

Mock Set A – Paper 2

Solutions

For Pearson Edexcel GCSE Mathematics (1MA1)

Higher tier • Paper 2 (Calculator)

Each question is shown in grey, followed by the working, one step per line. The final answer is in a box. *Marks* shows how the marks are usually given in the exam, and **Tip** points out a common mistake.

1 (5 marks)

- (a) Cerys simplifies $(2x^3y)^4$ and gets $8x^{12}y^4$. What mistake has Cerys made?

Every factor inside the bracket must be raised to the power 4.

$(x^3)^4 = x^{12}$ and y^4 are correct.

But $2^4 = 2 \times 2 \times 2 \times 2 = 16$, not $2 \times 4 = 8$.

The correct answer is $16x^{12}y^4$.

Answer: She worked out $2 \times 4 = 8$ instead of $2^4 = 16$ (the answer should be $16x^{12}y^4$).

Tip: Say exactly what the mistake is: “she multiplied 2 by 4 instead of working out 2^4 ”. Just writing “the 8 is wrong” is not enough.

- (b) Factorise fully $12xy^2 - 18x^2y$

The highest common factor of 12 and 18 is 6.

Both terms contain x and y , so the HCF is $6xy$.

$12xy^2 \div 6xy = 2y$ and $18x^2y \div 6xy = 3x$

$$12xy^2 - 18x^2y = 6xy(2y - 3x)$$

Answer: $6xy(2y - 3x)$

Tip: “Fully” means take out every common factor: number, x and y . Expand your answer to check it.

Marks: 2 marks for $6xy(2y - 3x)$. 1 mark for a correct partial factorisation, such as $6x(2y^2 - 3xy)$.

(c) Expand and simplify $(4x - 3)(x + 6)$

Multiply each term in the first bracket by each term in the second.

$$4x \times x = 4x^2, \quad 4x \times 6 = 24x, \quad -3 \times x = -3x, \quad -3 \times 6 = -18$$

$$4x^2 + 24x - 3x - 18$$

$$\text{Collect the } x \text{ terms: } 24x - 3x = 21x$$

Answer: $4x^2 + 21x - 18$

Marks: 1 mark for 4 correct terms (or 3 correct terms with correct signs). 1 mark for the simplified answer.

2 (2 marks)

Use your calculator to work out

$$\frac{\sqrt{48.6} + 2.7^3}{5 \tan 38^\circ}$$

Give your answer correct to 3 significant figures.

$$\text{Numerator: } \sqrt{48.6} + 2.7^3 = 6.97137 \dots + 19.683 = 26.6543 \dots$$

$$\text{Denominator: } 5 \tan 38^\circ = 5 \times 0.78128 \dots = 3.90642 \dots$$

$$26.6543 \dots \div 3.90642 \dots = 6.82320 \dots$$

To 3 significant figures: 6.82

Answer: 6.82

Tip: Put brackets round the whole top and the whole bottom, or work them out separately first. Check your calculator is in degrees.

Marks: 1 mark for working out the top or the bottom correctly. 1 mark for 6.82.

3 (2 marks)

LMN is a right-angled triangle.

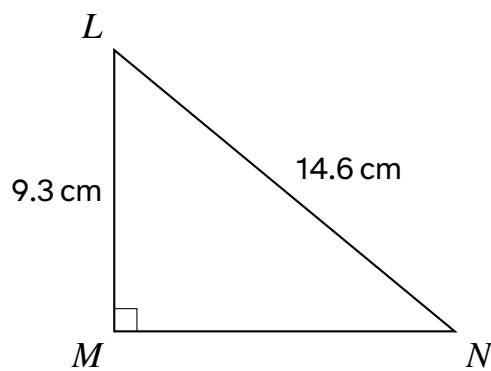


Diagram **NOT** accurately drawn

Work out the length of MN .

Give your answer correct to 3 significant figures.

LN is the hypotenuse, so subtract to find a shorter side.

$$MN^2 = 14.6^2 - 9.3^2 = 213.16 - 86.49 = 126.67$$

$$MN = \sqrt{126.67} = 11.2547 \dots$$

To 3 significant figures: 11.3

Answer: 11.3 cm

Tip: Check which side is the hypotenuse first. Adding the squares gives 17.3, which is longer than the hypotenuse, so it cannot be right.

Marks: 1 mark for $14.6^2 - 9.3^2$. 1 mark for 11.3.

4 (3 marks)

- (a) Write 936 as a product of its prime factors.

Divide by primes: $936 = 2 \times 468$

$468 = 2 \times 234$, $234 = 2 \times 117$

$117 = 3 \times 39$, $39 = 3 \times 13$

So $936 = 2 \times 2 \times 2 \times 3 \times 3 \times 13$

In index form: $2^3 \times 3^2 \times 13$

Answer: $2^3 \times 3^2 \times 13$

Tip: Your answer must be a product (with $\times$ signs), not a list of factors. Multiply back to check you get 936.

Marks: 1 mark for a full method (factor tree or repeated division). 1 mark for the product of primes.

- (b) $A = 2^3 \times 3 \times 5^2$

$$B = 2 \times 3^4 \times 7$$

Write down the lowest common multiple (LCM) of A and B .

Give your answer as a product of powers of its prime factors.

The LCM uses every prime that appears, with its highest power.

2^3 (from A), 3^4 (from B), 5^2 (from A), 7 (from B)

Answer: $2^3 \times 3^4 \times 5^2 \times 7$

Tip: For the LCM take the **highest** power of each prime. Taking the lowest powers gives the HCF.

5 (4 marks)

Marek needs 18 rolls of garden fleece to cover his vegetable beds.
Two shops sell the same rolls of fleece.

Shop A	Shop B
£8.20 per roll Buy 3 rolls, get 1 more roll free	£7.25 per roll 20% off the total cost when you spend more than £100

Which shop is cheaper for 18 rolls of fleece, and by how much?
You must show all your working.

Shop A: for every 3 rolls Marek pays for, he gets 1 free, so each group of 4 rolls costs the price of 3.

$18 = 4 + 4 + 4 + 4 + 2$, so he pays for $3 + 3 + 3 + 3 + 2 = 14$ rolls.

Cost: $14 \times £8.20 = £114.80$

Shop B: $18 \times £7.25 = £130.50$, which is more than £100, so she gets 20% off.

Cost: $130.50 \times 0.8 = £104.40$

Difference: $114.80 - 104.40 = £10.40$

Answer: Shop B, by £10.40

Tip: With “buy 3, get 1 free” you get 4 rolls for the price of 3. $18 \div 4$ is not a whole number, so count carefully: 16 rolls in groups of 4, then 2 more that you pay for.

Marks: 1 mark for a correct method for Shop A (paying for 14 rolls). 1 mark for a correct method for Shop B ($18 \times 7.25 \times 0.8$). 1 mark for both totals, £114.80 and £104.40. 1 mark for Shop B is cheaper by £10.40.

6 (2 marks)

The mass of a newborn kitten is m grams.
 $m = 110$ correct to 2 significant figures.

Complete the error interval for m .

110 to 2 significant figures means rounding to the nearest 10.

Half of 10 is 5.

Lower bound: $110 - 5 = 105$

Upper bound: $110 + 5 = 115$

Answer: $105 \leq m < 115$

Tip: The second significant figure of 110 is in the tens column, so the bounds are 5 either side, not 0.5 either side.

Marks: 1 mark for 105. 1 mark for 115.

7 (3 marks)

Ines buys a used electric scooter for £1250

The value of the scooter falls by 18% in the first year.

Its value then falls by 9% in each of the next two years.

Ines says, "At the end of the 3 years, the scooter will have lost more than a third of its value." Is Ines correct?

A fall of 18% leaves 82%, so the first multiplier is 0.82

A fall of 9% leaves 91%, so the next two multipliers are 0.91 and 0.91

Value after 3 years: $1250 \times 0.82 \times 0.91^2 = £848.80$

If the scooter lost exactly a third, it would be worth $\frac{2}{3} \times 1250 = £833.33$

£848.80 is more than £833.33, so it has lost **less** than a third of its value.

(Or: it lost $1250 - 848.80 = £401.20$, which is less than $\frac{1}{3} \times 1250 = £416.67$.)

So Ines is **not** correct.

Answer: No. The scooter is worth £848.80, which is more than $\frac{2}{3}$ of £1250 (£833.33), so it has lost less than a third (about 32.1%).

Tip: Adding the percentages ($18 + 9 + 9 = 36\%$) makes it look as if Ines is right, but each fall is a percentage of a smaller value. Use multipliers, and always compare two numbers when you give your conclusion.

Marks: 1 mark for $1250 \times 0.82 (= 1025)$. 1 mark for using 0.91 twice to get £848.80 (or the multiplier 0.679...). 1 mark for 'No' with a correct comparison, such as £848.80 and £833.33, or 32.1% and 33.3%.

8 (2 marks)

A bag of sand contains 2.45×10^6 grains of sand.

The total mass of the sand in the bag is 2.2×10^3 grams.

Work out the mean mass of one grain of sand.

Give your answer in standard form correct to 3 significant figures.

Mean mass = total mass $\div$ number of grains

$$(2.2 \times 10^3) \div (2.45 \times 10^6) = 0.000\,897\,959\ldots$$

In standard form: $8.979 \ldots \times 10^{-4}$

To 3 significant figures: 8.98×10^{-4}

Answer: 8.98×10^{-4} g

Tip: Divide the mass by the number of grains, not the other way round. A grain of sand is very light, so expect a negative power of 10.

Marks: 1 mark for dividing the total mass by the number of grains. 1 mark for 8.98×10^{-4} .

9 (4 marks)

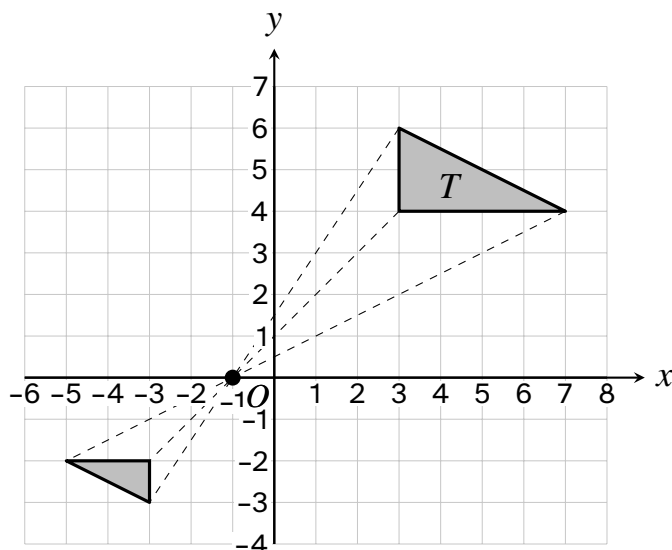
- (a) On the grid, enlarge triangle T by scale factor $-\frac{1}{2}$ with centre of enlargement $(-1, 0)$

Find the vector from the centre $(-1, 0)$ to each vertex, multiply it by $-\frac{1}{2}$, then add it to the centre.

$(3, 4): \begin{pmatrix} 4 \\ 4 \end{pmatrix} \rightarrow \begin{pmatrix} -2 \\ -2 \end{pmatrix}$, giving $(-3, -2)$

$(7, 4): \begin{pmatrix} 8 \\ 4 \end{pmatrix} \rightarrow \begin{pmatrix} -4 \\ -2 \end{pmatrix}$, giving $(-5, -2)$

$(3, 6): \begin{pmatrix} 4 \\ 6 \end{pmatrix} \rightarrow \begin{pmatrix} -2 \\ -3 \end{pmatrix}$, giving $(-3, -3)$



Answer: Triangle with vertices $(-3, -2)$, $(-5, -2)$ and $(-3, -3)$

Tip: A negative scale factor puts the image on the **other side** of the centre, upside down. Scale factor $-\frac{1}{2}$ also makes it half the size.

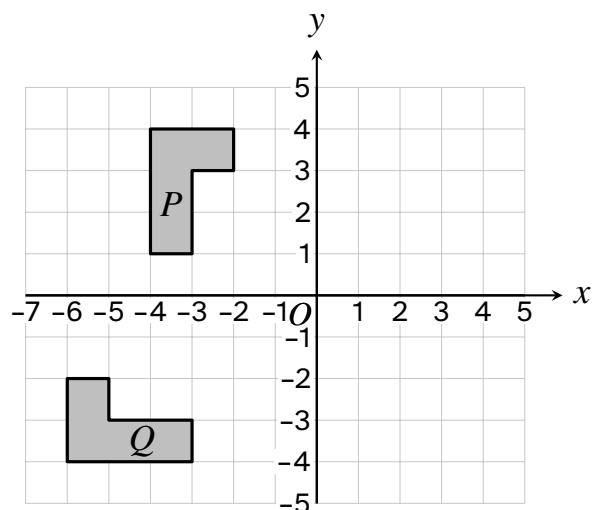
Marks: 2 marks for the correct triangle. 1 mark for a triangle the right size and turned the right way but in the wrong place, or for 2 correct vertices.

- (b) Describe fully the single transformation that maps shape P onto shape Q .

Q is the same size as P but turned through a quarter turn, so it is a rotation.

With tracing paper, a quarter turn of P anticlockwise gives a shape the same way round as Q .

Find the centre with tracing paper, or check: rotating $(-4, 1)$ through 90° anticlockwise about $(-1, -1)$ gives $(-3, -4)$, which is a vertex of Q .



Answer: Rotation 90° anticlockwise, centre $(-1, -1)$

Tip: “Describe fully” a rotation needs three things: the word rotation, the angle and direction, and the centre. Do not give two transformations.

Marks: 2 marks for rotation, 90° anticlockwise and centre $(-1, -1)$. 1 mark for rotation with one of these two details correct.

10 (3 marks)

Solve $\frac{5x+2}{3} - \frac{2x-7}{4} = 2$

Show clear algebraic working.

Multiply every term by 12 (the LCM of 3 and 4):

$$4(5x+2) - 3(2x-7) = 24$$

$$20x + 8 - 6x + 21 = 24$$

$$14x + 29 = 24$$

$$14x = -5$$

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

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

Tip: Multiply the 2 on the right-hand side by 12 as well. Watch the sign: $-3 \times (-7) = +21$.

Marks: 1 mark for multiplying through by 12 correctly. 1 mark for expanding with the correct signs and collecting terms. 1 mark for $-5/14$.

11 (3 marks)

The Hawks netball team play two matches.

Each match is either won or lost.

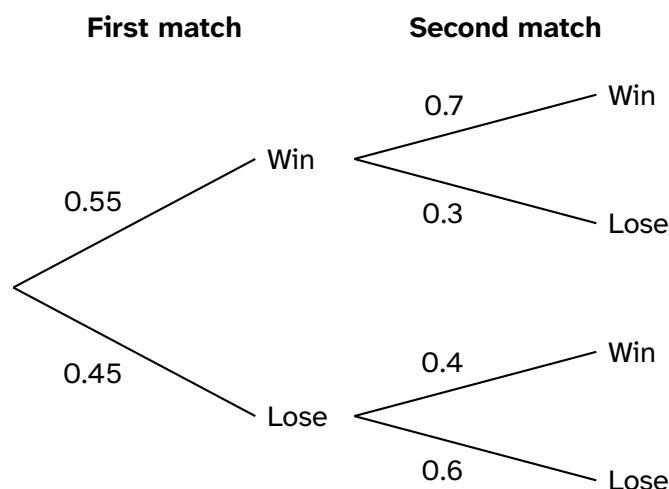
The probability that the Hawks win the first match is 0.55

If the Hawks win the first match, the probability that they win the second match is 0.7

If the Hawks lose the first match, the probability that they win the second match is 0.4

The coach says, “We are more likely to win exactly one of the matches than to win both.” Is the coach correct?

A tree diagram helps. The probabilities on each pair of branches add up to 1.



$$P(\text{win both}) = 0.55 \times 0.7 = 0.385$$

Exactly one win: win then lose, **or** lose then win.

$$P(\text{exactly one win}) = 0.55 \times 0.3 + 0.45 \times 0.4 = 0.165 + 0.18 = 0.345$$

$0.345 < 0.385$, so winning exactly one match is **less** likely than winning both.

The coach is **not** correct.

Answer: No. $P(\text{exactly one win}) = 0.345$, which is less than $P(\text{win both}) = 0.385$

Tip: The second-match probabilities depend on the result of the first match, so you cannot use 0.55 twice. Draw a tree, multiply along the branches, and add the two routes that give exactly one win.

Marks: 1 mark for $P(\text{win both}) = 0.385$ or one correct product for exactly one win. 1 mark for $P(\text{exactly one win}) = 0.165 + 0.18 = 0.345$. 1 mark for 'No' with both probabilities.

12 (3 marks)

Here are the first five terms of a quadratic sequence.

5 12 25 44 69

Find an expression, in terms of n , for the n th term of this sequence.

First differences: 7, 13, 19, 25

Second differences: 6, 6, 6

Half of 6 is 3, so the sequence starts $3n^2$

$3n^2$: 3, 12, 27, 48, 75

Sequence $-3n^2$: 2, 0, -2, -4, -6

This linear sequence goes down by 2, and its zero term is 4: $-2n + 4$

n th term = $3n^2 - 2n + 4$

Answer: $3n^2 - 2n + 4$

Tip: Halve the second difference to get the coefficient of n^2 . Check your answer with $n = 5$: $75 - 10 + 4 = 69$.

Marks: 1 mark for $3n^2$. 1 mark for subtracting $3n^2$ to get 2, 0, -2, -4, -6 (or another correct method for the linear part). 1 mark for $3n^2 - 2n + 4$.

13 (4 marks)

Kit grows two varieties of runner bean, variety *X* and variety *Y*.

She measures the length, in cm, of each bean she picks.

The box plot shows information about the lengths of the beans of variety *X*.

The table shows information about the lengths of the beans of variety *Y*.

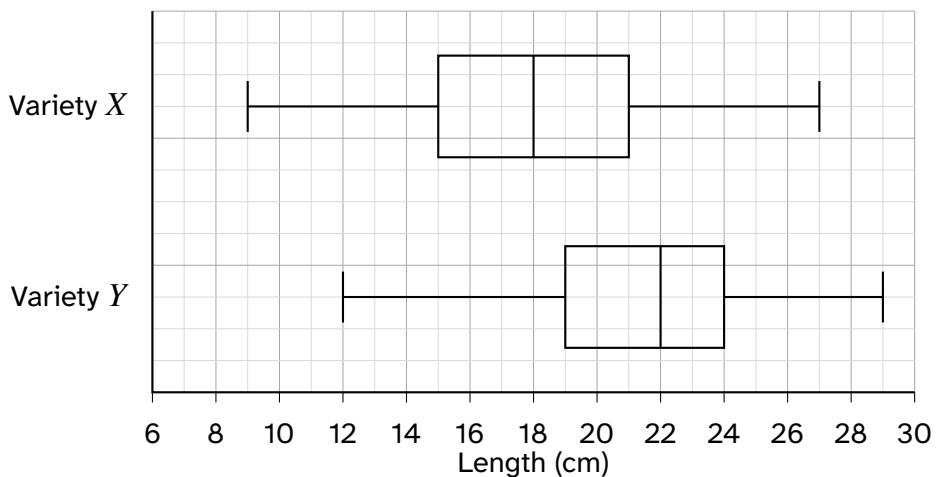
Shortest length	12 cm
Lower quartile	19 cm
Median	22 cm
Upper quartile	24 cm
Longest length	29 cm

- (a) On the grid, draw a box plot for the information about the beans of variety *Y*.

Draw the box from the lower quartile (19) to the upper quartile (24).

Draw a line across the box at the median (22).

Draw whiskers out to the shortest (12) and longest (29) lengths.



Answer: Box plot with whiskers at 12 and 29, box from 19 to 24 and median at 22

Tip: Only every second number is labelled on this scale: each small square is 1 cm. Check 19 and 29 carefully.

Marks: 2 marks for a fully correct box plot. 1 mark for 3 or 4 values correctly plotted including the box or whiskers.

- (b) Compare the distribution of the lengths of the beans of variety X with the distribution of the lengths of the beans of variety Y .

Medians: variety X 18 cm, variety Y 22 cm.

Variety Y has the higher median, so on average the beans of variety Y were longer.

Interquartile ranges: variety X $21 - 15 = 6$ cm, variety Y $24 - 19 = 5$ cm.

Variety Y has the smaller IQR, so the lengths of the beans of variety Y are more consistent.

Answer: The beans of variety Y were longer on average (higher median, 22 cm > 18 cm) and their lengths were more consistent (smaller IQR, 5 cm < 6 cm).

Tip: Compare one average (the median) and one measure of spread (the IQR), and say what each one means for the beans. Just listing values does not score.

Marks: 1 mark for comparing the medians in context. 1 mark for comparing the interquartile ranges (or ranges) in context.

14 (4 marks)

Ola makes 920 cm^3 of plant feed by mixing concentrate with water.

She mixes them so that volume of concentrate : volume of water = 3:20

The density of the concentrate is 1.36 g/cm^3

The density of water is 1 g/cm^3

Work out the density of the plant feed.

Give your answer correct to 3 significant figures.

Share the volume in the ratio 3:20: there are $3 + 20 = 23$ parts.

One part = $920 \div 23 = 40 \text{ cm}^3$

Concentrate: $3 \times 40 = 120 \text{ cm}^3$; water: $20 \times 40 = 800 \text{ cm}^3$

Mass of concentrate = $120 \times 1.36 = 163.2 \text{ g}$; mass of water = $800 \times 1 = 800 \text{ g}$

Total mass = $163.2 + 800 = 963.2 \text{ g}$

Density = $963.2 \div 920 = 1.04695 \dots$

To 3 significant figures: 1.05 g/cm^3

Answer: 1.05 g/cm^3

Tip: You cannot add the densities. Work out each mass, add them, then divide by the total volume.

Marks: 1 mark for splitting the volume (120 and 800). 1 mark for a mass (163.2 g or 800 g). 1 mark for total mass $\div$ total volume. 1 mark for 1.05.

15 (5 marks)

The diagram shows a shape made by cutting a square from one corner of a rectangle. The rectangle is $(3x + 2)$ cm long and $(2x - 1)$ cm wide. The square has sides of length x cm. The area of the shape is 25 cm^2

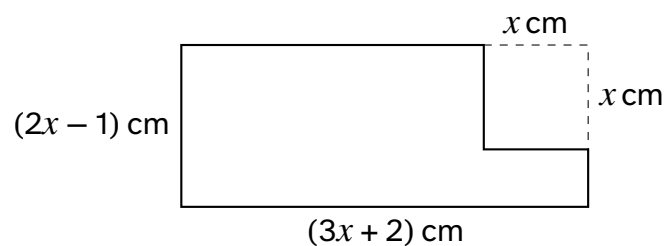


Diagram **NOT** accurately drawn

(a) Show that $5x^2 + x - 27 = 0$

$$\text{Area of the rectangle} = (3x + 2)(2x - 1) = 6x^2 - 3x + 4x - 2 = 6x^2 + x - 2$$

$$\text{Area of the square} = x^2$$

$$\text{Area of the shape} = 6x^2 + x - 2 - x^2 = 5x^2 + x - 2$$

$$\text{The area is } 25 \text{ cm}^2, \text{ so } 5x^2 + x - 2 = 25$$

Subtract 25 from both sides: $5x^2 + x - 27 = 0$ as required.

Answer: $(3x + 2)(2x - 1) - x^2 = 25$, so $5x^2 + x - 27 = 0$

Tip: In a “show that” question you must write every step, including the area of the rectangle before you subtract the square and the line $5x^2 + x - 2 = 25$.

Marks: 1 mark for $(3x + 2)(2x - 1) - x^2$ (the area of the rectangle subtract the area of the square). 1 mark for expanding correctly and showing every step to $5x^2 + x - 27 = 0$.

- (b) Work out the perimeter of the shape.
Give your answer correct to 3 significant figures.
You must show all your working.

Solve $5x^2 + x - 27 = 0$ with the formula: $a = 5$, $b = 1$, $c = -27$

$$x = \frac{-1 \pm \sqrt{1^2 - 4 \times 5 \times (-27)}}{2 \times 5} = \frac{-1 \pm \sqrt{541}}{10}$$

$$x = 2.2259 \dots \text{ or } x = -2.4259 \dots$$

x is a length, so it must be positive: $x = 2.2259 \dots$

Perimeter: the two edges of the cut corner (x and x) replace two pieces of the same total length, so the perimeter is the same as the rectangle's.

$$\text{Perimeter} = 2(3x + 2) + 2(2x - 1) = 10x + 2$$

$$= 10 \times 2.2259 \dots + 2 = 24.259 \dots$$

To 3 significant figures: 24.3 cm

Answer: 24.3 cm

Tip: Reject the negative solution: a length cannot be negative. Then add up all six edges of the shape. Cutting a square from a corner does not change the perimeter.

Marks: 1 mark for substituting correctly into the quadratic formula. 1 mark for using the positive value of x (2.2259...) in a correct expression for the perimeter, such as $10x + 2$. 1 mark for 24.3.

16 (4 marks)

Silas wants to estimate the number of snails in his garden.

On Saturday he catches 42 snails.

He puts a small dot of paint on the shell of each snail and then releases them.

On Sunday he catches 55 snails.

7 of these snails have a dot of paint on their shell.

- (a) Work out an estimate for the number of snails in Silas's garden.

Assume the fraction of marked snails in Sunday's sample is the same as in the whole garden.

Let N be the number of snails in the garden.

$$\frac{42}{N} = \frac{7}{55}$$

$$N = \frac{42 \times 55}{7} = 6 \times 55 = 330$$

Answer: 330

Tip: Check the fractions are the right way up: $\frac{\text{marked in sample}}{\text{sample}} = \frac{\text{marked in total}}{\text{total}}$. Adding or multiplying the numbers without a method gets no marks.

Marks: 1 mark for $7/55$ or $42/N$. 1 mark for $42 \times 55 \div 7$. 1 mark for 330.

- (b) The paint had come off some of the marked snails before Sunday. How does this affect your answer to part (a)?

Some of the snails caught on Sunday had been marked on Saturday but had lost their paint.

So they were counted as unmarked, and the true number of marked snails in Sunday's sample was more than 7.

Dividing by a number that is too small makes $\frac{42 \times 55}{7}$ too big.

So the answer to part (a) is an **overestimate**: there are probably fewer than 330 snails.

Answer: The estimate of 330 is too high (an overestimate), because fewer marked snails were counted on Sunday than there should have been.

Tip: Say which way the estimate changes (too high or too low) **and** why. "It makes it less accurate" does not score.

17 (3 marks)

The line **L** has equation $3y + 2x = 12$

Find an equation of the line that is perpendicular to **L** and passes through the point $(-4, 5)$

Rearrange **L** into $y = mx + c$: $3y = -2x + 12$, so $y = -\frac{2}{3}x + 4$

Gradient of **L** = $-\frac{2}{3}$

Perpendicular gradient = $\frac{3}{2}$ (negative reciprocal)

$y = \frac{3}{2}x + c$ through $(-4, 5)$: $5 = \frac{3}{2} \times (-4) + c = -6 + c$

$c = 11$

Answer: $y = \frac{3}{2}x + 11$

Tip: The gradient of **L** is not 2 or -2 : make y the subject first. Then flip it and change the sign.

Marks: 1 mark for the gradient of **L**, $-2/3$. 1 mark for using gradient $3/2$ with the point $(-4, 5)$. 1 mark for the equation.

18 (4 marks)

Farah and Jonah each have some savings.

Farah's savings : Jonah's savings = 5:2

Their grandmother gives each of them £30

Jonah now has $\frac{3}{5}$ of the amount that Farah now has.

How much money did Farah and Jonah each have before their grandmother gave them the money?

You must show all your working.

Before: Farah has $5x$ pounds and Jonah has $2x$ pounds.

After: Farah has $5x + 30$ and Jonah has $2x + 30$.

Jonah now has $\frac{3}{5}$ of Farah's amount: $2x + 30 = \frac{3}{5}(5x + 30)$

Multiply by 5: $10x + 150 = 15x + 90$

$60 = 5x$, so $x = 12$

Farah: $5 \times 12 = £60$; Jonah: $2 \times 12 = £24$

Check: 90 and 54, and $54 = \frac{3}{5} \times 90$ (correct)

Answer: Farah £60, Jonah £24

Tip: Both amounts go up by the same £30, so the difference between them stays the same. Do not add 30 to the ratio numbers.

Marks: 1 mark for the amounts after, $5x + 30$ and $2x + 30$. 1 mark for a correct equation. 1 mark for solving to $x = 12$. 1 mark for £60 and £24.

19 (2 marks)

EFG is a triangle.

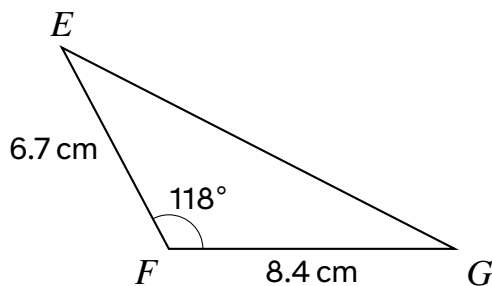


Diagram **NOT** accurately drawn

Work out the area of triangle EFG .

Give your answer correct to 3 significant figures.

Two sides and the angle between them are known, so use $\text{Area} = \frac{1}{2}ab \sin C$

$$\begin{aligned}\text{Area} &= \frac{1}{2} \times 8.4 \times 6.7 \times \sin 118^\circ \\ &= 28.14 \times 0.88294 \dots = 24.846 \dots\end{aligned}$$

To 3 significant figures: 24.8 cm^2

Answer: 24.8 cm^2

Tip: This triangle is not right-angled, so $\frac{1}{2} \times 8.4 \times 6.7$ is wrong. The formula is on the formulae sheet.

Marks: 1 mark for $\frac{1}{2} \times 8.4 \times 6.7 \times \sin 118^\circ$. 1 mark for 24.8.

20 (2 marks)

The graph of $y = f(x)$ is drawn on the grid.

The graph has a turning point at $(-1, -4)$

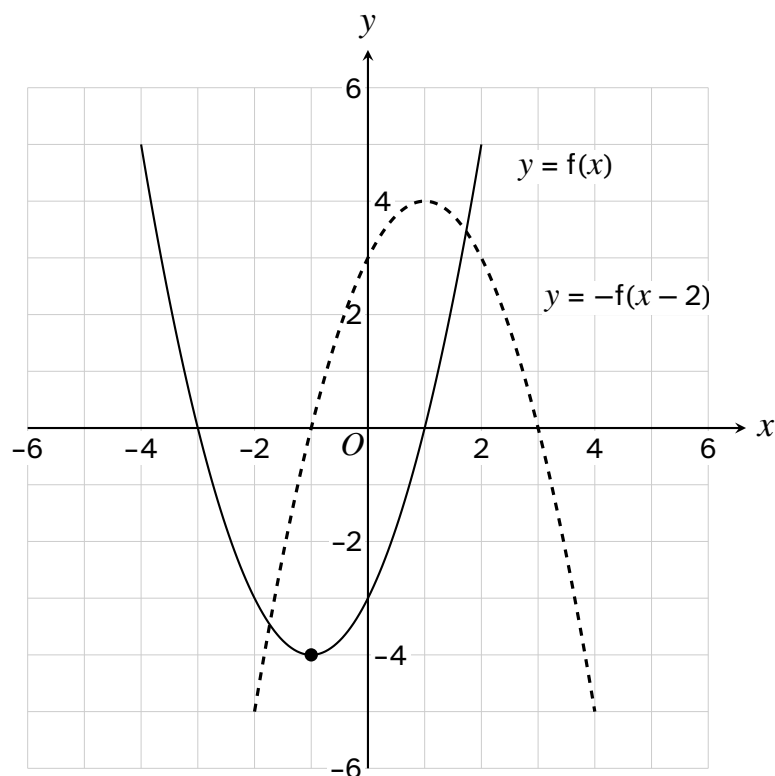
On the grid, sketch the graph of $y = -f(x - 2)$

$y = f(x - 2)$ is a translation of $y = f(x)$ by $\begin{pmatrix} 2 \\ 0 \end{pmatrix}$: 2 to the **right**.

The turning point $(-1, -4)$ moves to $(1, -4)$ and the x -intercepts $(-3, 0)$ and $(1, 0)$ move to $(-1, 0)$ and $(3, 0)$.

The minus sign in front, $y = -f(x - 2)$, then reflects this graph in the x -axis: every y -coordinate changes sign.

So the turning point becomes a maximum at $(1, 4)$, the x -intercepts stay at $(-1, 0)$ and $(3, 0)$, and the curve crosses the y -axis at $(0, 3)$.



Answer: An $\cap$ -shaped curve with maximum $(1, 4)$, through $(-1, 0)$, $(0, 3)$ and $(3, 0)$ (dashed on the grid)

Tip: Do one transformation at a time. $f(x - 2)$ moves the graph 2 to the **right**; the minus sign in front reflects it in the x -axis. Track the turning point: $(-1, -4) \rightarrow (1, -4) \rightarrow (1, 4)$.

Marks: 2 marks for the correct curve. 1 mark for one of the two transformations done correctly: a $\cup$ -shaped curve with minimum $(1, -4)$ (just $f(x - 2)$), or an $\cap$ -shaped curve with maximum $(-1, 4)$ (just $-f(x)$), or an $\cap$ -shaped curve through $(-1, 0)$ and $(3, 0)$.

21 (6 marks)

The diagram shows a plan of a plot of land, $ABCD$.

A path runs along the diagonal AC .

$AB = 52$ m, $BC = 38$ m, $AC = 71$ m

Angle $DAB = 76^\circ$

Angle $ADC = 60^\circ$

Daniel is going to put a fence along the whole boundary of the plot of land.

Fencing is sold in rolls. Each roll is 20 m long and costs £37.50

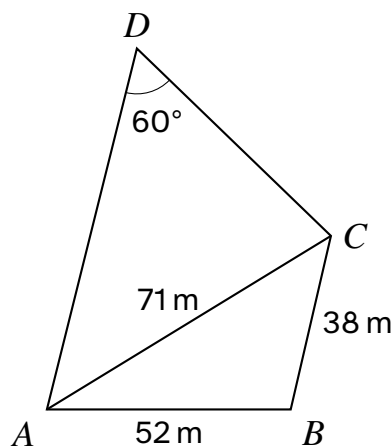


Diagram **NOT** accurately drawn

Work out the total cost of the fencing Daniel needs to buy.

You must show all your working.

The boundary is $AB + BC + CD + DA$. AB and BC are known, so find CD and DA (the path AC is not part of the boundary).

In triangle ABC all three sides are known, so use the cosine rule to find angle BAC .

$$\cos BAC = \frac{52^2 + 71^2 - 38^2}{2 \times 52 \times 71} = \frac{6301}{7384} = 0.85333 \dots, \text{ so angle } BAC = 31.424 \dots^\circ$$

$$\text{Angle } CAD = 76^\circ - 31.424 \dots^\circ = 44.575 \dots^\circ$$

$$\text{Angle } ACD = 180^\circ - 60^\circ - 44.575 \dots^\circ = 75.424 \dots^\circ$$

In triangle ACD , use the sine rule with $AC = 71$ m opposite angle $ADC = 60^\circ$:

$$CD = \frac{71 \times \sin 44.575 \dots^\circ}{\sin 60^\circ} = 57.540 \dots \text{ m}$$

$$DA = \frac{71 \times \sin 75.424 \dots^\circ}{\sin 60^\circ} = 79.345 \dots \text{ m}$$

$$\text{Perimeter} = 52 + 38 + 57.540 \dots + 79.345 \dots = 226.88 \dots \text{ m}$$

Number of rolls: $226.88 \dots \div 20 = 11.34 \dots$, so Daniel needs 12 rolls (he cannot buy part of a roll).

$$\text{Cost} = 12 \times \text{£}37.50 = \text{£}450$$

Answer: £450

Tip: Plan first: you need the two unknown sides, CD and DA . Neither triangle is right-angled, so use the cosine rule and then the sine rule. Keep full calculator values, and round the number of rolls **up**.

Marks: 1 mark for the cosine rule in triangle ABC. 1 mark for angle CAD (44.6°). 1 mark for the sine rule to find CD or DA. 1 mark for both CD (57.5 m) and DA (79.3 m). 1 mark for the perimeter divided by 20 and rounded up to 12 rolls. 1 mark for £450.

22 (4 marks)

Find the set of values of x for which

$$3x^2 + x - 14 \leq 0 \quad \text{and} \quad 4 - 3x < 2x + 9$$

You must show all your working.

Factorise: $3x^2 + x - 14 = (3x + 7)(x - 2)$

Critical values: $x = -\frac{7}{3}$ and $x = 2$

$y = 3x^2 + x - 14$ is a U-shaped curve, so it is ≤ 0 between the roots: $-\frac{7}{3} \leq x \leq 2$

Linear: $4 - 3x < 2x + 9$, so $-5 < 5x$, so $x > -1$

Both must be true. $x > -1$ cuts off the lower part, as $-1 > -\frac{7}{3}$.

$$-1 < x \leq 2$$

Answer: $-1 < x \leq 2$, ie $\{x: -1 < x \leq 2\}$

Tip: Sketch $y = 3x^2 + x - 14$ to see that it is below the x -axis **between** the roots. Then keep only the values that satisfy both inequalities.

Marks: 1 mark for the critical values $-7/3$ and 2. 1 mark for $-7/3 \leq x \leq 2$. 1 mark for $x > -1$. 1 mark for the final set $-1 < x \leq 2$.

23 (6 marks)

Can A and can B are mathematically similar.

The total surface area of can A is 880 cm^2

The total surface area of can B is 1430 cm^2

When both cans are full of olive oil, can B holds 1.95 kg more olive oil than can A .

The density of olive oil is 0.91 g/cm^3

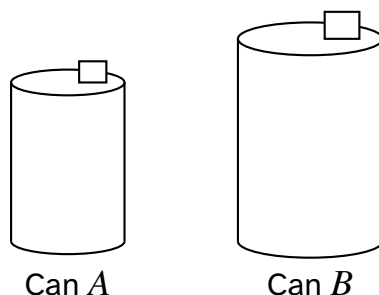


Diagram **NOT** accurately drawn

Work out the volume of olive oil that can A holds when it is full.

Give your answer in litres, correct to 3 significant figures.

You must show all your working.

$$\text{Area scale factor (from } A \text{ to } B) = \frac{1430}{880} = 1.625$$

$$\text{Length scale factor} = \sqrt{1.625} = 1.2747 \dots$$

$$\text{Volume scale factor} = (\sqrt{1.625})^3 = 2.0714 \dots, \text{ so volume of } B = 2.0714 \dots \times \text{volume of } A$$

Can B holds $1.95 \text{ kg} = 1950 \text{ g}$ more oil than can A .

$$\text{Volume of this extra oil} = \frac{\text{mass}}{\text{density}} = \frac{1950}{0.91} = 2142.857 \dots \text{ cm}^3$$

Let V be the volume of can A . Then $2.0714 \dots V - V = 2142.857 \dots$

$1.0714 \dots \times V = 2142.857 \dots$, so $V = 1999.9 \dots \text{cm}^3$

$1999.9 \dots \text{cm}^3 \div 1000 = 1.9999 \dots \text{litres}$

To 3 significant figures: 2.00 litres

Answer: 2.00 litres

Tip: Go from area to length (square root) to volume (cube). The 1.95 kg is the **difference** between the two cans, so it matches $(2.07 \dots - 1)$ times the volume of can A , not $2.07 \dots$ times it.

Marks: 1 mark for the area scale factor 1.625. 1 mark for the length scale factor (1.27...). 1 mark for the volume scale factor (2.07...). 1 mark for $1950 \div 0.91$ (the volume of the extra oil). 1 mark for $(2.07 \dots - 1) \times V = 2142.8 \dots$ or an equivalent method. 1 mark for 2.00.
