

Mock Set B – 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 (2 marks)

Use your calculator to work out the value of

$$\frac{\sqrt[3]{68.9} + \sqrt{14.2}}{7.31 - 2.86}$$

Write down all the figures on your calculator display.

Work out the top: $\sqrt[3]{68.9} + \sqrt{14.2} = 4.09958 \dots + 3.76828 \dots = 7.86787 \dots$

Work out the bottom: $7.31 - 2.86 = 4.45$

Divide: $7.86787 \dots \div 4.45$

The calculator display shows 1.768061185

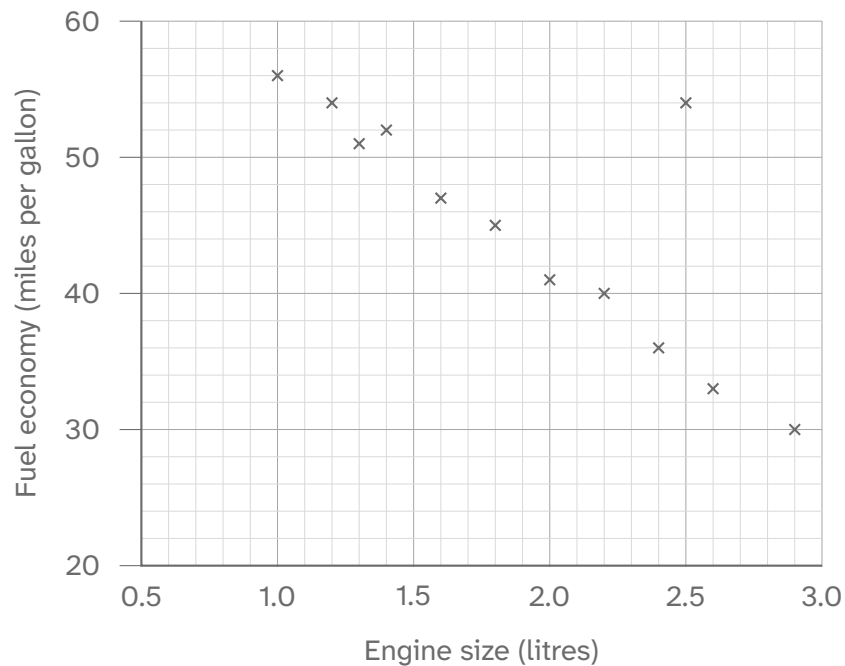
Answer: 1.768061185

Tip: Put brackets round the whole top and the whole bottom, or work out each one separately first. Write down every figure: do not round.

Marks: 1 mark for working out the top (7.867...) or the bottom (4.45). 1 mark for the full calculator display.

2 (3 marks)

The scatter graph shows information about the engine size and the fuel economy of each of 12 cars.



- (a) What type of correlation does this scatter graph show?

As the engine size increases, the fuel economy (miles per gallon) decreases.

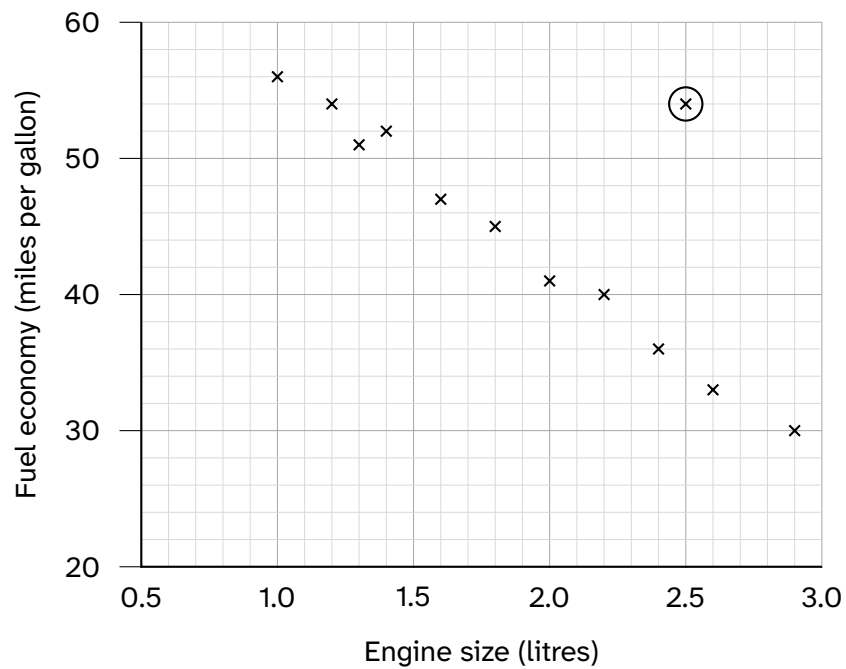
So the scatter graph shows negative correlation.

Answer: Negative correlation

Tip: “Negative” is enough here. Do not describe it as an inverse proportion or a relationship between particular cars.

- (b) One of the points is an outlier.
Write down the coordinates of this point.

The outlier is the point that does not follow the pattern of the others.



The car with an engine size of 2.5 litres does 54 miles per gallon, much more than other cars with engines of about this size.

Answer: (2.5, 54)

- (c) Elliot wants to use this scatter graph to estimate the fuel economy of a car with an engine size of 4.5 litres. Explain why his estimate may not be reliable.

The engine sizes of the cars in the data go from 1.0 to 2.9 litres.

4.5 litres is well outside this range.

We do not know that the pattern carries on for much bigger engines, so the estimate may not be reliable.

Answer: 4.5 litres is outside the range of the data (the biggest engine is 2.9 litres), so the trend may not continue.

Tip: Using a line of best fit outside the range of the data is called extrapolation. Say that the value is outside the data range, not just that “the line is not accurate”.

3 (3 marks)

Solve $6(3 - x) = 2x + 7$

Show clear algebraic working.

Expand the bracket: $18 - 6x = 2x + 7$

Add $6x$ to both sides: $18 = 8x + 7$

Subtract 7 from both sides: $11 = 8x$

Divide by 8: $x = \frac{11}{8}$ (= 1.375)

Answer: $x = \frac{11}{8}$ (or 1.375)

Tip: $6 \times (-x) = -6x$. Move the x terms to the side where they will be positive ($+6x$ on both sides) to avoid sign mistakes.

Marks: 1 mark for expanding the bracket correctly. 1 mark for collecting the x terms on one side and the numbers on the other. 1 mark for $11/8$.

4 (3 marks)

Last year, the price of a cinema ticket was £10.85 and the price of a large popcorn was £5.40

This year, the price of a cinema ticket is £12.20 and the price of a large popcorn is £6.15

Kian says, "The price of the cinema ticket went up by the greater percentage, because it went up by more money." Is Kian correct?

Ticket: increase = $12.20 - 10.85 = £1.35$

Percentage increase = $\frac{1.35}{10.85} \times 100 = 12.44 \dots \%$

Popcorn: increase = $6.15 - 5.40 = £0.75$

Percentage increase = $\frac{0.75}{5.40} \times 100 = 13.88 \dots \%$

13.9% is greater than 12.4%, so the popcorn went up by the greater percentage.

Kian is **not** correct: the ticket went up by more money, but the popcorn went up by a greater percentage of its original price.

Answer: No. The ticket went up by 12.4% but the popcorn went up by 13.9%.

Tip: Divide the increase by the **original** price, not the new price. A bigger increase in pounds does not always mean a bigger percentage increase.

Marks: 1 mark for one correct percentage increase (or multiplier). 1 mark for both. 1 mark for 'No' with both percentages.

5 (3 marks)

Anya invests £7500 in a savings account.

The account pays compound interest at

4.6% for the first year

2.85% per year for each year after the first year.

At the end of how many years will Anya's investment first be worth more than £8800?
You must show all your working.

First year: multiply by $1 + \frac{4.6}{100} = 1.046$

End of year 1: $7500 \times 1.046 = £7845$

Each year after that: multiply by 1.0285

End of year 2: $7845 \times 1.0285 = £8068.58 \dots$

End of year 3: $\times 1.0285 = £8298.53 \dots$

End of year 4: $\times 1.0285 = £8535.04 \dots$

End of year 5: $\times 1.0285 = £8778.29 \dots$ (not more than £8800)

End of year 6: $\times 1.0285 = £9028.47 \dots$ (more than £8800)

So the investment is first worth more than £8800 at the end of 6 years.

Answer: 6 years

Tip: Count the first year too: 7845×1.0285^5 is the value at the end of year 6, not year 5. Show the value just below £8800 and the value just above it.

Marks: 1 mark for 7500×1.046 ($= 7845$). 1 mark for going on year by year with $\times 1.0285$ (or using 7845×1.0285^n) far enough to pass £8800. 1 mark for 6, with the values for 5 and 6 years shown.

6 (4 marks)

(a) Complete the table of values for $y = x^3 - 6x + 3$

x	-3	-2	-1	0	1	2	3
y	-6	7	8	3	-2	-1	12

Substitute each missing value of x into $y = x^3 - 6x + 3$.

$$x = -2: (-2)^3 - 6 \times (-2) + 3 = -8 + 12 + 3 = 7$$

$$x = 1: 1^3 - 6 \times 1 + 3 = 1 - 6 + 3 = -2$$

$$x = 3: 3^3 - 6 \times 3 + 3 = 27 - 18 + 3 = 12$$

Answer: 7, -2, 12

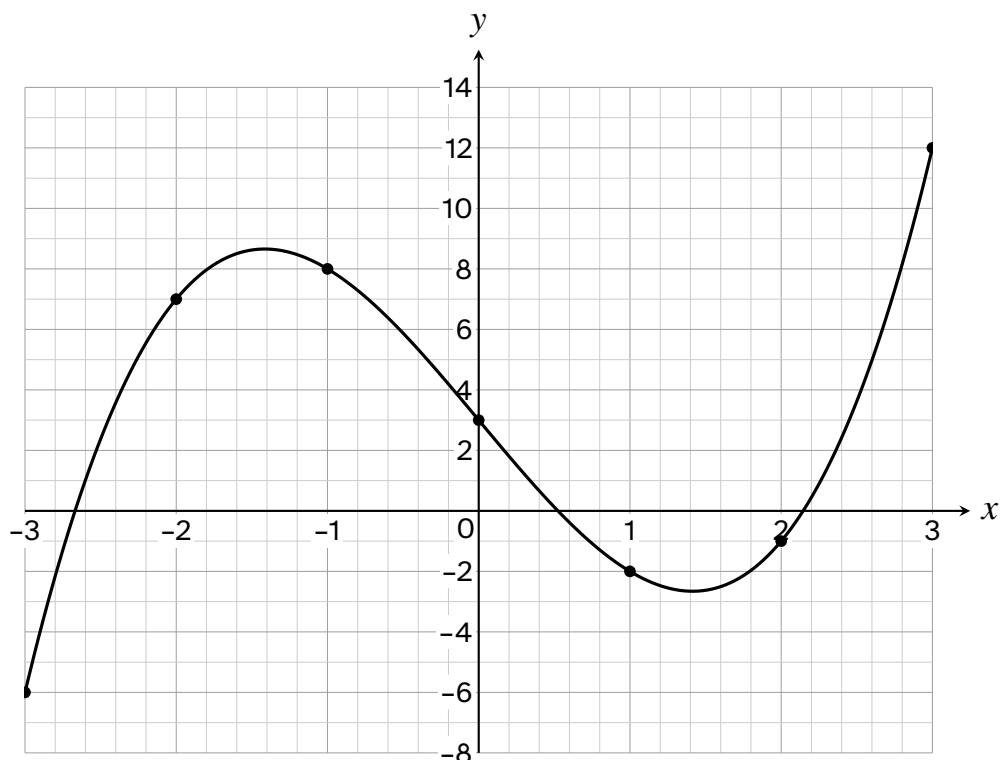
Tip: $(-2)^3 = -8$ and $-6 \times (-2) = +12$. A cubic table is not symmetrical, so do not copy values across.

Marks: 2 marks for all three values correct. 1 mark for one or two correct.

(b) On the grid, draw the graph of $y = x^3 - 6x + 3$ for values of x from -3 to 3

Plot the seven points from the table.

Join them with one smooth curve.



Answer: Smooth curve through $(-3, -6)$, $(-2, 7)$, $(-1, 8)$, $(0, 3)$, $(1, -2)$, $(2, -1)$, $(3, 12)$

Tip: Draw one smooth curve, not straight lines between the points. The curve goes a little above 8 between $x = -2$ and $x = -1$, and a little below -2 between $x = 1$ and $x = 2$.

Marks: 1 mark for plotting at least 5 points correctly. 1 mark for a smooth curve through all 7 points.

7 (2 marks)

Graphene is a material made of very thin sheets.

One sheet of graphene is 0.000 000 34 mm thick.

A scientist makes a stack of 6.5×10^5 sheets of graphene.

Work out the total thickness of the stack.

Give your answer in millimetres, in standard form.

0.000 000 34 in standard form is 3.4×10^{-7}

Total thickness = thickness of one sheet $\times$ number of sheets

$$(3.4 \times 10^{-7}) \times (6.5 \times 10^5) = 22.1 \times 10^{-2} = 0.221$$

In standard form: 2.21×10^{-1} mm

Answer: 2.21×10^{-1} mm

Tip: Count the zeros carefully: 0.000 000 34 has the 3 in the seventh decimal place, so it is 3.4×10^{-7} . 22.1×10^{-2} is not in standard form.

Marks: 1 mark for $3.4 \times 10^{-7} \times 6.5 \times 10^5$ or 0.221. 1 mark for 2.21×10^{-1} .

8 (2 marks)

The point A has coordinates $(-5, 8)$ and the point B has coordinates $(8, -2)$

Calculate the distance AB .

Give your answer correct to 3 significant figures.

Horizontal distance: $8 - (-5) = 13$

Vertical distance: $8 - (-2) = 10$

Use Pythagoras: $AB^2 = 13^2 + 10^2 = 169 + 100 = 269$

$AB = \sqrt{269} = 16.401\dots$

To 3 significant figures: 16.4

Answer: 16.4

Tip: A quick sketch helps. Subtracting a negative adds: $8 - (-5) = 13$, not 3.

Marks: 1 mark for $13^2 + 10^2$ (or the differences 13 and 10 used in Pythagoras). 1 mark for 16.4.

9 (3 marks)

A nurse, Efe, sets up a drip to give a patient 1.25 litres of fluid.

The fluid is given at a constant rate over 6 hours.

Each drop of fluid has a volume of 0.05 ml.

How many drops per minute should the drip deliver?

Give your answer correct to the nearest whole number.

Convert litres to millilitres: 1.25 litres = 1250 ml

Number of drops: $1250 \div 0.05 = 25\,000$ drops

Convert the time to minutes: $6 \text{ hours} = 6 \times 60 = 360 \text{ minutes}$

Drops per minute: $25\,000 \div 360 = 69.44 \dots$

To the nearest whole number: 69 drops per minute

Answer: 69 drops per minute

Tip: Change everything into matching units before you divide: litres to millilitres (multiply by 1000) and hours to minutes (multiply by 60).

Marks: 1 mark for converting to 1250 ml or 360 minutes. 1 mark for a complete method, such as $1250 \div 0.05 \div 360$. 1 mark for 69.

10 (3 marks)

Expand and simplify $(x + 4)(x - 7)(x + 2)$

Expand the first two brackets: $(x + 4)(x - 7) = x^2 - 7x + 4x - 28 = x^2 - 3x - 28$

Multiply by $(x + 2)$: $x(x^2 - 3x - 28) + 2(x^2 - 3x - 28)$

$= x^3 - 3x^2 - 28x + 2x^2 - 6x - 56$

Collect like terms: $x^3 - x^2 - 34x - 56$

Answer: $x^3 - x^2 - 34x - 56$

Tip: Expand two brackets first, then multiply every term by each term of the third bracket.
Check the constant: $4 \times (-7) \times 2 = -56$.

Marks: 1 mark for expanding two of the brackets correctly. 1 mark for multiplying by the third bracket (at least 3 of the 6 terms correct). 1 mark for $x^3 - x^2 - 34x - 56$.

11 (2 marks)

The diagram shows a wheelchair ramp.

The ramp rises 0.45 m over a horizontal distance of 5.4 m.

The angle between the ramp and the ground is x .

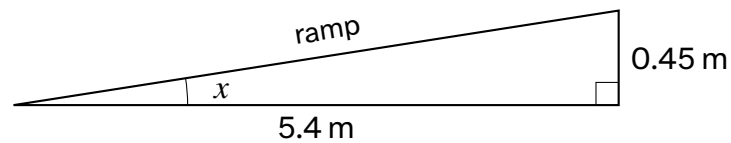


Diagram **NOT** accurately drawn

For safety, a wheelchair ramp must make an angle of less than 5° with the horizontal ground. Is this ramp safe?

From the angle x : the 0.45 m side is opposite and the 5.4 m side is adjacent.

O and A, so use tan: $\tan x = \frac{0.45}{5.4} = 0.0833 \dots$

$$x = \tan^{-1}(0.0833 \dots) = 4.76 \dots^\circ$$

$4.76 \dots^\circ$ is less than 5° , so the ramp **is** safe.

Answer: Yes. The angle is $4.76 \dots^\circ$, which is less than 5° .

Tip: The 5.4 m is along the ground, so it is the adjacent side, not the ramp itself. Make sure your calculator is in degrees, and write the comparison with 5° in your conclusion.

Marks: 1 mark for $\tan x = 0.45/5.4$. 1 mark for 'Yes' with the angle $4.76 \dots$ compared with 5° .

12 (4 marks)

Iqra asks 150 visitors to a zoo whether they went to the café and whether they went to the gift shop.

$\frac{3}{5}$ of the visitors went to the gift shop.

30% of the visitors who went to the gift shop also went to the café.

28 visitors went to neither the café nor the gift shop.

One of the visitors who went to the café is chosen at random.

Work out the probability that this visitor also went to the gift shop.

You must show all your working.

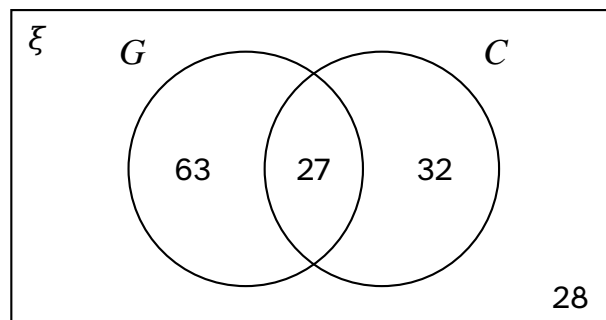
A Venn diagram helps. G = went to the gift shop, C = went to the café.

Gift shop: $\frac{3}{5} \times 150 = 90$ visitors

Gift shop and café: 30% of 90 = $0.3 \times 90 = 27$

Gift shop only: $90 - 27 = 63$

Café only: $150 - 90 - 28 = 32$



Visitors who went to the café: $27 + 32 = 59$

So the probability is $\frac{27}{59}$

Answer: $\frac{27}{59}$

Tip: 30% is of the **gift shop** visitors, not of all 150. The visitor is chosen from those who went to the café, so the denominator is 59, not 150.

Marks: 1 mark for 90 (gift shop) or 27 (both). 1 mark for 32 (café only) or a fully correct Venn diagram. 1 mark for 59 visitors went to the café. 1 mark for 27/59.

13 (5 marks)

Isaac hits 60 golf balls at a driving range. The table shows information about the distances, d metres, that the balls travelled.

Distance (d m)	$100 < d \leq 120$	$120 < d \leq 140$	$140 < d \leq 160$	$160 < d \leq 180$	$180 < d \leq 200$	$200 < d \leq 220$
Frequency	4	9	15	18	10	4

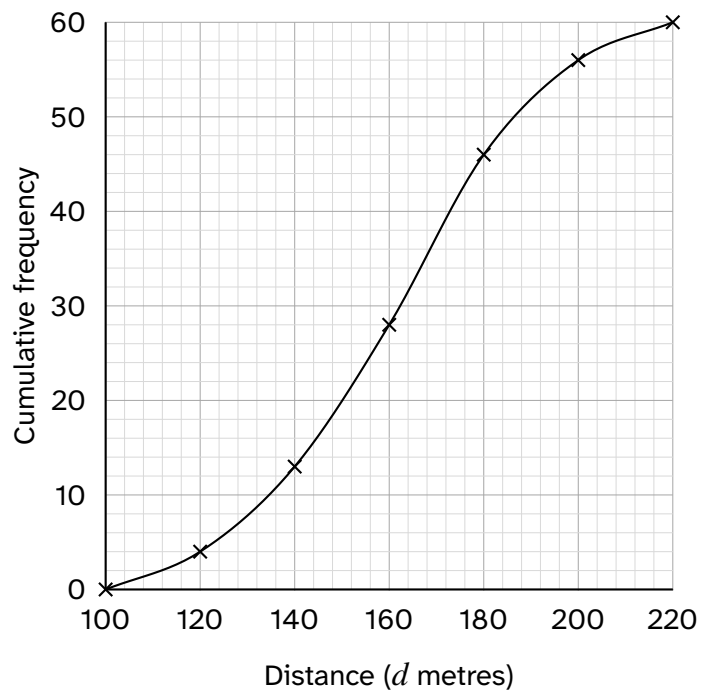
- (a) On the grid, draw a cumulative frequency graph for this information.

Work out the cumulative frequencies (running totals):

Distance (d m)	$100 < d \leq 120$	$120 < d \leq 140$	$140 < d \leq 160$	$160 < d \leq 180$	$180 < d \leq 200$	$200 < d \leq 220$
Frequency	4	9	15	18	10	4
Cumulative frequency	4	13	28	46	56	60

Plot each one at the **upper** end of its class: (120, 4), (140, 13), (160, 28), (180, 46), (200, 56), (220, 60)

No ball travelled 100 m or less, so also plot (100, 0). Join the points with a smooth curve.



Answer: Points plotted at (100, 0), (120, 4), (140, 13), (160, 28), (180, 46), (200, 56), (220, 60), joined with a curve or line segments

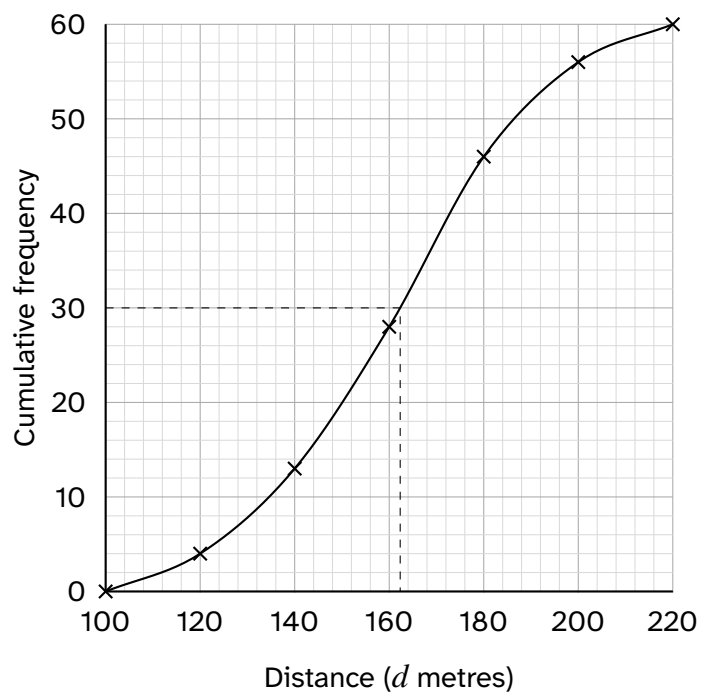
Tip: Plot at the upper class boundaries (120, 140, ...), not at the midpoints, and plot the running totals, not the frequencies.

Marks: 1 mark for at least 4 points plotted correctly. 1 mark for a fully correct graph.

- (b) Use your graph to find an estimate for the median distance.

Half of 60 is 30.

Read across from 30 on the cumulative frequency axis to the curve, then down.



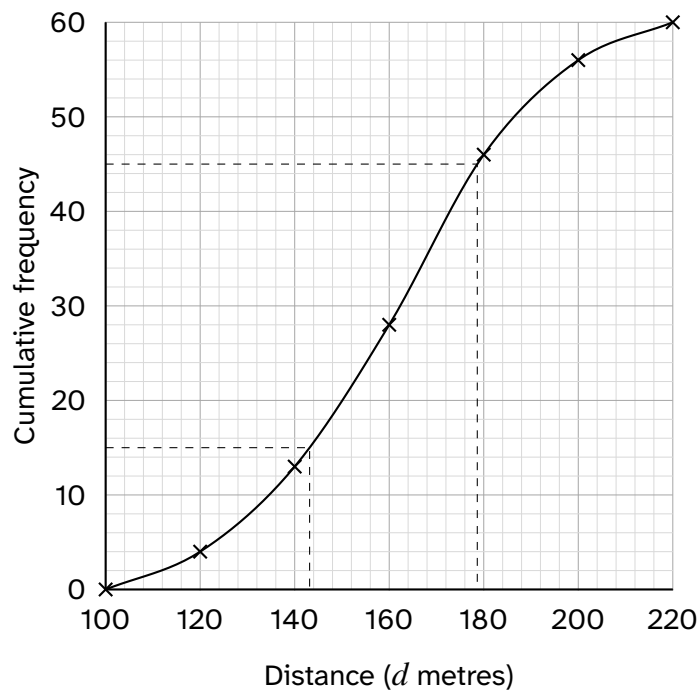
Median $\approx$ 162 m

Answer: About 162 m (from 160 to 164)

- (c) Use your graph to find an estimate for the interquartile range.

Lower quartile: read across from $\frac{1}{4} \times 60 = 15$: about 143 m

Upper quartile: read across from $\frac{3}{4} \times 60 = 45$: about 179 m



Interquartile range = $179 - 143 = 36$ m

Answer: About 36 m (from 32 to 40)

Tip: The quartiles are at 15 and 45 (a quarter and three-quarters of 60). Subtract the distances you read off, not the cumulative frequencies.

Marks: 1 mark for reading the graph at 15 and at 45. 1 mark for an answer from 32 to 40.

14 (4 marks)

Raj, Sid and Tom run a gardening business together.

They share the profit for one year in the ratio

Raj's share : Sid's share : Tom's share = 5:4:3

Sid's share is £1460

Raj then gives some of his share to Tom.

Sid keeps all of his share.

Tom now has 40% of the total profit.

How much money did Raj give to Tom?

You must show all your working.

Sid has 4 parts, and 4 parts = £1460

$$1 \text{ part} = 1460 \div 4 = \text{£}365$$

$$\text{Raj: } 5 \times 365 = \text{£}1825; \text{ Tom: } 3 \times 365 = \text{£}1095$$

$$\text{Total profit: } 12 \times 365 = \text{£}4380 \text{ (this does not change).}$$

$$\text{Afterwards, Tom has 40\% of the total: } 0.4 \times 4380 = \text{£}1752$$

$$\text{Raj gave Tom } 1752 - 1095 = \text{£}657$$

$$\text{Check: Raj now has } 1825 - 657 = \text{£}1168, \text{ and } 1168 + 1460 + 1752 = 4380$$

Answer: £657

Tip: The total does not change when money is passed between the three friends. Work out the total first, then 40% of it.

Marks: 1 mark for one part = £365. 1 mark for the total (£4380) or Tom's first amount (£1095).
1 mark for 40% of the total (£1752). 1 mark for £657.

15 (4 marks)

F is inversely proportional to the square of d .

$$F = 12.5 \text{ when } d = 3.2$$

(a) Find a formula for F in terms of d .

$$F \text{ is inversely proportional to } d^2, \text{ so } F = \frac{k}{d^2}$$

$$\text{Substitute } F = 12.5 \text{ and } d = 3.2: 12.5 = \frac{k}{3.2^2} = \frac{k}{10.24}$$

$$k = 12.5 \times 10.24 = 128$$

$$F = \frac{128}{d^2}$$

Answer: $F = \frac{128}{d^2}$

Tip: Write the formula with k first, $F = \frac{k}{d^2}$. Do not forget to square 3.2.

Marks: 1 mark for $F = k/d^2$ with values substituted. 1 mark for $F = 128/d^2$.

- (b) The value of F is halved.
Work out the percentage increase in the value of d .
Give your answer correct to 1 decimal place.

$$F = \frac{128}{d^2}, \text{ so } d^2 = \frac{128}{F}$$

If F is halved, d^2 is doubled.

So d is multiplied by $\sqrt{2} = 1.41421 \dots$

Percentage increase = $(1.41421 \dots - 1) \times 100 = 41.421 \dots \%$

To 1 decimal place: 41.4%

(Check with numbers: $F = 12.5$ at $d = 3.2$; $F = 6.25$ at $d = \sqrt{128 \div 6.25} = 4.525 \dots$,
and $4.525 \dots \div 3.2 = 1.414 \dots$)

Answer: 41.4%

Tip: Halving F does not double d . Because d is squared, d^2 doubles, so d goes up by a factor of $\sqrt{2}$.

Marks: 1 mark for showing d is multiplied by $\sqrt{2}$ (or using two values of d , such as 3.2 and 4.525...). 1 mark for 41.4.

16 (4 marks)

- (a) Show that the equation $x^3 + 6x - 13 = 0$ can be rearranged to give $x = \frac{13}{x^2 + 6}$

Add 13 to both sides: $x^3 + 6x = 13$

Factorise the left-hand side: $x(x^2 + 6) = 13$

Divide both sides by $x^2 + 6$: $x = \frac{13}{x^2 + 6}$

Answer: $x^3 + 6x = 13$, so $x(x^2 + 6) = 13$, so $x = \frac{13}{x^2 + 6}$

Tip: The key step is to factorise $x^3 + 6x$ as $x(x^2 + 6)$. Show it: you cannot just write down the given answer.

- (b) Starting with $x_0 = 1.5$, use the iteration formula $x_{n+1} = \frac{13}{x_n^2 + 6}$ three times to find an estimate for a solution of $x^3 + 6x - 13 = 0$.
Give your answer correct to 4 decimal places.

$$x_1 = \frac{13}{1.5^2 + 6} = \frac{13}{8.25} = 1.575757 \dots$$

$$x_2 = \frac{13}{1.575757 \dots^2 + 6} = 1.532474 \dots$$

$$x_3 = \frac{13}{1.532474 \dots^2 + 6} = 1.557170 \dots$$

To 4 decimal places: 1.5572

Answer: 1.5572

Tip: Use the ANS key: type $13 \div (1.5^2 + 6)$, press =, then type $13 \div (\text{ANS}^2 + 6)$ and press = twice more. Keep every figure until the end.

Marks: 1 mark for $x_1 = 1.5757 \dots$ 1 mark for working out x_2 and x_3 . 1 mark for 1.5572.

17 (3 marks)

Show that $\frac{4}{x+5} - \frac{x-27}{x^2+2x-15}$ simplifies to $\frac{a}{x+b}$ where a and b are integers.

Factorise the second denominator: $x^2 + 2x - 15 = (x+5)(x-3)$

So the common denominator is $(x+5)(x-3)$:

$$\frac{4}{x+5} - \frac{x-27}{(x+5)(x-3)} = \frac{4(x-3) - (x-27)}{(x+5)(x-3)}$$

Numerator: $4x - 12 - x + 27 = 3x + 15 = 3(x+5)$

$$\frac{3(x+5)}{(x+5)(x-3)} = \frac{3}{x-3} \quad (\text{cancel the common factor } x+5)$$

So the expression simplifies to $\frac{3}{x-3}$, with $a = 3$ and $b = -3$, which are integers.

Answer: $\frac{3}{x-3}$

Tip: Factorise the quadratic denominator first: then the common denominator is just $(x+5)(x-3)$. Put $x-27$ in a bracket, because the minus sign changes both terms:
 $-(x-27) = -x+27$.

Marks: 1 mark for factorising $x^2 + 2x - 15$ as $(x+5)(x-3)$ or using a correct common denominator. 1 mark for the numerator $3x+15$ over the common denominator. 1 mark for $3/(x-3)$ with all steps shown.

18 (3 marks)

PQR is a triangle.

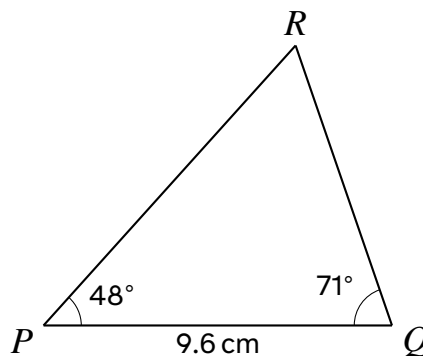


Diagram **NOT** accurately drawn

Work out the length of QR .

Give your answer correct to 3 significant figures.

$$\text{Angle } PRQ = 180^\circ - 48^\circ - 71^\circ = 61^\circ$$

QR is opposite angle P (48°) and PQ is opposite angle R (61°).

$$\text{Sine rule: } \frac{QR}{\sin 48^\circ} = \frac{9.6}{\sin 61^\circ}$$

$$QR = \frac{9.6 \times \sin 48^\circ}{\sin 61^\circ} = 8.1569 \dots$$

To 3 significant figures: 8.16 cm

Answer: 8.16 cm

Tip: Pair each side with the angle opposite it. PQ is opposite angle R , so you need angle R first.

Marks: 1 mark for angle $R = 61^\circ$. 1 mark for a correct sine rule statement. 1 mark for 8.16.

19 (3 marks)

- (a) Write $x^2 + 10x + 34$ in the form $(x + p)^2 + q$ where p and q are integers.

Halve the coefficient of x : $10 \div 2 = 5$, so start with $(x + 5)^2$

$$(x + 5)^2 = x^2 + 10x + 25$$

$$x^2 + 10x + 34 = (x + 5)^2 - 25 + 34$$

$$= (x + 5)^2 + 9$$

Answer: $(x + 5)^2 + 9$

Tip: $(x + 5)^2$ gives an extra 25, so subtract it: $34 - 25 = 9$.

Marks: 1 mark for $(x + 5)^2$. 1 mark for $(x + 5)^2 + 9$.

- (b) Hence, explain why the curve with equation $y = x^2 + 10x + 34$ does not cross the x -axis.

$$y = (x + 5)^2 + 9$$

$(x + 5)^2$ is a square, so it is never negative: $(x + 5)^2 \geq 0$.

So $y \geq 9$ for every value of x .

The turning point is a minimum at $(-5, 9)$, which is above the x -axis, so the curve never reaches $y = 0$.

Answer: The minimum point is $(-5, 9)$, which is above the x -axis (since $(x + 5)^2 \geq 0$, $y \geq 9$), so y is never 0.

Tip: Refer to your answer to part (a): give the turning point $(-5, 9)$, or say that $(x + 5)^2 \geq 0$ so y is always at least 9.

20 (4 marks)

Bottle A and bottle B are two mathematically similar perfume bottles.
Both bottles are made from the same type of glass.

The mass of bottle A is 150 g.

The mass of bottle B is 320 g.

The total surface area of bottle B is 230 cm^2

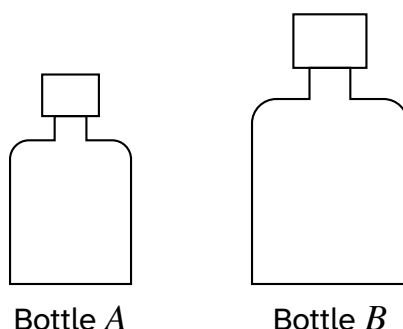


Diagram **NOT** accurately drawn

Work out the total surface area of bottle A .

Give your answer correct to 3 significant figures.

You must show all your working.

The bottles are similar and made of the same glass, so the ratio of the masses is the volume scale factor.

$$\text{Volume scale factor (from } A \text{ to } B) = \frac{320}{150} = 2.1333 \dots$$

$$\text{Length scale factor} = \sqrt[3]{2.1333 \dots} = 1.2875 \dots$$

$$\text{Area scale factor} = 1.2875 \dots^2 = 1.6572 \dots$$

$$\text{Bottle } A \text{ is the smaller bottle, so divide: } 230 \div 1.6572 \dots = 138.789 \dots$$

To 3 significant figures: 139 cm^2

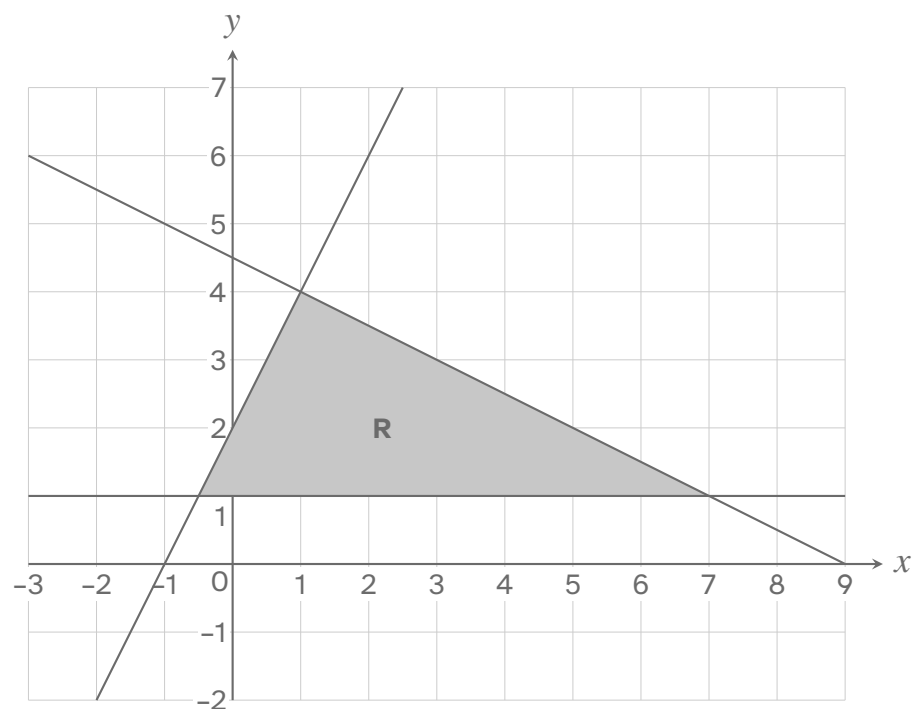
Answer: 139 cm^2

Tip: Mass is linked to volume, so the mass ratio is the **volume** scale factor. Cube root it to get the length scale factor, then square that to get the area scale factor.

Marks: 1 mark for the volume scale factor $320/150$ (or $150/320$). 1 mark for the length scale factor (cube root). 1 mark for the area scale factor (square). 1 mark for 139.

21 (3 marks)

The shaded region **R** is bounded by three straight lines.



Find the three inequalities that define the shaded region **R**.

The horizontal line is $y = 1$. **R** is above it: $y \geq 1$

The line through $(-1, 0)$ and $(0, 2)$ has gradient 2 and y-intercept 2: $y = 2x + 2$. **R** is below it: $y \leq 2x + 2$

The line through $(1, 4)$ and $(9, 0)$ has gradient $-\frac{1}{2}$ and y-intercept 4.5: $y = -\frac{1}{2}x + 4.5$, ie $x + 2y = 9$. **R** is below it: $x + 2y \leq 9$

Check with a point inside **R**, eg (2, 2): $2 \geq 1$, $2 \leq 6$, $2 + 4 = 6 \leq 9$ (all true)

Answer: $y \geq 1$, $y \leq 2x + 2$, $x + 2y \leq 9$ (or $y \leq -\frac{1}{2}x + 4.5$)

Tip: Find the equation of each line first (gradient and y-intercept), then decide which side of the line the region is on. Test a point inside the region to check.

Marks: 1 mark for each correct inequality (the lines are solid, so use $\leq$ or $\geq$).

22 (4 marks)

A is the point $(-4, 6)$ and B is the point $(4, 2)$

The point C lies on the line with equation $y = 3x - 1$

C is the same distance from A as it is from B .

Find the coordinates of C .

You must show all your working.

Points that are the same distance from A and B lie on the perpendicular bisector of AB .

$$\text{Midpoint of } AB: \left(\frac{-4 + 4}{2}, \frac{6 + 2}{2} \right) = (0, 4)$$

$$\text{Gradient of } AB = \frac{2 - 6}{4 - (-4)} = \frac{-4}{8} = -\frac{1}{2}$$

Perpendicular gradient = 2 (the negative reciprocal of $-\frac{1}{2}$)

Perpendicular bisector: $y = 2x + 4$ (it passes through $(0, 4)$)

C is on both lines: $3x - 1 = 2x + 4$, so $x = 5$ and $y = 3 \times 5 - 1 = 14$

Check: $CA^2 = 9^2 + 8^2 = 145$ and $CB^2 = 1^2 + 12^2 = 145$, so $CA = CB$.

Answer: (5, 14)

Tip: "The same distance from A and B " means C is on the perpendicular bisector of AB . Find its equation, then solve it simultaneously with $y = 3x - 1$.

Marks: 1 mark for the midpoint $(0, 4)$ or the gradient of AB $(-\frac{1}{2})$. 1 mark for the perpendicular gradient 2. 1 mark for the equation $y = 2x + 4$ and solving it with $y = 3x - 1$. 1 mark for $(5, 14)$.

23 (5 marks)

Victor rides his motorbike around a race track.

The length of the track is 3.85 km, correct to the nearest 10 metres.

Victor takes 2 minutes 34 seconds to ride once around the track, correct to the nearest second.

The lap record for this track is an average speed of 89.7 km/h.

Victor says, "I have definitely beaten the lap record." Is Victor correct?

Distance: 3.85 km = 3850 m to the nearest 10 m, so it is between 3845 m and 3855 m.

Time: 2 minutes 34 seconds = 154 s to the nearest second, so it is between 153.5 s and 154.5 s.

To be **sure** the record was beaten, the slowest possible speed must be more than 89.7 km/h.

$$\text{Slowest speed} = \frac{\text{lower bound of distance}}{\text{upper bound of time}} = \frac{3845}{154.5} = 24.886 \dots \text{ m/s}$$

Convert to km/h (multiply by 3600, divide by 1000): $24.886 \dots \times 3.6 = 89.59 \dots \text{ km/h}$

89.59 ... is less than 89.7, so Victor's average speed could have been slower than the lap record.

(Using the measured values, $3850 \div 154 \times 3.6 = 90 \text{ km/h}$, which looks faster than the record, but the bounds show we cannot be sure.)

Victor is **not** correct.

Answer: No. The lower bound of the speed is 89.59 ... km/h, which is less than 89.7 km/h, so Victor may not have beaten the lap record.

Tip: For the smallest possible speed, divide the **smallest** distance by the **largest** time. Using the measured values gives exactly 90 km/h, which hides the problem.

Marks: 1 mark for a correct bound for the distance (3845 or 3855) or the time (153.5 or 154.5).

1 mark for lower bound of distance $\div$ upper bound of time. 1 mark for converting to km/h. 1

mark for 89.59... 1 mark for 'No' with the comparison $89.59 \dots < 89.7$.

24 (4 marks)

The diagram shows a cuboid $ABCDEFGH$ with a horizontal base $ABCD$.

$AB = 8.6$ cm and $BC = 6.4$ cm

Angle $FAB = 31^\circ$

M is the midpoint of the edge GH .

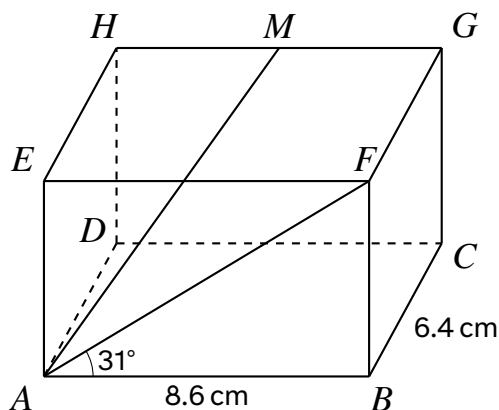


Diagram **NOT** accurately drawn

Work out the size of the angle between AM and the base $ABCD$.

Give your answer correct to 1 decimal place.

Height of the cuboid: in the right-angled triangle ABF ,

$$BF = 8.6 \times \tan 31^\circ = 5.1674 \dots \text{ cm}$$

Let N be the midpoint of CD . N is directly below M , so $MN = BF = 5.1674 \dots$ cm and angle $MNA = 90^\circ$.

The angle we need is angle MAN .

$DN = 8.6 \div 2 = 4.3$ cm and $AD = BC = 6.4$ cm. In the right-angled triangle ADN :

$$AN = \sqrt{4.3^2 + 6.4^2} = \sqrt{59.45} = 7.7103 \dots \text{ cm}$$

$$\tan MAN = \frac{MN}{AN} = \frac{5.1674 \dots}{7.7103 \dots} = 0.67018 \dots$$

$$\text{Angle } MAN = \tan^{-1}(0.67018 \dots) = 33.829 \dots^\circ$$

To 1 decimal place: 33.8°

Answer: 33.8°

Tip: Find the point N on the base directly below M ; the angle is in the right-angled triangle AMN . N is the midpoint of CD , not the point C or D .

Marks: 1 mark for the height of the cuboid (5.17 cm). 1 mark for AN , the distance from A to the point below M (7.71 cm). 1 mark for a correct trig statement for the angle. 1 mark for 33.8.
