Thursday.

- (b) How much further? [2 marks]

On Friday, Daniel travelled 13 kilometres.

- (c) Show this information on the pictogram. [1 mark]

(a)

(b)

(c)

[Total 4 marks]

4. The table shows the air temperature at different heights above sea level.



Height above sea level (metres)	Temperature ($^{\circ}\text{C}$)
14 000	-60
12 000	-58
9000	-50
7000	-40
6000	-32
4000	-17
2000	-1
0	12

(a) Work out the difference in temperature between a height of 0 m and a height of 12 000 m. *[1 mark]*

(b) Work out the difference in temperature between a height of 4000 m and a height of 6000 m. *[1 mark]*

(c) At what height is the temperature 10°C warmer than the temperature at a height of 9000 m? *[1 mark]*

(a)

(b)

(c)

[Total 3 marks]

5. (a) Write $8d - 4d + 7d$ in its simplest form. [1 mark]



(b) Write $m \times 10p$ in its simplest form. [1 mark]

(c) Solve the equation $x + 5 = -19$. [1 mark]

(d) Solve the equation $\frac{y}{8} = 6$. [1 mark]

(e) Write $a \times a \times a \times a$ in its simplest form. [1 mark]

Given that $k = 8$ and $n = 12$,

(f) work out the value of $9k - 4n$. [2 marks]

(a)

(b)

(c)

(d)

(e)

(f)

[Total 7 marks]

6. Last year, Lucas used 2358 units of electricity, and each unit cost 0.28 euros.



Lucas had already been paying towards his electricity, at 42 euros each month, throughout last year.

Work out how much more Lucas has to pay for the electricity he used last year.

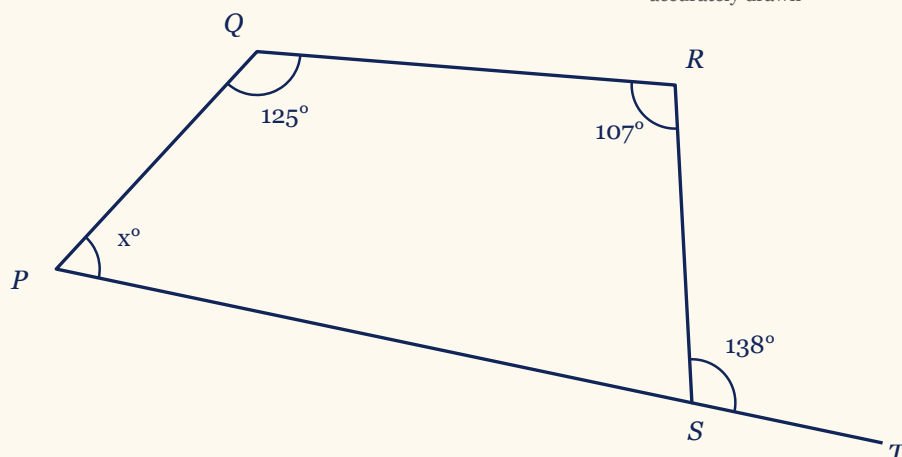
..... euros

[Total 4 marks]

7.



Diagram NOT
accurately drawn



PQRS is a quadrilateral.

PST is a straight line.

Work out the value of x . Give a reason for each stage of your working.

.....
[Total 4 marks]

8. There are 80 sweets in a jar.



27 of the sweets are lemon.

10 of the sweets are orange.

The rest of the sweets are strawberry.

One of the sweets in the jar is chosen at random.

(a) Write down the probability that this sweet is lemon. [1 mark]

(b) Find the probability that this sweet is strawberry. [2 marks]

(a)

(b)

[Total 3 marks]

9. 15 identical notebooks cost 41.25 pounds.



Work out the cost of 52 of these notebooks.

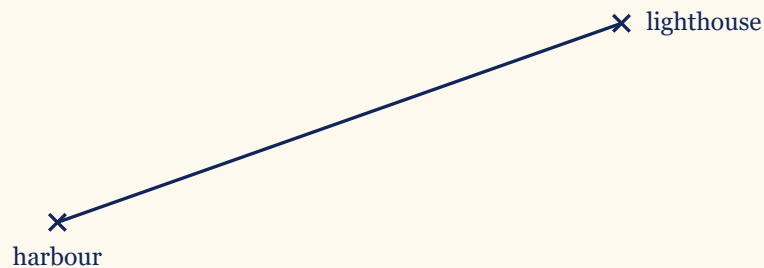
..... pounds

[Total 2 marks]

10. The scale diagram shows the positions of a harbour and a lighthouse.



1 cm represents 1.5 km



Emma walks from the harbour to the lighthouse along a straight path.

She takes 18 minutes to walk each km.

Work out how many minutes Emma takes to walk from the harbour to the lighthouse.

..... minutes

[Total 3 marks]

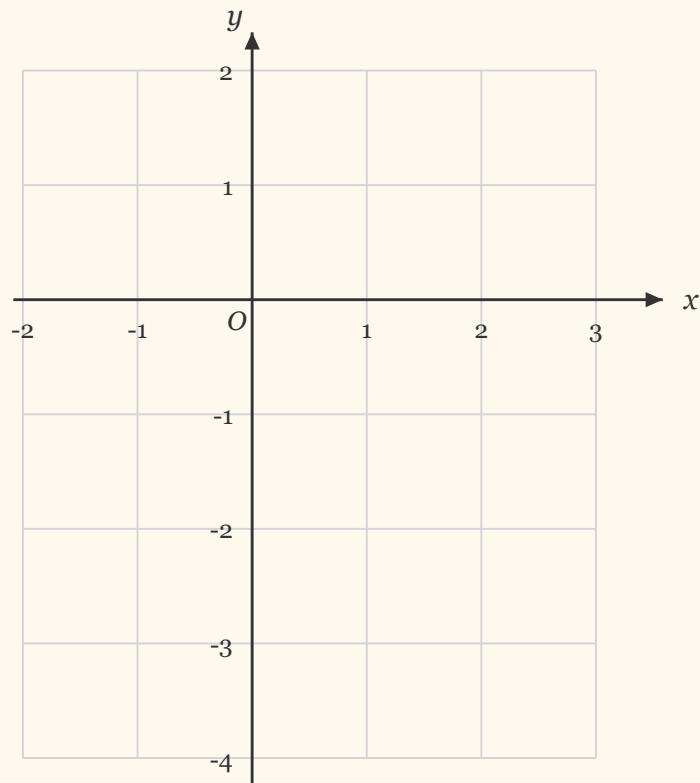
11. Rearrange the formula $c = 8d + 5$ to make d the subject.



.....

[Total 2 marks]

- 12.** Draw the graph of $y = \frac{1}{2}x - 1$ for values of x from -2 to 3 on the grid provided.



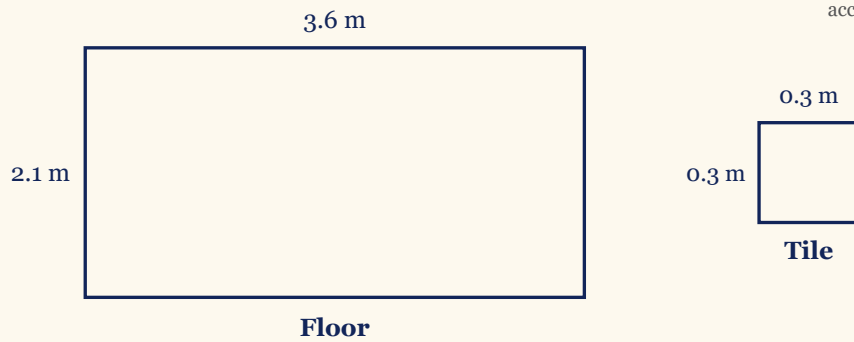
Draw the line on the grid above.

[Total 3 marks]

13.



Diagram NOT
accurately drawn



The diagram shows a rectangular floor and a square tile.

Nathan wants to cover all of the floor with tiles.

The tiles are sold in boxes.

There are 6 tiles in each box.

Each box of tiles costs £17.50.

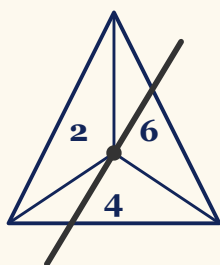
Work out the total cost of the tiles Nathan needs.

.....
[Total 4 marks]

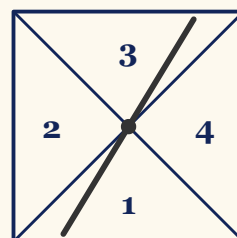
- 14.** Lucy has a fair triangular spinner and a fair square spinner. The triangular spinner lands on 2, 4 or 6. The square spinner lands on 1, 2, 3 or 4.



Lucy spins each spinner once and adds the two numbers to get her score.



Triangular spinner



Square spinner

- (a)** Complete the table to show all possible scores. Four of the scores have been done for you. *[2 marks]*

		Square spinner			
		1	2	3	4
Triangular spinner	2	3	4		
	4			7	
	6				10

- (b)** Find the probability that her score is 9 or less. *[2 marks]*

(a)

(b)

[Total 4 marks]

- 15.** A homeware shop buys 140 mugs.



35% of the 140 mugs cost \$6 each.

$\frac{1}{4}$ of the 140 mugs cost \$8 each.

The rest of the 140 mugs cost \$10 each.

Work out the total cost of the 140 mugs.

..... dollars

[Total 4 marks]

- 16.** Work out an estimate for the value of 31.4×48.7 by rounding each number to one significant figure.

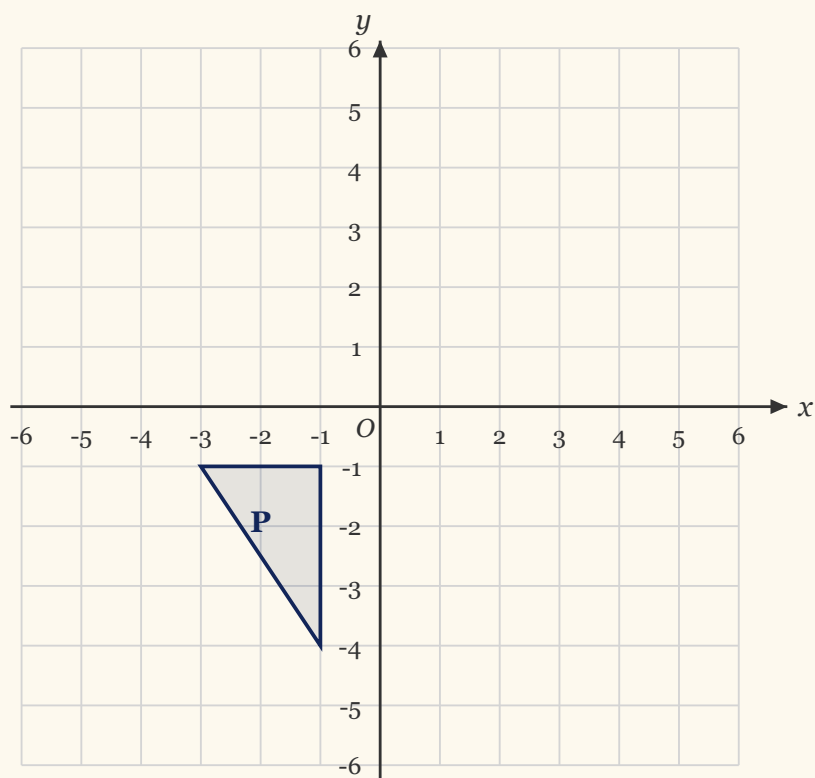


Show your working clearly.

.....

[Total 2 marks]

17. Triangle P is drawn on the grid below.



Reflect shape P in the line $x = 1$.

Draw the reflected shape on the grid above.

[Total 2 marks]

- 18.** The table shows some information about the amounts, in dollars, spent by 60 customers at a bookshop.



Amount spent (p dollars)	Frequency
$10 < p \leq 15$	18
$15 < p \leq 20$	16
$20 < p \leq 25$	14
$25 < p \leq 30$	8
$30 < p \leq 35$	4

- (a) Write down the modal class. *[1 mark]*
- (b) Work out an estimate for the mean amount spent by the 60 customers. *[4 marks]*

(a)

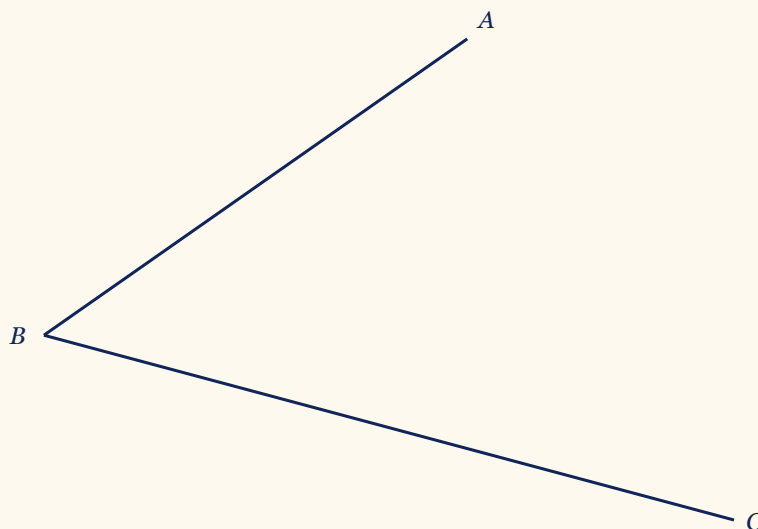
(b)

[Total 5 marks]

- 19.** Use a ruler and a pair of compasses only to construct the bisector of angle ABC .



You must show all your construction lines.



Construct the bisector on the diagram above.

[Total 2 marks]

- 20.** (a) Simplify $(p^3)^5$ [1 mark]



- (b) Expand and simplify $2n(4n + 3) + n(n - 4)$ [2 marks]

- (c) Solve $\frac{2x + 5}{3} = 4 - x$ [3 marks]

Show clear algebraic working.

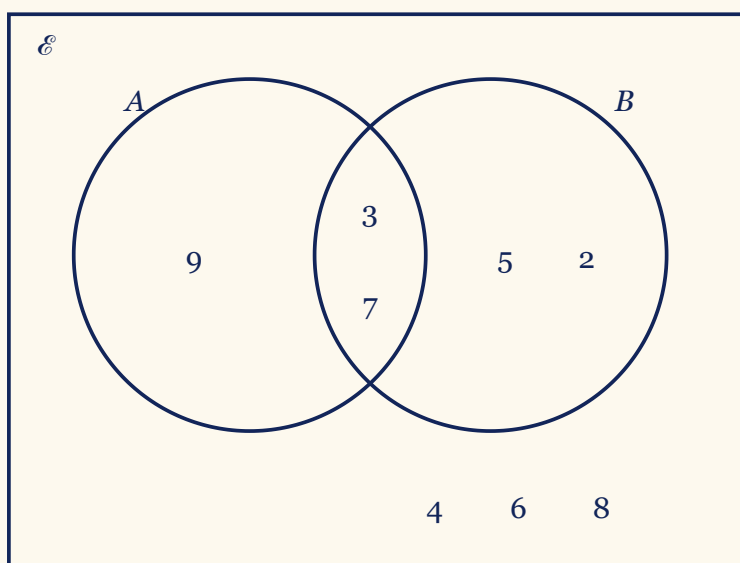
(a)

(b)

(c)

[Total 6 marks]

21. Here is a Venn diagram.



(a) List the members of the set B [1 mark]

(b) List the members of the set $A \cap B$ [1 mark]

(c) List the members of the set A' [1 mark]

(a)

(b)

(c)

[Total 3 marks]

- 22.** The diagram shows a paddling pool in the shape of a cylinder.

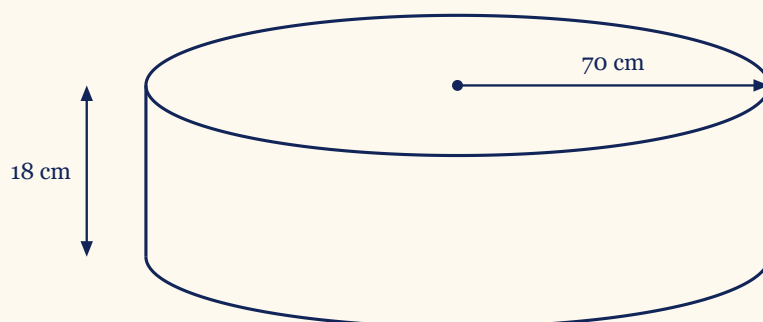


Diagram NOT
accurately drawn

The radius of the cylinder is 70 cm.

The height of the cylinder is 18 cm.

Work out the volume of the cylinder.

Give your answer in litres correct to the nearest litre.

..... litres

[Total 4 marks]

23. $A = 2^3 \times 5^4 \times 7 \times 11$

$$B = 2^2 \times 5^2 \times 7^2$$

$$C = 2^2 \times 5^3 \times 7^4$$



Find the highest common factor (HCF) of A , B and C .

Write your answer as a product of prime factors.

.....

[Total 2 marks]

- 24.** Shop A and Shop B both sell the same model of tablet.



The normal price of the tablet is not the same in the two shops.

Shop A	Shop B
Our normal price £475	Get 15% off our normal price
Get 16% off our normal price	Only pay £408

Which shop gives more money off their normal price?
Show your working clearly.

.....
[Total 4 marks]

- 25.** (a)(i) Factorise $x^2 + 5x - 24$ [2 marks]



(a)(ii) Hence, solve $x^2 + 5x - 24 = 0$ [1 mark]

(b) Solve the inequality $3y + 5 > 7y - 10$ [3 marks]

Show clear algebraic working.

(a)(i)

(a)(ii)

(b)

[Total 6 marks]

26. (a) Write 8.4×10^{-5} as an ordinary number. [1 mark]



(b) Work out $(6.5 \times 10^{-40}) \times (8 \times 10^{185})$ [2 marks]

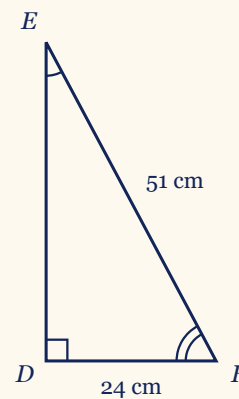
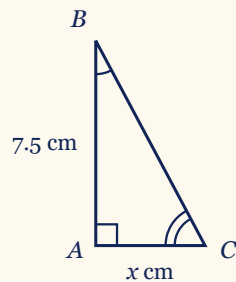
Give your answer in standard form.

(a)

(b)

[Total 3 marks]

27. Here are two similar triangles.



Diagrams NOT
accurately drawn

Work out the value of x .
Show your working clearly.

.....
[Total 5 marks]

Worked Solutions & Mark Schemes

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

Question 1 - Exam Solution

Understanding the Question

Given

Five bridge lengths, in metres:
Corvale 13 972, Highmoor 12 940,
Kelbrook 24 512, Ashlon 16 918, Denmoor
17 540.

Find

(a) the longest bridge, (b) the value of the 9 in 13 972, (c) the bridge whose length rounds to 17 000, (d) 12 940 in words, and (e) the combined length of Corvale and Denmoor.

Plan the Solution

- Read the five lengths from the table, kept lined up by place value.
- For (a) compare the whole numbers; for (c) round each length to the nearest thousand.
- For (b) use the column the 9 sits in; for (d) read the number in words, block by block.
- For (e) add the two required lengths using column addition.

Worked Solution [5 marks]

Place value and rounding: each digit in a whole number is worth its face value times its column heading (ones, tens, hundreds, thousands, ten-thousands). To round to the nearest thousand, look at the hundreds digit: 5 or more rounds the thousands up, less than 5 rounds down.

Part (a): find the longest bridge.

$12\,940 < 13\,972 < 16\,918 < 17\,540 < 24\,512$

Greatest length: 24 512 (Kelbrook).

(Reason: Kelbrook is the only length with a 2 in the ten-thousands column; every other length has a 1 there, so it is the greatest.)

Part (b): value of the 9 in 13 972.

Columns: 1 ten-thousand, 3 thousands, 9 hundreds, 7 tens, 2 ones.

$$9 \times 100 = 900$$

(Reason: the 9 sits in the hundreds column, so its value is 9 times 100.)

Part (c): which length rounds to 17 000.

13 972 $\rightarrow$ 14 000, 12 940 $\rightarrow$ 13 000, 24 512 $\rightarrow$ 25 000

16 918 $\rightarrow$ 17 000, 17 540 $\rightarrow$ 18 000

Only 16 918 rounds to 17 000 (Ashlon).

(Reason: for 16 918 the hundreds digit is 9, so the thousands round up to 17; for 17 540 the hundreds digit is 5, so it rounds up to 18 instead.)

Part (d): write 12 940 in words.

12 thousands, 9 hundreds, 4 tens.

twelve thousand nine hundred and forty

(Reason: read the number one place-value block at a time.)

Part (e): combined length of Corvale and Denmoor.

$$\begin{array}{r} 13\,972 \\ + 17\,540 \\ \hline 31\,512 \end{array}$$

(Reason: adding by column: 2 plus 0 is 2; 7 plus 4 is 11, carry 1; 9 plus 5 plus 1 is 15, carry 1; 3 plus 7 plus 1 is 11, carry 1; 1 plus 1 plus 1 is 3.)

(a) Kelbrook Bridge

(b) 900

(c) Ashlon Bridge

(d) twelve thousand nine hundred and forty

(e) 31 512 metres

Verification

- ✓ **Check (a):** Kelbrook is the only length of 20 000 or more, so it is unambiguously the greatest.
- ✓ **Check (b):** $10\,000 + 3\,000 + 900 + 70 + 2 = 13\,972$, so the 900 term is the 9.
- ✓ **Check (c):** 16 918 is 82 below 17 000 and 918 above 16 000, so it is nearer 17 000; 17 540 is 540 above 17 000, so it rounds to 18 000 and is correctly excluded.
- ✓ **Check (d):** Reverse: twelve thousand nine hundred and forty $= 12\,000 + 900 + 40 = 12\,940$.

✓ **Check (e):** Reverse by subtraction: $31\,512 - 17\,540 = 13\,972$ (Corvale) and $31\,512 - 13\,972 = 17\,540$ (Denmoor).

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a) Kelbrook Bridge	B1	allow minor spelling	✓
(b) 900	B1	allow 9 hundreds	✓
(c) Ashlon Bridge	B1	allow minor spelling	✓
(d) twelve thousand nine hundred and forty	B1	allow minor spelling; the word and is optional	✓
(e) 31 512	B1	cao	✓

Full marks: 5/5

Question 2 - Exam Solution

Understanding the Question

Given

A triangle with its two slanting sides marked equal, and a quadrilateral with four equal sides and a right angle at each corner.

Find

(a) the mathematical name of each shape, (b) the line of symmetry of the triangle, and (c) the order of rotational symmetry of the quadrilateral.

Plan the Solution

- Name each shape from the marks on it: equal sides on a triangle, and equal sides plus right angles on a quadrilateral.
- For (b) recall that an isosceles triangle has one line of symmetry, through the apex.
- For (c) count how many times the square looks the same in one full turn.

Worked Solution [4 marks]

Naming and symmetry: a triangle with two equal sides is isosceles; a quadrilateral with four equal sides and four right angles is a square. A line of symmetry is a fold line

that maps the shape onto itself; the order of rotational symmetry is the number of positions, in one full turn, where the shape looks unchanged.

Part (a)(i): name the triangle.

Two sides are marked equal, and the third (the base) is a different length.

(Reason: a triangle with exactly two equal sides is isosceles (it is not equilateral, which needs all three equal).)

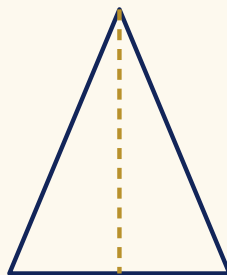
Part (a)(ii): name the quadrilateral.

All four sides are marked equal, and every corner is a right angle.

(Reason: four equal sides with four right angles is a square (equal sides but no right angles would be a rhombus; right angles but unequal sides would be a rectangle).)

Part (b): line of symmetry of the triangle.

The isosceles triangle has one line of symmetry: from the apex, straight down to the midpoint of the base.



(Reason: folding along this line maps the two equal sides onto each other and the base onto itself.)

Part (c): order of rotational symmetry of the square.

A square looks identical after each quarter-turn, at 90, 180, 270 and 360 degrees.

$$\frac{360^\circ}{90^\circ} = 4$$

(Reason: there are four positions in a full turn where the square looks unchanged.)

(a)(i) Isosceles

(a)(ii) Square

(b) One line of symmetry, from the apex to the midpoint of the base

(c) 4

Verification

- ✓ **Check (a)(i):** Two equal sides with a different third side is isosceles by definition, and not equilateral.
- ✓ **Check (a)(ii):** Four equal sides rules out a rectangle; four right angles rules out a rhombus; together they give a square.
- ✓ **Check (b):** Folding along the apex-to-base-midpoint line maps the two equal sides onto each other, so it is a genuine line of symmetry; an isosceles triangle has exactly one.
- ✓ **Check (c):** Four quarter-turns of 90° complete a full 360° , and each turn gives an identical square, so the order is 4.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a)(i) Isosceles	B1	allow minor spelling	✓
(a)(ii) Square	B1	allow minor spelling	✓
(b) Correct line of symmetry drawn	B1	vertical line from apex to base midpoint	✓
(c) 4	B1	cao	✓

Full marks: 4/4

Question 3 - Exam Solution

Understanding the Question

Given

Find

Each full square on the pictogram represents 4 kilometres.

Monday 4 squares, Tuesday 4 squares, Wednesday 4 and three-quarter squares, Thursday 2 and a half squares.

(a) the distance on Tuesday, (b) how much further Wednesday is than Thursday, and (c) how to show 13 kilometres on Friday.

Plan the Solution

- Read each day by multiplying the number of squares by 4 kilometres, counting part-squares as fractions of 4.
- For (b) work out Wednesday and Thursday, then subtract.
- For (c) find how many squares represent 13 kilometres at 4 kilometres per square.

Worked Solution [4 marks]

Reading a pictogram: each symbol stands for a fixed amount given in the key (here 4 kilometres), and a part-symbol stands for the same fraction of that amount. Multiply the number of symbols by the key value to get the total.

Part (a): Tuesday.

Tuesday has 4 full squares, and each square is 4 kilometres.

$$4 \times 4 = 16 \text{ km}$$

(Reason: four squares, each worth 4 kilometres, give 16 kilometres.)

Part (b): how much further on Wednesday than Thursday.

Wednesday: 4 full squares and a three-quarter square, where $\frac{3}{4} \times 4 = 3 \text{ km}$.

$$\text{Wednesday} = 4 \times 4 + 3 = 16 + 3 = 19 \text{ km}$$

Thursday: 2 full squares and a half square, where $\frac{1}{2} \times 4 = 2 \text{ km}$.

$$\text{Thursday} = 2 \times 4 + 2 = 8 + 2 = 10 \text{ km}$$

$$19 - 10 = 9 \text{ km}$$

(Reason: read both days from the pictogram, then subtract the smaller from the larger.)

Part (c): show 13 kilometres on Friday.

$$13 = 12 + 1 = (3 \times 4) + 1$$

So 13 kilometres is 3 full squares and one quarter-square (the quarter-square is the remaining 1 kilometre).

Friday



(Reason: at 4 kilometres per square, 13 kilometres is three whole squares with 1 kilometre left, shown as a quarter-square.)

(a) 16 km

(b) 9 km

(c) 3 full squares and one quarter-square (= 13 km)

Verification

- ✓ **Check (a):** Four squares at 4 kilometres each is $4 \times 4 = 16$.
- ✓ **Check (b):** Rebuild each total: Wednesday is $4.75 \times 4 = 19$ and Thursday is $2.5 \times 4 = 10$, and $19 - 10 = 9$.
- ✓ **Check (c):** Reverse: 3 full squares and a quarter-square is $3 \times 4 + 1 = 13$.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a) 16	B1	cao	✓
(b) Wednesday = 19 and Thursday = 10 (or 19 - 10)	M1	allow 19 and 10 read from the pictogram	✓
(b) 9	A1	correct answer scores both marks	✓
(c) 3 full squares and one quarter-square	B1	oe, e.g. 13 quarter-squares	✓

Full marks: 4/4

Question 4 - Exam Solution

Understanding the Question

Given

Find

A table of air temperatures against height above sea level.

At 0 m it is 12 degrees; at 4000 m, -17 ; at 6000 m, -32 ; at 9000 m, -50 ; at 12 000 m, -58 (degrees Celsius).

(a) the temperature difference between 0 m and 12 000 m, (b) the difference between 4000 m and 6000 m, and (c) the height where the temperature is 10 degrees warmer than at 9000 m.

Plan the Solution

- Read each temperature from the table, taking care with the negative values.
- For a difference, subtract the lower temperature from the higher one.
- For (c) add 10 to the temperature at 9000 m, then read off the matching height.

Worked Solution [3 marks]

Subtracting negative numbers: subtracting a negative is the same as adding, so $a - (-b) = a + b$. A difference in temperature is always the higher reading minus the lower reading.

Part (a): difference between 0 m and 12 000 m.

At 0 m the temperature is 12; at 12 000 m it is -58 .

$$12 - (-58) = 12 + 58 = 70$$

(Reason: subtract the lower reading from the higher; subtracting negative 58 adds 58.)

Part (b): difference between 4000 m and 6000 m.

At 4000 m the temperature is -17 ; at 6000 m it is -32 .

$$-17 - (-32) = -17 + 32 = 15$$

(Reason: negative 17 is the higher reading; subtracting negative 32 adds 32.)

Part (c): height 10 degrees warmer than at 9000 m.

At 9000 m the temperature is -50 . Ten degrees warmer means add 10.

$$-50 + 10 = -40$$

From the table, -40 degrees is the temperature at a height of 7000 m.

(Reason: warmer means a higher temperature, so add; then match the result to a height in the table.)

(a) 70 °C

(b) 15 °C

(c) 7000 m

Verification

- ✓ **Check (a):** Counting up from -58 to 12 is $58 + 12 = 70$.
- ✓ **Check (b):** -17 is warmer than -32 , and the gap is $(-17) - (-32) = 15$.
- ✓ **Check (c):** At 7000 m the temperature is -40 , and $(-40) - (-50) = 10$, so it is 10 degrees warmer than at 9000 m.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a) 70	B1	cao	✓
(b) 15	B1	cao	✓
(c) 7000	B1	allow -40	✓

Full marks: 3/3

Question 5 - Exam Solution

Understanding the Question

Given

Six short algebra tasks: simplify three expressions, solve two equations, and substitute values into a fourth.

Find

(a) simplify $8d - 4d + 7d$, (b) simplify $m \times 10p$, (c) solve $x + 5 = -19$, (d) solve $\frac{y}{8} = 6$, (e) simplify $a \times a \times a \times a$, and (f) evaluate $9k - 4n$ for $k = 8$, $n = 12$.

Plan the Solution

- For a simplify, combine like terms or multiply the parts together.
- For a solve, do the inverse operation to both sides to leave the letter on its own.
- For (f), substitute the given values and then evaluate.

Worked Solution [7 marks]

Algebra basics: like terms can be added or subtracted; a product is written with the number first and the letters after; a repeated product is written as a power; and an

equation is solved by doing the same inverse operation to both sides.

Part (a): simplify $8d$ minus $4d$ plus $7d$.

All three are like terms in d , so combine the number parts.

$$8 - 4 + 7 = 11 \quad \Rightarrow \quad 8d - 4d + 7d = 11d$$

(Reason: like terms in the same letter can be added and subtracted directly.)

Part (b): simplify m times $10p$.

$$m \times 10p = 10 \times m \times p = 10mp$$

(Reason: multiply the parts together, writing the number first and then the letters ($10pm$ is equally correct).)

Part (c): solve x plus 5 equals negative 19 .

Subtract 5 from both sides to leave x on its own.

$$x = -19 - 5 = -24$$

(Reason: the inverse of adding 5 is subtracting 5 .)

Part (d): solve y over 8 equals 6 .

Multiply both sides by 8 to undo the division.

$$y = 6 \times 8 = 48$$

(Reason: the inverse of dividing by 8 is multiplying by 8 .)

Part (e): simplify a times a times a times a .

$$a \times a \times a \times a = a^4$$

(Reason: the letter a is multiplied by itself four times, which is a to the power 4 .)

Part (f): work out $9k$ minus $4n$ when k equals 8 and n equals 12 .

$$9k = 9 \times 8 = 72, \quad 4n = 4 \times 12 = 48$$

$$9k - 4n = 72 - 48 = 24$$

(Reason: substitute the given values, then subtract.)

(a) $11d$

(b) $10mp$

(c) $x = -24$

(d) $y = 48$

(e) a^4

(f) 24

Verification

✓ **Check (a):** Put $d = 1$: $8 - 4 + 7 = 11 = 11 \times 1$.

✓ **Check (b):** Put $m = 2$ and $p = 3$: $m \times 10p = 2 \times 30 = 60$ and $10mp = 10 \times 2 \times 3 = 60$.

✓ **Check (c):** Put $x = -24$ back: $-24 + 5 = -19$.

✓ **Check (d):** Put $y = 48$ back: $\frac{48}{8} = 6$.

✓ **Check (e):** Put $a = 2$: $2 \times 2 \times 2 \times 2 = 16 = 2^4$.

✓ **Check (f):** $72 - 48 = 24$, and $72 = 9 \times 8$, $48 = 4 \times 12$.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a) $11d$	B1	coefficients combined	✓
(b) $10mp$	B1	or $10pm$	✓
(c) -24	B1	cao	✓
(d) 48	B1	cao	✓
(e) a^4	B1	cao	✓
(f) $9 \times 8 (= 72)$ and $4 \times 12 (= 48)$	M1	both products seen	✓
(f) 24	A1	correct answer scores both marks	✓

Full marks: 7/7

Question 6 - Exam Solution

Understanding the Question

Given

2358 units of electricity, each costing 0.28 euros; and 42 euros paid each month for 12 months.

Find

how much more Lucas still has to pay for last year.

Plan the Solution

- Work out the total cost of all the units used.
- Work out how much has already been paid over the 12 months.
- Subtract what has been paid from the total cost.

Worked Solution [4 marks]

Cost and payment: total cost is the number of units times the cost per unit; a monthly payment over a year is multiplied by 12; the amount still owed is the total cost minus what has already been paid.

Step 1: total cost of the electricity used.

Multiply the number of units by the cost of one unit.

$$2358 \times 0.28 = 660.24 \text{ euros}$$

(Reason: the total cost is the number of units multiplied by the price of each unit.)

Step 2: total already paid last year.

He paid 42 euros a month for 12 months.

$$42 \times 12 = 504 \text{ euros}$$

(Reason: twelve monthly payments of 42 euros.)

Step 3: how much more to pay.

Subtract what has already been paid from the total cost.

$$660.24 - 504 = 156.24 \text{ euros}$$

(Reason: the amount still owed is the total cost minus the amount already paid.)

156.24 euros

Verification

- ✓ **Check A:** Add back what was paid to what is still owed: $504 + 156.24 = 660.24$, the total cost.
- ✓ **Check B:** The total splits correctly: $\frac{660.24}{0.28} = 2358$ units, and $\frac{504}{12} = 42$ euros a month.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
Step 1: $2358 \times 0.28 (= 660.24)$	M1	total cost of the units	✓
Step 2: $42 \times 12 (= 504)$	M1	total paid in the year	✓
Step 3: their 660.24 - their 504	M1	oe, any complete valid method	✓
156.24	A1	correct answer scores full marks	✓

Full marks: 4/4

Question 7 - Exam Solution

Understanding the Question

Given

Quadrilateral PQRS with angle 125 at Q and angle 107 at R (degrees). PST is a straight line, and the angle RST at S is 138 degrees. The angle at P is x degrees.

Find

the value of x, giving a reason at each stage.

Plan the Solution

- Use the straight line PST to find the interior angle of the quadrilateral at S.
- Use the angle sum of the quadrilateral to find x.

Worked Solution [4 marks]

Angle facts: angles on a straight line add up to 180° , and the interior angles of a quadrilateral add up to 360° .

Step 1: interior angle of the quadrilateral at S (angle PSR).

PST is a straight line, so angle PSR and the 138° angle together make 180° .

$$180 - 138 = 42$$

So angle PSR is 42° .

(Reason: angles on a straight line add up to 180 degrees.)

Step 2: use the angle sum of the quadrilateral to find x.

The four interior angles are x, 125, 107 and 42 (degrees), and they add up to 360.

$$x = 360 - (125 + 107 + 42) = 360 - 274 = 86$$

(Reason: the angles in a quadrilateral add up to 360 degrees.)

$$x = 86$$

Verification

✓ **Check A:** All four interior angles: $86 + 125 + 107 + 42 = 360$, the angle sum of a quadrilateral.

✓ **Check B:** At S the interior and exterior angles: $42 + 138 = 180$, a straight line.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
Step 1: $180 - 138 (= 42)$	M1	angle PSR	✓
Step 2: $360 - (42 + 107 + 125)$	M1	angle sum of the quadrilateral	✓
86	A1	correct answer scores full marks	✓
one correct reason	B1	dep on M1; angles on a straight line = 180, or angles in a quadrilateral = 360	✓

Full marks: 4/4

Question 8 - Exam Solution

Understanding the Question

Given

80 sweets in total: 27 lemon, 10 orange, and the rest strawberry. One sweet is chosen at random.

Find

- (a) the probability the sweet is lemon, and
- (b) the probability the sweet is strawberry.

Plan the Solution

- A probability is the number of favourable sweets divided by the total number of sweets.
- For (b), first work out how many strawberry sweets there are, then form the probability.

Worked Solution [3 marks]

Probability: for equally likely outcomes, the probability is $\frac{\text{number of favourable outcomes}}{\text{total number of outcomes}}$.

Part (a): probability the sweet is lemon.

There are 27 lemon sweets out of 80 in total.

$$P(\text{lemon}) = \frac{27}{80}$$

(Reason: the probability is the number of lemon sweets over the total number of sweets.)

Part (b): probability the sweet is strawberry.

First find how many strawberry sweets there are.

$$80 - (27 + 10) = 80 - 37 = 43$$

$$P(\text{strawberry}) = \frac{43}{80}$$

(Reason: subtract the lemon and orange sweets from the total, then divide by the total.)

$$\begin{array}{l} \text{(a)} \quad \frac{27}{80} \\ \text{(b)} \quad \frac{43}{80} \end{array}$$

Verification

✓ **Check A:** The three counts add back to the total: $27 + 10 + 43 = 80$.

✓ **Check B:** The three probabilities add to 1: $\frac{27}{80} + \frac{10}{80} + \frac{43}{80} = \frac{80}{80} = 1$.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a) $\frac{27}{80}$	B1	oe, e.g. 0.3375 or 33.75%	✓
(b) $80 - (27 + 10) (= 43)$	M1	or (80 - 37) over 80	✓
(b) $\frac{43}{80}$	A1	oe, e.g. 0.5375 or 53.75%	✓

Full marks: 3/3

Question 9 - Exam Solution

Understanding the Question

Given

15 identical notebooks cost 41.25 pounds.

Find

the cost of 52 notebooks.

Plan the Solution

- Find the cost of one notebook by dividing the cost of 15 by 15.
- Multiply the cost of one notebook by 52.

Worked Solution [2 marks]

Unitary method: to scale a cost, first find the cost of one item, then multiply by the number of items required.

Step 1: cost of one notebook.

Divide the cost of 15 notebooks by 15.

$$\frac{41.25}{15} = 2.75 \text{ pounds}$$

(Reason: the cost of one is the total cost shared equally between the 15 notebooks.)

Step 2: cost of 52 notebooks.

Multiply the cost of one notebook by 52.

$$2.75 \times 52 = 143 \text{ pounds}$$

(Reason: fifty-two notebooks cost fifty-two times the cost of one.)

143 pounds

Verification

- ✓ **Check A:** Reverse: $\frac{143}{52} = 2.75$ pounds per notebook, matching Step 1.
- ✓ **Check B:** $2.75 \times 15 = 41.25$ pounds, the given cost of 15 notebooks.
- ✓ **Check C:** Single-line method agrees: $\frac{52}{15} \times 41.25 = 143$.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
Step 1: $\frac{41.25}{15}$ (= 2.75)	M1	or (52 over 15) times 41.25	✓
143	A1	correct answer scores full marks	✓

Full marks: 2/2

Question 10 - Exam Solution

Understanding the Question

Given

A scale diagram where 1 cm represents 1.5 km. Emma walks the straight path from the harbour to the lighthouse, taking 18 minutes for each km.

Find

the number of minutes Emma takes.

Plan the Solution

- Measure the straight path on the scale diagram, in centimetres.
- Convert that length to a real distance in km using the scale.
- Multiply the distance by 18 to get the time in minutes.

Worked Solution [3 marks]

Scale drawings and rates: a length on a scale diagram is converted to a real distance by multiplying by the scale; a time is then found by multiplying the distance by the minutes taken per km.

Step 1: measure the path.

The straight line from the harbour to the lighthouse measures 6 cm.

(Reason: this is the length of the path on the scale diagram.)

Step 2: convert to a real distance.

Each centimetre represents 1.5 km.

$$6 \times 1.5 = 9 \text{ km}$$

(Reason: multiply the measured length by the scale to get the real distance.)

Step 3: work out the time.

Emma takes 18 minutes for each km.

$$9 \times 18 = 162 \text{ minutes}$$

(Reason: the time is the distance in km multiplied by 18 minutes per km.)

162 minutes

Verification

✓ **Check A:** Reverse: $\frac{162}{18} = 9 \text{ km}$, and $\frac{9}{1.5} = 6 \text{ cm}$, the measured length.

✓ **Check B:** The conversions combine consistently: $6 \times 1.5 \times 18 = 162$.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
Step 1-2: measured length $\times 1.5 (= 9)$	M1	measure 6 cm (allow 5.8 to 6.2), convert to km	✓
Step 3: their $9 \times 18 (= 162)$	M1	multiply the km distance by 18; 18 times 1.5 alone does not score	✓
162	A1	allow 156.6 to 167.4	✓

Full marks: 3/3

Question 11 - Exam Solution

Understanding the Question

Given

The formula $c = 8d + 5$.

Find

d in terms of c (make d the subject).

Plan the Solution

- Get the term containing d on its own by subtracting 5 from both sides.
- Divide both sides by 8 to leave d as the subject.

Worked Solution [2 marks]

Changing the subject: undo the operations around the required letter by doing the same inverse operation to both sides, one step at a time.

Step 1: get the d term on its own.

Subtract 5 from both sides.

$$c - 5 = 8d$$

(Reason: the inverse of adding 5 is subtracting 5.)

Step 2: make d the subject.

Divide both sides by 8.

$$\frac{c - 5}{8} = d$$

Writing d first: $d = \frac{c - 5}{8}$

(Reason: the inverse of multiplying by 8 is dividing by 8.)

$$d = \frac{c - 5}{8}$$

Verification

✓ **Check:** Substitute the rearranged d back into the original: $8 \times \frac{c - 5}{8} + 5 = (c - 5) + 5 = c$, the left-hand side.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
Step 1: $c - 5 = 8d$	M1	one correct rearrangement step, oe	✓
Step 2: $d = \frac{c - 5}{8}$	A1	accept $d = c/8 - 5/8$, or $(5 - c)/(-8)$; must see $d = \dots$	✓

Full marks: 2/2

Question 12 - Exam Solution

Understanding the Question

Given

The equation $y = \frac{1}{2}x - 1$, to be drawn for x from -2 to 3 .

Find

the straight-line graph.

Plan the Solution

- Make a table of values by working out y for each whole-number x from -2 to 3 .
- Plot the points and join them with a single straight line.

Worked Solution [3 marks]

Drawing a straight-line graph: substitute several x -values into the equation to get matching y -values, plot the points, then draw one straight line through them.

Step 1: make a table of values.

Work out y for each x using $y = \frac{1}{2}x - 1$.

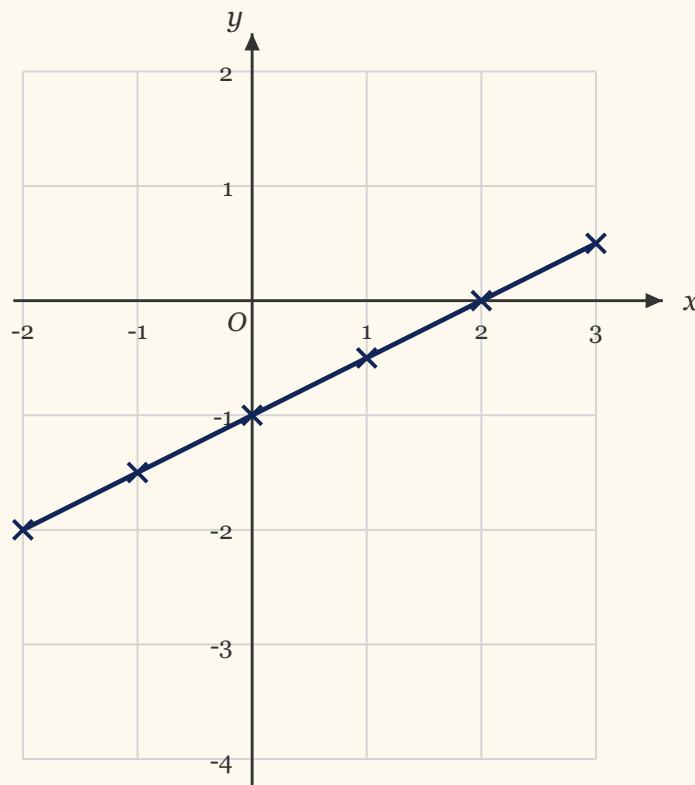
x	-2	-1	0	1	2	3
y	-2	-1.5	-1	-0.5	0	0.5

For example, at $x = -2$: $\frac{1}{2}(-2) - 1 = -1 - 1 = -2$; and at $x = 3$: $\frac{1}{2}(3) - 1 = 1.5 - 1 = 0.5$.

(Reason: each y -value comes from substituting the x -value into the equation.)

Step 2: plot the points and draw the line.

Plot $(-2, -2)$, $(-1, -1.5)$, $(0, -1)$, $(1, -0.5)$, $(2, 0)$, $(3, 0.5)$, then draw one straight line through them from $x = -2$ to $x = 3$.



(Reason: the points lie on a straight line, so a single ruled line joins them.)

A straight line from $(-2, -2)$ to $(3, 0.5)$, through $(0, -1)$ and $(2, 0)$.

Verification

- ✓ **Check A:** The line crosses the y-axis at $y = -1$, matching the -1 in the equation.
- ✓ **Check B:** From point to point the graph rises 0.5 for every 1 across, a gradient of $\frac{0.5}{1} = \frac{1}{2}$, matching the $\frac{1}{2}x$.
- ✓ **Check C:** The point $(2, 0)$ lies on the line, and $\frac{1}{2}(2) - 1 = 0$.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
A correct straight line between $x =$	B3	B2: correct segment through at least 3 points, or all 6 points plotted not joined. B1: at least 2 correct	✓

Step	Mark	Description	Got it?
-2 and $x = 3$		points, or a line of gradient $1/2$ through (0, -1)	

Full marks: 3/3

Question 13 - Exam Solution

Understanding the Question

Given

A rectangular floor 3.6 m by 2.1 m, square tiles 0.3 m by 0.3 m, 6 tiles per box, each box £17.50.

Find

the total cost of the tiles needed.

Plan the Solution

- Work out the area of the floor and the area of one tile.
- Divide to find the number of tiles, then divide by 6 to find the number of boxes.
- Multiply the number of boxes by the cost of one box.

Worked Solution [4 marks]

Tiling and cost: the number of tiles is the floor area divided by the area of one tile; the number of boxes is the tiles divided by the tiles per box; the cost is the number of boxes times the price per box.

Step 1: area of the floor and area of one tile.

$$\text{floor} = 3.6 \times 2.1 = 7.56 \text{ m}^2$$

$$\text{tile} = 0.3 \times 0.3 = 0.09 \text{ m}^2$$

(Reason: area of a rectangle is length times width.)

Step 2: number of tiles needed.

Divide the floor area by the area of one tile.

$$\frac{7.56}{0.09} = 84 \text{ tiles}$$

$$\text{Check by fitting: } \frac{3.6}{0.3} = 12 \text{ across and } \frac{2.1}{0.3} = 7 \text{ down, giving } 12 \times 7 = 84.$$

(Reason: each tile covers 0.09 square metres, so this is how many fit.)

Step 3: number of boxes needed.

There are 6 tiles in each box.

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

(Reason: the tiles divide exactly into full boxes.)

Step 4: total cost.

Each box costs £17.50.

$$14 \times 17.50 = 245$$

So the total cost is £245.

(Reason: fourteen boxes at £17.50 each.)

£245

Verification

- ✓ **Check A:** Reverse: $\frac{245}{17.50} = 14$ boxes, and $14 \times 6 = 84$ tiles.
- ✓ **Check B:** Coverage: $84 \times 0.09 = 7.56 \text{ m}^2$, exactly the area of the floor.
- ✓ **Check C:** The tiles fit exactly (12 across, 7 down), so no cutting or spare tiles are needed.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
$3.6 \times 2.1 (= 7.56)$, or $0.3 \times 0.3 (= 0.09)$, or $\frac{3.6}{0.3} (= 12)$, or $\frac{2.1}{0.3} (= 7)$	M1	any correct first step	✓
their $\frac{7.56}{0.09} (= 84)$, or $12 \times 7 (= 84)$	M1	number of tiles	✓
their $\frac{84}{6} \times 17.50$	M1	complete method (boxes then cost)	✓
245	A1	correct answer scores full marks	✓

Full marks: 4/4

Question 14 - Exam Solution

Understanding the Question

Given

A fair triangular spinner (2, 4, 6) and a fair square spinner (1, 2, 3, 4). The score is the sum of the two numbers.

Find

(a) all possible scores in the table, and (b) the probability the score is 9 or less.

Plan the Solution

- For each pair, add the triangular number and the square number to fill the table.
- For (b), count how many of the twelve equally likely scores are 9 or less.

Worked Solution [4 marks]

Sample space and probability: each cell of the table is one equally likely outcome; the probability of an event is the number of outcomes in the event divided by the total number of outcomes.

Part (a): complete the table.

Add the triangular spinner number to the square spinner number in each cell.

		Square spinner			
		1	2	3	4
Triangular spinner	2	3	4	5	6
	4	5	6	7	8
	6	7	8	9	10

(Reason: each score is the sum of the two spinner numbers (the four given values were 3, 4, 7 and 10).)

Part (b): probability the score is 9 or less.

There are $3 \times 4 = 12$ equally likely scores in the table.

Only one score is greater than 9 (the 10, from $6 + 4$), so 11 of the 12 scores are 9 or less.

$$P(\text{score} \leq 9) = \frac{11}{12}$$

(Reason: count the outcomes of 9 or less, over the total of 12.)

(a) All twelve scores as shown in the completed table

(b) $\frac{11}{12}$

Verification

- ✓ **Check (a):** Every cell equals its row value plus its column value, for example $6 + 3 = 9$ and $4 + 2 = 6$.
- ✓ **Check (b):** Listing the scores that are 9 or less: all except the single 10, which is 11 of the 12, giving $\frac{11}{12}$.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
All 8 missing scores correct (see completed table)	B2	B1 for 6 or 7 of the 8 correct	✓
(b) $\frac{11}{12}$, or $\frac{m}{12}$ with $m < 12$, or $\frac{11}{n}$ with $n > 11$, or $11 : 12$	M1	a valid probability form	✓
(b) $\frac{11}{12}$	A1	oe, e.g. 0.9166... or 91.66% truncated or rounded	✓

Full marks: 4/4

Question 15 - Exam Solution

Understanding the Question

Given

A homeware shop buys 140 mugs. 35% of them cost \$6 each, a quarter of them cost \$8 each, and the rest cost \$10 each.

Find

the total cost of the 140 mugs.

Plan the Solution

- Work out how many mugs are in each price group.

- Multiply each group size by its price, then add the three amounts.

Worked Solution [4 marks]

Percentage and fraction of a quantity: a percentage or a fraction of an amount is that fraction multiplied by the amount, and the three groups must together make all 140 mugs.

Step 1: the mugs at \$6 each (35% of 140).

$$35\% \text{ of } 140 = \frac{35}{100} \times 140 = 49$$

(Reason: find 35% of 140.)

Step 2: the mugs at \$8 each (a quarter of 140).

$$\frac{1}{4} \times 140 = \frac{140}{4} = 35$$

(Reason: find one quarter of 140.)

Step 3: the mugs at \$10 each (the rest).

$$140 - 49 - 35 = 56$$

(Reason: the three groups must total 140 mugs.)

Step 4: the cost of each group.

$$49 \times 6 = 294$$

$$35 \times 8 = 280$$

$$56 \times 10 = 560$$

(Reason: the number in each group multiplied by its price, in dollars.)

Step 5: the total cost.

$$294 + 280 + 560 = 1134$$

(Reason: add the three group costs.)

Total cost = \$1134

Verification

- ✓ **Check the counts:** The group sizes add to $49 + 35 + 56 = 140$ mugs, the total bought.
- ✓ **Check with the mean price:** The rest is $1 - 0.35 - 0.25 = 0.40$ of 140, so the mean price is $0.35 \times 6 + 0.25 \times 8 + 0.40 \times 10 = 8.10$ dollars, giving $140 \times 8.10 = 1134$.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
One correct group size: $0.35 \times 140 = 49$, or $\frac{1}{4} \times 140 = 35$, or the rest $140 - 49 - 35 = 56$	M1	oe, e.g. 35% built as 14 + 14 + 14 + 7	✓
One correct group cost: $49 \times 6 = 294$, or $35 \times 8 = 280$, or $56 \times 10 = 560$	M1	oe	✓
All three group costs correct: 294 and 280 and 560	M1	all three required	✓
\$1134	A1	cao	✓

Full marks: 4/4

Question 16 - Exam Solution

Understanding the Question

Given

The calculation 31.4×48.7 , to be estimated by rounding each number to one significant figure.

Find

an estimate for the value of 31.4×48.7 .

Plan the Solution

- Round each number to one significant figure.
- Multiply the two rounded numbers together.

Worked Solution [2 marks]

Rounding to one significant figure: keep only the first non-zero digit, then look at the digit immediately after it. If that digit is 5 or more, round the kept digit up; otherwise leave it unchanged. Zeros hold the place value, so a two-digit whole number stays in the tens.

Step 1: round 31.4 to one significant figure.

$$31.4 \approx 30$$

(Reason: the first significant figure is the 3 in the tens column, and the next digit is 1, which is less than 5, so the 3 stays.)

Step 2: round 48.7 to one significant figure.

$$48.7 \approx 50$$

(Reason: the first significant figure is the 4 in the tens column, and the next digit is 8, which is 5 or more, so the 4 rounds up to 5.)

Step 3: multiply the rounded numbers.

$$30 \times 50 = 1500$$

(Reason: the estimate is the product of the two one-significant-figure values.)

Estimate = 1500

Verification

- ✓ **Check by factorising:** $30 \times 50 = (3 \times 10) \times (5 \times 10) = 15 \times 100 = 1500$, the same estimate.
- ✓ **Check it is reasonable:** The exact product is $31.4 \times 48.7 = 1529.18$, so the estimate of 1500 is about 2% below the true value, which is close.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
At least one number correctly rounded to one significant figure: 30 or 50	M1	oe	✓
1500	A1	cao, dependent on M1; working required, and the 1500 must come from the correct figures 30 and 50	✓

Full marks: 2/2

Question 17 - Exam Solution

Understanding the Question

Given

Find

Triangle P has vertices $(-3, -1)$, $(-1, -1)$ and $(-1, -4)$, and the mirror line is $x = 1$.

the image of shape P after reflection in the line $x = 1$.

Plan the Solution

- Read off the three vertices of shape P.
- Reflect each vertex in turn, then join the three image points.

Worked Solution [2 marks]

Reflection in a vertical line: the line $x = a$ is vertical, so every point keeps its y-coordinate and moves to the same perpendicular distance on the other side of the line. In symbols, $(x, y) \rightarrow (2a - x, y)$.

Step 1: write down the vertices of shape P.

$(-3, -1)$, $(-1, -1)$, $(-1, -4)$

(Reason: reflect one vertex at a time, then join them up.)

Step 2: apply the rule for the line $x = 1$.

$(x, y) \rightarrow (2 \times 1 - x, y) = (2 - x, y)$

(Reason: the mirror line is vertical, so only the x-coordinate changes.)

Step 3: reflect each vertex.

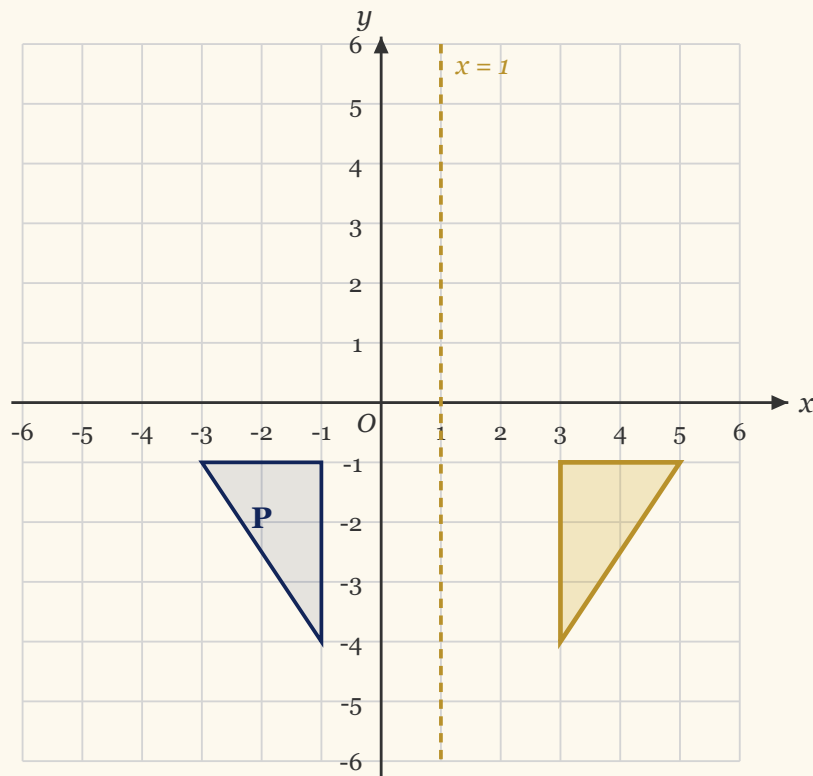
$(-3, -1) \rightarrow (5, -1)$

$(-1, -1) \rightarrow (3, -1)$

$(-1, -4) \rightarrow (3, -4)$

(Reason: each vertex moves to the same distance on the other side of the line, 4 units for the first and 2 units for the other two.)

Step 4: join the image points.



(Reason: the image is congruent to shape P, with the mirror line halfway between them.)

Triangle with vertices $(3, -1)$, $(5, -1)$ and $(3, -4)$

Verification

- ✓ **Check the midpoints:** Each vertex and its image must have a midpoint on the mirror line: $\frac{-3+5}{2} = 1$, $\frac{-1+3}{2} = 1$ and $\frac{-1+3}{2} = 1$, all giving $x = 1$.
- ✓ **Check it is congruent:** Both triangles have side lengths 2, 3 and $\sqrt{13}$, and every y-coordinate is unchanged, so the image is the same shape and size as P.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
Triangle with vertices $(3, -1)$, $(5, -1)$ and $(3, -4)$	B2	B1 for a correct reflection in a different vertical line, or for two of the three image vertices correct, or for a correct reflection in the line $y = 1$	✓

Full marks: 2/2

Question 18 - Exam Solution

Understanding the Question

Given

A grouped frequency table of the amounts spent, in dollars, by 60 customers, with class boundaries at 10, 15, 20, 25, 30 and 35 and frequencies 18, 16, 14, 8 and 4.

Find

(a) the modal class, and (b) an estimate for the mean amount spent.

Plan the Solution

- For (a), pick out the class with the largest frequency.
- For (b), estimate each amount by its class midpoint, multiply by the frequency, add the products, then divide by the total frequency.

Worked Solution [5 marks]

Estimated mean of grouped data: the individual values are unknown, so each class is represented by its midpoint. The estimated mean is the sum of frequency times midpoint, divided by the total frequency. The **modal class** is simply the class with the largest frequency.

Part (a): write down the modal class.

Compare the frequencies and pick the largest.

$$\text{Largest frequency} = 18 \Rightarrow 10 < p \leq 15$$

(Reason: the modal class is the class with the largest frequency, read straight from the table.)

Part (b), step 1: find each midpoint and multiply it by the frequency.

Each class is represented by its midpoint, for example $\frac{10 + 15}{2} = 12.5$.

Amount spent (p dollars)	Frequency	Midpoint	Frequency $\times$ Midpoint
$10 < p \leq 15$	18	12.5	225
$15 < p \leq 20$	16	17.5	280
$20 < p \leq 25$	14	22.5	315
$25 < p \leq 30$	8	27.5	220

Amount spent (p dollars)	Frequency	Midpoint	Frequency $\times$ Midpoint
$30 < p \leq 35$	4	32.5	130
Total	60		1170

(Reason: the exact amounts are unknown, so the midpoint is the best single estimate for every value in a class.)

Part (b), step 2: add the products.

$$225 + 280 + 315 + 220 + 130 = 1170$$

(Reason: this estimates the total amount spent by all 60 customers.)

Part (b), step 3: divide by the total frequency.

$$\text{Estimated mean} = \frac{1170}{60} = 19.5$$

(Reason: the mean is the estimated total divided by the number of customers.)

$$\text{(a) } 10 < p \leq 15$$

$$\text{(b) } 19.5 \text{ dollars}$$

Verification

- ✓ **Check (a):** The frequencies are 18, 16, 14, 8 and 4. The largest is 18, which belongs to the first class, so that class is the modal class.
- ✓ **Check (b) by a coded mean:** Taking 22.5 as an assumed mean with class width 5, the coded values are $-2, -1, 0, 1, 2$, giving $\sum fu = -36$. Then $22.5 + 5 \times \frac{-36}{60} = 22.5 - 3 = 19.5$, the same answer by a different method.
- ✓ **Check (b) lies between the bounds:** Using the lowest value in each class gives $\frac{1020}{60} = 17$ and using the highest gives $\frac{1320}{60} = 22$, so an estimate of 19.5 sits sensibly between them. The frequencies also total $18 + 16 + 14 + 8 + 4 = 60$.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a) $10 < p \leq 15$	B1	accept any equivalent way of writing the 10 to 15 class	✓
(b) At least four correct products added: $12.5 \times$	M2	need not be evaluated. If not M2, award M1 for a consistent value from within each	✓

Step	Mark	Description	Got it?
$18 + 17.5 \times 16 + 22.5 \times 14 + 27.5 \times 8 + 32.5 \times 4$, or $225 + 280 + 315 + 220 + 130$		interval (end points allowed) used for at least four products which are added, or for correct midpoints found for at least four classes but not added	
(b) $\frac{1170}{60}$	M1	dependent on at least M1; allow division by their own total frequency provided the addition or a total is seen	✓
(b) 19.5	A1	oe	✓

Full marks: 5/5

Question 19 - Exam Solution

Understanding the Question

Given

Angle ABC , with its vertex at B and arms BA and BC .

Find

the bisector of angle ABC , using a ruler and a pair of compasses only, with all the construction arcs left showing.

Plan the Solution

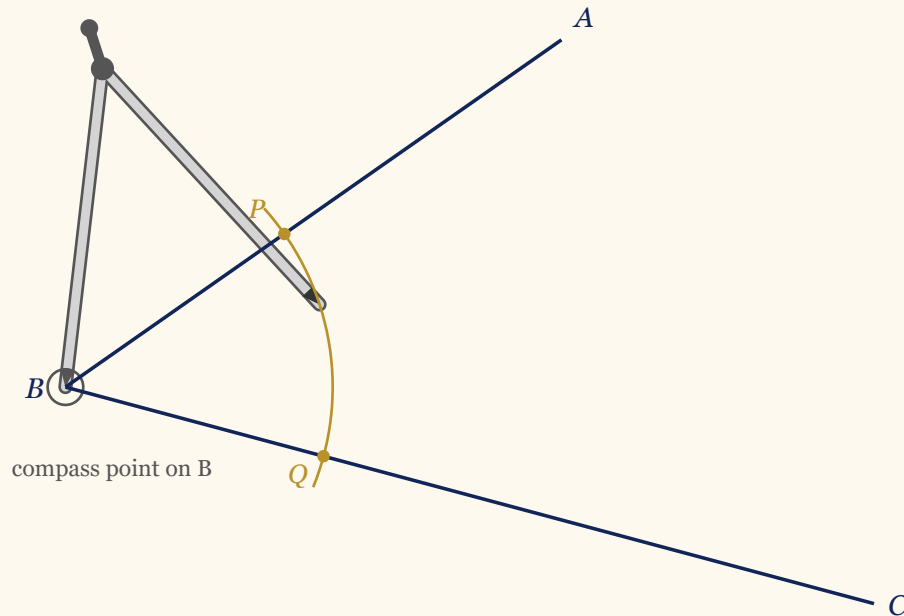
- Draw one arc centred on the vertex B that cuts both arms of the angle.
- From each of those two crossing points, draw an arc of the same radius so that the two arcs meet.
- Join B to the point where the two arcs meet.

Worked Solution [2 marks]

Constructing an angle bisector: the bisector is the set of points that are the same distance from both arms. Compass arcs of equal radius are what guarantee those equal distances, which is why the arcs must be left on the diagram - they are the evidence that the line was constructed rather than measured or guessed.

Step 1: draw an arc from the vertex B .

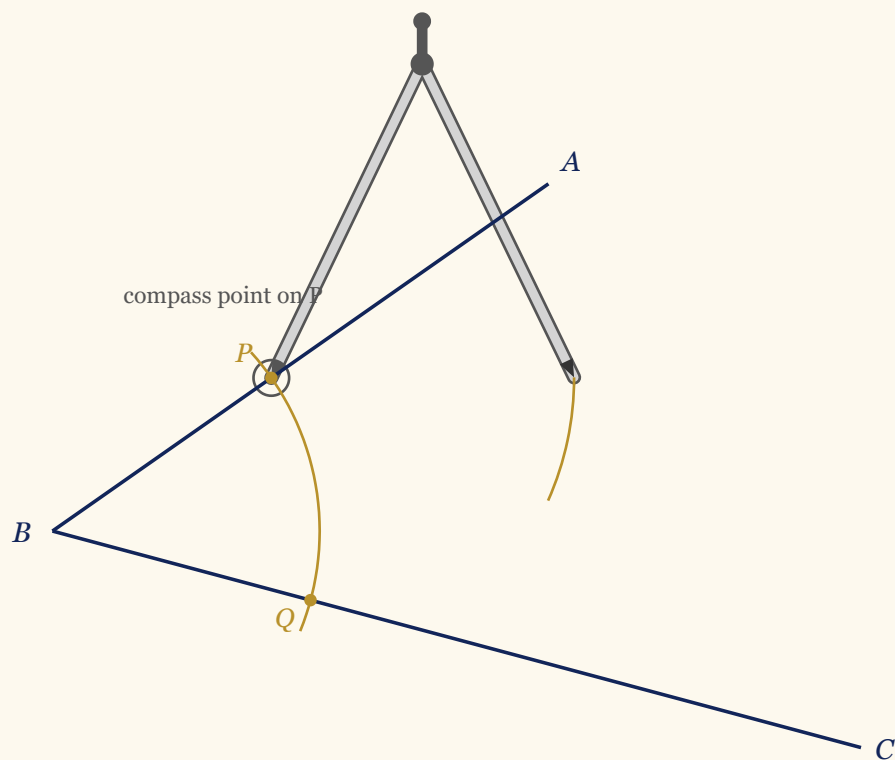
Set the compasses to any convenient radius. Put the compass point on B and draw an arc that crosses both arms. Label the crossing points P on BA and Q on BC .



(Reason: both crossing points come from one arc centred on B , so $BP = BQ$.)

Step 2: draw an arc from P.

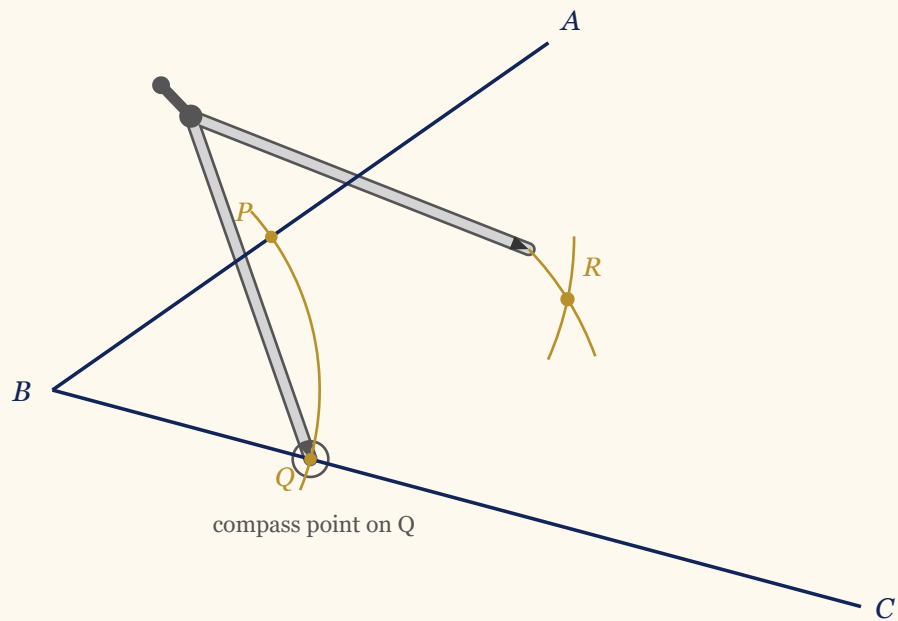
Open the compasses a little wider, put the point on P and draw an arc inside the angle.



(Reason: every point on this arc is the same distance from P.)

Step 3: draw a matching arc from Q.

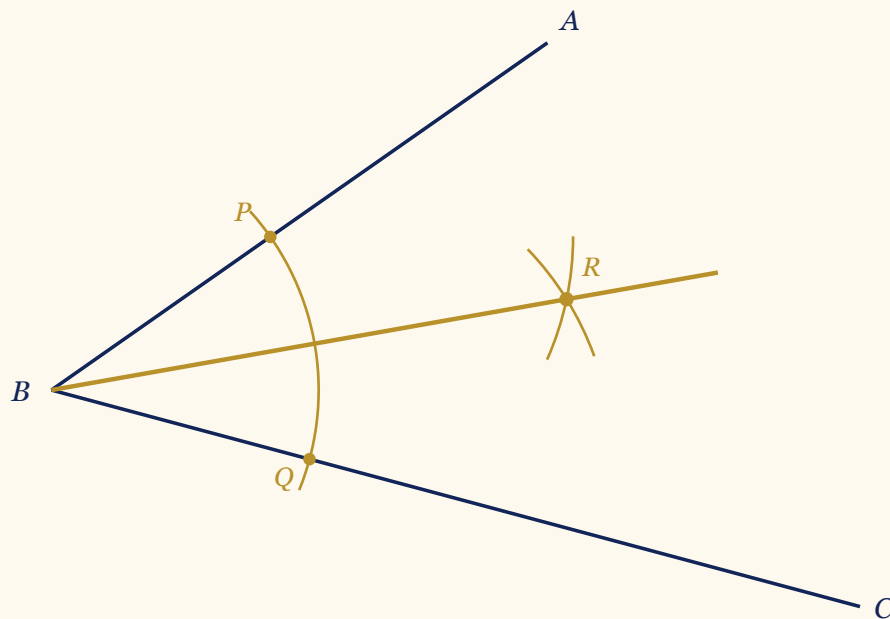
Without changing the opening, put the point on Q and draw a second arc. The two arcs cross at R .



(Reason: the two arcs share the same radius, so $PR = QR$.)

Step 4: join B to R.

Use the ruler to draw a straight line from B through R . Leave every arc on the diagram.



(Reason: BR is the bisector, and the arcs are what earn the marks.)

BR is the bisector of angle ABC , with all the construction arcs left showing

Verification

- ✓ **Check by congruent triangles:** In triangles BPR and BQR : $BP = BQ$ from the arc centred on B , $PR = QR$ from the equal arcs centred on P and Q , and BR is common. The triangles are congruent by SSS, so $\angle PBR = \angle QBR$.
- ✓ **Check by measuring:** Angle ABC on this diagram measures 50° , so each half should measure 25° , and $25 + 25 = 50$.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
A fully correct bisector of angle ABC , with all the relevant construction arcs shown	B2	B1 for all the arcs drawn but no bisector, or for a correct bisector with no arcs or too few arcs	✓

Full marks: 2/2

Question 20 - Exam Solution

Understanding the Question

Given

Three separate algebra tasks: a power raised to a power, a pair of brackets to expand and simplify, and a linear equation containing a fraction.

Find

(a) $(p^3)^5$ in its simplest form, (b) $2n(4n + 3) + n(n - 4)$ expanded and simplified, and (c) the solution of $\frac{2x + 5}{3} = 4 - x$.

Plan the Solution

- For (a), use the index law for a power raised to a power.
- For (b), expand each bracket separately, then collect like terms.
- For (c), multiply every term by 3 to clear the fraction, gather the x terms on one side, then divide.

Worked Solution [6 marks]

Index law: $(a^m)^n = a^{mn}$, so a power raised to a power multiplies the indices.

Expanding: every term inside a bracket is multiplied by the term outside it. **Solving:** whatever is done to one side of an equation must be done to every term on the other side.

Part (a): simplify a power of a power.

$$(p^3)^5 = p^{3 \times 5} = p^{15}$$

(Reason: a power raised to a power multiplies the indices.)

Part (b), step 1: expand each bracket.

$$2n(4n + 3) = 8n^2 + 6n$$

$$n(n - 4) = n^2 - 4n$$

(Reason: multiply every term inside each bracket by the term outside it.)

Part (b), step 2: collect like terms.

$$8n^2 + 6n + n^2 - 4n$$
$$= 9n^2 + 2n$$

(Reason: the two squared terms combine, and $6n$ minus $4n$ leaves $2n$.)

Part (c), step 1: remove the fraction.

$$3 \times \frac{2x + 5}{3} = 3(4 - x)$$
$$2x + 5 = 12 - 3x$$

(Reason: multiply every term on both sides by 3.)

Part (c), step 2: gather the x terms on one side.

$$2x + 3x = 12 - 5$$
$$5x = 7$$

(Reason: add $3x$ to both sides, then subtract 5 from both sides.)

Part (c), step 3: divide by the coefficient of x .

$$x = \frac{7}{5} = 1.4$$

(Reason: divide both sides by 5.)

$$(a) p^{15}$$

$$(b) 9n^2 + 2n$$

$$(c) x = \frac{7}{5}$$

Verification

✓ **Check (a):** Written out, $(p^3)^5$ means five lots of p^3 multiplied together, and $3 + 3 + 3 + 3 + 3 = 15$, giving p^{15} .

✓ **Check (b) by substitution:** Taking $n = 2$, the original expression gives $4(11) + 2(-2) = 40$, and the simplified form gives $9(4) + 2(2) = 40$, so the two agree.

✓ **Check (c) by substitution:** Taking $x = \frac{7}{5}$, the numerator becomes $2 \times \frac{7}{5} + 5 = \frac{39}{5}$, so the left side is $\frac{1}{3} \times \frac{39}{5} = \frac{13}{5}$, and the right side is $4 - \frac{7}{5} = \frac{13}{5}$. Both sides are equal.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a) p^{15}	B1	cao	✓
(b) Expansion with at least three correct terms: $8n^2 + 6n + n^2 - 4n$	M1	the term $8n$ squared must be seen, not just $2n$ times $4n$	✓
(b) $9n^2 + 2n$	A1	oe, e.g. $2n + 9n$ squared, or $n(9n + 2)$, or $n(2 + 9n)$	✓
(c) Fraction removed with the right hand side correctly multiplied by 3: $2x + 5 = 12 - 3x$	M1	or the left hand side separated, e.g. two thirds of x plus five thirds equals 4 minus x	✓
(c) Their four term equation rearranged with the x terms on one side: $5x = 7$	M1	follow through, dependent on a four term equation	✓
(c) $x = \frac{7}{5}$	A1	oe, e.g. 1.4; dependent on both method marks in part (c)	✓

Full marks: 6/6

Question 21 - Exam Solution

Understanding the Question

Given

A Venn diagram with two overlapping sets inside a universal set: 9 lies in A only, 3 and 7 lie in the overlap, 5 and 2 lie in B only, and 4, 6 and 8 lie outside both circles.

Find

(a) the members of B , (b) the members of $A \cap B$, and (c) the members of A' .

Plan the Solution

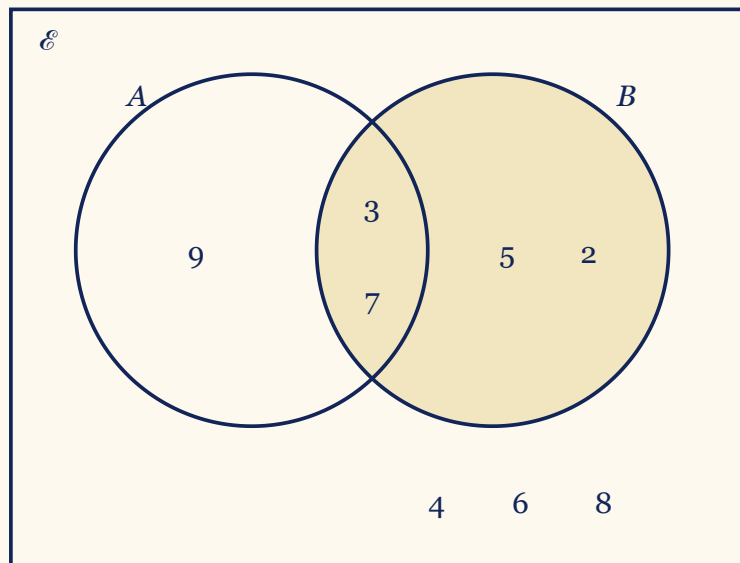
- For (a), take everything inside circle B , including the overlap.
- For (b), take only the region where the two circles overlap.
- For (c), take everything in the universal set that is outside circle A .

Worked Solution [3 marks]

Reading a Venn diagram: a set contains everything inside its own circle, and the overlap belongs to BOTH sets. $A \cap B$ is the intersection, meaning the members in A **and** in B . The dash in A' means the complement, that is every member of the universal set $\mathcal{E}$ that is **not** in A , so it includes the part of B outside the overlap as well as the numbers outside both circles.

Part (a): the members of B.

Circle B holds the overlap 3 and 7, together with 5 and 2.

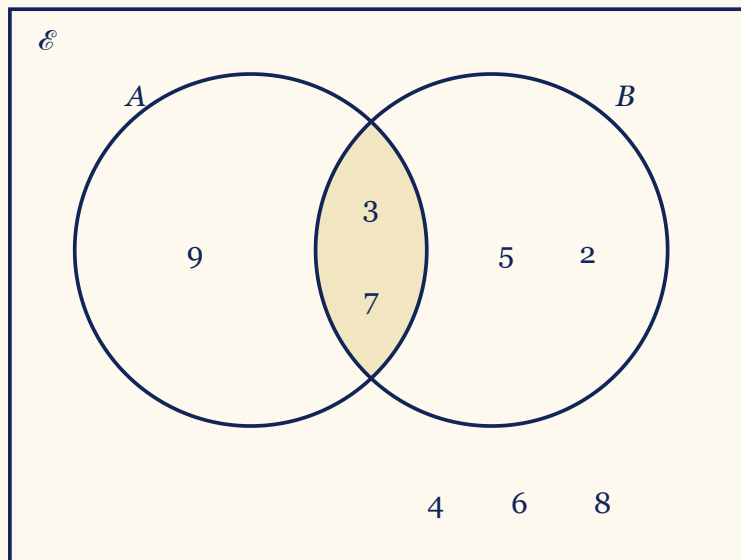


$$B = \{2, 3, 5, 7\}$$

(Reason: everything inside circle B counts, and the overlap is inside circle B too.)

Part (b): the members of A intersect B.

Only the region where the two circles overlap belongs to both sets.

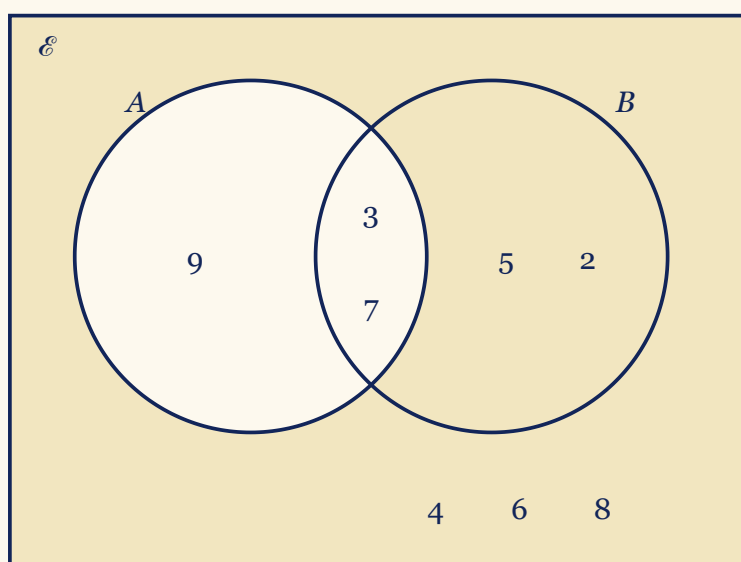


$$A \cap B = \{3, 7\}$$

(Reason: the intersection is the members that are in A and in B at the same time.)

Part (c): the members of A complement.

Circle A holds $A = \{3, 7, 9\}$, and the universal set is $\mathcal{E} = \{2, 3, 4, 5, 6, 7, 8, 9\}$, so everything else is outside A.



$$A' = \{2, 4, 5, 6, 8\}$$

(Reason: the complement takes in the part of B outside the overlap as well as the numbers outside both circles.)

(a) 2, 3, 5, 7

(b) 3, 7

(c) 2, 4, 5, 6, 8

Verification

- ✓ **Check by counting:** The universal set has 8 members and A has 3 of them, so A' must have $8 - 3 = 5$ members. The answer to (c) lists exactly 5.
- ✓ **Check the two halves fit together:** Putting A and A' together gives 3, 7, 9 with 2, 4, 5, 6, 8, which is all eight members of $\mathcal{E}$ with nothing repeated and nothing missing.
- ✓ **Two marks that are commonly dropped:** In (a) the overlap is easy to forget, but 3 and 7 are inside circle B , so they belong to B . In (c) it is tempting to give only 4, 6 and 8, but 5 and 2 are outside circle A as well, so they belong to A' too.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a) 2, 3, 5, 7	B1	all four present, no repeats and no extra numbers; any order; commas or spaces both accepted	✓
(b) 3, 7	B1	both present, no repeats and no extra numbers; any order	✓
(c) 2, 4, 5, 6, 8	B1	all five present, no repeats and no extra numbers; any order	✓

Full marks: 3/3

Question 22 - Exam Solution

Understanding the Question

Given

Find

A cylinder of radius 70 cm and height 18 cm, with the answer required in litres to the nearest litre.

the volume of the cylinder, in litres correct to the nearest litre.

Plan the Solution

- Substitute the radius and the height into the formula for the volume of a cylinder.
- Work the volume out in cubic centimetres, then convert it to litres and round.

Worked Solution [4 marks]

Volume of a cylinder: $V = \pi r^2 h$, the area of the circular face multiplied by the height. **Units:** the radius and the height are both in centimetres, so the volume comes out in cubic centimetres, and 1 litre is the same as 1000 cubic centimetres.

Step 1: substitute into the formula.

$$V = \pi r^2 h = \pi \times 70^2 \times 18$$

(Reason: the radius is 70 cm and the height is 18 cm.)

Step 2: simplify to an exact value.

$$V = \pi \times 4900 \times 18 = 88200\pi \text{ cm}^3$$

(Reason: squaring 70 gives 4900, and 4900 times 18 gives 88200.)

Step 3: evaluate.

$$V = 277\,088.47 \dots \text{ cm}^3$$

(Reason: keep the extra decimals until the very end, so the rounding is not affected.)

Step 4: convert to litres.

$$V = \frac{277\,088.47 \dots}{1000} = 277.088 \dots \text{ litres}$$

(Reason: there are 1000 cubic centimetres in 1 litre, so divide by 1000.)

Step 5: round to the nearest litre.

$$277.088 \dots \approx 277$$

(Reason: the value lies between 276.5 and 277.5, so it rounds to 277.)

Volume = 277 litres

Verification

- ✓ **Check by working in metres:** Taking $r = 0.7$ m and $h = 0.18$ m gives $V = \pi \times 0.7^2 \times 0.18 = 0.0882\pi = 0.277\,088\dots \text{ m}^3$. Since 1 m^3 is 1000 litres, this is $277.088\dots$ litres, the same answer without ever using cubic centimetres.
- ✓ **Check the size is sensible:** The exact volume is 88200π , and π is a little over 3, so the volume is a little over $264\,600 \text{ cm}^3$, which is a little over 264 litres. An answer of 277 litres fits that estimate.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
Use of $\pi r^2 h$: $\pi \times 70^2 \times 18$, or $\pi \times 0.7^2 \times 0.18$	M1	oe	✓
88200π or $277\,088(.472)$, or 0.0882π or $0.277(088472)$	A1	allow 276 948 to 277 200, or 0.276 948 to 0.277 200	✓
Their cubic centimetre volume divided by 1000, or their cubic metre volume multiplied by 1000	M1	allow any volume containing pi, 70 and 18 to be divided by 1000, or containing pi, 0.7 and 0.18 to be multiplied by 1000	✓
277	A1	awrt 277	✓

Full marks: 4/4

Question 23 - Exam Solution

Understanding the Question

Given

Three numbers already written as products of their prime factors: $A = 2^3 \times 5^4 \times 7 \times 11$, $B = 2^2 \times 5^2 \times 7^2$ and $C = 2^2 \times 5^3 \times 7^4$.

Find

the highest common factor of A , B and C , written as a product of prime factors.

Plan the Solution

- Compare the three factorisations one prime at a time.

- Take the lowest power of each prime that appears in all three numbers, then multiply those together.

Worked Solution [2 marks]

Highest common factor from prime factorisations: the HCF has to divide every one of the numbers, so for each prime it can only use the LOWEST power that all of them have. A prime that is missing from even one number cannot appear in the HCF at all. Taking the highest power instead would give the lowest common multiple, not the highest common factor.

Step 1: line up the power of each prime.

Set the three factorisations side by side, prime by prime.

Prime	In A	In B	In C	Lowest power
2	2^3	2^2	2^2	2^2
5	5^4	5^2	5^3	5^2
7	7	7^2	7^4	7
11	11	none	none	not in all three

(Reason: writing them in a table makes the smallest power in each row easy to pick out.)

Step 2: take the lowest power of each prime that all three share.

2^2 , 5^2 , 7

The prime 11 appears in A only, so it cannot be part of a factor common to all three.

(Reason: the HCF must divide B and C as well as A, and neither B nor C has a factor of 11.)

Step 3: multiply the chosen powers together.

$$\text{HCF} = 2^2 \times 5^2 \times 7 = 700$$

(Reason: the product of the lowest common powers is the highest common factor.)

$$\text{HCF} = 2^2 \times 5^2 \times 7 \text{ (that is, 700)}$$

Verification

✓ **Check it divides all three:** Evaluating gives $A = 385\,000$, $B = 4900$ and $C = 1\,200\,500$. Then $\frac{385\,000}{700} = 550$, $\frac{4900}{700} = 7$ and $\frac{1\,200\,500}{700} = 1715$, all whole numbers.

- ✓ **Check nothing larger works:** Doubling the answer gives 1400, but $\frac{4900}{1400} = 3.5$, which is not a whole number, so 1400 is not a common factor. That confirms 700 really is the highest.
- ✓ **Two marks that are commonly dropped:** The first is including 11, which sits in *A* alone. The second is taking the highest power of each prime rather than the lowest, which produces the lowest common multiple instead.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
$2^2 \times$ $5^2 \times$ 7	B2	allow $2 \times 2 \times 5 \times 5 \times 7$, in any order; the answer must be a product of prime factors and must not include a 1; correct working with 700 on the answer line also scores B2. B1 for 2 to the p times 5 to the q times 7 to the r with two of p, q and r correct, or for one mistake in their product, or for 700 alone	✓

Full marks: 2/2

Question 24 - Exam Solution

Understanding the Question

Given

Shop A advertises a normal price of £475 with 16% off. Shop B advertises 15% off its own normal price, with £408 to pay. The two normal prices are different.

Find

which shop takes more money off its normal price, with the working shown.

Plan the Solution

- For Shop A the normal price is given, so take 16% of it straight away.
- For Shop B the £408 is the sale price, so work back to the normal price first, then find the reduction.
- Compare the two reductions in pounds, not the two percentages.

Worked Solution [4 marks]

Percentage of an amount: a reduction of $r\%$ takes off $\frac{r}{100}$ of the ORIGINAL amount.

Reverse percentage: if the price after a 15% reduction is known, that price is 85% of the original, so the original is found by dividing, not by multiplying. A normal price is always LARGER than the price paid after a discount, which is a quick way to spot a reversed calculation.

Step 1: Shop A, the money taken off.

$$16\% \text{ of } 475 = 0.16 \times 475 = 76$$

So Shop A takes £76 off.

(Reason: the normal price at Shop A is given, so the percentage is taken directly from it.)

Step 2: Shop B, work back to the normal price.

The £408 is the price AFTER the reduction, so it is $100\% - 15\% = 85\%$ of the normal price.

$$0.85 \times (\text{normal price}) = 408$$

$$\text{normal price} = \frac{408}{0.85} = 480$$

(Reason: the sale price is a known percentage of the normal price, so the normal price is recovered from it.)

Step 3: Shop B, the money taken off.

$$480 - 408 = 72$$

Or straight from the percentage: $0.15 \times 480 = 72$.

So Shop B takes £72 off.

(Reason: the reduction is the normal price minus the price actually paid.)

Step 4: compare the two reductions.

$$76 > 72$$

(Reason: the question asks for the money taken off, not the percentage and not the final price.)

Shop A, which takes £76 off compared with £72 at Shop B

Verification

✓ **Check the reverse percentage:** If the normal price at Shop B really is £480, then taking 15% off leaves $0.85 \times 480 = 408$, which is exactly the price on the poster.

✓ **Check by the one percent method:** Since £408 is 85% , one percent is $\frac{408}{85} = 4.8$, so the 15% reduction is $4.8 \times 15 = 72$. The same £72, without ever finding the normal price.

- ✓ **Two marks that are commonly dropped:** The first is treating the £408 as the normal price and working out $0.15 \times 408 = 61.20$, but £408 is the price after the discount. The second is answering from the percentages alone, since 16% beats 15%; the mark scheme needs both 72 and 76 to be seen.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
Shop A: $475 \times 0.16 (= 76)$, or $475 \times (1 - 0.16) (= 399)$	M1	oe	✓
Shop B: the sale price recognised as 85%, e.g. $1 - 0.15 = 0.85$, or $100\% - 15\% = 85\%$, or $x - 0.15x = 408$, or $\frac{408}{85} = 4.8$	M1	oe	✓
Shop B: $\frac{408}{0.85} = 480$, or $\frac{408}{85} \times 100 = 480$, or $4.8 \times 100 = 480$, or $\frac{408}{85} \times 15 = 72$	M1	oe	✓
Shop A, with both 72 and 76 seen	A1	dependent on both method marks for Shop B; working is required	✓

Full marks: 4/4

Question 25 - Exam Solution

Understanding the Question

Given

A quadratic expression $x^2 + 5x - 24$ to factorise and then use, and a separate linear inequality $3y + 5 > 7y - 10$ to solve.

Find

(a)(i) the factorised form, (a)(ii) the solutions of $x^2 + 5x - 24 = 0$, and (b) the solution of the inequality.

Plan the Solution

- For (a)(i), find two integers whose product is the constant term and whose sum is the coefficient of x.

- For (a)(ii), set each factor equal to zero, using the factorisation already found.
- For (b), gather the y terms on the side that keeps them positive, then divide.

Worked Solution [6 marks]

Factorising $x^2 + bx + c$: look for two integers with product c and sum b . **The zero product rule:** if two things multiply to give zero then at least one of them is zero, which is why the word *hence* matters - part (ii) reuses the factors rather than starting again.

Inequalities: they behave like equations except that multiplying or dividing by a NEGATIVE number reverses the inequality sign, so it is safer to rearrange first and keep the variable term positive.

Part (a)(i): factorise the quadratic.

Two integers are needed with product -24 and sum $+5$.

The pair is 8 and -3 , since $8 \times (-3) = -24$ and $8 + (-3) = 5$.

$$x^2 + 5x - 24 = (x + 8)(x - 3)$$

(Reason: the constant term fixes the product of the two numbers and the x coefficient fixes their sum.)

Part (a)(ii): hence solve the equation.

$$(x + 8)(x - 3) = 0$$

So either $x + 8 = 0$ or $x - 3 = 0$.

$$x = -8 \quad \text{or} \quad x = 3$$

(Reason: a product is zero only when one of its factors is zero, and the factors are already known from part (i).)

Part (b), step 1: gather the y terms so they stay positive.

$$3y + 5 > 7y - 10$$

Add 10 to both sides:

$$3y + 15 > 7y$$

Subtract $3y$ from both sides:

$$15 > 4y$$

(Reason: moving the y terms to the right keeps their coefficient positive, so no sign reversal is needed later.)

Part (b), step 2: divide by 4.

$$\frac{15}{4} > y$$

Read the other way round, this says

$$y < \frac{15}{4} = 3.75$$

(Reason: dividing by a positive number leaves the inequality sign unchanged.)

$$(a)(i) (x + 8)(x - 3)$$

$$(a)(ii) x = -8 \quad \text{or} \quad x = 3$$

$$(b) y < \frac{15}{4}$$

Verification

- ✓ **Check (a)(i) by expanding:** $(x + 8)(x - 3) = x^2 - 3x + 8x - 24 = x^2 + 5x - 24$, which is the expression given.
- ✓ **Check (a)(ii) by substituting:** Putting $x = -8$ gives $64 - 40 - 24 = 0$, and putting $x = 3$ gives $9 + 15 - 24 = 0$. Both are roots.
- ✓ **Check (b) on both sides of the boundary:** At $y = \frac{15}{4}$ each side equals $\frac{65}{4}$, so that value is exactly the boundary and the inequality is strict. Testing $y = 0$ gives $5 > -10$, which is true, and testing $y = 4$ gives $17 > 18$, which is false. So the values that work are the ones BELOW 3.75.
- ✓ **Three marks that are commonly dropped:** Writing $(x - 8)(x + 3)$ instead, which expands to $x^2 - 5x - 24$. Reading the factor $(x + 8)$ as giving $x = 8$ rather than $x = -8$. And, if the y terms are collected on the left instead, reaching $-4y > -15$ and forgetting to reverse the sign when dividing by -4 .

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a)(i) $(x \pm 8)(x \pm 3)$, or $(x + a)(x + b)$ where $ab = -24$ or $a + b = 5$, with a and b integers	M1	oe	✓
(a)(i) $(x + 8)(x - 3)$	A1	any letter allowed in place of x ; must be in the form $(x + a)(x + b)$ with a and b integers	✓
(a)(ii) -8 and 3	B1	follow through from their factors in part (a)(i); no mark if part (a)(i) scored nothing	✓

Step	Mark	Description	Got it?
(b) $3y - 7y > -10 - 5$, or $5 + 10 > 7y - 3y$	M1	allow an equals sign, and condone an incorrect inequality sign at this stage	✓
(b) $-4y > -15$, or $15 > 4y$, or $y = \frac{15}{4}$	M1	allow an equals sign, and condone an incorrect inequality sign at this stage	✓
(b) $y < \frac{15}{4}$	A1	dependent on at least one method mark; oe such as y less than 3.75; the answer line must carry the correct inequality sign	✓

Full marks: 6/6

Question 26 - Exam Solution

Understanding the Question

Given

One number written in standard form to be rewritten as an ordinary number, and a product of two numbers in standard form to be worked out.

Find

(a) 8.4×10^{-5} as an ordinary number, and (b) the product $(6.5 \times 10^{-40}) \times (8 \times 10^{185})$ in standard form.

Plan the Solution

- For (a), a negative index means dividing by a power of ten, so the decimal point moves to the left.
- For (b), multiply the two front numbers and add the two indices, then adjust so the front number sits between 1 and 10.

Worked Solution [3 marks]

Standard form: a number is in standard form when it is written as $a \times 10^n$ with $1 \leq a < 10$ and n a whole number. **Multiplying:** multiply the front numbers and ADD the indices, because $10^m \times 10^n = 10^{m+n}$. **Adjusting:** if the front number comes out as 10 or more, make it smaller by moving a factor of ten across into the power, which raises the index.

Part (a): write it as an ordinary number.

A negative index means dividing, so $10^{-5} = \frac{1}{100\,000}$.

$$8.4 \times 10^{-5} = \frac{8.4}{100\,000} = 0.000\,084$$

(Reason: the decimal point moves five places to the left, one place for each power of ten.)

Part (b), step 1: multiply the front numbers and add the indices.

$$(6.5 \times 8) \times 10^{-40+185} = 52 \times 10^{145}$$

(Reason: multiplying powers of the same base adds the indices, and 6.5 times 8 is 52.)

Part (b), step 2: put the answer into standard form.

Standard form needs the front number to satisfy $1 \leq a < 10$, and 52 is too large.

$$52 = 5.2 \times 10$$

$$52 \times 10^{145} = 5.2 \times 10 \times 10^{145} = 5.2 \times 10^{146}$$

(Reason: making the front number ten times smaller means the power of ten must be ten times larger, so the index goes UP by one.)

$$\text{(a) } 0.000\,084$$

$$\text{(b) } 5.2 \times 10^{146}$$

Verification

- ✓ **Check (a) by multiplying back:** $0.000\,084 \times 10^5 = 8.4$, which is the number the question started from.
- ✓ **Check (b) by a different order:** Normalise first instead of last. Since $6.5 \times 8 = 52 = 5.2 \times 10^1$, the product is $5.2 \times 10^1 \times 10^{-40} \times 10^{185} = 5.2 \times 10^{1-40+185} = 5.2 \times 10^{146}$. A different route to the same answer.
- ✓ **Check the adjustment goes the right way:** The front number was made ten times smaller, from 52 to 5.2, so the power of ten has to become ten times larger to keep the value the same. That means the index must RISE from 145 to 146, not fall.
- ✓ **Three marks that are commonly dropped:** Stopping at 52×10^{145} , which earns the method mark but not the accuracy mark because 52 is not between 1 and 10. Adjusting the index downwards to 10^{144} . And multiplying the indices instead of adding them, which would give -40×185 rather than $-40 + 185$.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
(a) 0.000 084	B1	cao	✓
(b) 52×10^{145} , or 5.2×10^n , or $p \times 10^{146}$ where p is at least 1 and less than 10	M1	oe	✓
(b) 5.2×10^{146}	A1	correct answer scores full marks unless it follows obviously incorrect working	✓

Full marks: 3/3

Question 27 - Exam Solution

Understanding the Question

Given

Two similar right-angled triangles. In triangle ABC the right angle is at A , with $AB = 7.5$ cm and $AC = x$ cm. In triangle DEF the right angle is at D , with $DF = 24$ cm and $EF = 51$ cm.

Find

the value of x .

Plan the Solution

- Use Pythagoras in the larger triangle to find the side DE, which is the one that pairs with the given 7.5 cm.
- Divide the two paired sides to get the scale factor.
- Use the scale factor on the pair that contains x.

Worked Solution [5 marks]

Similar figures: corresponding sides are in the same ratio, so one triangle is an enlargement of the other by a single scale factor. **Matching the sides up:** the markings do the pairing for you, since the right angles match, the single arcs match and the double arcs match. **Pythagoras:** in a right-angled triangle the square on the hypotenuse equals

the sum of the squares on the other two sides, so a missing side can always be recovered from the other two.

Step 1: use Pythagoras in triangle DEF to find DE.

The right angle is at D , so EF is the hypotenuse.

$$DE^2 = 51^2 - 24^2 = 2601 - 576 = 2025$$

$$DE = \sqrt{2025} = 45$$

(Reason: the two shorter sides square and add to the square on the hypotenuse, so subtracting recovers the missing one.)

Step 2: pair up the sides and find the scale factor.

The right angles pair A with D , the single arcs pair B with E , and the double arcs pair C with F . So AB pairs with DE , and AC pairs with DF .

$$\text{scale factor} = \frac{DE}{AB} = \frac{45}{7.5} = 6$$

(Reason: AB and DE are the sides that lie between the right angle and the single arc, so they are the pair to divide.)

Step 3: apply the scale factor to the pair containing x .

$$DF = 6 \times AC$$

$$24 = 6x$$

$$x = \frac{24}{6} = 4$$

(Reason: AC pairs with DF , so DF is the enlargement of AC by the scale factor.)

$$x = 4$$

Verification

- ✓ **Check through the third pair of sides:** In triangle ABC , Pythagoras gives $BC = \sqrt{7.5^2 + 4^2} = \sqrt{56.25 + 16} = \sqrt{72.25} = 8.5$. Enlarging by the scale factor gives $6 \times 8.5 = 51$, which is exactly the length of EF in the question.
- ✓ **Check all three ratios agree:** $\frac{45}{7.5} = 6$, $\frac{24}{4} = 6$ and $\frac{51}{8.5} = 6$. One single scale factor fits every pair, which is what similar means.
- ✓ **Check Pythagoras closes in the larger triangle:** $45^2 + 24^2 = 2025 + 576 = 2601 = 51^2$, so the side found in Step 1 is consistent with the two lengths given.
- ✓ **Three marks that are commonly dropped:** Pairing the 7.5 cm with the 51 cm. The 7.5 cm is a shorter side, so it pairs with DE and not with the hypotenuse. Multiplying by the

scale factor instead of dividing, which gives 144. And trying $\frac{24}{7.5}$ without finding DE first, which pairs two sides that do not correspond.

Mark Scheme Breakdown

Step	Mark	Description	Got it?
Pythagoras applied correctly: $51^2 = DE^2 + 24^2$, or $DE^2 = 51^2 - 24^2$ ($= 2025$)	M1	oe; also allow a correct trigonometric start such as cos of angle DFE equals 24 over 51	✓
Square rooting: $DE = \sqrt{2025} = 45$	M1	oe	✓
A correct method for the scale factor: $\frac{\text{their } DE}{7.5}$ ($= 6$), or $\frac{\text{their } DE}{7.5} \left(= \frac{1}{6} \right)$	M1	their DE must be clearly identified; allow 0.17 or better for one sixth	✓
A correct method for x: $\frac{24}{6}$, or $24 \times \frac{1}{6}$, or $\frac{7.5}{\text{their } DE} \times 24$	M1	dependent on the previous method mark	✓
$x = 4$	A1	the value of 4 must come from correct figures	✓

Full marks: 5/5

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