

Work out 5.4×0.24



Hint: Multiply without any decimal points and then think about where in your answer to put the point back in. Would an estimate help?

Estimate for the answer:

$$5.4 \times 0.24 \approx 5 \times \frac{1}{4} = 1.25$$

5.4 and 0.24 become 54 and 24

$$\begin{array}{r} 54 \\ \times 24 \\ \hline 216 \\ 1080 \\ \hline 1296 \end{array}$$

So looking at my estimate my answer must be 1.296

.....
(Total 3 marks)

Jane has a carton of orange juice.
The carton is in the shape of a cuboid.

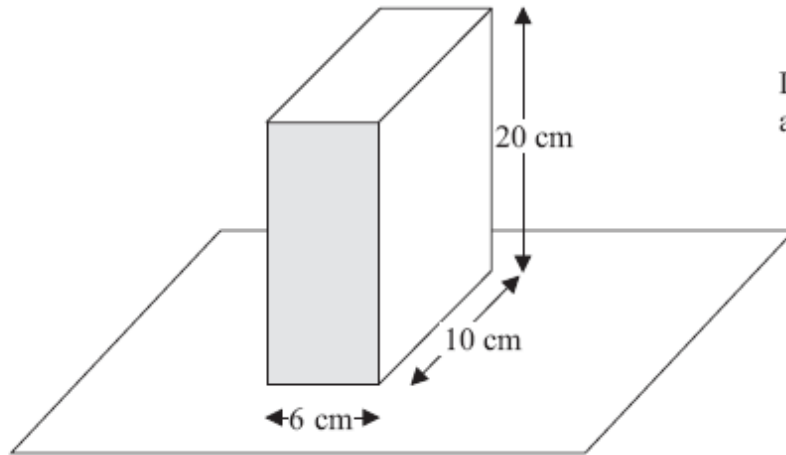


Diagram **NOT**
accurately drawn

The depth of the orange juice in the carton is 8 cm.

Jane closes the carton.

Then she turns the carton over so that it stands on the shaded face.

Work out the depth, in cm, of the orange juice now.

Hint: Work out the initial volume first

$$\text{Initial volume of juice} = 6 \times 10 \times 8 = 480 \text{ cm}^3$$

$$\text{So } 480 = 6 \times 20 \times d \quad \text{where } d \text{ is the new depth}$$

$$480 = 120 \times d$$

$$d = 4 \text{ cm}$$

..... cm

(Total 3 marks)

Write the following numbers in order of size.
Start with the smallest number.



0.038×10^2

3800×10^{-4}

380

0.38×10^{-1}

Hint: Change these all into "real" numbers

$$0.038 \times 10^2 = 0.038 \times 100 = 3.8$$

$$3800 \times 10^{-4} = 3800 \times \frac{1}{10000} = 0.38$$

$$380 = 380$$

$$0.38 \times 10^{-1} = 0.38 \times \frac{1}{10} = 0.038$$

So Smallest

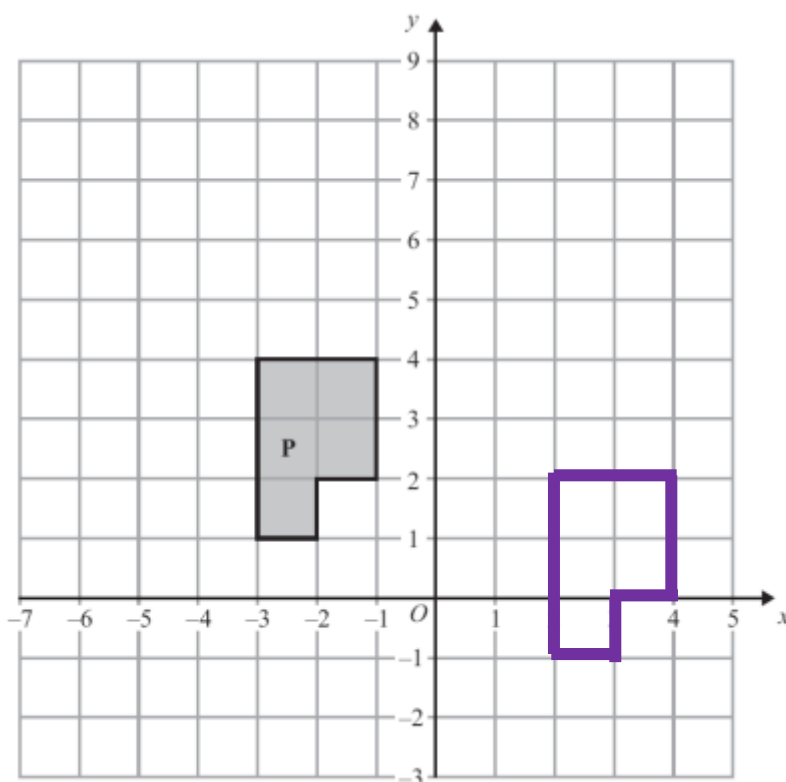
Biggest

$$0.38 \times 10^{-1} \quad 3800 \times 10^{-4} \quad 0.038 \times 10^2 \quad 380$$

(Total 2 marks)



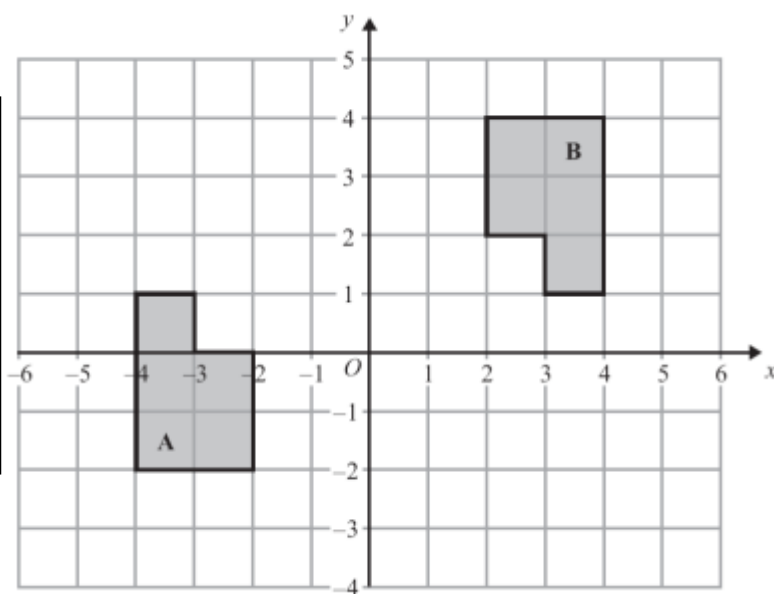
Hint: A translation is a shift to the left or right and up or down



- (a) Translate shape P by the vector $\begin{pmatrix} 5 \\ -2 \end{pmatrix}$.

(2)

Hint: 3 marks means 3 pieces of information in your answer



- (b) Describe fully the single transformation that maps shape A onto shape B.

Rotation

180°

Centre of Rotation (0, 1)

(3)

(Total 5 marks)



(a) Simplify $\frac{(x+2)^2}{x+2}$

Hint: Remember what squaring means

$$\begin{aligned} \frac{(x+2)^2}{x+2} &= \frac{(x+2)(x+2)}{x+2} \\ &= x+2 \end{aligned}$$

(1)

(b) Simplify $2a^2b \times 3a^3b$

Hint: Take each variable one at a time and remember that if it doesn't have a power that means to the power 1

$$\begin{aligned} 2a^2b \times 3a^3b &= 2 \times a^2 \times b \times 3 \times a^3 \times b \\ &= 2 \times 3 \times a^2 \times a^3 \times b^1 \times b^1 \\ &= 6a^5b^2 \end{aligned}$$

.....
(2)

(Total 3 marks)



Talil is going to make some concrete mix.
He needs to mix cement, sand and gravel in the ratio 1 : 3 : 5 by weight.

Talil wants to make 180 kg of concrete mix.

Talil has

15 kg of cement

85 kg of sand

100 kg of gravel

Does Talil have enough cement, sand and gravel to make the concrete mix?

Hint: Look at all the things needed to make concrete!
And you can't just guess - you have to have proof of your answer!

cement : sand : gravel	Total
1 : 3 : 5	9

To make a total of 180kg he needs to multiply each by 20

20 : 60 : 100

So he has enough sand and gravel but not enough cement, so the answer is no

(Total 4 marks)

Suha has a full 600 ml bottle of wallpaper remover.
She is going to mix some of the wallpaper remover with water.



Here is the information on the label of the bottle.

Wallpaper remover
600 ml

Mix $\frac{1}{4}$ of the wallpaper remover
with 4500 ml of water

Suha is going to use 750 ml of water.

How many millilitres of wallpaper remover should Suha use?
You must show your working.

Hint: Think about the fraction of the water Suha has

If Suha had the full amount of water she
would use $\frac{1}{4}$ of the remover ie. 150 ml

$$\frac{750}{4500} = \frac{75}{450} = \frac{3}{18} = \frac{1}{6}$$

So she need to use $\frac{1}{6}$ of the remover,
ie. $\frac{1}{6}$ of 150 ml = 25 ml

.....ml

(Total 4 marks)

Sasha carried out a survey of 60 students.

She asked them how many CDs they each have.



This table shows information about the numbers of CDs these students have.

Number of CDs	0 – 4	5 – 9	10 – 14	15 – 19	20 – 24
Frequency	8	11	9	14	18

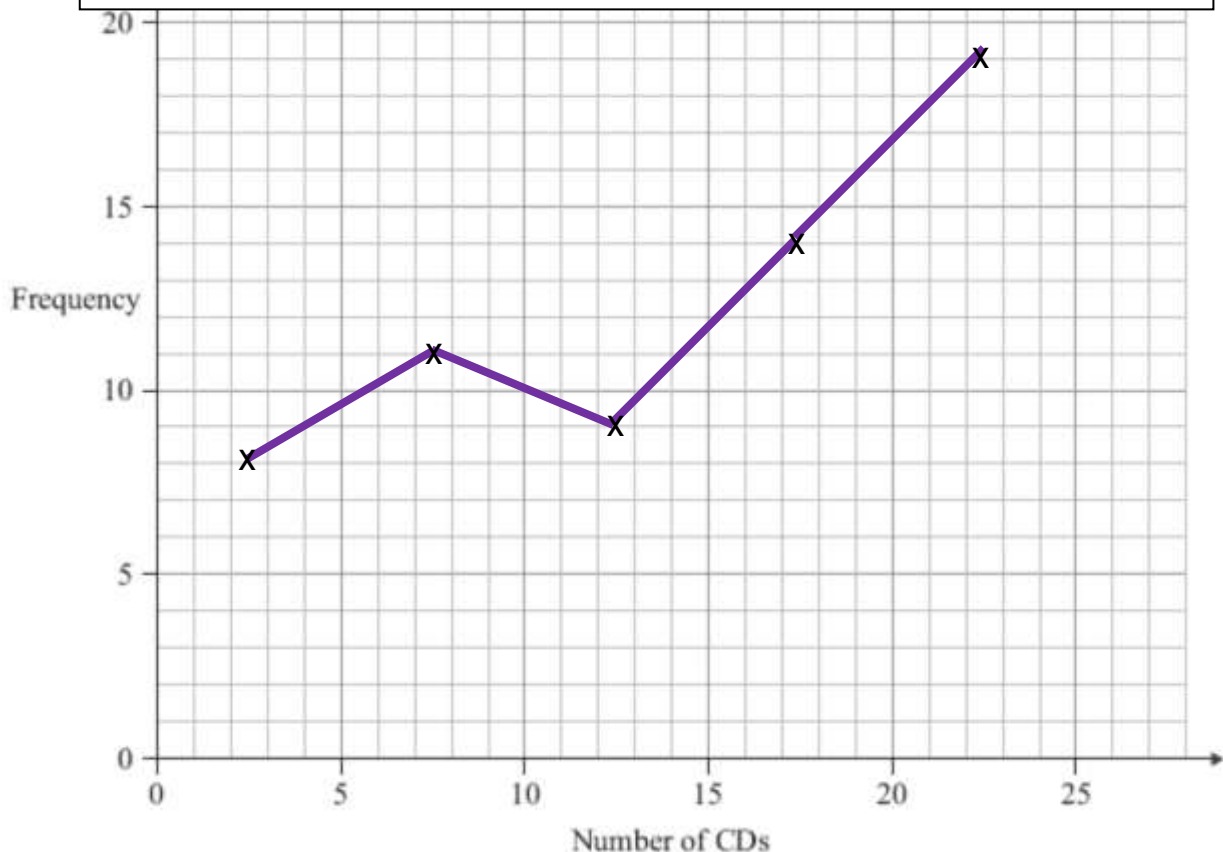
- (a) Write down the class interval containing the median.

Median is the one in the middle
60 students so student 29 and 30
So interval 15 – 19

(1)

- (b) On the grid, draw a frequency polygon to show the information given in the table.

Hint: A frequency polygon is plotted against mid-points!



(2)

(Total 3 marks)

9

Make q the subject of the formula $5(q + p) = 4 + 8p$
Give your answer in its simplest form.



Hint: undo the equation but by bit until it says $q = \dots$

$$\begin{array}{ll}
 5(q + p) = 4 + 8p & \text{Multiply out the bracket} \\
 5q + 5p = 4 + 8p & \text{Bring the p's to the RHS by subtracting } 5p \\
 5q = 4 + 3p & \text{Divide through by } 5 \\
 q = \frac{4 + 3p}{5} &
 \end{array}$$

This is considered to be the simplest form

$q = \dots\dots\dots$

(Total 3 marks)

(a) Expand and simplify $(x - 3)(x + 5)$



Hint: Make sure you multiply out and simplify
Would a grid help with the multiplication?
Take care with the negatives

$$\begin{aligned}(x - 3)(x + 5) &= x^2 + 5x - 3x - 15 \\ &= x^2 + 2x - 15\end{aligned}$$

.....
(2)

(b) Solve $x^2 + 8x - 9 = 0$

Hint: Factorise first and then solve each bracket

$$x^2 + 8x - 9 = (x + 9)(x - 1) = 0$$

$$\begin{aligned}\text{So either } (x + 9) &= 0 \quad \text{or} \quad (x - 1) = 0 \\ x &= -9 \quad \text{or} \quad x = 1\end{aligned}$$

.....
(3)

(Total 5 marks)

(a) Solve the inequality

$$3t + 1 < t + 12$$



Hint: Treat it like an equation

$$3t + 1 < t + 12$$

$$2t + 1 < 12$$

$$2t < 11$$

$$t < 5\frac{1}{2}$$

.....
(2)

(b) t is a whole number.

Write down the largest value of t that satisfies

$$3t + 1 < t + 12$$

The largest whole number value must be 5

Check: $3 \times 5 + 1 = 16$ which is less than $5 + 12$

$3 \times 6 + 1 = 19$ which is not less than $6 + 12$

.....
(1)

(Total 3 marks)

The distance from Fulbeck to Ganby is 10 miles.
The distance from Ganby to Horton is 18 miles.



Raksha is going to drive from Fulbeck to Ganby.
Then she will drive from Ganby to Horton.

Raksha leaves Fulbeck at 10 00.
She drives from Fulbeck to Ganby at an average speed of 40mph.

Raksha wants to get to Horton at 10 35.

Work out the average speed Raksha must drive at from Ganby to Horton.

Hint: Do it bit by bit for the parts of the journey and the journey as a whole
Remember that a speed is the distance covered in a unit of time

Raksha has 35 mins to do the journey, ie. $\frac{7}{12}$ hour
Journey to Fulbeck: distance = 10 miles

speed = 40 mph

So time = $\frac{1}{4}$ hour = 15 mins

Journey to Ganby: distance = 18 miles

time = 20 mins = $\frac{1}{3}$ hour

So speed = 54 miles per hour

.....mph

(Total 3 marks)



M is directly proportional to L^3 .

When $L = 2$, $M = 160$

Find the value of M when $L = 3$

Hint: use the first lot of figures to find your constant

Direct proportion $M \propto L^3$

ie. $M = kL^3$

So if $L = 2$ and $M = 160$, $160 = k \times 8$

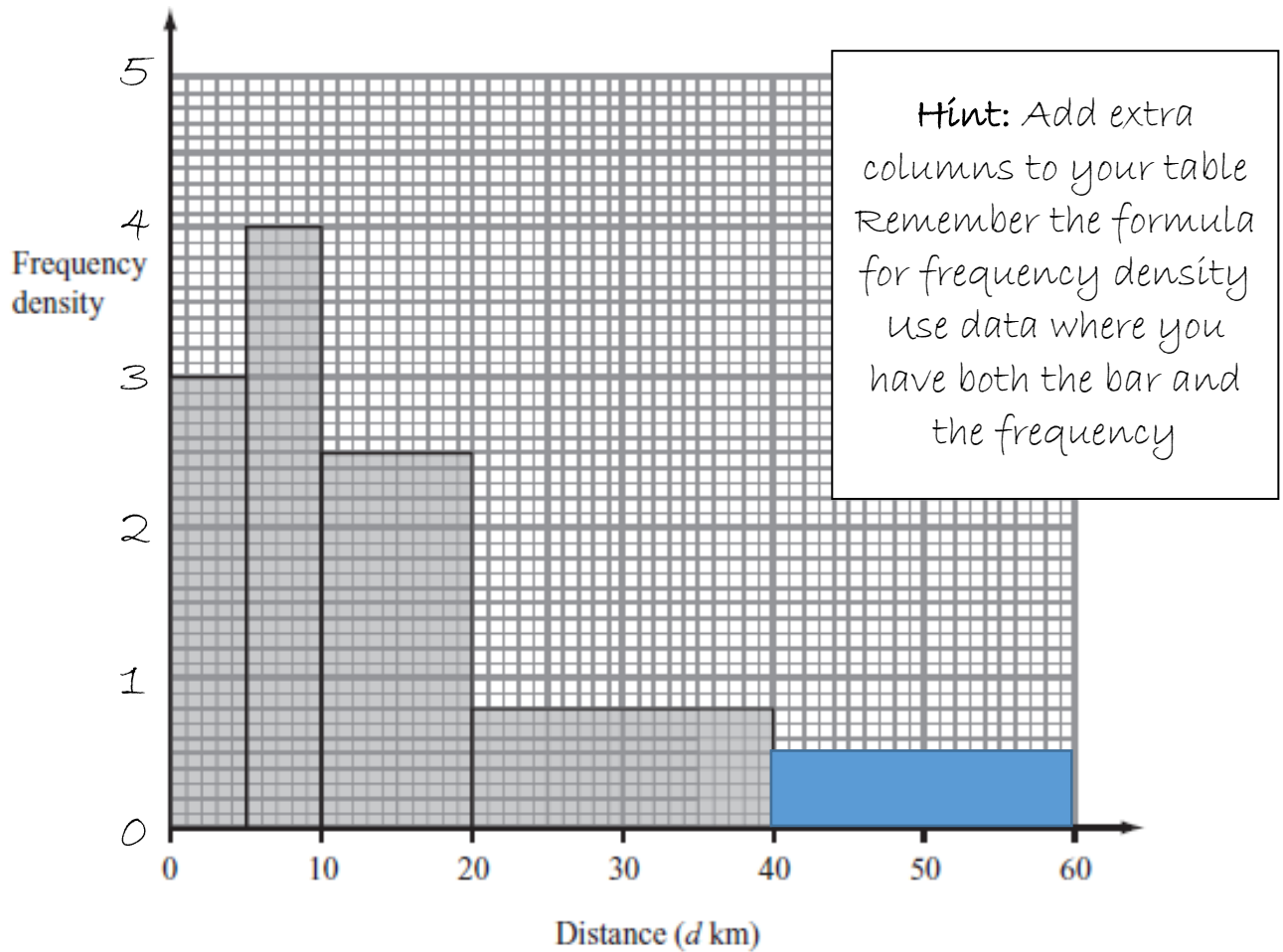
$$k = 20$$

So $m = 20L^3$

And if $L = 3$, $M = 20 \times 3^3 = 20 \times 27 = 540$

.....
(Total 4 marks)

The incomplete histogram and table give some information about the distances some teachers travel to school.



$$\text{Frequency density} = \frac{\text{frequency}}{\text{column width}}$$

(a) Use the information in the histogram to complete the frequency table.

Distance (d km)	Frequency	Column Width	Frequency density
$0 < d \leq 5$	15	5	3
$5 < d \leq 10$	20	5	
$10 < d \leq 20$	25	10	2.5
$20 < d \leq 40$	16	20	0.8
$40 < d \leq 60$	10	20	0.5

1. Calculate the frequency density for the first bar
2. put the scale on the y-axis
3. and read off the fd's and complete the table

(2)

(b) Use the information in the table to complete the histogram.

(1)

(Total 3 marks)



- (a) Write down the value of $49^{\frac{1}{2}}$

Hint: What does power $\frac{1}{2}$ mean?

7

(1)

- (b) Write $\sqrt{45}$ in the form $k\sqrt{5}$, where k is an integer.

Hint: What multiplication can 45 be written as?

$$45 = 9 \times 5$$

$$\text{So } \sqrt{45} = \sqrt{(9 \times 5)} = \sqrt{9} \times \sqrt{5} = 3\sqrt{5}$$

(1)

(Total 2 marks)



$$x = 0.0\dot{4}\dot{5}$$

Prove algebraically that x can be written as $\frac{1}{22}$

Hint: use powers of 10 and algebra

$$\text{Let } x = 0.0\dot{4}\dot{5}$$

$$\text{So } x = 0.045454545 \dots$$

$$100x = 4.545454545 \dots \quad \text{Subtract them}$$

$$99x = 4.5$$

$\times$ by 10 to get whole nos only

$$990x = 45$$

now divide to make a fraction

$$x = \frac{45}{990}$$

and cancel

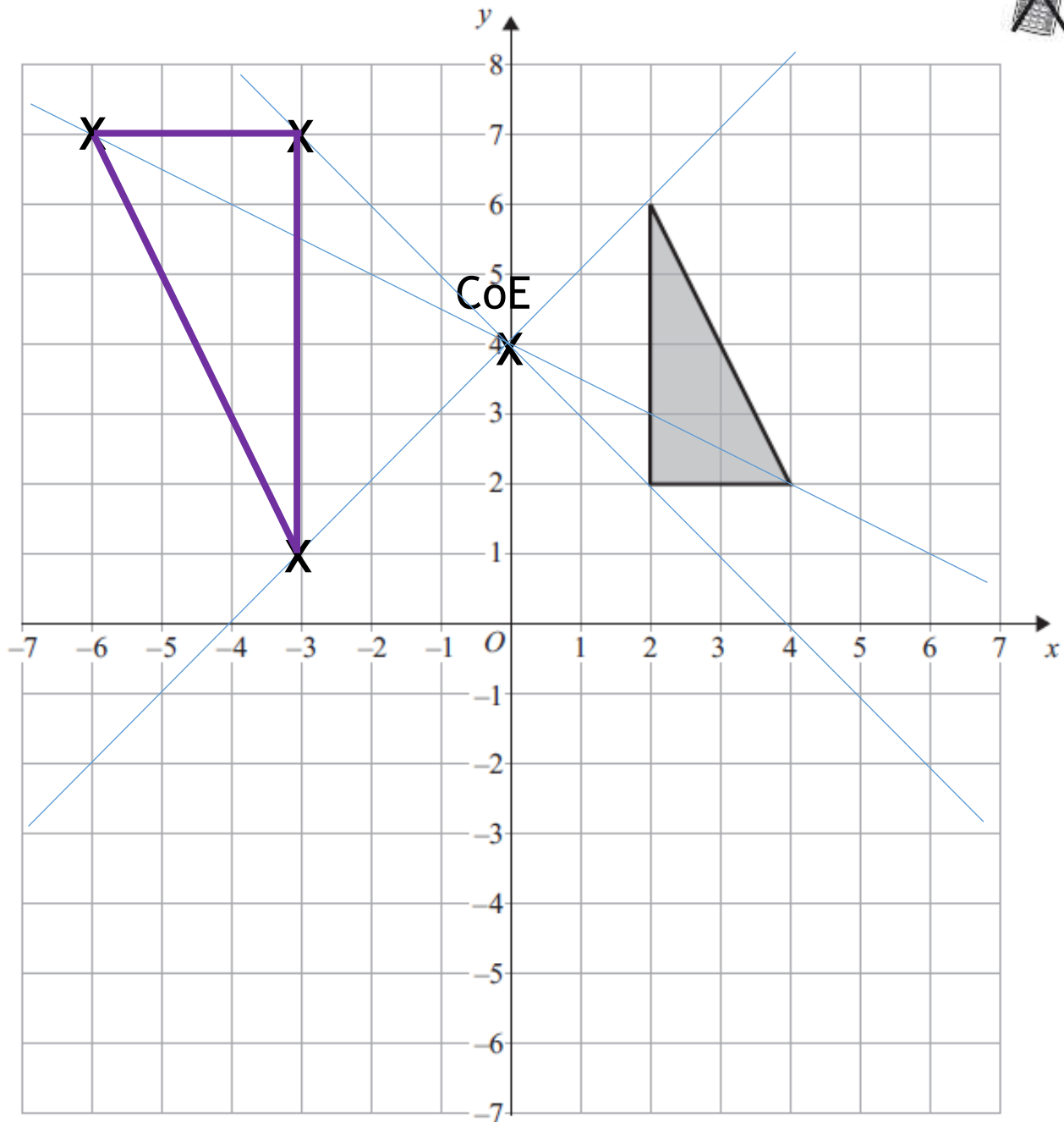
$$990$$

$$x = \frac{1}{22}$$

QED

$$22$$

(Total 3 marks)



Enlarge the shaded shape by a scale factor of $-1\frac{1}{2}$, centre (0, 4).

*Hint: What does a negative scale factor do?
Count the distances*

(Total 3 marks)



There are three different types of sandwiches on a shelf.

There are

4 egg sandwiches,
5 cheese sandwiches
and 2 ham sandwiches.

Erin takes at random 2 of these sandwiches.

Work out the probability that she takes 2 different types of sandwiches.

*Hint: A tree diagram might help or you can work it out considering all the possible outcomes
Is this replacement or non-replacement?*

All possible outcomes

$$EE \quad EC \quad \frac{4}{11} \times \frac{5}{10} = \frac{20}{110} \quad EH \quad \frac{4}{11} \times \frac{2}{10} = \frac{8}{110}$$

$$CE \quad \frac{5}{11} \times \frac{4}{10} = \frac{20}{110} \quad CC \quad \frac{5}{11} \times \frac{4}{10} = \frac{20}{110} \quad CH \quad \frac{5}{11} \times \frac{2}{10} = \frac{10}{110}$$

$$HE \quad \frac{2}{11} \times \frac{4}{10} = \frac{8}{110} \quad HC \quad \frac{2}{11} \times \frac{5}{10} = \frac{10}{110} \quad HH$$

$$\begin{aligned} P(2 \text{ different types}) &= \frac{20}{110} + \frac{8}{110} + \frac{20}{110} + \frac{10}{110} + \frac{8}{110} + \frac{10}{110} \\ &= \frac{76}{110} \\ &= \frac{38}{55} \end{aligned}$$

Or this can be done by calculating EE, CC and HH and subtracting from 1

.....
(Total 5 marks)

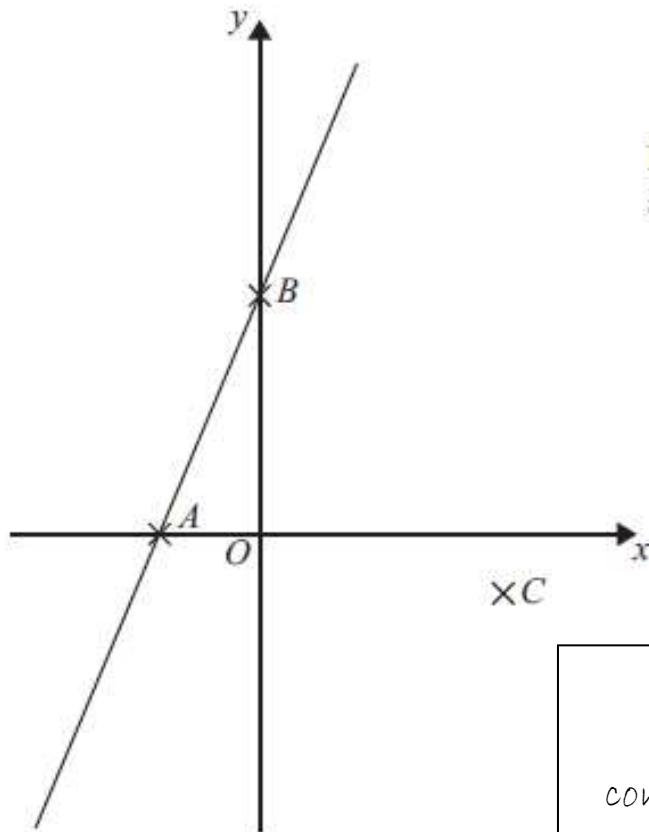


Diagram NOT
accurately drawn

Hint: What is the
connection between the
gradient of a line and its
perpendicular?

In the diagram
A is the point $(-2, 0)$
B is the point $(0, 4)$
C is the point $(5, -1)$

Find an equation of the line that passes through C and is perpendicular to AB.

Equation of given line: $y = m_1x + c$

$$y = 2x + 4$$

$$m_1m_2 = -1 \quad \text{So } 2 \times m_2 = -1 \quad m_2 = -1/2$$

Equation of perpendicular line: $y = -1/2x + c$

Point $(5, -1) \quad -1 = -1/2 \times 5 + c$

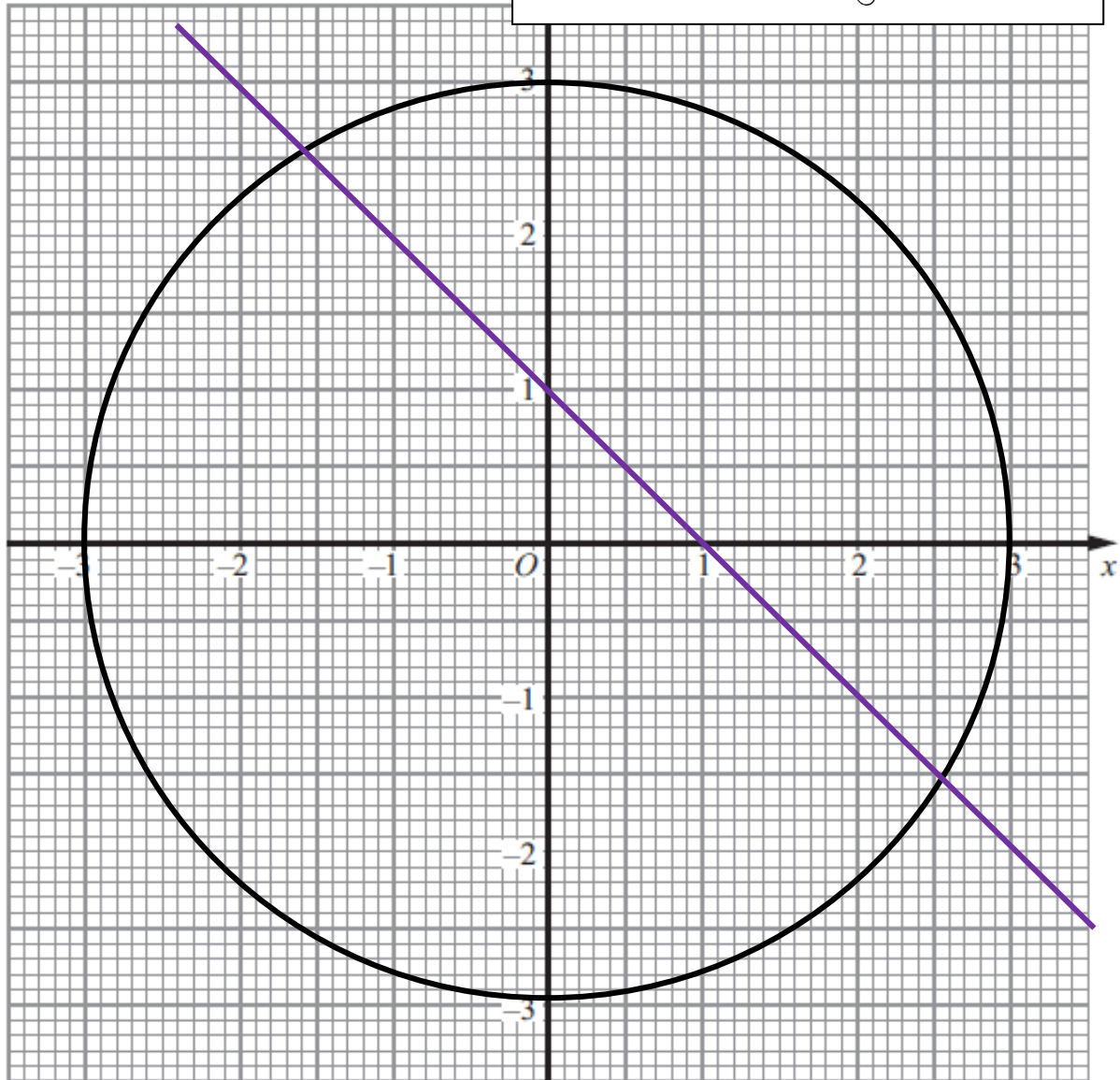
$$c = 3/2$$

$$\text{So } y = -1/2x + 3/2$$

(Total 4 marks)

(a) Construct the graph of $x^2 + y^2 = 9$

Hint: Remember the equation of a circle $x^2 + y^2 = r^2$



(2)

(b) By drawing the line $x + y = 1$ on the grid, solve the equations $x^2 + y^2 = 9$
 $x + y = 1$

$$x = 2.6, y = -1.6 \text{ or}$$

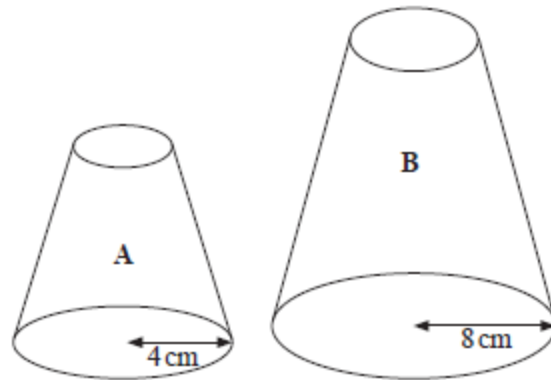
$$x = -1.6, y = 2.6$$

$$x = \dots\dots\dots, y = \dots\dots\dots$$

$$\text{or } x = \dots\dots\dots, y = \dots\dots\dots$$

(3)

(Total 5 marks)



Two solid shapes, **A** and **B**, are mathematically similar.

The base of shape **A** is a circle with radius 4 cm.

The base of shape **B** is a circle with radius 8 cm.

The surface area of shape **A** is 80 cm^2 .

(a) Work out the surface area of shape **B**.

Hint: Area SF = (Linear SF)²
Volume SF = (Linear SF)³

Linear SF = 2, so Area SF = 4

Surface area of shape B = $4 \times 80 = 320 \text{ cm}^2$

..... cm^2
(2)

The volume of shape **B** is 600 cm^3 .

(b) Work out the volume of shape **A**.

Linear SF = 2, so Volume SF = 8

Volume of shape A = $600 \div 8 = 75 \text{ cm}^3$

..... cm^3
(2)

(Total 4 marks)

Eric travels from the UK to India every year.

In 2010, the exchange rate was £1 = 67.1 rupees.

In 2012, the exchange rate was £1 = 82.5 rupees.

In 2010 Eric changed £600 into rupees.

How many pounds (£) did Eric have to change to rupees in 2012 to get the same number of rupees as he did in 2010?

Hint: Do this step by step, 2010 first

2010 $\times \frac{600}{1}$ $\curvearrowright$ £1 = 67.1 rupees
 $\rightarrow$ £600 = 600×67.1
 $= 40260$ rupees

2012 £1 = 82.5 rupees $\times \frac{40260}{82.5}$
 $? = 40260$ rupees $\curvearrowleft$

$? = £488$

£

(Total 3 marks)

23

Ali is planning a party.

He wants to buy some cakes and some sausage rolls.

The cakes are sold in boxes.

There are 12 cakes in each box.

Each box of cakes costs £2.50.

The sausage rolls are sold in packs.

There are 8 sausage rolls in each pack.

Each pack of sausage rolls costs £1.20.

Ali wants to buy more than 60 cakes and more than 60 sausage rolls.

He wants to buy exactly the same number of cakes as sausage rolls.

What is the least amount of money Ali will have to pay?

Hint: This uses common multiples

Cakes come in 12's 12, 24, ... 60, 72, 84 ...

Sausage rolls come in 8's 8, 16, ... 64, 72, 80 ...

So 72 is the first common multiple more than 60

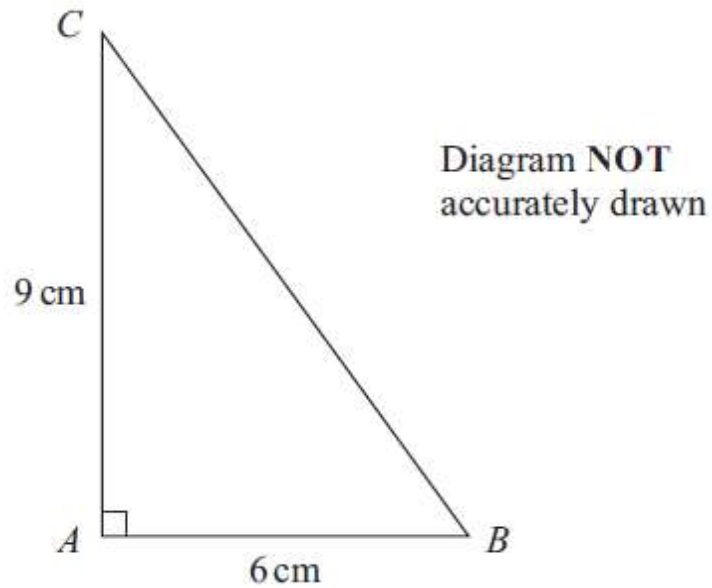
$72 \div 12 = 6$ packs of cakes and $6 \times £2.50 = £15$

$72 \div 8 = 9$ packs of sausage rolls and $9 \times £1.20 = £10.80$

So the total cost is £25.80

£.....

(Total 5 marks)



ABC is a right-angled triangle.

$AB = 6$ cm.

$AC = 9$ cm.

Work out the length of BC .

Give your answer correct to 3 significant figures.

Hint: Whose theorem are we using here?

Pythagoras' Theorem

$$x^2 = 6^2 + 9^2$$

$$x^2 = 36 + 81$$

$$x^2 = 117$$

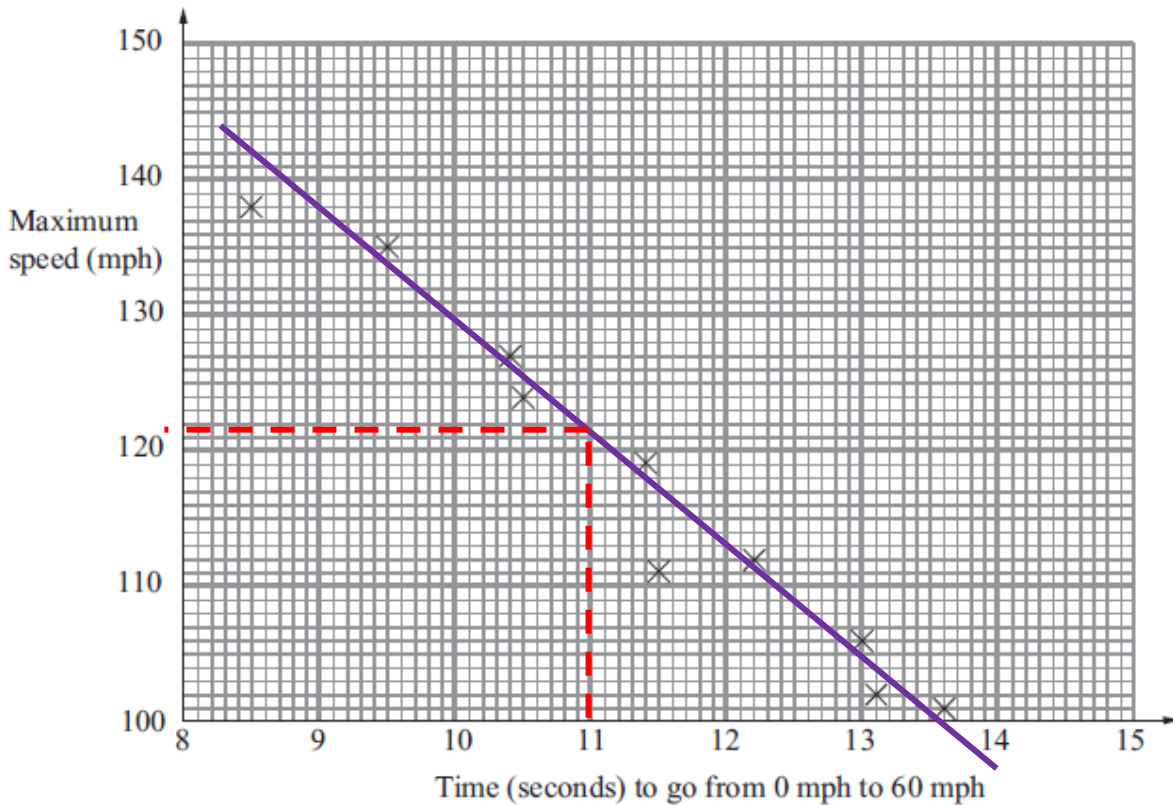
$$x = 10.8166538264 \dots$$

$$= 10.8 \text{ to 3 sig figs}$$

.....cm

(Total 3 marks)

The scatter graph shows some information about 10 cars.
It shows the time, in seconds, it takes each car to go from 0 mph to 60 mph.
For each car, it also shows the maximum speed, in mph.



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

Negative correlation

.....
(1)

The time a car takes to go from 0 mph to 60 mph is 11 seconds.

(b) Estimate the maximum speed for this car.

Hint: A line of best fit helps get a good estimate, so draw on the graph

On the graph with my line of best fit I get 121 mph
But accept any reasonable answer in the range 117 to 123

..... mph
(2)

(Total 3 marks)

A town has three car parks.

South car park has x spaces.

North car park has 48 more spaces than South car park.

Central car park has four times as many spaces as South car park.

The total number of spaces in South car park and Central car park is more than twice the number of spaces in North car park.

Work out the least possible number of spaces in South car park.

Hint: This is easiest solved by writing algebraic expressions for each car park

South x

North $x + 48$

Central $4x$

South + Central $> 2 \times$ North

$$x + 4x > 2(x + 48)$$

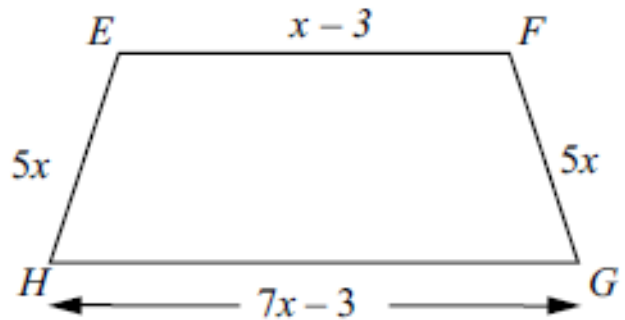
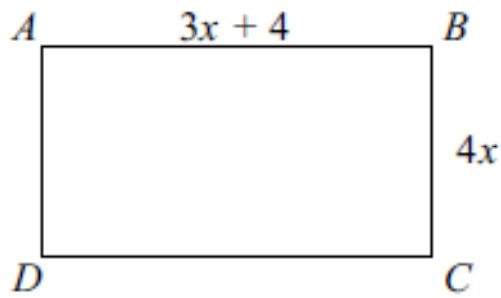
$$5x > 2x + 96$$

$$3x > 96$$

$$x > 32$$

.....
(Total 5 marks)

$ABCD$ is a rectangle.
 $EFGH$ is a trapezium.



The perimeters of these two shapes are the same.
 All measurements are in centimetres.

(i) Work out the value of x .

Hint: If the perimeters are the same that means they are equal

$$\begin{aligned} P \text{ rectangle} &= 3x + 4 + 4x + 3x + 4 + 4x \\ &= 14x + 8 \end{aligned}$$

$$\begin{aligned} P \text{ trapezium} &= x - 3 + 5x + 7x - 3 + 5x \\ &= 18x - 6 \end{aligned}$$

$$18x - 6 = 14x + 8$$

$$4x = 14$$

$$x = 3.5$$

$x = \dots\dots\dots$

(ii) Write down the length and the width of the rectangle.

$$\text{Rectangle length} = 3x + 4 = 14.5 \text{ cm}$$

$$\text{Rectangle width} = 4x = 14 \text{ cm}$$

length cm

width cm

(Total 6 marks)

28

When a water pipe bursts the water can cause damage.

The damage can be minor or severe.

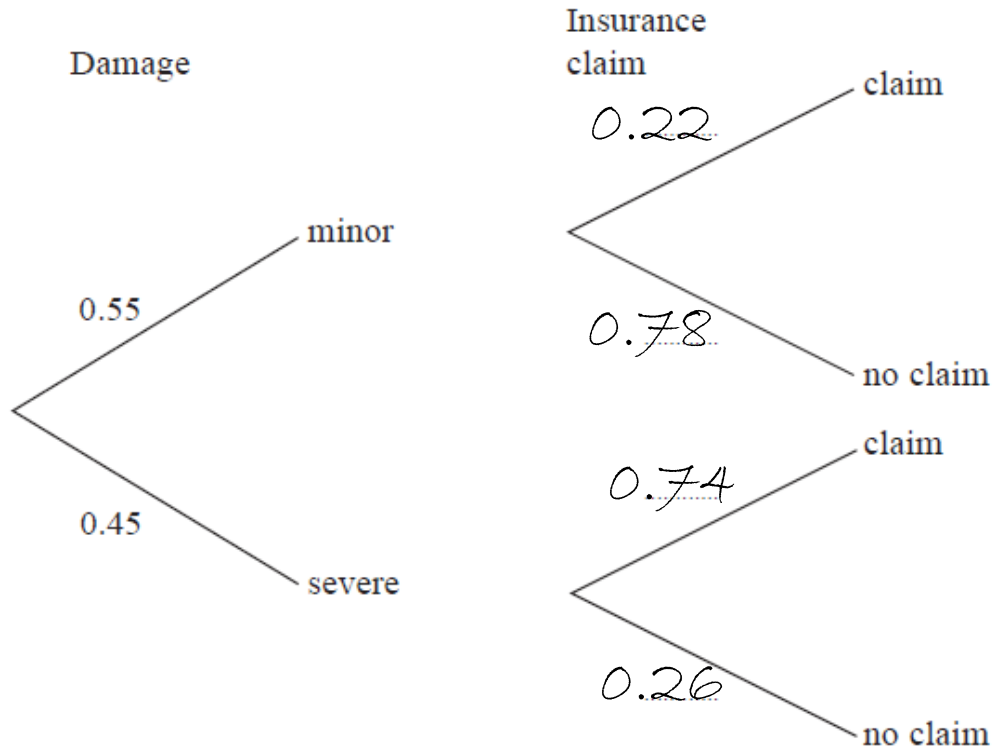
The probability of minor damage is 0.55

The probability of severe damage is 0.45

Insurance claims can be made for the damage.

When the damage is minor, the probability that an insurance claim is made is 0.22

When the damage is severe, the probability that an insurance claim is made is 0.74



(a) Complete the decision tree diagram.

(2)

The insurance company uses the information in the decision tree diagram to decide whether they need to increase their charges for insurance.

If the probability that insurance claims for damage will be made is greater than 50%, the insurance company will increase their charges for insurance.

(b) Will the insurance company increase their charges?

Hint: In which cases are there claims? Work out these probs.

Minor - Claim $0.55 \times 0.22 = 0.121$

Severe - Claim $0.45 \times 0.74 = 0.333$

So chance of a claim = 0.454, so no they won't increase their charges

(4)
(Total 6 marks)

Solve $x + 2y = 3$

$x - y = 6$

Hint: Simultaneous equations are easier to solve if you can add the two equations together and eliminate a variable

I'm going to eliminate the y 's because one equation is positive and the other is negative.

$$\begin{array}{l} x + 2y = 3 \\ x - y = 6 \end{array} \quad \left. \vphantom{\begin{array}{l} x + 2y = 3 \\ x - y = 6 \end{array}} \right\}$$

$$\begin{array}{l} x + 2y = 3 \\ 2x - 2y = 12 \end{array} \quad \left. \vphantom{\begin{array}{l} x + 2y = 3 \\ 2x - 2y = 12 \end{array}} \right\} \quad \boxed{+}$$

$$3x = 15$$

$$x = 5 \text{ and } y = -1$$

$$x = \dots\dots\dots$$

$$y = \dots\dots\dots$$

(Total 3 marks)

Colin, Dave and Emma share some money.

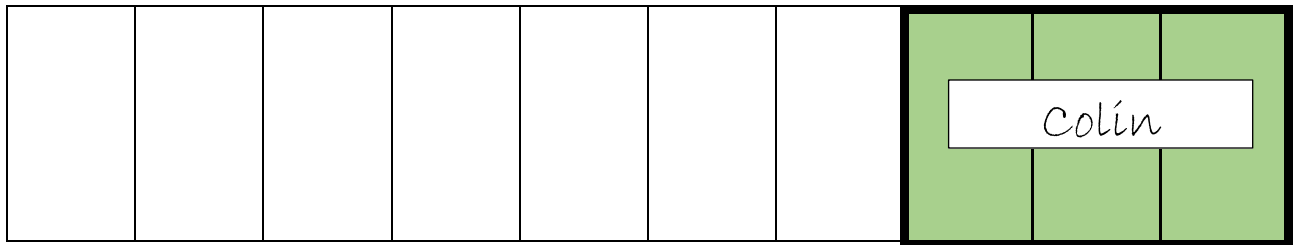
Colin gets $\frac{3}{10}$ of the money.

Emma and Dave share the rest of the money in the ratio 3 : 2.

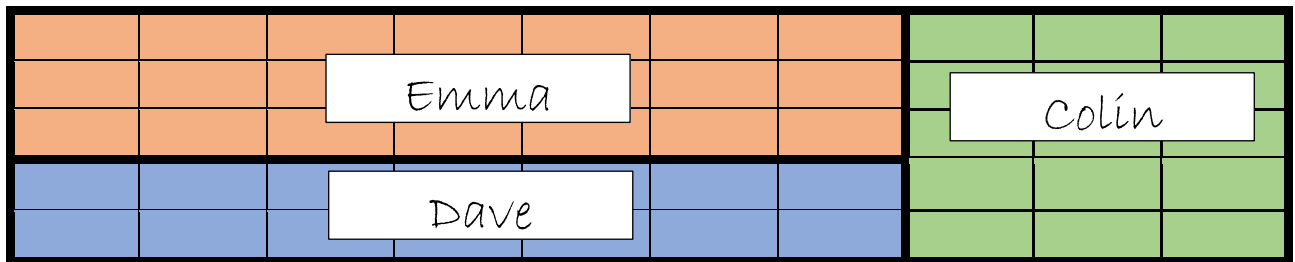
What is Dave's share of the money?

Hint: Drawing diagrams can help you understand and think about the information

So Emma and Dave share $\frac{7}{10}$ in the ratio 3 : 2



If we chop those 7 pieces into 5 pieces each (and Colins' bits) then that makes fiftieths altogether.



And Dave gets $\frac{14}{50}$

.....
(Total 4 marks)

The n th term of a sequence is $n^2 + 4$

Alex says

“The n th term of the sequence is always a prime number when n is an odd number.”

Alex is wrong.

Give an example to show that Alex is wrong.

Hint: All you have to do is find out counter-example

$$n\text{th term} = n^2 + 4$$

Prime numbers $n = 1, 3, 5, 7, 11, 13 \dots$

If $n = 1$, $n^2 + 4 = 5$ which is prime

If $n = 3$, $n^2 + 4 = 13$ which is prime

If $n = 5$, $n^2 + 4 = 29$ which is prime

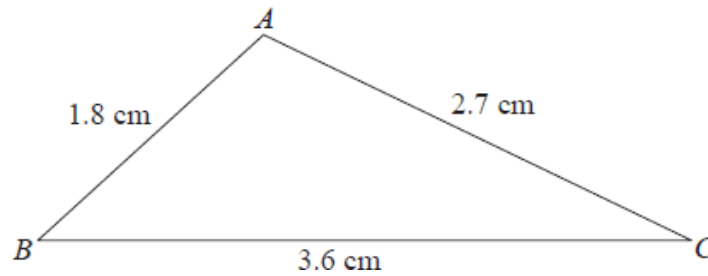
If $n = 7$, $n^2 + 4 = 53$ which is prime

If $n = 9$, $n^2 + 4 = 85$ which is NOT prime

So Alex is wrong

(Total 2 marks)

The diagram shows a triangle ABC .



- (a) Work out the size of angle A .
Give your answer correct to 1 decimal place.

Hint: All 3 sides and a missing angle - which rule is this?

$$\text{Cosine Rule: } a^2 = b^2 + c^2 - 2bc \cos A$$

$$3.6^2 = 2.7^2 + 1.8^2 - 2 \times 2.7 \times 1.8 \times \cos A$$

$$12.96 = 10.53 - 9.72 \times \cos A$$

$$\cos A = -0.25$$

$$A = 104.4775122 = 104.5 \text{ to 1 dp} \quad \text{.....}^\circ \quad (3)$$

- (b) Work out the area of triangle ABC .
Give your answer correct to 1 decimal place.

$$\text{Area of a triangle} = \frac{1}{2}bs \sin A$$

$$= \frac{1}{2} \times 2.7 \times 1.8 \times \sin 104.5$$

$$= 2.352837381 \dots$$

$$= 2.4 \text{ to 1 dp}$$

$$\text{..... cm}^2 \quad (2)$$

(Total 5 marks)

33

The average fuel consumption (c) of a car, in kilometres per litre, is given by the formula

$$c = \frac{d}{f}$$

where d is the distance travelled in kilometres and f is the fuel used in litres.

$d = 190$ correct to 3 significant figures.

$f = 25.7$ correct to 1 decimal place.

By considering bounds, work out the value of c to a suitable degree of accuracy.

You must show **all** of your working **and** give a reason for your final answer.

Hint: work out the upper and lower bounds of everything including the calculation

Distance: $LB = 189.5$ $UB = 190.5$

Fuel: $LB = 25.65$ $UB = 25.75$

Smallest consumption: $c = \frac{189.5}{25.75} = 7.359223301$

Biggest consumption: $c = \frac{190.5}{25.65} = 7.426900585$

Both calculations round to 7.4, so 7.4 is a suitable degree of accuracy

(Total 5 marks)

Liquid A has a density of 0.7 g/cm^3 .

Liquid B has a density of 1.6 g/cm^3 .

140 g of liquid A and 128 g of liquid B are mixed to make liquid C.

Work out the density of liquid C.

Hint: Density = $\frac{\text{Mass}}{\text{Volume}}$

$$\text{Liquid A: } D = \frac{M_A}{V_A} \quad \text{so } 0.7 = \frac{140}{V_A}$$

$$V_A = 200 \text{ cm}^3$$

$$\text{Liquid B: } D = \frac{M_B}{V_B} \quad \text{so } 1.6 = \frac{128}{V_B}$$

$$V_B = 80 \text{ cm}^3$$

$$\text{Liquid C: } D = \frac{M_A + M_B}{V_A + V_B} = \frac{140 + 128}{200 + 80}$$

$$= \frac{268}{280}$$

$$= 0.957142857$$

$$= 0.98 \text{ (2 dp)}$$

..... g/cm^3

(Total 4 marks)

f is the function $f(x) = 2x + 5$.

(a) Find $f(3)$. $f(3) = 2 \times 3 + 5$
 $= 11$

(1)

(b) Express the inverse function f^{-1} in the form $f^{-1}(x) =$

$$f^{-1}(x) = \frac{x - 5}{2}$$

$f^{-1}(x) = \dots\dots\dots$
 (2)

g is the function $g(x) = x^2 - 25$.

(c) Find $g(-3)$. $g(-3) = (-3)^2 - 25$
 $= 9 - 25$
 $= -16$

(1)

(d) (i) Find $gf(x)$.

Give your answer as simply as possible.

Hint: $gf(x)$ means
 f first then g

$$\begin{aligned} gf(x) &= g(2x + 5) \\ &= (2x + 5)^2 - 25 \\ &= 4x^2 + 20x + 25 - 25 \\ &= 4x^2 + 20x \end{aligned}$$

(ii) Solve $gf(x) = 0$.

$$gf(x) = 4x^2 + 20x = 0$$

$$4x(x + 5) = 0$$

$$\text{Either } 4x = 0 \text{ or } (x + 5) = 0$$

$$\text{So } x = 0 \text{ or } x = -5$$

(5)

(Total 9 marks)

Phil has 20 sweets in a bag.

5 of the sweets are orange.

7 of the sweets are red.

8 of the sweets are yellow.

Phil takes at random **two** sweets from the bag.

Work out the probability that the sweets will **not** be the same colour.

Hint: you can draw a probability tree or work it out from listing all outcomes

All possible outcomes

OO

$$\text{OR } \frac{5}{20} \times \frac{7}{19} = \frac{35}{380}$$

$$\text{OY } \frac{5}{20} \times \frac{8}{19} = \frac{40}{380}$$

$$\text{RO } \frac{7}{20} \times \frac{5}{19} = \frac{35}{380}$$

RR

$$\text{RY } \frac{7}{20} \times \frac{8}{19} = \frac{56}{380}$$

$$\text{YO } \frac{8}{20} \times \frac{5}{19} = \frac{40}{380}$$

$$\text{YR } \frac{8}{20} \times \frac{7}{19} = \frac{56}{380}$$

YY

$$\begin{aligned} P(2 \text{ different types}) &= \frac{35}{380} + \frac{40}{380} + \frac{35}{380} + \frac{56}{380} + \frac{40}{380} + \frac{56}{380} \\ &= \frac{262}{380} \\ &= \frac{131}{190} \end{aligned}$$

Or this can be done by calculating OO, RR and YY and subtracting from 1

.....
(Total 4 marks)

P is inversely proportional to the square of x .

Given that $x = 5$ when $P = 6$, find the value of P when $x = 8$

Give your answer correct to 2 decimal places.

Hint: use the first lot of figures to find your constant

Inverse proportion $P \propto \frac{1}{x^2}$

ie. $P = \frac{k}{x^2}$

So if $x = 5$ and $P = 6$, $6 = \frac{k}{25}$

$$k = 150$$

So $P = \frac{150}{x^2}$

And if $x = 8$, $P = \frac{150}{8^2} = \frac{150}{64} = 2.34375$

$P = \dots\dots\dots$

(Total 3 marks)

38

Fred is making two rectangular flower beds.

The dimensions of the larger rectangle will be three times the dimensions of the smaller rectangle.

There is going to be the same depth of soil in each flower bed.

Fred needs 180 kg of soil for the smaller flower bed.

Work out how much soil Fred needs for the larger flower bed.

Hint: This is about Area scale Factor

As there is the same depth of soil, the area of the flower beds is the key information

The linear scale factor from small to big is 3

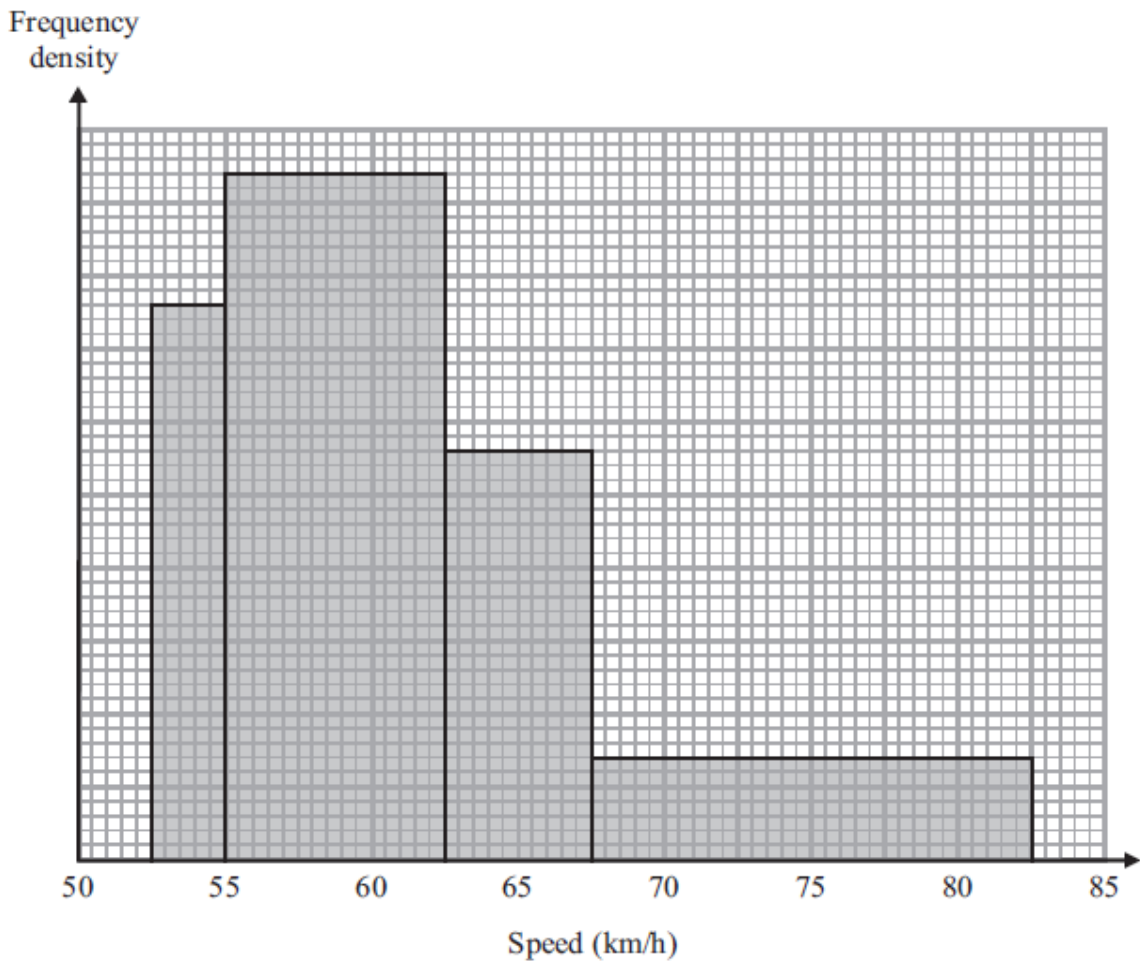
So the area scale factor is 9

So he will need $9 \times 180 = 1620$ kg of soil

..... kg

(Total 2 marks)

The histogram gives information about the speeds, in km/h, of some cars on a road.



Work out an estimate for the median speed.

Give your answer correct to 1 decimal place. You must show your working.

Hint: Histograms use frequency density related to the area of a bar

$$\text{Area bar 1} = 2.5 \times 7.6 = 19$$

$$\text{Area bar 2} = 7.5 \times 9.4 = 70.5$$

$$\text{Area bar 3} = 5 \times 5.6 = 28$$

$$\text{Area bar 4} = 13 \times 1.4 = 18.2$$

$$\text{Total area} = 135.7$$

Median is at area 67.85 which is in bar 2

$$67.85 - 19 = 48.85$$

$$48.85 \div 9.4 = 5.2074 \dots$$

$$\text{So median} \approx 60.2 \text{ (1 dp)}$$

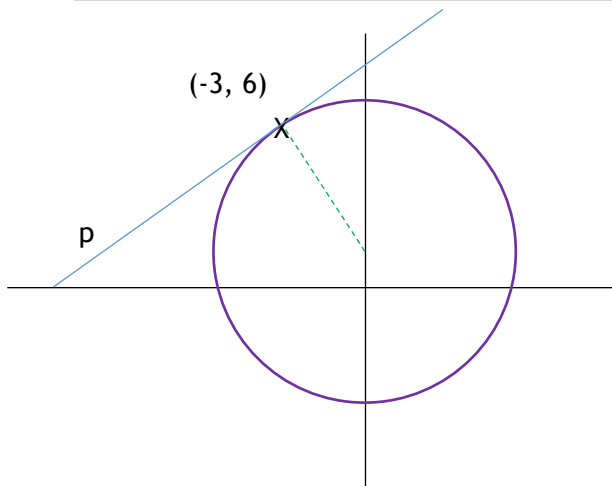
(Total 4 marks)

The line **L** is a tangent to the circle $x^2 + y^2 = 45$ at the point $(-3, 6)$.

The line **L** crosses the x -axis at the point P .

Work out the coordinates of P .

Hint: Draw a sketch of this so you know what you are looking at



Equation of the line forming the radius

$$y = mx + c \quad m = -2, c = 0$$

$$\text{So } y = -2x$$

Gradients of perpendicular lines: $m_1 m_2 = -1$

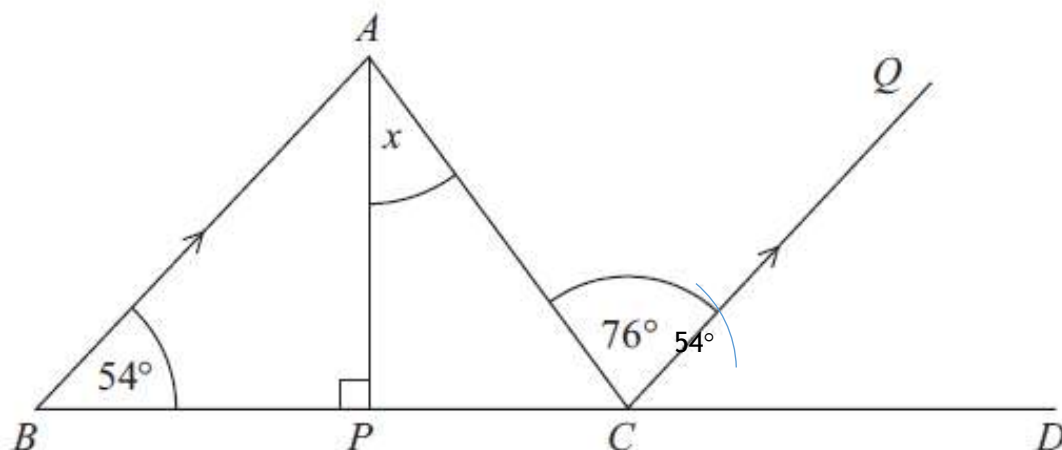
So gradient of tangent $= \frac{1}{2}$

This means for every step to the right you go up $\frac{1}{2}$

So for every step to the left you go down $\frac{1}{2}$

As we're at 6 up and I want to be at zero, I will have to take 12 steps to the left. And I'm already at -3, so I will end up at $(-15, 0)$

.....
(Total 4 marks)



$BPCD$ is a straight line.

BA is parallel to CQ .

AP is perpendicular to BC .

Angle $ABC = 54^\circ$

Angle $ACQ = 76^\circ$

Work out the size of the angle marked x .

Give reasons for your answer.

Hint: Draw on your diagram any angles you already know and give your reasons

Angle $DCQ = 54^\circ$ because corresponding angles on parallel lines are equal

Angle $CPA = 90^\circ$ because angles on a straight line add up to 180°

Angle $PCA = 50^\circ$ because angles on a straight line add up to 180°

So angle $x = 180 - 90 - 50 = 40^\circ$ because angles in a triangle add to 180°

Or any equivalent argument

(Total 4 marks)

Jenny is organising a party.
She buys some paper plates and some plastic cups.

Paper plates are sold in packs.
There are 25 plates in a pack.
Each pack costs 78p.

Plastic cups are sold in packs.
There are 35 cups in a pack.
Each pack costs £1.10

Jenny buys exactly the same number of plates and cups.

What is the least amount of money she pays?

Hint: This is about common multiples

Paper plates: 25, 50, 75, 100, 125, 150, 175, 200 ...

Plastic cups: 35, 70, 105, 140, 175, 205 ...

The lowest common multiple is 175

ie. 7 packs of plates + 5 packs of cups

$$= 7 \times £0.78 + 5 \times £1.10$$

$$= £10.96$$

£

(Total 5 marks)

There are only red beads and green beads in a bag.

The ratio of the number of red beads to the number of green beads is 5 : 9

Hint: Ratio is part to part and fraction is part to whole

$$\text{Fraction of red} = \frac{5}{14} \quad \dots\dots\dots (1)$$

There is a total of 84 beads in the bag.

(b) How many of the beads are green?

$$\text{Number of green} = \frac{9}{14} \times 84 = 54 \quad \dots\dots\dots (3)$$

Susie is going to put some more beads in the bag.

There will still be only red beads and green beads in the bag.

Susie wants to have twice as many green beads as red beads in the bag.

(c) What beads should she put in the bag?

You must explain your answer.

$$\text{Number of green} = 54$$

$$\text{And number of red} = 30$$

So if she wants twice as many green as red
she should add 6 green

(3)

(Total 7 marks)

The table shows some information about the average adult spending in 2008 as a percentage of average **total** adult spending in 2008.

Item	Percentage
food	11%
housing	11%
leisure	13%
clothes	5%
transport	14%
household goods	8%
other items	38%

In May 2008, Katie spent a total of £425.

She spent £48.45 of the £425 on food.

Compare the percentage that Katie spent on food with the average adult spending on food.

Hint: Read the question carefully

$$\text{So } £48.45 \text{ out of } £425 = \frac{48.45}{425} \times 100 = 11.4\%$$

So Katie spends slightly more on food than the average adult

(Total 3 marks)

Coventry Estates sells houses.

In February they sold twice as many houses as in January.

In March they sold 10 more houses than in February.

In April they sold half as many houses as in March.

Coventry Estates sold a minimum of 123 houses from 1st January to 30th April.

Find the least number of houses sold in January.

Hint: Let x be in the number of houses they sold in January

January: x houses

February: $2x$

March: $2x + 10$

April: $\frac{2x + 10}{2} = x + 5$

From Jan - April they sold:

$$x + 2x + 2x + 10 + x + 5 = 6x + 15$$

$$6x + 15 \geq 123$$

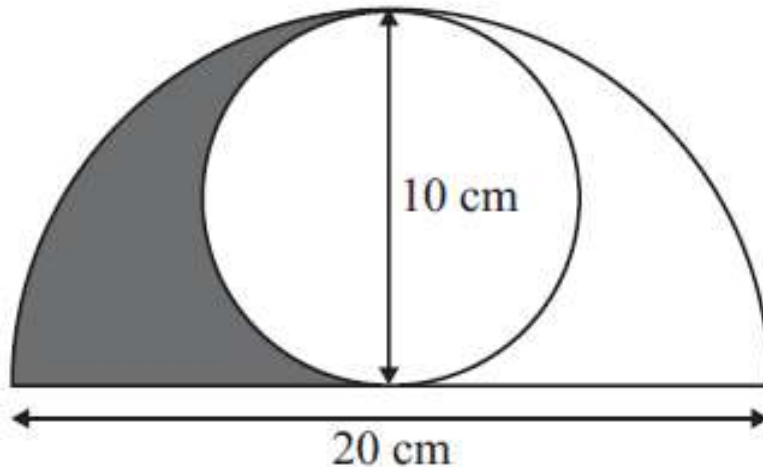
$$6x \geq 108$$

$$x \geq 18$$

So the least number is 18

.....
(Total 5 marks)

The diagram shows a circle inside a semicircle.



The circle has a diameter of 10 cm.
The semicircle has a diameter of 20 cm.

Work out the area shaded.
Give your answer correct to 1 decimal place.

Hint: Area shaded is $\frac{1}{4}$ of the big circle - $\frac{1}{2}$ of the little circle

$$\text{Area of circle} = \pi r^2$$

$$\text{Big circle } r = 10, \text{ area} = 100\pi$$

$$\text{Little circle } r = 5, \text{ area} = 25\pi$$

$$\text{Area of shaded part} = \frac{1}{4} \times 100\pi - \frac{1}{2} \times 25\pi$$

$$= 25\pi - 12.5\pi$$

$$= 12.5\pi$$

$$= 39.26990817 \dots$$

$$= 39.3 \text{ to 1 dp} \dots \text{ cm}^2$$

(Total 5 marks)

Ali was asked to solve the equation $6x - 2 = 3(x + 4)$

Here is his working.

$$6x - 2 = 3(x + 4)$$

$$6x - 2 = 3x + 7$$

$$6x = 3x + 9$$

$$3x = 9$$

$$x = 3$$

Asif's answer is wrong.
What mistake did he make?

.....

.....

Hint: Try to describe the error and also show what he should have done

He didn't multiply out the bracket correctly

$$6x - 2 = 3(x + 4)$$

becomes

$$6x - 2 = 3x + 12$$

$$6x = 3x + 14$$

$$3x = 14$$

$$x = 14/3$$

(Total 1 mark)

Sam invests £5000 at 2.8% per annum compound interest for 4 years.

- (a) Work out the value of Sam's investment at the end of 4 years.

Hint: Remember the difference between simple and compound interest

Compound interest amount

$$= \text{Amount} \times (1 + \text{Interest})^{\text{Time}}$$

$$= 5000 \times (1 + 0.028)^4$$

$$= 5000 \times 1.028^4$$

$$= \text{£}5583.96 \text{ to the nearest penny} \dots\dots\dots$$

(3)

Andy invests £12 000 in a variable rate compound interest account.

The interest is

2% for the first year

3.5% for the second year

5% for the third year

- (b) Work out the value of Andy's investment at the end of 3 years.

Hint: Do each part separately

First year: $\text{£}12000 \times 1.02$

Second year: $(\text{£}12000 \times 1.02) \times 1.035$

Third year: $((12000 \times 1.02) \times 1.035) \times 1.05$
 $= \text{£}13301.82$

£.....

(2)

(Total 5 marks)

A rectangular lawn has a length of $3x$ metres and a width of $2x$ metres.
The lawn has a path of width 1 metre on three of its sides.

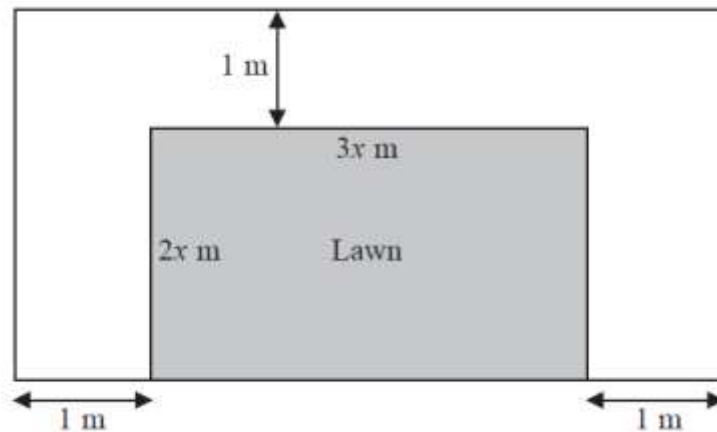


Diagram NOT
accurately drawn

The total area of the lawn and the path is 100 m^2 .

(a) Show that $6x^2 + 7x - 98 = 0$

Hint: What is the total length in terms of x , and then what is the total width in terms of x ?

$$\text{Total area: } (3x + 2)(2x + 1) = 100$$

$$6x^2 + 7x + 2 = 100$$

$$6x^2 + 7x - 98 = 0$$

(2)

(b) Calculate the area of the lawn.
Show clear algebraic working.

$$\text{Factorise: } (3x + 14)(2x - 7) = 0$$

$$\text{So } 3x + 14 = 0 \text{ or } 2x - 7 = 0$$

$$3x = -14 \text{ or } 2x = 7$$

$$x \text{ is negative or } x = 3.5$$

Can't have a negative length, so $x = 3.5$

$$\text{And the lawn is } 10.5 \times 7 = 73.5 \text{ m}^2$$

..... m^2
(5)

(Total 7 marks)

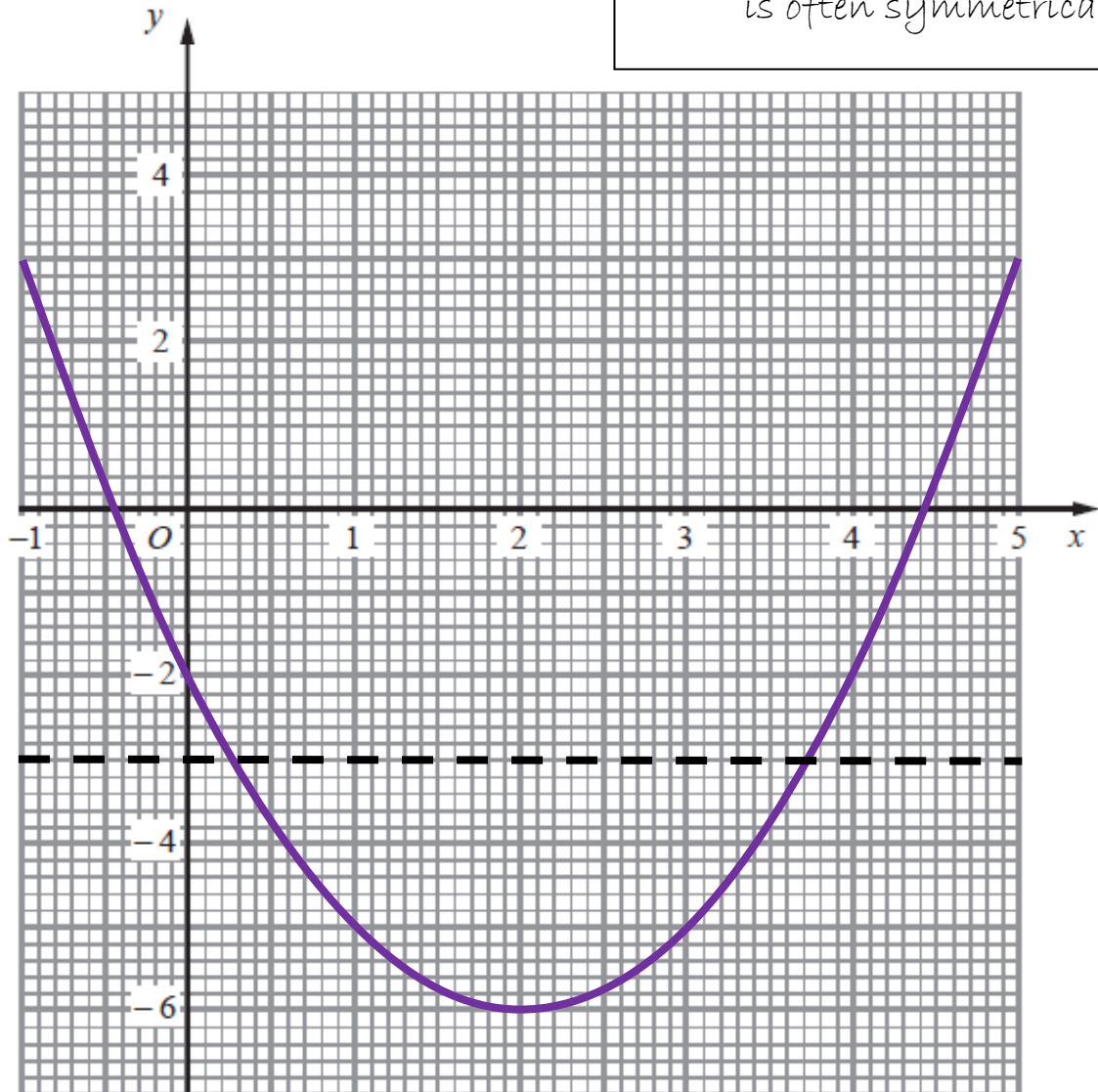
(a) Complete the table of values for $y = x^2 - 4x - 2$

x	-1	0	1	2	3	4	5
y	3	-2	-5	-6	-5	-2	3

(2)

(b) On the grid, draw the graph of $y = x^2 - 4x - 2$

Hint: Remember that a quadratic is often symmetrical



(2)

(c) Use your graph to estimate the values of x when $y = -3$

An extra line for $y = -3$
 $x = 0.3, 3.7$

$x = \dots\dots\dots$

$x = \dots\dots\dots$

(2)

(Total 6 marks)

In a sale, normal prices are reduced by 12%.

The sale price of a digital camera is £132.88

Work out the normal price of the digital camera.

Hint: So you know how much 88% is

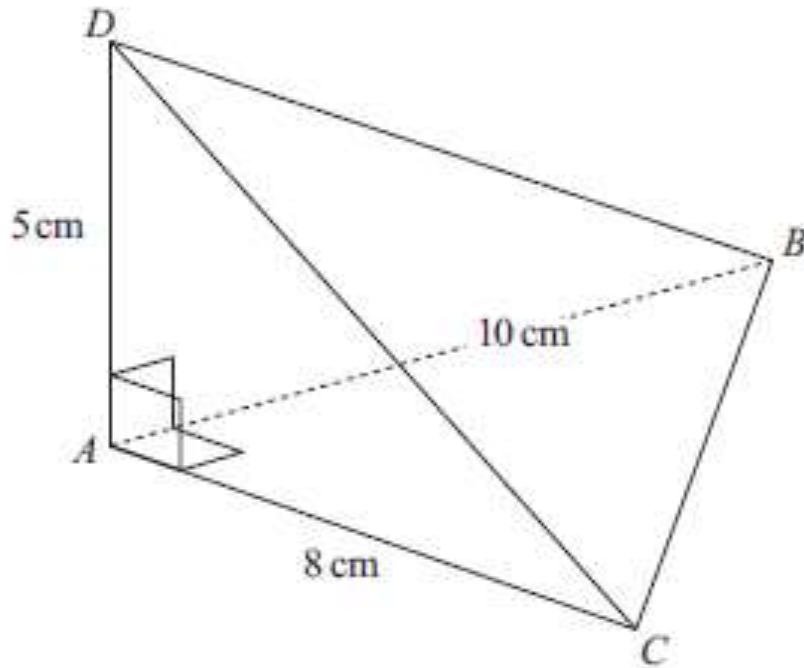
$$88\% = 132.88$$

$$1\% = 132.88 \div 88$$

$$\begin{aligned} 100\% &= 132.88 \times 100/88 \\ &= £151 \end{aligned}$$

£

(Total 3 marks)



The diagram shows a tetrahedron.

AD is perpendicular to both AB and AC .

$AB = 10$ cm.

$AC = 8$ cm.

$AD = 5$ cm.

Hint: BDC is not a right angle triangle but all the others are

Angle $BAC = 90^\circ$.

Calculate the size of angle BDC .

Give your answer correct to 1 decimal place.

$$BC^2 = AB^2 + AC^2 \quad DC^2 = DA^2 + AC^2 \quad DB^2 = AB^2 + DA^2$$

$$= 10^2 + 8^2$$

$$BC = \sqrt{164}$$

$$= 5^2 + 8^2$$

$$DC = \sqrt{89}$$

$$= 10^2 + 5^2$$

$$DB = \sqrt{125}$$

$$\text{Cosine Rule: } BC^2 = DC^2 + DB^2 - 2 \times DC \times DB \cos CDB$$

$$164 = 89 + 125 - 2 \times \sqrt{89} \times \sqrt{125} \cos CDB$$

$$\text{Angle } CDB = 76.3^\circ$$

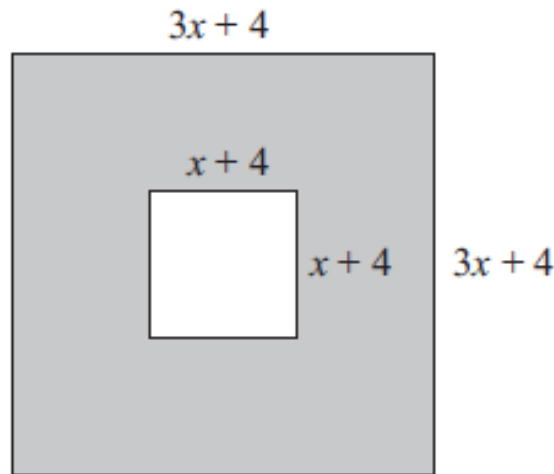
.....°

(Total 6 marks)

A machine part is made by cutting a small square from the centre of a large square piece of steel.

The dimensions of the machine part are shown on the diagram.

All measurements are in cm.



The perimeter of the small square is two thirds of the perimeter of the large square.
Work out the length of a side of the small square.

Hint: Find the perimeter of each square

$$\text{Little square perimeter} = 4x + 16$$

$$\text{Big square perimeter} = 12x + 16$$

$$\text{Little square perimeter} = \frac{2}{3} \text{ big square perimeter}$$

$$4x + 16 = \frac{2}{3} (12x + 16)$$

$$4x + 16 = 8x + \frac{32}{3}$$

$$\frac{16}{3} = 4x$$

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

$$\text{Side of the little square} = \frac{4}{3} + 4 = 5\frac{1}{3} \dots \text{cm}$$

(Total 5 marks)

Carolyn has 20 biscuits in a tin.

She has

- 12 plain biscuits
- 5 chocolate biscuits
- 3 ginger biscuits

Carolyn takes at random two biscuits from the tin.

Work out the probability that the two biscuits were **not** the same type.

Hint: You can draw a probability tree or work it out from listing all outcomes

All possible outcomes

PP

$$PC \quad \frac{12}{20} \times \frac{5}{19} = \frac{60}{380}$$

$$PG \quad \frac{12}{20} \times \frac{3}{19} = \frac{36}{380}$$

$$CP \quad \frac{5}{20} \times \frac{12}{19} = \frac{60}{380}$$

CC

$$CG \quad \frac{5}{20} \times \frac{3}{19} = \frac{15}{380}$$

$$GP \quad \frac{3}{20} \times \frac{12}{19} = \frac{36}{380}$$

$$GC \quad \frac{3}{20} \times \frac{5}{19} = \frac{15}{380}$$

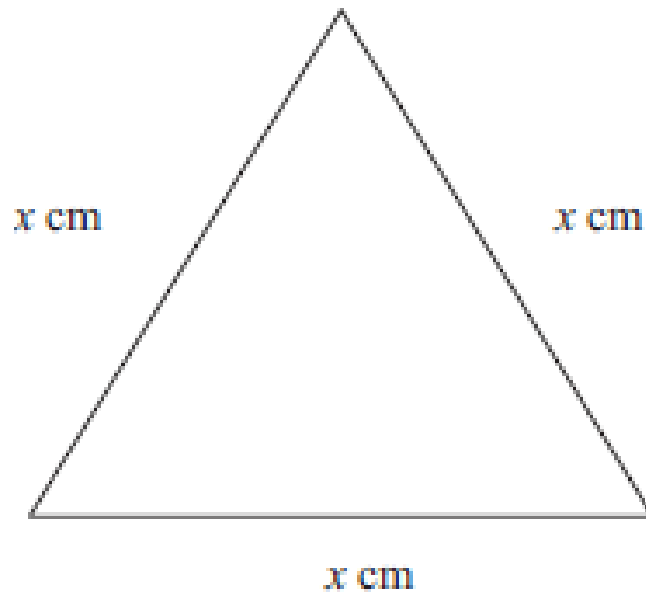
GG

$$\begin{aligned} P(2 \text{ different types}) &= \frac{60}{380} + \frac{36}{380} + \frac{60}{380} + \frac{15}{380} + \frac{36}{380} + \frac{15}{380} \\ &= \frac{222}{380} \\ &= \frac{111}{190} \end{aligned}$$

Or this can be done by calculating PP, CC and GG and subtracting from 1

.....
(Total 4 marks)

The diagram shows an equilateral triangle.



The area of the equilateral triangle is 36 cm^2 .

Find the value of x .

Give your answer correct to 3 significant figures.

*Hint: What is the trig formula for the area of a triangle?
And remember that this is an equilateral triangle*

$$\text{Area} = \frac{1}{2} ab \sin C$$

$$= \frac{1}{2} \times x \times x \times \sin 60 = 36$$

$$\frac{1}{2} x^2 \times \sin 60 = 36$$

$$x = 9.118028228 \dots$$

$$= 9.12 \text{ to 3 sig figs}$$

$x = \dots\dots\dots$

(Total 3 marks)

Prove algebraically that the product of two odd numbers is **always** an odd number.

Hint: Remember what the generic odd number is for proof

Two odd numbers are $(2n + 1)$ and $(2m + 1)$

$$\begin{aligned}(2n + 1)(2m + 1) \\&= 4nm + 2n + 2m + 1 \\&= 2(2nm + n + m) + 1\end{aligned}$$

The first term is even because it can be divided by 2.

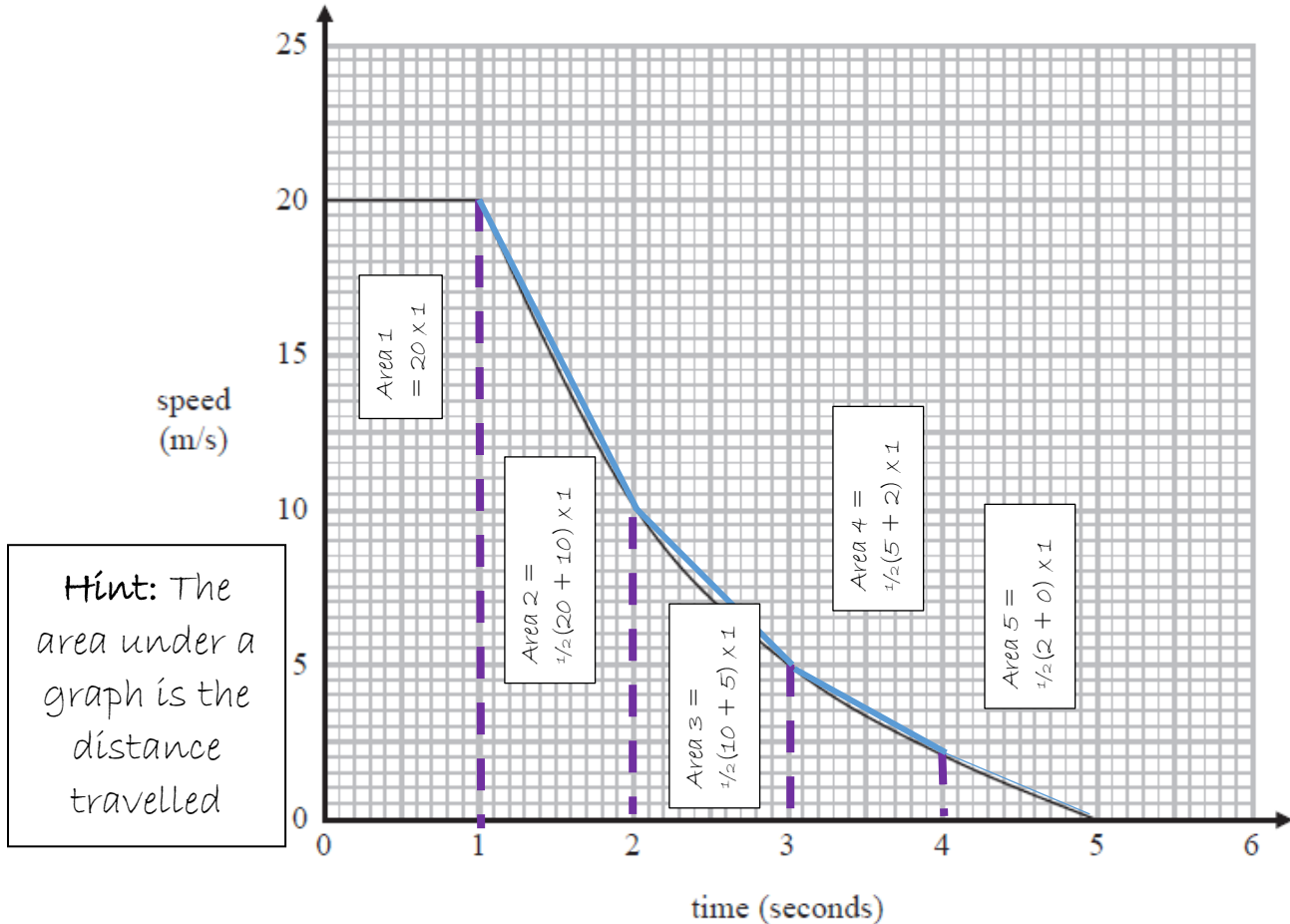
And if you add one to any even number the result is always odd.

QED

A car is approaching a set of traffic lights.
The traffic lights turn red.

It takes the car 4 seconds to slow down to a stop.

Here is the speed-time graph for the 5 seconds until the car stops.



(a) Work out an estimate for the distance the car travels in these 5 seconds.

$$20 + 15 + 7.5 + 3.5 + 1 = 47 \text{ m}$$

..... m
(3)

(b) Is your answer to (a) an underestimate or an overestimate of the actual distance the car travels in these 5 seconds?

Give a reason for your answer.

the area of each trapezium is larger than the area under the curve so it is an overestimate..... (1)

(Total 4 marks)

A farmer wants to estimate the number of rabbits on his farm.

On Monday he catches 120 rabbits.

He puts a tag on each rabbit.

He then lets the rabbits run away.

On Tuesday the farmer catches 70 rabbits.

15 of these rabbits have a tag on them.

Work out an estimate for the total number of rabbits on the farm.

You must write down any assumptions you have made.

<i>Hint: This is Capture - Recapture</i> $\frac{\text{tagged rabbits in sample}}{\text{sample size}} = \frac{\text{tagged rabbits}}{\text{population size rabbits}}$

$$\frac{15}{70} = \frac{120}{\text{population}}$$

$$\text{Population} = \frac{70 \times 120}{15} = 560 \text{ rabbits}$$

Any mathematical assumption such as:
 population hasn't changed overnight
 sample is random

(Total 4 marks)

Axel and Lethna are driving along a motorway.

They see a road sign.

The road sign shows the distance to Junction 8

It also shows the average time drivers take to get to Junction 8

To Junction 8
30 miles
26 minutes

The speed limit on the motorway is 70 mph.

Lethna says

“We will have to drive faster than the speed limit to drive 30 miles in 26 minutes.”

Is Lethna right?

You must show how you get your answer.

Hint: Remember that speed is the distance covered in a unit of time

30 miles in 26 mins

speed = $30 \div 26$ miles per minute

= $30 \div 26 \times 60$ miles per hour

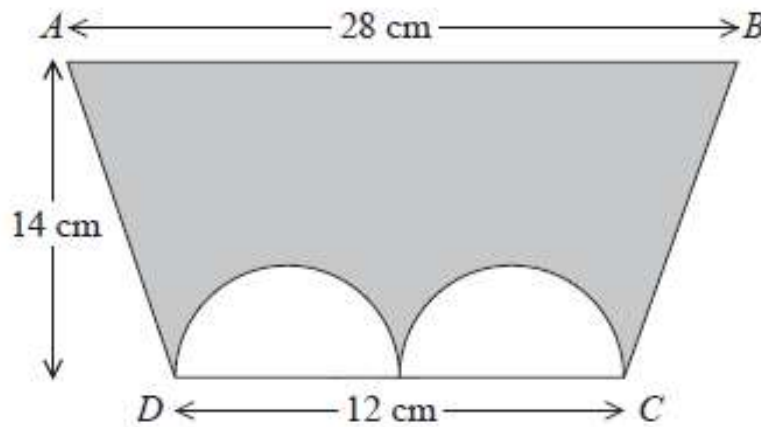
= 69.2307692308 ... mph

So no they won't have to drive faster than the speed limit ... just

Or other relevant calculation

(Total is 3 marks)

The diagram shows a trapezium $ABCD$ and two identical semicircles.



The centre of each semicircle is on DC .

Work out the area of the shaded region.

Give your answer correct to 3 significant figures.

Hint: Deal with each area separately

$$\begin{aligned}
 \text{Area of trapezium} &= \frac{1}{2} \times (\text{top} + \text{bottom}) \times \text{height} \\
 &= \frac{1}{2} \times (28 + 12) \times 14 \\
 &= 280 \text{ cm}^2
 \end{aligned}$$

Both semi circles make one full circle, $r = 3 \text{ cm}$

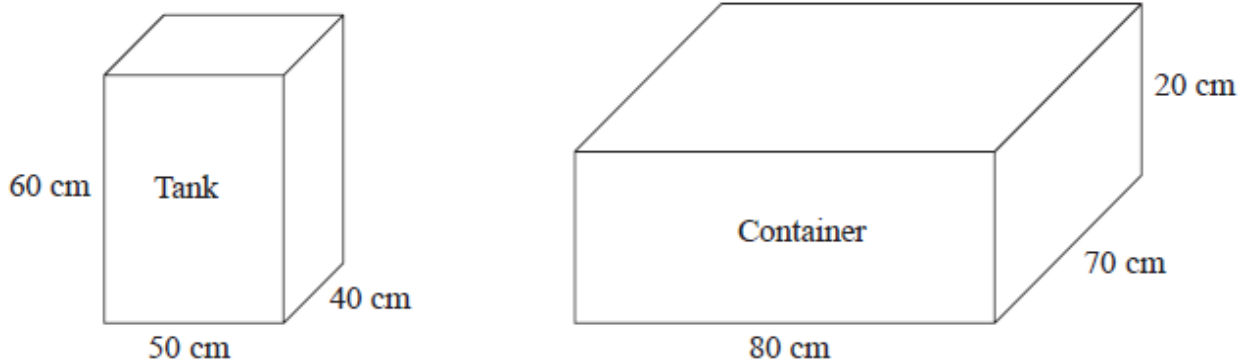
$$\begin{aligned}
 \text{Area of circle} &= \pi r^2 \\
 &= \pi \times 3^2 \\
 &= 9\pi
 \end{aligned}$$

$$\begin{aligned}
 \text{So area of shaded part} &= 280 - 9\pi \\
 &= 251.725666118 \dots \\
 &= 252 \text{ cm}^2 \text{ to 3 sig figs}
 \end{aligned}$$

.....cm²

(Total is 4 marks)

The diagram shows a tank in the shape of a cuboid.
It also shows a container in the shape of a cuboid.



The tank is full of oil.
The container is empty

35% of the oil from the tank is spilled.
The rest of the oil from the tank is put into the container.

Work out the height of the oil in the container.
Give your answer to an appropriate degree of accuracy.

Hint: Deal with each cuboid separately

$$\begin{aligned}\text{Volume of tank} &= 60 \times 50 \times 40 \\ &= 120000 \text{ cm}^3\end{aligned}$$

35% of the oil is lost so 65% remains

$$65\% \text{ of } 120000 = 0.65 \times 120000 = 78000 \text{ cm}^3$$

$$\text{Volume of container} = 80 \times 70 \times h = 78000$$

$$\text{So } h = 78000 \div (80 \times 70)$$

$$= 13.9285714286 \dots$$

$$= 13.9 \text{ cm (to 1 dp)}$$

.....cm

(Total is 5 marks)

In a company, the ratio of the number of men to the number of women is 3 : 2

40% of the men are under the age of 25

10% of the women are under the age of 25

What percentage of all the people in the company are under the age of 25?

Hint: Deal with each cuboid separately

Men : Women

3 : 2

3 : 2

5 5

So $\frac{3}{5}$ of 40 and $\frac{2}{5}$ of 10

$$= \frac{3}{5} \times 40 + \frac{2}{5} \times 10 = 28\%$$

.....%

(Total is 4 marks)

Katy invests £2000 in a savings account for 3 years.

The account pays compound interest at an annual rate of

2.5% for the first year

x % for the second year

x % for the third year

There is a total amount of £2124.46 in the savings account at the end of 3 years.

Work out the rate of interest in the second year.

Hint: Deal with each year separately

First year: $2000 \times 1.025 = £2050$

Second year: $2050 \times (1 + x/100)$

Third year:

$$2050 \times (1 + x/100)^2 = 2124.46$$

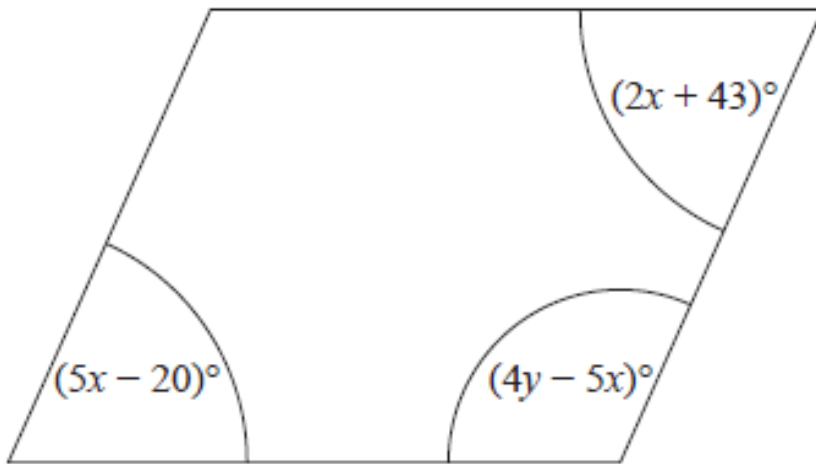
$$(1 + x/100)^2 = 2124.46/2050$$

$$\begin{aligned} (1 + x/100) &= \sqrt{(2124.46/2050)} \\ &= 1.01799899372 \dots \\ &= 1.018 \end{aligned}$$

ie. 1.8%

.....
(Total 5 is 4 marks)

Here is a parallelogram.



Work out the value of x and the value of y .

Hint: Opposite angles in a parallelogram are equal

$$5x - 20 = 2x + 43$$

$$3x = 63$$

$$x = 21^\circ$$

$$\text{Acute angle} = 5x - 20 = 85^\circ$$

$$\text{Acute angle} + \text{Obtuse angle} = 180^\circ$$

$$\text{So } 4y - 5x = 95$$

$$4y - 105 = 95$$

$$4y = 200$$

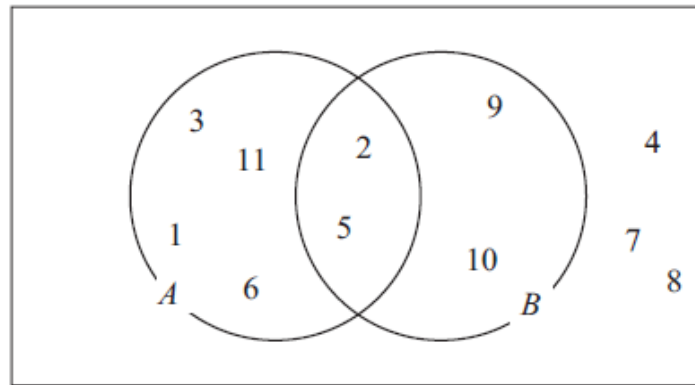
$$y = 50^\circ$$

$$x = \dots\dots\dots$$

$$y = \dots\dots\dots$$

(Total is 5 marks)

The Venn diagram shows the numbers 1 to 11



(a) Work out $P(A \cup B)$

Hint: This is set theory and Venn diagrams

$\cup$ is the union symbol

So $A \cup B = \{1, 2, 3, 5, 6, 9, 10, 11\}$

$$P(A \cup B) = \frac{8}{11}$$

.....
(2)

(b) Work out $P(B')$

B' means not B

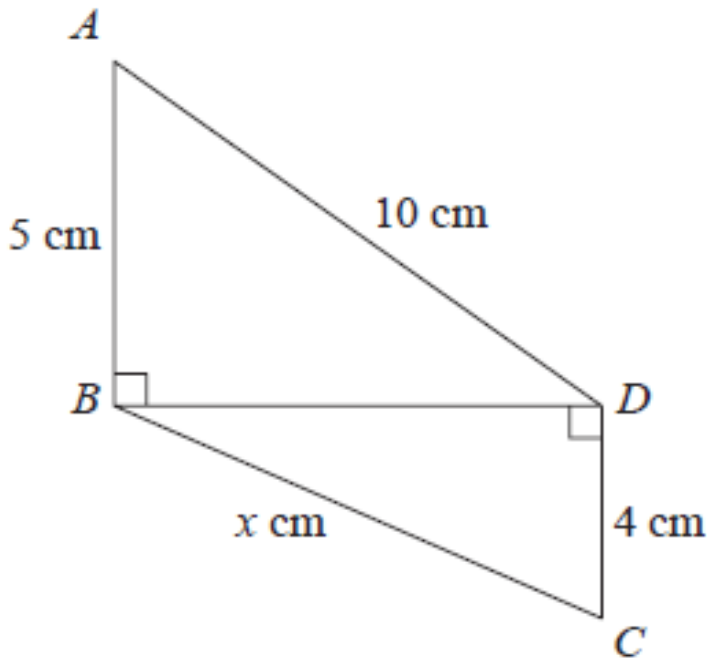
$B' = \{1, 3, 4, 6, 7, 8, 11\}$

$$P(B') = \frac{7}{11}$$

.....
(2)

(Total 4 marks)

Triangles ABD and BCD are right-angled triangles.



Work out the value of x .

Give your answer correct to 2 decimal places.

Hint: What maths works on right-angle triangles?

$$10^2 = 5^2 + y^2$$

$$100 = 25 + y^2$$

$$y^2 = 75$$

$$x^2 = y^2 + 4^2$$

$$x^2 = 75 + 16$$

$$x^2 = 91$$

$$x = 9.53939201417 \dots$$

$$= 9.54 \text{ (2 dp)}$$

.....

(Total is 4 marks)

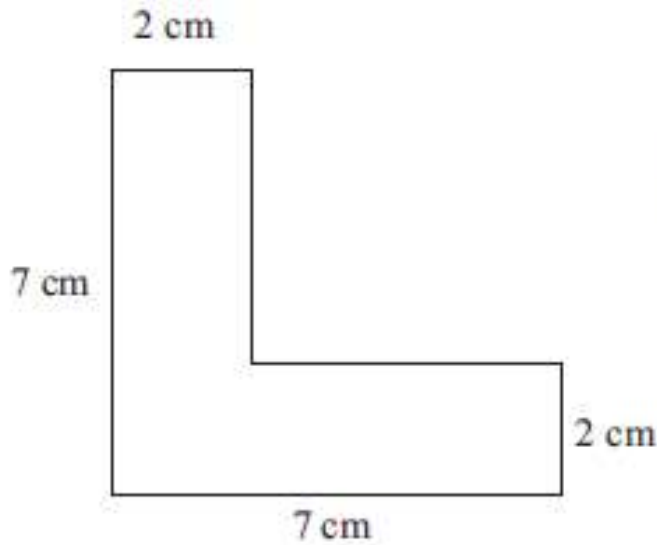


Diagram NOT
accurately drawn

The diagram shows the cross-section of a solid prism.
The length of the prism is 2 m.

The prism is made from metal.
The density of the metal is 8 grams per cm^3 .

Work out the mass of the prism.

Hint: Find the area of the prism first.

$$\begin{aligned}\text{Area} &= 7 \times 2 + 5 \times 2 \\ &= 24 \text{ cm}^2\end{aligned}$$

$$\begin{aligned}\text{So Volume} &= 24 \times 200 \\ &= 4800 \text{ cm}^3\end{aligned}$$

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

$$8 = \frac{m}{4800}$$

$$m = 38400 \text{ g}$$

.....
(Total 5 marks)

Dylan is driving from London to Newcastle.
He will drive a total distance of 240 miles.

Dylan leaves London at 09:30

It takes him $1\frac{1}{2}$ hours to travel the first 90 miles.

- (a) Use this information to estimate the time Dylan will arrive in Newcastle.
You must show how you get your answer.

Hint: Remember speed is the distance covered in a unit of time

90 miles in $1\frac{1}{2}$ hrs

Speed in first part of journey = 60 mph

So to cover 240 miles at that speed will take
6 hrs

So the estimate for time of arrival is 15:30

.....
(3)

- (b) Write down **one** assumption you made in your answer to part (a).

If your assumption is wrong, how would this affect your answer to part (a)?

I assumed he travelled at the same speed
throughout the journey

(1)

(Total 4 marks)

Arwen buys a car for £4000

The value of the car depreciates by 10% each year.

Work out the value of the car after two years.

Hint: This is a repeat percentage decrease

The value of the car is 90% of what it was the previous year

$$\begin{aligned}\text{After 2 years value} &= 4000 \times 0.9^2 \\ &= £3240\end{aligned}$$

£

(Total 3 marks)

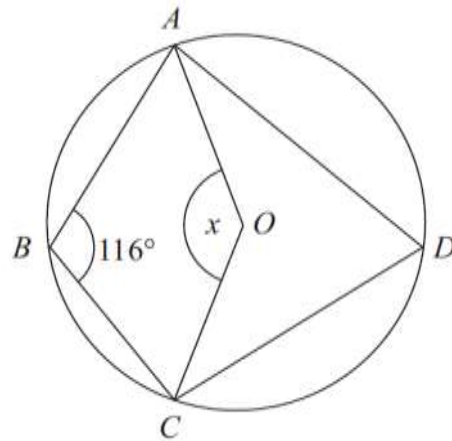


Diagram NOT
accurately drawn

A, B, C and D are points on the circumference of a circle with centre O .
Angle $ABC = 116^\circ$.

Find the size of the angle marked x .
Give reasons for your answer.

Hint: This question uses circle theorems

The angle at the centre is twice the angle at the circumference

$$\begin{aligned}\text{So angle reflex } COA &= 2 \times \text{Angle } CBA \\ &= 2 \times 116 \\ &= 232^\circ\end{aligned}$$

Angle at a point add to 360°

$$\begin{aligned}\text{So obtuse angle } COA &= x = 360 - 232 \\ &= 128^\circ\end{aligned}$$

(Total 4 marks)

There are 18 packets of sweets and 12 boxes of sweets in a carton.

The mean number of sweets in all the 30 packets and boxes is 14.

The mean number of sweets in the 18 packets is 10.

Work out the mean number of sweets in the boxes.

Hint: Find out the numbers of sweets first

$$\text{Mean} = \frac{\text{total}}{\text{Number}}$$

Packets only: number = $10 \times 18 = 180$ sweets

Packets & boxes: number = $14 \times 30 = 420$ sweets

So the number of sweets in the boxes is 240

And so the mean in the boxes = $\frac{240}{12} = 20$

.....
(Total 3 marks)

Solve $(x-1)^2 - 2(x-1) - 3 = 0$

Hint: Be careful with the negative signs

$$(x-1)^2 - 2(x-1) - 3 = 0$$

$$(x-1)(x-1) - 2(x-1) - 3 = 0$$

$$x^2 - 2x + 1 - 2x + 2 - 3 = 0$$

$$x^2 - 4x = 0$$

$$x(x-4) = 0$$

$$\text{so } x = 0 \text{ or } x - 4 = 0$$

$$\text{So } x = 0 \text{ or } 4$$

.....
(Total 4 marks)

Find the value of n so that $\frac{2^6 \times 2^3}{2^n} = 2^5$

Hint: Remember the laws of indices

$$\frac{2^6 \times 2^3}{2^n} = \frac{2^9}{2^n}$$

If the answer is to be 2^5 then the dividing power must be 2^4

$$\text{i.e. } n = 4$$

(Total 2 marks)

$$-6 \leq 2y < 5$$

y is an integer.

Write down all the possible values of y .

Hint: Split the inequality

$$\begin{array}{lll} -6 \leq 2y & \text{and} & 2y < 5 \\ -3 \leq y & \text{and} & y < 2.5 \end{array}$$

If y is an integer then y can be $-3, -2, -1, 0, 1$
and 2

.....
(Total 3 marks)

x and y are two numbers each greater than 3

The Highest Common Factor (HCF) of x and y is 3

The Lowest Common Multiple (LCM) of x and y is 36

Find x and y .

Hint: Remember the definitions of HCF and LCM

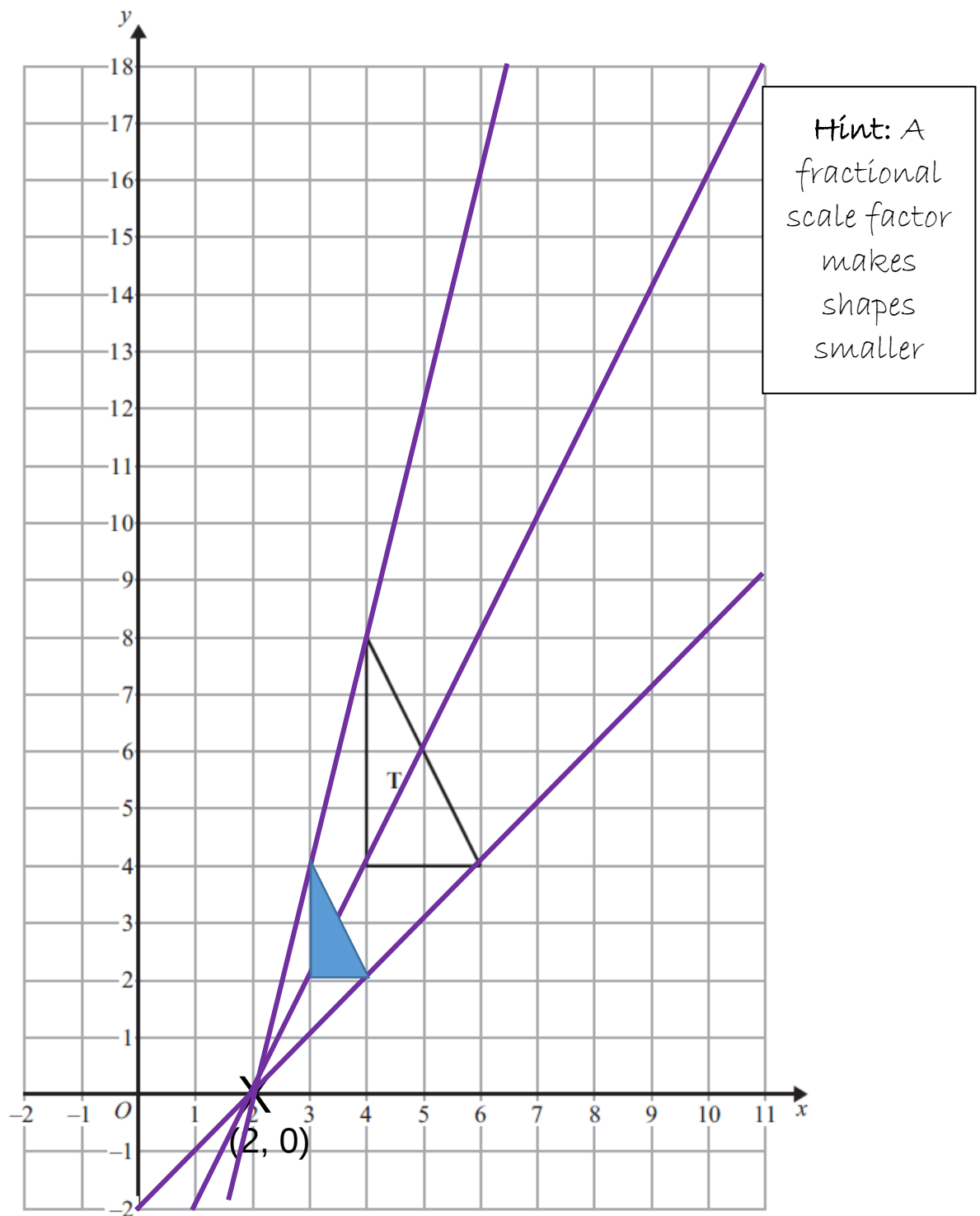
If the $\text{HCF} = 3$ then both numbers must be in the 3 times table

Factors of 36 are 1, 2, 3, 4, 6, 9, 12, 18 and 36

As they both are greater than 3 that could be 6, 9, 12, 18 and 36

The only pair that work are 9 and 12

.....
(Total 2 marks)



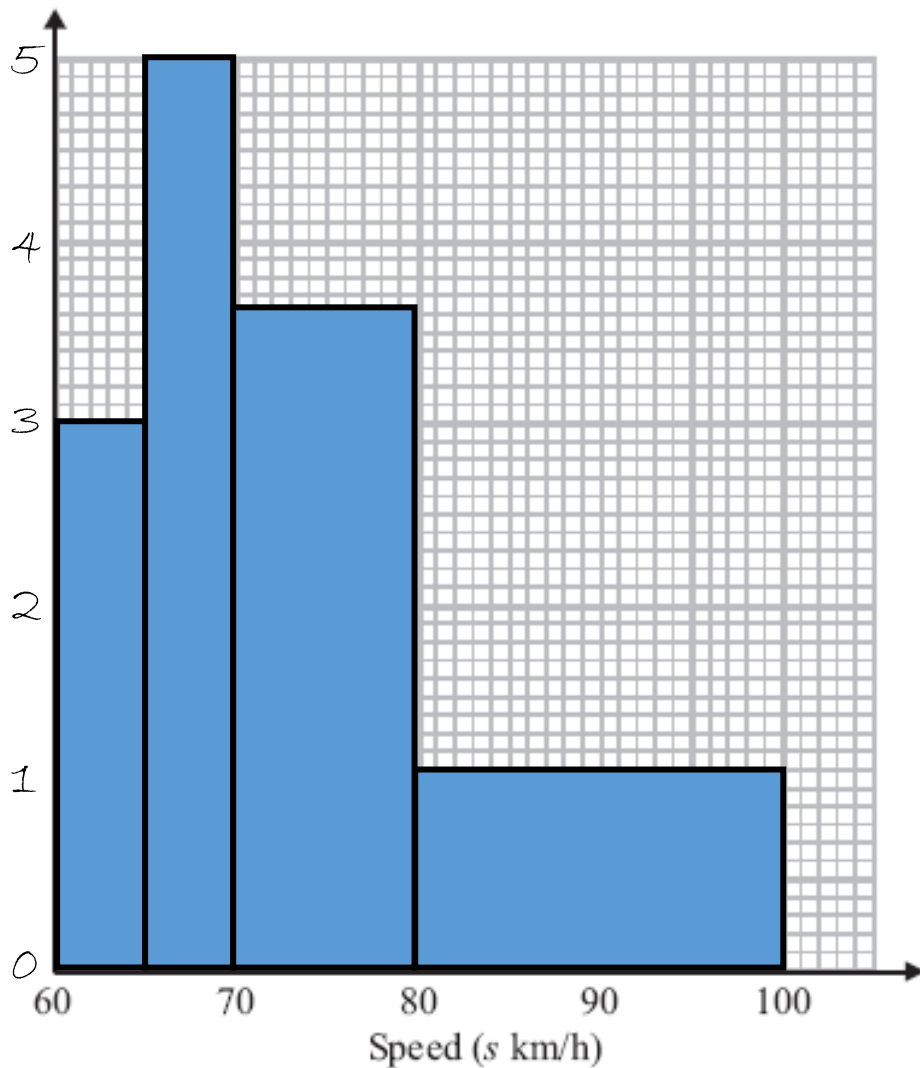
Enlarge triangle **T** by a scale factor $\frac{1}{2}$, centre $(2, 0)$.

(Total 3 marks)

The table gives some information about the speeds, in km/h, of 100 cars.

Hint: A histogram uses frequency density	Speed(s km/h)	Frequency	Width	Frequency density
	$60 < s \leq 65$	15	5	3
	$65 < s \leq 70$	25	5	5
	$70 < s \leq 80$	36	10	3.6
	$80 < s \leq 100$	24	20	1.2

(a) On the grid, draw a histogram for the information in the table.



(3)

(b) Work out an estimate for the number of cars with a speed of more than 85 km/h.

$$\frac{3}{4} \times 24 = 18 \text{ cars}$$

..... (2)
(Total 5 marks)

- (a) Simplify fully $\frac{x^2 + 3x - 4}{2x^2 - 5x + 3}$

Hint: Factorise both expressions

$$\begin{aligned}\frac{x^2 + 3x - 4}{2x^2 - 5x + 3} &= \frac{(x + 4)(x - 1)}{(2x - 3)(x - 1)} \\ &= \frac{x + 4}{2x - 3}\end{aligned}$$

.....
(3)

- (b) Write $\frac{4}{x+2} + \frac{3}{x-2}$ as a single fraction in its simplest form.

$$\begin{aligned}\frac{4}{x+2} + \frac{3}{x-2} &= \frac{4(x-2)}{(x+2)(x-2)} + \frac{3(x+2)}{(x+2)(x-2)} \\ &= \frac{4x - 8 + 3x + 6}{(x+2)(x-2)} \\ &= \frac{7x - 2}{(x+2)(x-2)}\end{aligned}$$

.....
(3)

(Total 6 marks)

The diagram shows a solid hemisphere of radius 5 cm.

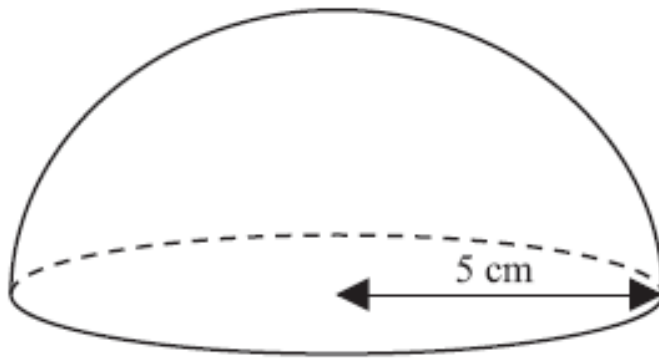


Diagram **NOT**
accurately drawn

Surface area of sphere = $4\pi r^2$

Find the **total** surface area of the solid hemisphere.
Give your answer in terms of π .

Hint: Make sure you work out **all** of the surface area!

$$\begin{aligned}\text{Curved surface area} &= \frac{1}{2} \times 4 \times \pi \times 5^2 \\ &= 50\pi\end{aligned}$$

$$\begin{aligned}\text{Bottom surface} &= \pi \times 5^2 \\ &= 25\pi\end{aligned}$$

$$\text{So total surface area} = 75\pi$$

..... cm²

(Total 3 marks)

There are 20 counters in a bag.

8 of the counters are yellow.

12 of the counters are green.

Asif takes at random two of the counters.

Work out the probability that the two counters are different colours.

Hint: You can draw a probability tree or work it out from listing all outcomes

$$\begin{aligned}
 P(2 \text{ different colours}) &= P(YG) + P(GY) \\
 &= \frac{8}{20} \times \frac{12}{19} + \frac{12}{20} \times \frac{8}{19} \\
 &= \frac{96}{380} + \frac{96}{380} \\
 &= \frac{192}{380} \\
 &= \frac{48}{95}
 \end{aligned}$$

.....
(Total 4 marks)

n is an integer greater than 1.

Use algebra to show that $(n^2 - 1) + (n - 1)^2$ is always equal to an even number.

Hint: Multiply it out

$$\begin{aligned}(n^2 - 1) + (n - 1)^2 &= n^2 - 1 + n^2 - 2n + 1 \\ &= 2n^2 - 2n \\ &= 2(n^2 - n)\end{aligned}$$

which is divisible by 2 and therefore even

QED

(Total 4 marks)

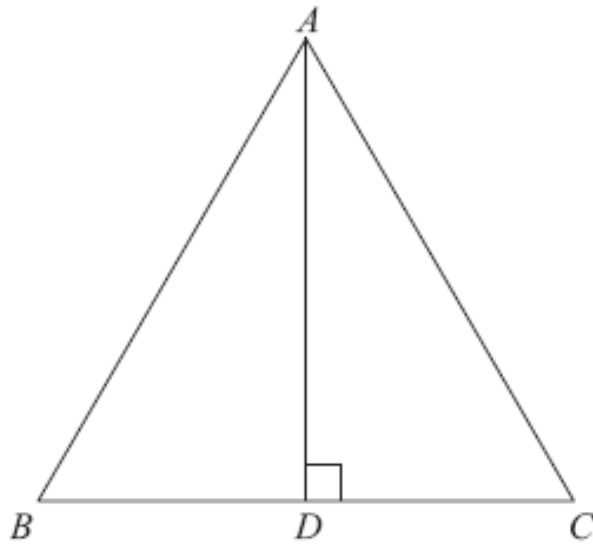


Diagram **NOT**
accurately drawn

ABC is an equilateral triangle.
 D lies on BC .
 AD is perpendicular to BC .

(a) Prove that triangle ADC is congruent to triangle ADB .

*Hint: Make sure you work out **all** of the surface area!*

$AB = AC$ (equilateral triangle)
 AD is a common side to both triangles
 $\angle ADC = \angle ADB = 90^\circ$
 So $\triangle ADB \equiv \triangle ADC$ (RHS)

OR $\angle DAC = \angle DAB$ (since $\angle ACD = \angle ABD$ and
 $\angle ADC = \angle ADB$)
 $AB = AC$ (equilateral triangle)
 AD is a common side to both triangles
 So $\triangle ADB \equiv \triangle ADC$ (3)

(b) Hence, prove that $BD = \frac{1}{2} AB$.

$AB = AC$ (equilateral triangle)
 $BD = DC$ (congruent $\triangle$ s)
 $BC = AB$ (equilateral $\triangle$ s)
 So $BD = \frac{1}{2} BC = \frac{1}{2} AB$

(2)

(Total 5 marks)

- (a) Rationalise the denominator of $\frac{6}{\sqrt{5}}$

Hint: Multiply to get rid of $\sqrt{5}$ in the denominator

$$\frac{6}{\sqrt{5}} = \frac{6}{\sqrt{5}} \times \frac{\sqrt{5}}{\sqrt{5}} = \frac{6\sqrt{5}}{5}$$

.....
(2)

- (b) Expand and simplify $(2 + \sqrt{10})(\sqrt{5} + \sqrt{20})$

$$\begin{aligned} (2 + \sqrt{10})(\sqrt{5} + \sqrt{20}) &= 2\sqrt{5} + 2\sqrt{20} + \sqrt{10}\sqrt{5} + \sqrt{10}\sqrt{20} \\ &= 2\sqrt{5} + \sqrt{80} + \sqrt{50} + \sqrt{200} \\ &= 2\sqrt{5} + 4\sqrt{5} + 5\sqrt{2} + 10\sqrt{2} \\ &= 6\sqrt{5} + 15\sqrt{2} \end{aligned}$$

.....
(4)

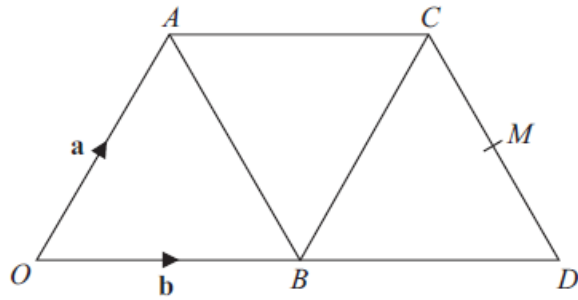
(Total 6 marks)

$OACD$ is a trapezium made from three equilateral triangles.

$$\overrightarrow{OA} = \mathbf{a}$$

$$\overrightarrow{OB} = \mathbf{b}$$

M is the midpoint of CD .



*Hint: Find the route you want your vectors to describe
use parallel vectors*

- (a) Write $\overrightarrow{AB}$ in terms of $\mathbf{a}$ and $\mathbf{b}$.

$$\begin{aligned}\overrightarrow{AB} &= \overrightarrow{AO} + \overrightarrow{OB} \\ &= -\mathbf{a} + \mathbf{b}\end{aligned}$$

.....

(1)

- (b) Show that $\overrightarrow{OC}$ is parallel to $\overrightarrow{BM}$.

$$\begin{aligned}\overrightarrow{OC} &= \overrightarrow{OA} + \overrightarrow{AC} \\ &= \mathbf{a} + \mathbf{b}\end{aligned}$$

$$\overrightarrow{BM} = \overrightarrow{BC} + \overrightarrow{CM} \text{ and } \overrightarrow{CM} = \frac{1}{2} \overrightarrow{AB}$$

$$\begin{aligned}\text{So } \overrightarrow{BM} &= \mathbf{a} + \frac{1}{2}(-\mathbf{a} + \mathbf{b}) \\ &= \frac{1}{2}\mathbf{a} + \frac{1}{2}\mathbf{b}\end{aligned}$$

$$\text{So } \overrightarrow{BM} = \frac{1}{2} \overrightarrow{OC} \text{ and so is parallel}$$

(4)

(Total 5 marks)

P is inversely proportional to V .

When $V = 8$, $P = 5$

(a) Find a formula for P in terms of V .

Hint: Find the constant first

$$P \propto \frac{1}{V}$$

$$\text{So } P = \frac{k}{V}$$

$$\text{When } V = 8, P = 5, \text{ so } 5 = \frac{k}{8} \quad \text{so } k = 40$$

$$\text{So } P = \frac{40}{V}$$

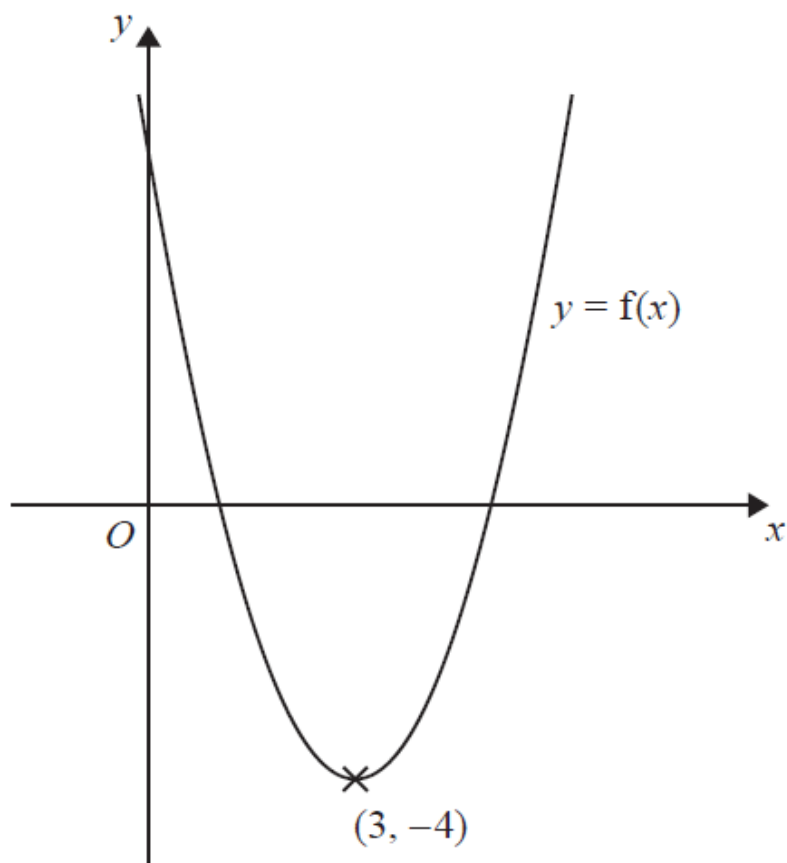
$$P = \dots\dots\dots (3)$$

(b) Calculate the value of P when $V = 2$

$$\text{When } V = 2, P = \frac{40}{2} = 20$$

$$\dots\dots\dots (1)$$

(Total 4 marks)



Hint: This is about transformation of curves

The diagram shows part of the curve with equation $y = f(x)$.
The coordinates of the minimum point of this curve are $(3, -4)$.

Write down the coordinates of the minimum point of the curve with equation

(i) $y = f(x) + 3$

$(3, -1)$

(..... ,)

(ii) $y = f(2x)$

$(1.5, -4)$

(..... ,)

(iii) $y = f(-x)$

$(-3, -4)$

(..... ,)

(Total 3 marks)

A has coordinates $(-3, 0)$

B has coordinates $(1, 6)$

C has coordinates $(5, 2)$

Find an equation of the line that passes through C and is perpendicular to AB.

Give your equation in the form $ax + by = c$ where a , b and c are integers.

Hint: Find the gradient of AB first

$$\text{Gradient of AB} = \frac{6}{4} = \frac{3}{2}$$

$$\text{So gradient of line} = -\frac{2}{3}$$

$$y = mx + c$$

$$\text{So } y = -\frac{2}{3}x + c$$

$$\text{When } x = 5, y = 2$$

$$\text{So } 2 = -\frac{2}{3} \times 5 + c$$

$$c = \frac{16}{3}$$

$$\text{so } y = -\frac{2}{3}x + \frac{16}{3}$$

$$3y + 2x = 16$$

.....
(Total 4 marks)

A box is on a table.

The area of the box in contact with the table is 1500 cm^2 .
The pressure on the table is 28 newtons/m^2 .

Work out the force exerted by the box on the table.
Give your answer correct to the nearest whole number.

$$p = \frac{F}{A}$$

p = pressure

F = force

A = area

Hint: use the units for pressure to help you get the formula

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

$$\begin{aligned} \text{Area} &= 1500 \text{ cm}^2 = 1500 \div 100 \div 100 \\ &= 0.15 \text{ m}^2 \end{aligned}$$

$$28 = \frac{F}{0.15}$$

$$\begin{aligned} F &= 28 \times 0.15 \\ &= 4.2 \text{ N} \end{aligned}$$

$$= 4 \text{ N to the nearest whole number}$$

.....newtons

(Total 3 marks)

Bilal is making sets of three candles.

He puts a white candle, a silver candle and a gold candle into each set.

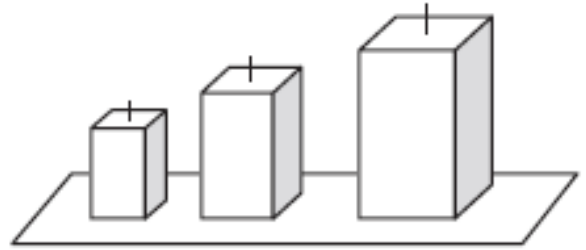
The candles are sold in packets of different sizes.

There are

25 white candles in a packet

12 silver candles in a packet

and 8 gold candles in a packet.



Bilal wants to use all the candles he buys.

- (i) What is the smallest number of packets of white candles, of silver candles and of gold candles he needs to buy?

Hint: This is about common multiples

$$\text{White } 25 = 5^2$$

$$\text{Silver } 12 = 2^2 \times 3$$

$$\text{Gold } 8 = 2^3$$

$$\text{So lowest common multiple} = 2^3 \times 3 \times 5^2$$

$$\text{White} = 24$$

$$\text{Silver} = 50$$

$$\text{Gold} = 75$$

..... packets of white candles

..... packets of silver candles

..... packets of gold candles

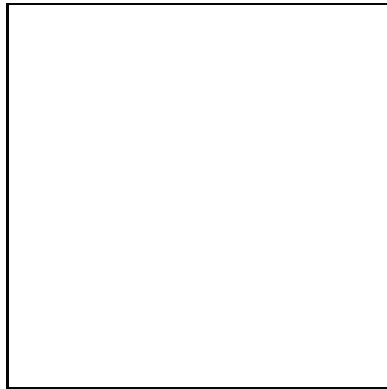
- (ii) How many sets of candles can Bilal make from the packets of candles he buys?

$$\text{Number of sets} = 2^3 \times 3 \times 5^2 = 600$$

..... sets

(Total 4 marks)

A square has sides of length 8.4 cm.



8.4 cm

Work out the length of a diagonal of the square.
Give your answer correct to 3 significant figures.

*Hint: Draw in the diagonal.
What sort of triangle does this make?*

$$d^2 = 8.4^2 + 8.4^2$$

$$d^2 = 141.12$$

$$d = 11.8793939239...$$

$$= 11.9 \text{ to 3 sig figs}$$

..... cm

(Total 3 marks)

There are a total of 120 counters in a box.

There are only red counters and blue counters in the box.

There are three times as many red counters as blue counters in the box.

Carl takes $\frac{1}{3}$ of the red counters from the box.

Kerry takes 80% of the blue counters from the box.

Work out the ratio of the number of red counters to the number of blue counters now in the box.

Give your ratio in its simplest form.

*Hint: Draw in the diagonal.
What sort of triangle does this make?*

If blue = x then red = $3x$ and $4x = 120$, so $x = 30$

Blue = 30

Red = 90

20% blue remain in the box = 6

$\frac{2}{3}$ red remain in the box = 60

Red : Blue

60 : 6 = 10 : 1

.....
(Total 5 marks)

The diagram shows a circular pond with a path around it.

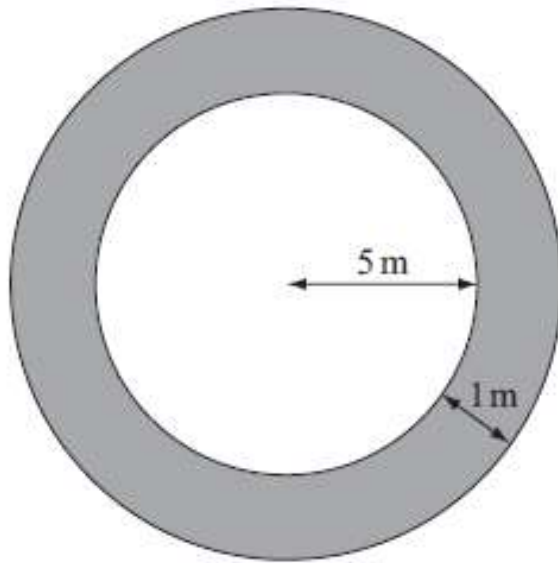


Diagram NOT
accurately drawn

The pond has a radius of 5m.
The path has a width of 1m.

Work out the area of the path.
Give your answer correct to 3 significant figures.

Hint: Area of a circle = πr^2

$$\begin{aligned}
 &\text{Area of big circle} - \text{area of little circle} \\
 &= \pi \times 6^2 - \pi \times 5^2 \\
 &= 36\pi - 25\pi \\
 &= 11\pi \\
 &= 34.5575191895 \dots \\
 &= 34.6 \text{ to 3 sig figs}
 \end{aligned}$$

..... m²

(Total 3 marks)

The total cost of 3 apples and 4 pears is £1.84

The total cost of 5 apples and 2 pears is £1.76

Work out the cost of one apple and the cost of one pear.

Hint: This is about simultaneous equations

$$\begin{cases} 3a + 4p = 184 \\ 5a + 2p = 176 \end{cases}$$

$$\begin{cases} -3a - 4p = -184 \\ 10a + 4p = 352 \end{cases}$$

$$7a = 168$$

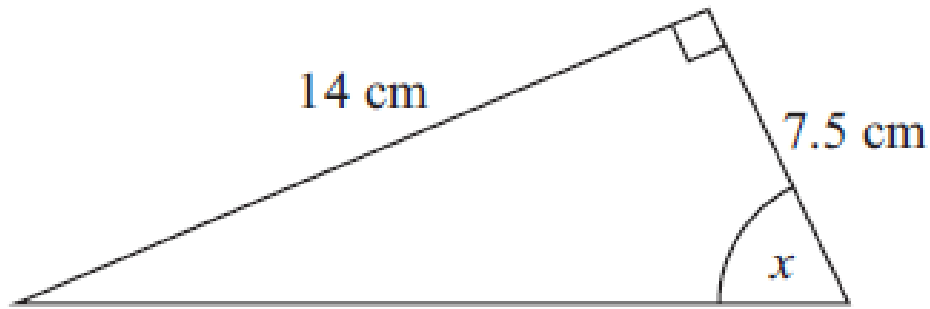
$$a = 24 \text{p and } p = 28 \text{p}$$

Cost of one applep

Cost of one pearp

(Total 4 marks)

Here is a right-angled triangle.



Work out the size of the angle marked x .
Give your answer to the nearest degree.

Hint: What maths can you do on a right-angle triangle?

$$\tan x = \frac{14}{7.5}$$

$$x = 61.8214098901 \dots$$

$$= 62^\circ \text{ to the nearest degree}$$

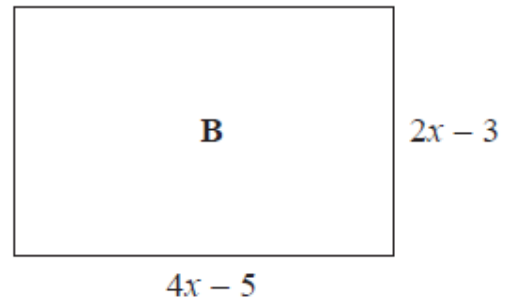
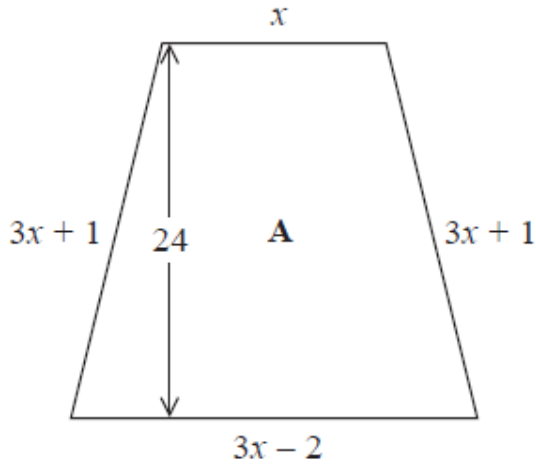
.....°

(Total 3 marks)

Jake is making badges of different shapes.

Badge **A** is in the shape of a trapezium.

Badge **B** is in the shape of a rectangle.



All measurements are in centimetres.

The perimeter of badge **A** and the perimeter of badge **B** are equal.

Jake needs to work out the area of badge **A**.

The area of badge **A** is $t \text{ cm}^2$.

Work out the value of t .

Hint: Put the two perimeters equal to each other

$$\begin{aligned} P \text{ trapezium} &= 3x + 1 + x + 3x + 1 + 3x - 2 \\ &= 10x \end{aligned}$$

$$\begin{aligned} P \text{ rectangle} &= 2x - 3 + 4x - 5 + 2x - 3 + 4x - 5 \\ &= 12x - 16 \end{aligned}$$

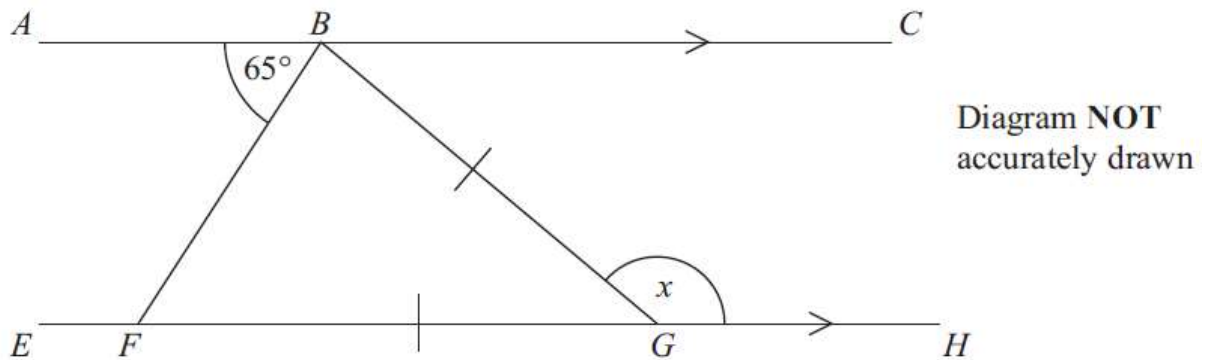
$$\text{So } 12x - 16 = 10x$$

$$2x = 16$$

$$x = 8$$

$$\begin{aligned} \text{Area of trapezium} &= \frac{1}{2} (\text{top} + \text{bottom}) \times \text{height} \\ &= \frac{1}{2} (8 + 22) \times 24 \\ &= 360 \text{ cm}^2 \end{aligned}$$

.....
(Total 6 marks)



ABC is parallel to $EFGH$.

$$GB = GF$$

$$\text{Angle } ABF = 65^\circ$$

Work out the size of the angle marked x .

Give reasons for your answer.

Hint: make sure your reasons are complete!

$\angle BFG = 65^\circ$ as alternate angles are equal

$\angle FBG = 65^\circ$ as base angles in an isosceles triangle are equal

$\angle FGB = 50^\circ$ as angles in a triangle add to 180°

$x = 130^\circ$ as angles on a straight line add to 180°

(Total 4 marks)

A circular clock face, centre O , has a minute hand OA and an hour hand OB .

$OA = 10$ cm.

$OB = 7$ cm.

Calculate the length of AB when the hands show 5 o'clock.

Give your answer correct to 3 significant figures.

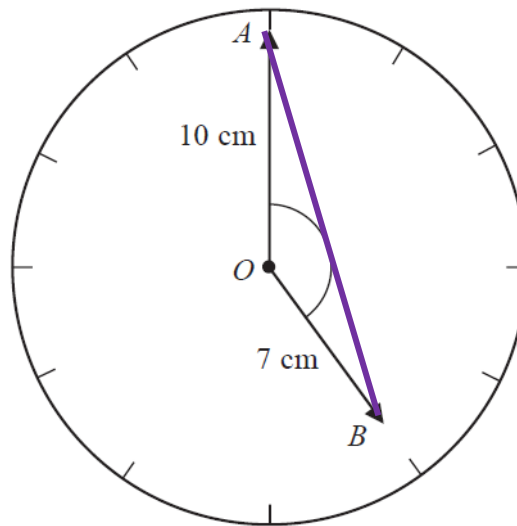


Diagram **NOT**
accurately drawn

Hint: Draw in the triangle

$$AB^2 = 10^2 + 7^2 - 2 \times 10 \times 7 \times \cos 150^\circ$$

$$= 149 - 140 \cos 150$$

$$270.24355653$$

$$AB = 16.4390862438$$

$$= 16.4 \text{ to 3 sig figs}$$

..... cm

(Total 4 marks)

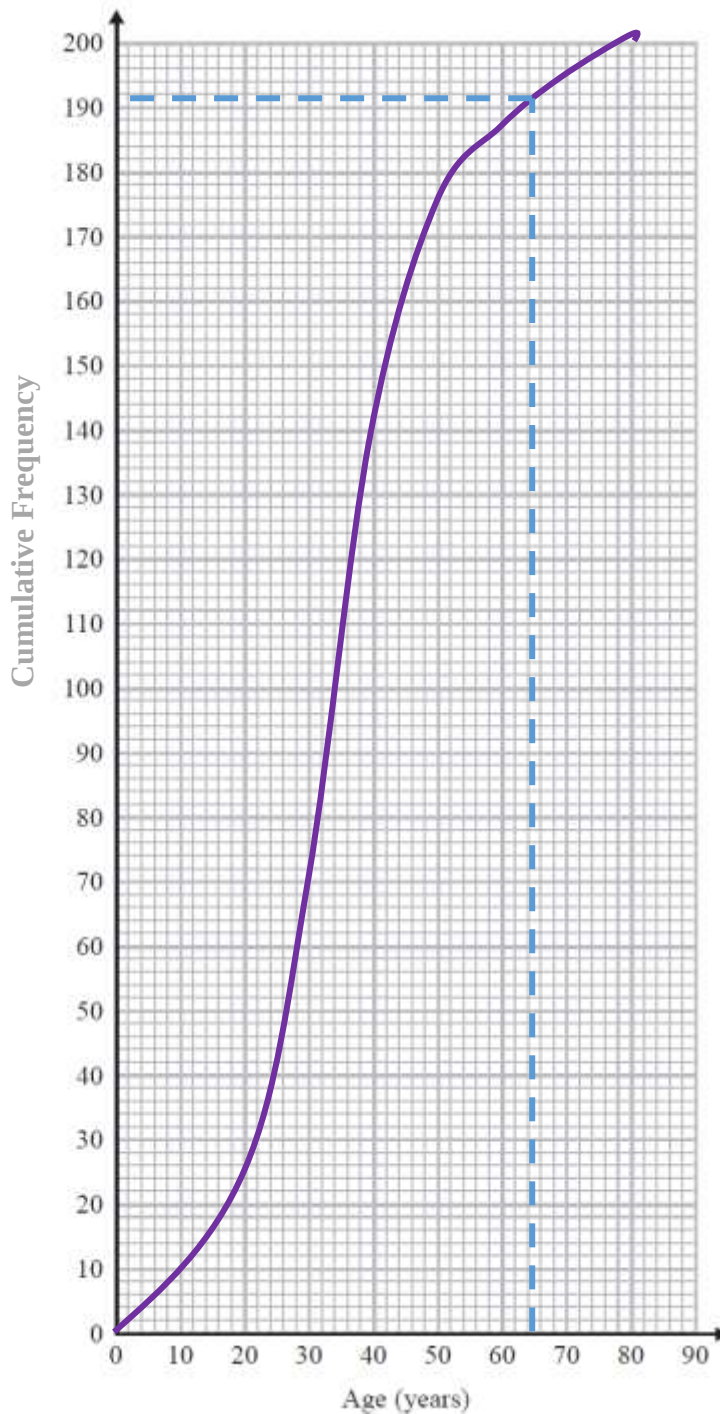
There are 200 workers at a factory.

The cumulative frequency table gives information about their ages.

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

(2)

Age (a years)	Cumulative frequency
$0 < a \leq 20$	25
$0 < a \leq 30$	70
$0 < a \leq 40$	138
$0 < a \leq 50$	175
$0 < a \leq 60$	186
$0 < a \leq 70$	194
$0 < a \leq 80$	200



(b) Graham says,
“10% of workers at the factory are older than 65”

Is Graham correct?

You must show how you get your answer.

Hint: Draw on the graph

$$(200 - 191) \div 200$$

$$\times 100 = 4.5\%$$

So no, he is not
correct

(2)

(Total 4 marks)

When a number is reduced by 30% the answer is 17920
What is the number?

Hint: This is a reverse percentage question

$$\text{So } 17920 = 70\%$$

$$10\% = 2560$$

$$100\% = 25600$$

.....
(Total 3 marks)

There are only

4 mint biscuits
and 1 toffee biscuit in a tin.

There are only

5 mint sweets
and 3 strawberry sweets in a packet.

Michael's mum lets him take one biscuit from the tin and one sweet from the packet.

Michael takes a biscuit at random from the tin.
He also takes a sweet at random from the packet.

Work out the probability that either the biscuit is mint or the sweet is mint, but not both.

Hint: You can draw a probability tree or work it out from listing all outcomes

All possible outcomes

MM

MS

$$\frac{4}{5} \times \frac{3}{8} = \frac{12}{40}$$

$$TM \quad \frac{1}{5} \times \frac{5}{8} = \frac{5}{40}$$

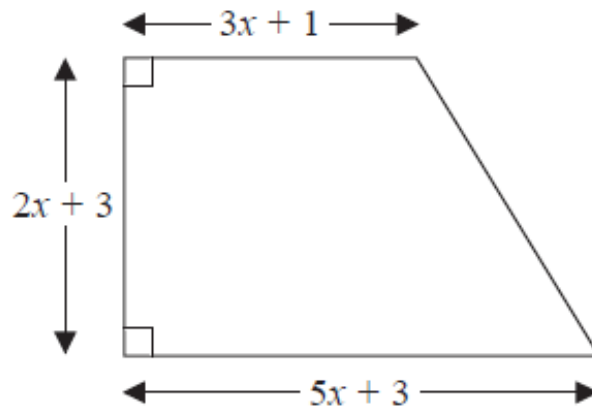
TS

$$\begin{aligned} P(MS \text{ or } TM) &= \frac{12}{40} + \frac{5}{40} \\ &= \frac{17}{40} \end{aligned}$$

Or this can be done by calculating PP, CC and GG and subtracting from 1

.....
(Total 3 marks)

The diagram shows a trapezium.



All the measurements are in centimetres.
The area of the trapezium is 46 cm^2 .

Hint: when solving a quadratic equation, if it says to give your answer to 2 dp then you need to use the quadratic formula

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

$$\text{Area of a trapezium} = \frac{1}{2}(t + b) \times h$$

$$\frac{1}{2}(3x + 1 + 5x + 3)(2x + 3) = 46$$

$$\frac{1}{2}(8x + 4)(2x + 3) = 46$$

$$(4x + 2)(2x + 3) = 46$$

$$8x^2 + 16x + 6 = 46$$

$$8x^2 + 16x - 40 = 0$$

$$x^2 + 2x - 5 = 0$$

(3)

(b) Solve the equation $x^2 + 2x - 5 = 0$

Give your solutions correct to 2 decimal places.

$$x^2 + 2x - 5 = 0$$

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

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

$$x = \frac{-2 \pm \sqrt{24}}{2}$$

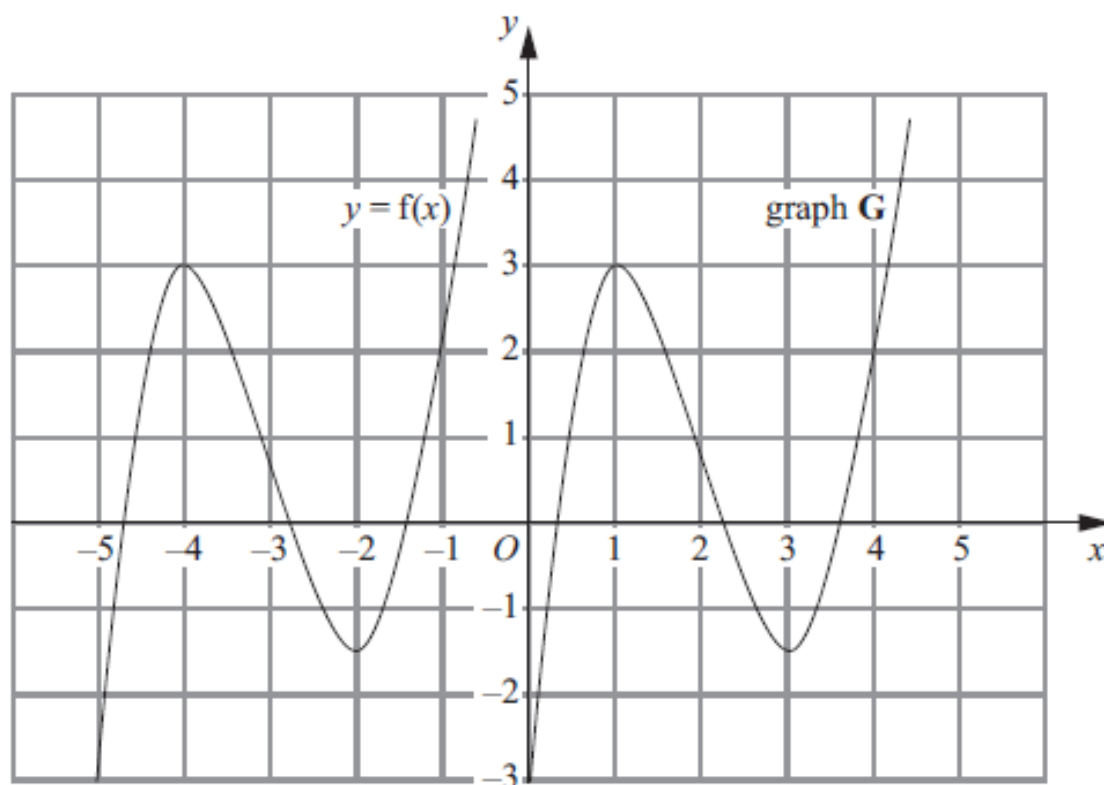
$$x = 1.44948974278 \dots \text{ or } -3.4494897428 \dots$$

So $x = 1.45$ or -3.45 to 2 dp

(3)

(Total 6 marks)

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



The graph **G** is a translation of the graph of $y = f(x)$.

(a) Write down, in terms of f , the equation of graph **G**.

Hint: Think of transforming of graphs

$$y = f(x - 5)$$

$y = \dots\dots\dots$
(1)

The graph of $y = f(x)$ has a maximum point at $(-4, 3)$.

(b) Write down the coordinates of the maximum point of the graph of $y = f(-x)$.

$(4, 3)$

$(\dots\dots\dots, \dots\dots\dots)$
(2)

(Total 3 marks)

$$x = 0.0\dot{1}5$$

Prove algebraically that x can be written as $\frac{1}{66}$

Hint: use powers of 10 and algebra

$$\text{Let } x = 0.0\dot{1}5$$

$$\text{So } x = 0.015151515 \dots$$

$$100x = 1.515151515 \dots \quad \text{Subtract them}$$

$$99x = 1.5$$

$\times$ by 10 to get whole nos only

$$990x = 15$$

now divide to make a fraction

$$x = \frac{15}{990}$$

and cancel

$$x = \frac{1}{66}$$

$$x = \frac{1}{66}$$

$$66$$

QED

(Total 3 marks)

Shabeen has a biased coin.

The probability that the coin will land on heads is 0.6.

Shabeen is going to throw the coin 3 times.

She says the probability that the coin will land on tails 3 times is less than 0.1.

Is Shabeen correct?

You must show all your working.

Hint: use powers of 10 and algebra

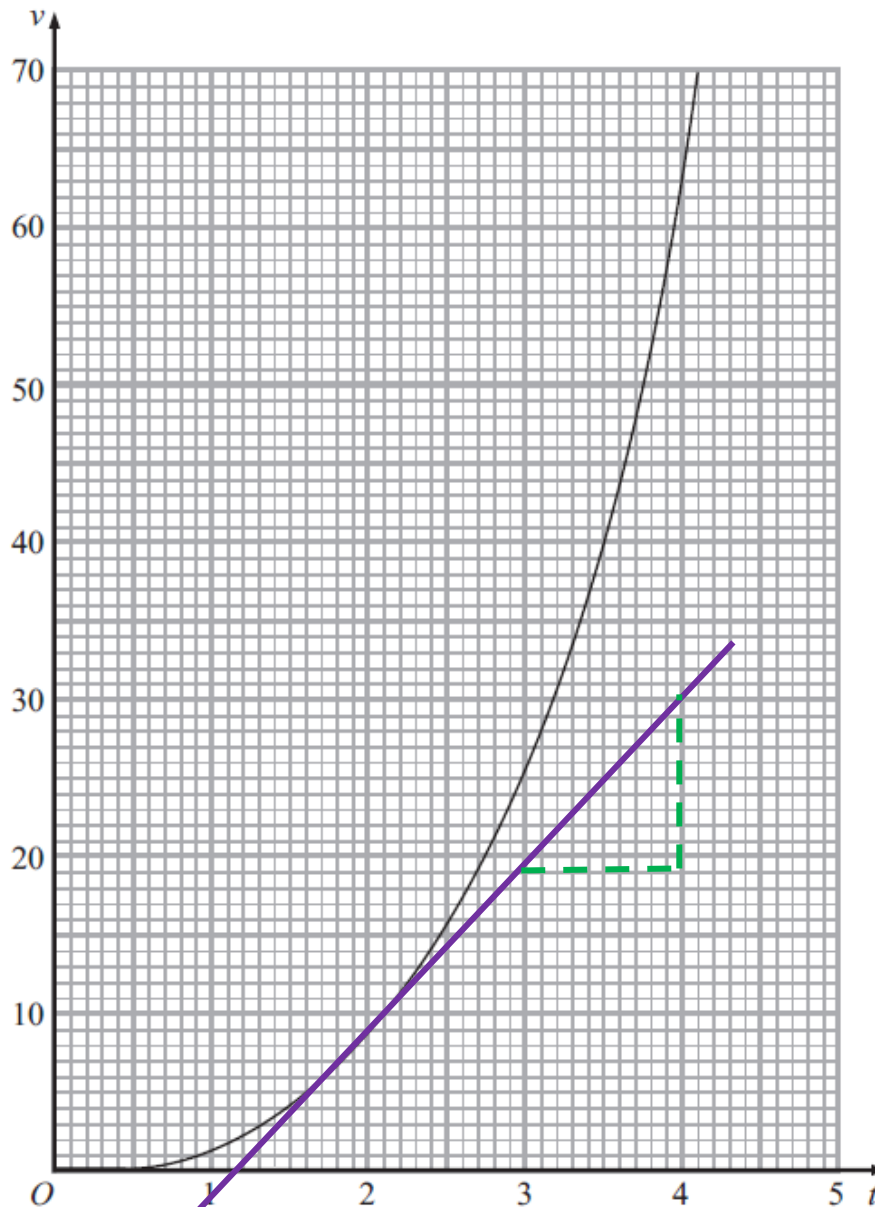
$$P(\text{tail}) = 0.4$$

$$\begin{aligned} P(TTT) &= 0.4 \times 0.4 \times 0.4 \\ &= 0.064 \end{aligned}$$

which is less than 0.1 so Shabeen is right.

(Total 3 marks)

The graph shows the velocity, v metres per second, of a rocket at time t seconds.



Find an estimate for the rate of change of the velocity of the rocket at $t = 2$

Hint: Rate of change is the gradient of a tangent of a graph

$$\text{Gradient} = \frac{\text{change in } y\text{'s}}{\text{change in } x\text{'s}} = \frac{11}{1} = 11$$

or any answer calculated from a gradient at $x = 2$, range 8 - 14 m/s^2

(Total 3 marks)

A road is 4530 m long, correct to the nearest 10 metres.

Kirsty drove along the road in 205 seconds, correct to the nearest 5 seconds.

The average speed limit for the road is 80 km/h.

Could Kirsty's average speed have been greater than 80 km/h?

You must show your working.

Hint: Find the lower and upper class bounds for each measurement

$$\text{Distance} \quad 4525 \text{ m} \leq d < 4535 \text{ m}$$

$$\text{Time} \quad 202.5 \text{ s} \leq t < 207.5 \text{ s}$$

$$\text{Speed} = \frac{\text{Distance}}{\text{Time}}$$

$$\text{Greatest Speed} = \frac{\text{Max. distance}}{\text{Min. time}}$$

$$\text{Max distance} = 4535 \text{ m} = 4.535 \text{ km}$$

$$\text{Min time} = 202.5 \text{ s} = 0.05625 \text{ hr}$$

$$\text{Greatest speed} = \frac{4.535}{0.05625} = 80.62222... \text{ km/h}$$

So yes her average speed was just above 80 mph

(Total 5 marks)

Here are the first 4 terms of a quadratic sequence.

7 18 33 52

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

Hint: Find the lower and upper class bounds for each measurement

	7	18	33	52
First diff	11	15	19	
Second diff		4	4	

So the quadratic sequence begins $2n^2$

n	1	2	3	4	
sequence	7	18	33	52	
$2n^2$	2	8	18	32	$2n^2$
	5	10	15	20	$5n$

So the n^{th} term is $2n^2 + 5n$

(Total 3 marks)

$$g(x) = \frac{4x}{3-x}$$

$$f(x) = 2x - 5$$

Given that $x > 3$, find the exact value of x such that $g^{-1}(x) = f(x)$.

Hint: $g^{-1}(x)$ means the inverse of the function $g(x)$

$$y = \frac{4x}{3-x}$$

$$y(3-x) = 4x$$

$$3y - xy = 4x$$

$$3y = 4x + xy$$

$$3y = x(4 + y)$$

$$x = \frac{3y}{4+y}$$

$$\text{So } g^{-1}(x) = \frac{3x}{4+x}$$

$$\text{If } g^{-1}(x) = f(x) \text{ then } \frac{3x}{4+x} = 2x - 5$$

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

$$3x = 2x^2 + 3x - 20$$

$$2x^2 - 20 = 0$$

$$x^2 = 10, \text{ so } x = \sqrt{10}$$

(Total 5 marks)

Each year Wenford Hospital records how long patients wait to be treated in the Accident and Emergency department.

In 2015 patients waited 11% less time than in 2014.

In 2015 the average time patients waited was 68 minutes.

- (a) Work out the average time patients waited in 2014.
Give your answer to the nearest minute.

Hint: This is a reverse percentage question

11% less means they waited 89% of the time

So 89% = 68 mins

$$100\% = 68 \times 100/89$$

$$= 76.404494382 \dots = 76 \text{ mins} \quad \text{..... minutes}$$

(3)

The hospital has a target to reduce the average time patients wait to be treated in the Accident and Emergency department to 60 minutes in 2016.

- (b) Work out the percentage decrease from 68 minutes to 60 minutes.

Decrease of 8 mins out of 68 mins

$$= 8/68 \times 100$$

$$= 11.7647058824 \dots$$

$$= 11.8\%$$

.....%

(2)

(Total 5 marks)

There are only red pens and blue pens in a box.
There are 12 red pens in the box.

The probability of taking at random a blue pen from the box is $\frac{2}{3}$

Work out the total number of pens in the box.

Hint: Find the lower and upper class bounds for each measurement

$$P(B) = \frac{2}{3}$$

$$\text{So } P(R) = \frac{1}{3}$$

$$\frac{1}{3} = \frac{12}{?} \quad \text{So } ? = 36 \text{ pens altogether}$$

.....

(Total 3 marks)

Each length of the side of square B is twice the length of the side of square A.

John says that this means the area of square B is twice the area of square A.

Is John right?
Justify your answer.

Hint: Can you think of a proof or counter-example?

.....
.....
If this is true then it has to be always true.

Example:

Square A has side 2 cm, so area is 4 cm^2

Square B must have side 4 cm, and its area is 16 cm^2 .

*This is not twice the area of square A.
So John is wrong.*

(Total 1 mark)

Show that $7\frac{1}{2} - 4\frac{2}{3} = 2\frac{5}{6}$

Hint: Subtracting mixed numbers is easier if you change them to improper fractions

$$\begin{aligned}
 7\frac{1}{2} - 4\frac{2}{3} &= \frac{15}{2} - \frac{14}{3} \\
 &= \frac{45}{6} - \frac{28}{6} \\
 &= \frac{17}{6} \\
 &= 2\frac{5}{6}
 \end{aligned}$$

(Total 3 marks)

Make t the subject of $5(t - g) = 2t + 7$

Hint: Make t the subject means rearrange the equation so it starts $t = \dots$

Multiply out the bracket first and then see what you have got.

$$5(t - g) = 2t + 7$$

$$5t - 5g = 2t + 7$$

$$3t - 5g = 7$$

$$3t = 7 + 5g$$

$$t = \frac{7 + 5g}{3}$$

$$3$$

.....
(Total 3 marks)

Henry is thinking about having a water meter.

These are the two ways he can pay for the water he uses.

Water Meter

A charge of £28.20 per year

plus

91.22p for every cubic metre of water used

1 cubic metre = 1000 litres

No Water Meter

A charge of £107 per year

Henry uses an average of 180 litres of water each day.

Henry wants to pay as little as possible for the water he uses.
Should Henry have a water meter?

Hint: Compare the two different methods.

Water Meter over a year

180 litres x 365 days

= 65700 litres

= 65.7 cubic metres

65.7 x 0.9122 + 28.20

= 88.13154

= £88.13

No Water Meter over a year

Total charge is £107

So it is cheaper for Henry to have a water meter.

Or any other answer worked out over the same time period for each method.

Eg. per day A1 for 29 - 30p and 24 - 24.3p

Accept working based on 365, 366, 356¹/₄ and 364 (52x7) days in a year

(Total 5 marks)

Cameron invests £1200 for 3 years in a savings account.
He gets 4.1% per annum **simple** interest.

Mitchell invests £1200 for 3 years in a savings account.
He gets 4% per annum **compound** interest.

Who will have the most money in his savings account at the end of the 3 years?
You must show all your working.

Hint: Compare the two different methods.

Cameron

$$£1200 \times 0.041 = £49.20$$

$$£49.20 \times 3 = £147.60$$

$$£1200 + £147.60 = £1347.60$$

Mitchell

$$\begin{aligned} £1200 \times 1.041^3 &= £1353.734052 \\ &= £1353.73 \end{aligned}$$

So Mitchell will have the most money after 3 years.

(Total 5 marks)

Here are the first four terms of an arithmetic sequence.

3 10 17 24

(a) Find, in terms of n , an expression for the n th term of this arithmetic sequence.

Hint: Relate the sequence to the times table with that difference

1	2	3	4	
3	10	17	24	has a difference of 7
7	14	21	28	$7n$

And subtract 4

.....
(2)

So $7n - 4$

(b) Is 150 a term of this sequence?

You must explain how you get your answer.

$$7n - 4 = 150$$

$$7n = 154$$

$$n = 22$$

which is a whole number so 150 is in the sequence

or an answer showing the sequence going

... 136, 143, 150, 157, ...

(2)

(Total 4 marks)

Here are the marks that James scored in eleven maths tests.

16 12 19 18 17 13 13 20 11 19 17

- (a) Find the interquartile range of these marks.

Hint: You need to put these results in order first.

11 12 13 13 16 17 17 18 19 19 20



LQ



median



UQ

(3)

$$IQR = UQ - LQ = 6$$

Sunil did the same eleven maths tests.

The median mark Sunil scored in his tests is 17.

The interquartile range is 8.

- (b) Which one of Sunil or James has the more consistent marks?

Give a reason for your answer.

James is more consistent because his interquartile range is smaller

(1)

Sunil did four more maths tests.

His scores in these four tests were 16, 20, 18 and 10.

- (c) How does his new median mark for the fifteen tests compare with his median mark of 17 for the eleven tests?

Tick (✓) one box.

☐

new median is lower

☒

new median is 17

☐

new median is higher

Explain your answer.

Because two of the new values are larger than the current median and two are below

(1)

(Total 5 marks)

ABC is a triangle.

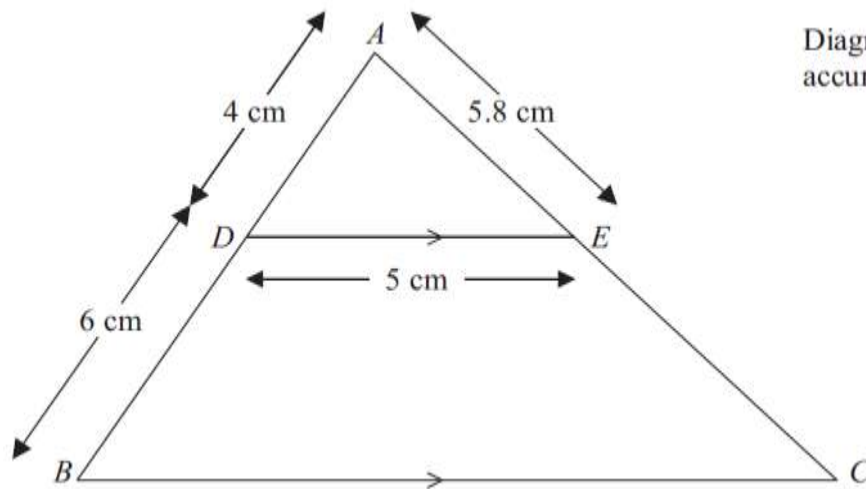


Diagram NOT
accurately drawn

D is a point on AB and E is a point on AC .

DE is parallel to BC .

$AD = 4$ cm, $DB = 6$ cm, $DE = 5$ cm, $AE = 5.8$ cm.

Calculate the perimeter of the trapezium $DBCE$.

Hint: The two triangles are similar.

As triangle ABC and triangle ADE are similar they are enlargements of each other.

The known common sides are AD and AB .

So the SF ADE to $ABC = \frac{10}{4} = \frac{5}{2}$

So $BC = \frac{5}{2} \times 5 = 12.5$ cm

And $AC = \frac{5}{2} \times 5.8 = 14.5$ cm

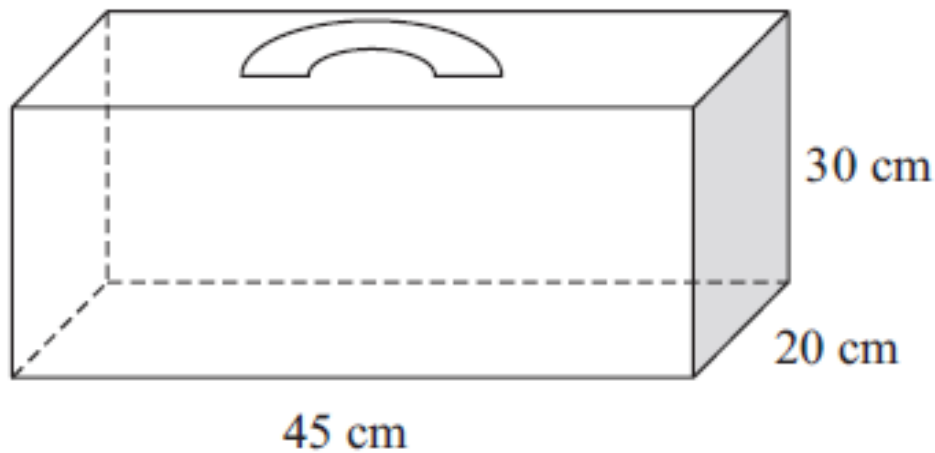
So $EC = 14.5 - 5.8 = 8.7$ cm

So the perimeter = $6 + 5 + 8.7 + 12.5$
 $= 32.2$ cm

..... cm

(Total 4 marks)

The diagram shows Diana's suitcase.
The suitcase is in the shape of a cuboid.



Diana has a walking stick that folds.
The folded walking stick has a length of 60 cm.

Diana wants to put the folded walking stick in the suitcase.

Will the folded walking stick fit in the suitcase?

Hint: The longest length in the suitcase is the diagonal of the cuboid.

using Pythagoras' theorem for 3D

The length of the 3D diagonal

$$= \sqrt{45^2 + 20^2 + 30^2}$$

$$= \sqrt{3325}$$

$$= 57.6628129734 \dots \text{ cm}$$

As the stick is 60 cm, it won't fit in the suitcase.

(Total 4 marks)

The surface area of Earth is $510\,072\,000\text{ km}^2$.

The surface area of Jupiter is $6.21795 \times 10^{10}\text{ km}^2$.

The surface area of Jupiter is greater than the surface area of Earth.

How many times greater?

Give your answer in standard form.

Hint: Standard form is a number in the form $A \times 10^n$ where $1 \leq A < 10$ and n is an integer

$$(\text{SA Jupiter}) = x \times (\text{SA Earth})$$

$$\text{So } x = \frac{\text{SA Jupiter}}{\text{SA Earth}}$$

$$= \frac{6.21795 \times 10^{10}}{510072000}$$

$$= 121.903378347$$

$$= 1.22 \times 10^2$$

$$= 1.22 \times 10^2$$

$$= 1.22 \times 10^2$$

.....
(Total 3 marks)

Brian's band is playing at a concert in a hall.

The loudness of a band varies inversely as the square of the distance from the band.
 Brian measures the normal loudness of his band as 100 decibels at a distance of 5 metres.

The band has to stop playing if the loudness is 85 decibels or more at a distance of 5.4 metres.

Does the band have to stop playing?

Hint: use the given numbers to find the constant

L = loudness and d = distance

$$L \propto \frac{1}{d^2} \quad \text{So } L = \frac{k}{d^2}$$

$$\text{When } L = 100, d = 5, \text{ so } 100 = \frac{k}{5^2}$$

$$\text{so } k = 100 \times 25 = 2500$$

$$\text{So } L = \frac{2500}{d^2}$$

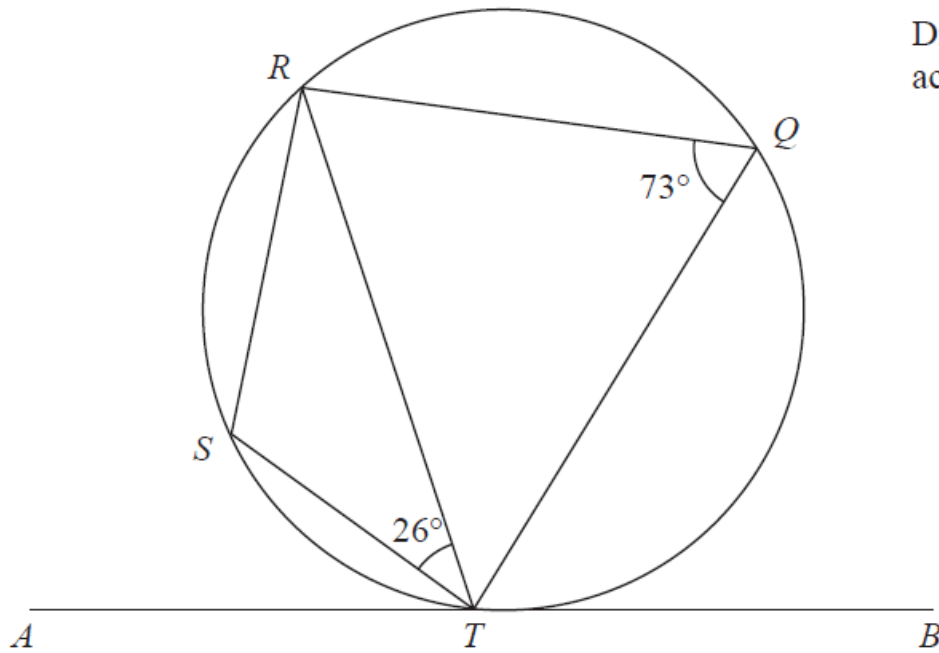
At $d = 5.4\text{m}$

$$\text{the loudness} = \frac{2500}{5.4^2} = 85.7338820302 \dots$$

So yes they have to stop playing

(Total 4 marks)

Diagram **NOT**
accurately drawn



Q, R, S and T are points on a circle.
 ATB is the tangent to the circle at T

Angle $STR = 26^\circ$

Angle $RQT = 73^\circ$

Work out the size of angle STA

Give a reason for each stage in your working.

Hint: Make sure you state each angle theorem fully

Alternate segment theorem

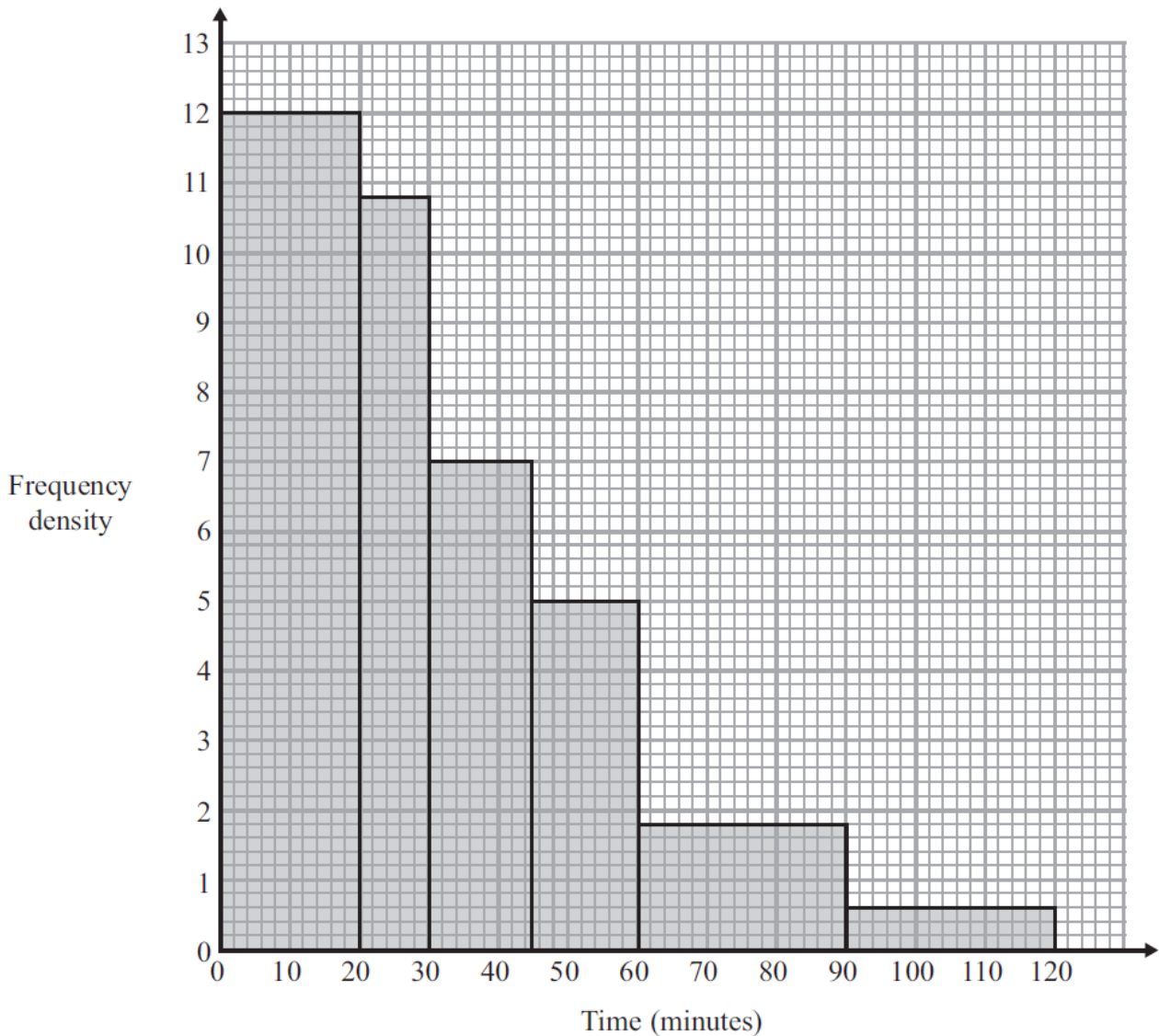
Angle $RTA = \text{angle } RQT = 73^\circ$

So angle $STA = 73 - 26 = 47^\circ$

.....^o

(Total 3 marks)

The histogram shows information about the times, in minutes, that some passengers had to wait at an airport.



Work out the percentage of the passengers who had to wait for more than one hour.

Hint: Find the total area of the histogram first

$$\begin{aligned} \text{Total Area} &= 20 \times 12 + 10 \times 10.8 + 15 \times 7 + 15 \times 5 + \\ &30 \times 1.8 + 30 \times 0.6 \\ &= 600 \end{aligned}$$

$$\begin{aligned} \text{Area waiting more than one hour} &= 30 \times 1.8 + 30 \times 0.6 \\ &= 72 \end{aligned}$$

$$\text{So percentage} = \frac{72}{600} \times 100 = 12\%$$

(Total 3 marks)

Given that $\left(2^{\frac{1}{2}}\right)^n = \frac{2^x}{8^y}$

express n in terms of x and y .

Hint: Make sure you state each angle theorem fully

$$\left(2^{\frac{1}{2}}\right)^n = \frac{2^x}{8^y}$$

$$2^{\frac{n}{2}} = \frac{2^x}{(2^3)^y}$$

$$2^{\frac{n}{2}} = \frac{2^x}{2^{3y}}$$

$$2^{\frac{n}{2}} = 2^{x-3y}$$

$$\text{So } \frac{n}{2} = x - 3y$$

$$\text{And } n = 2x - 6y$$

.....
(Total 3 marks)

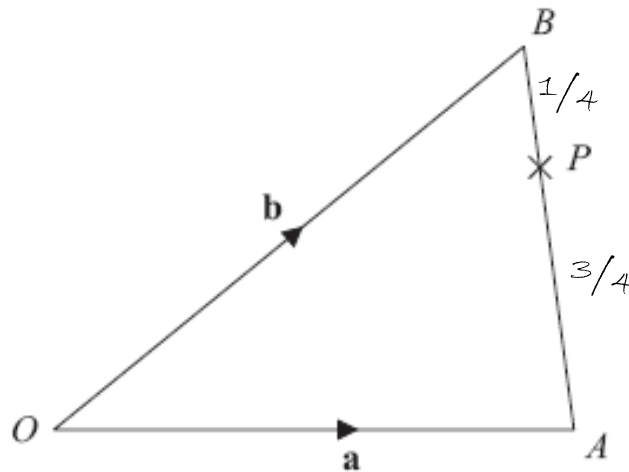


Diagram **NOT**
accurately drawn

OAB is a triangle.

$$\overrightarrow{OA} = \mathbf{a}$$

$$\overrightarrow{OB} = \mathbf{b}$$

- (a) Find $\overrightarrow{AB}$ in terms of $\mathbf{a}$ and $\mathbf{b}$.

$$\begin{aligned}\overrightarrow{AB} &= \overrightarrow{AO} + \overrightarrow{OB} \\ &= -\mathbf{a} + \mathbf{b} \quad \text{or} \quad \mathbf{b} - \mathbf{a}\end{aligned}$$

.....
(1)

P is the point on AB such that $AP : PB = 3 : 1$

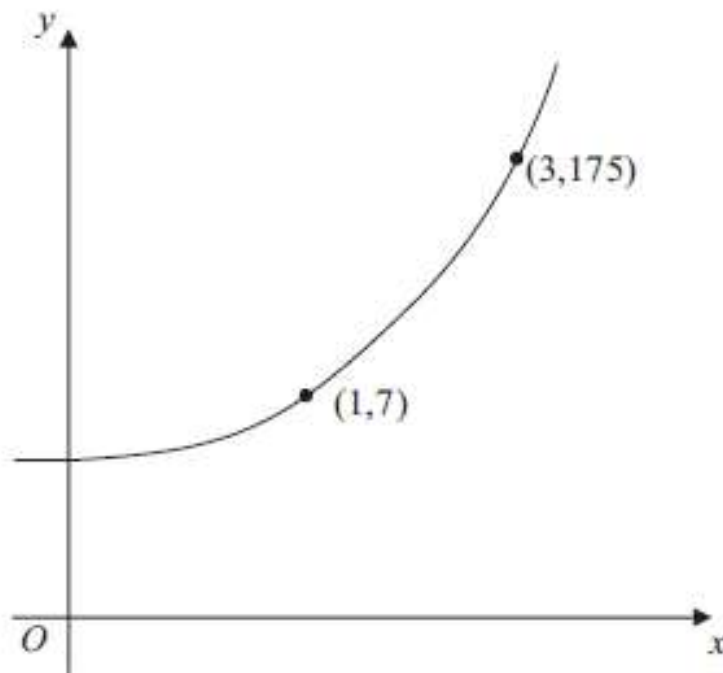
- (b) Find $\overrightarrow{OP}$ in terms of $\mathbf{a}$ and $\mathbf{b}$.
Give your answer in its simplest form.

Hint: A ratio of $3 : 1$ means that the distance from A to P is $\frac{3}{4}$ of the distance from A to B

$$\begin{aligned}\overrightarrow{OP} &= \overrightarrow{OA} + \frac{3}{4}\overrightarrow{AP} \\ &= \mathbf{a} + \frac{3}{4}(\mathbf{b} - \mathbf{a}) \\ &= \frac{1}{4}\mathbf{a} + \frac{3}{4}\mathbf{b}\end{aligned}$$

.....
(3)

(Total 4 marks)



The sketch shows a curve with equation

$$y = ka^x$$

where k and a are constants, and $a > 0$

The curve passes through the points $(1, 7)$ and $(3, 175)$.

Calculate the value of k and the value of a .

Hint: Substitute the points into the equation first

$$y = ka^x \quad (1, 7) \Rightarrow 7 = ka$$

$$(3, 175) \Rightarrow 175 = ka^3$$

$$k = \frac{7}{a} \text{ and substituting in } 175 = \frac{7a^3}{a}$$

$$\text{So } 175 = 7a^2 \Rightarrow 25 = a^2$$

$$\text{So } a = 5 \text{ and } k = 7/5$$

$$k = \dots\dots\dots$$

$$a = \dots\dots\dots$$

(Total 3 marks)

A and **B** are straight lines.

Line **A** has equation $2y = 3x + 8$.

Line **B** goes through the points $(-1, 2)$ and $(2, 8)$.

Do lines **A** and **B** intersect?

You must show all your working.

Hint: Find the equation of line B

Line A: $y = 1.5x + 4$

So gradient $= 1.5$

Line B: gradient $= \frac{\text{change in } y}{\text{change in } x} = \frac{8 - 2}{2 - (-1)} = \frac{6}{3} = 2$

The gradients are different so the lines are not parallel.

Therefore they must cross.

Or a carefully drawn graph showing the two lines cross at $(0, 4)$

(Total 3 marks)

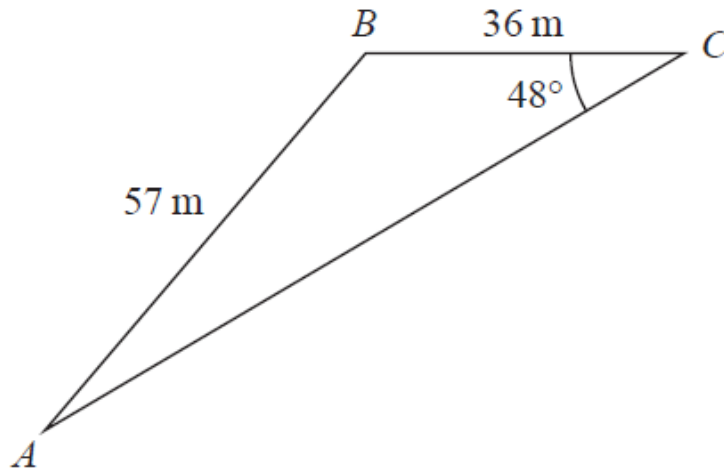


Diagram **NOT**
accurately drawn

Work out the area of triangle ABC.
Give your answer correct to 3 significant figures.

Hint: use the sine rule to find angle A, and then find angle C

$$\frac{\sin A}{36} = \frac{\sin B}{57}$$

$$36 \quad 57$$

$$A = \sin^{-1} \left(\frac{\sin 48}{57} \times 36 \right) = 27.9924121058 \dots$$

$$= 28.0^\circ \text{ to 1 dp}$$

$$\text{Angle } C = 180 - 48 - 28.0 = 104^\circ$$

$$\text{Area} = \frac{1}{2} \times 57 \times 36 \sin C = 995.490534805 \dots$$

$$= 995.49 \text{ m}^2 \text{ to 2 dp}$$

..... m²

(Total 4 marks)

The diagram shows a cylinder inside a cone on a horizontal base.

The cone and the cylinder have the same vertical axis.
The base of the cylinder lies on the base of the cone.

The circumference of the top face of the cylinder touches the curved surface of the cone.

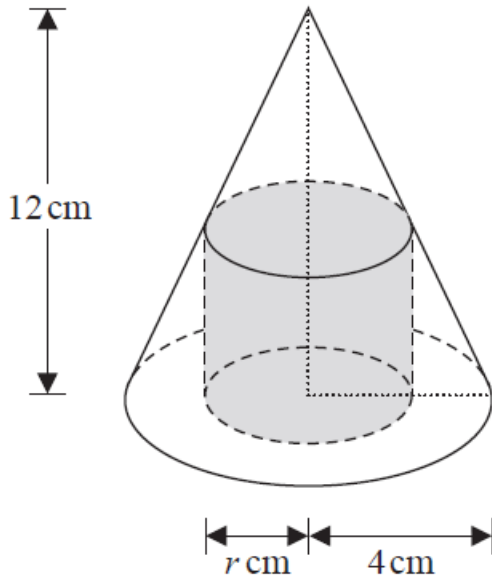
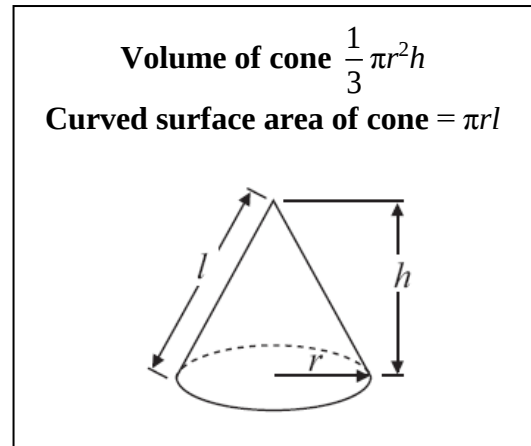


Diagram **NOT** accurately drawn



The height of the cone is 12 cm and the radius of the base of the cone is 4 cm.

- (a) Work out the curved surface area of the cone.
Give your answer correct to 3 significant figures.

$$\text{Sloping height of cone} = \sqrt{12^2 + 4^2} = \sqrt{160}$$

$$\text{Curved surface area of cone} = \pi \times 4 \times \sqrt{160}$$

$$= 158.953412253 \dots$$

$$= 159 \text{ cm}^2 \text{ to 3 sig figs}$$

..... cm²
(3)

The cylinder has radius r cm and volume V cm³

(b) Show that $V = 12\pi r^2 - 3\pi r^3$

So $\frac{\text{height of cylinder}}{\text{radius of cylinder}} = \frac{\text{height of cone}}{\text{radius of cone}}$

$$\frac{12 - h}{r} = \frac{12}{4}$$

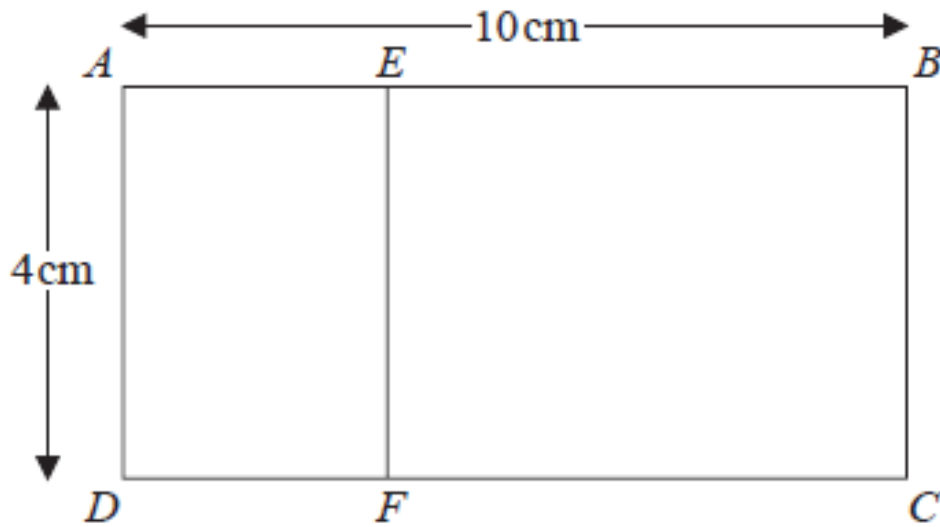
$$12 - h = 3r \Rightarrow h = 12 - 3r$$

$$V = \pi \times r^2 \times (12 - 3r) = 12\pi r^2 - 3\pi r^3$$

(3)

(Total 6 marks)

Rectangle $ABCD$ is mathematically similar to rectangle $DAEF$.



$AB = 10$ cm.

$AD = 4$ cm.

Work out the area of rectangle $DAEF$.

Hint: Similar shapes are enlargements of each other, but take care matching the sides

$$\text{Area of } ABCD = 10 \times 4 = 40 \text{ cm}^2$$

Side AB big becomes side AD small

$$\text{So SF linear big} \rightarrow \text{small} = \frac{4}{10}$$

$$\text{So SF area} = \frac{16}{100}$$

$$\text{So area} = \frac{16}{100} \times 40 = 6.4 \text{ cm}^2$$

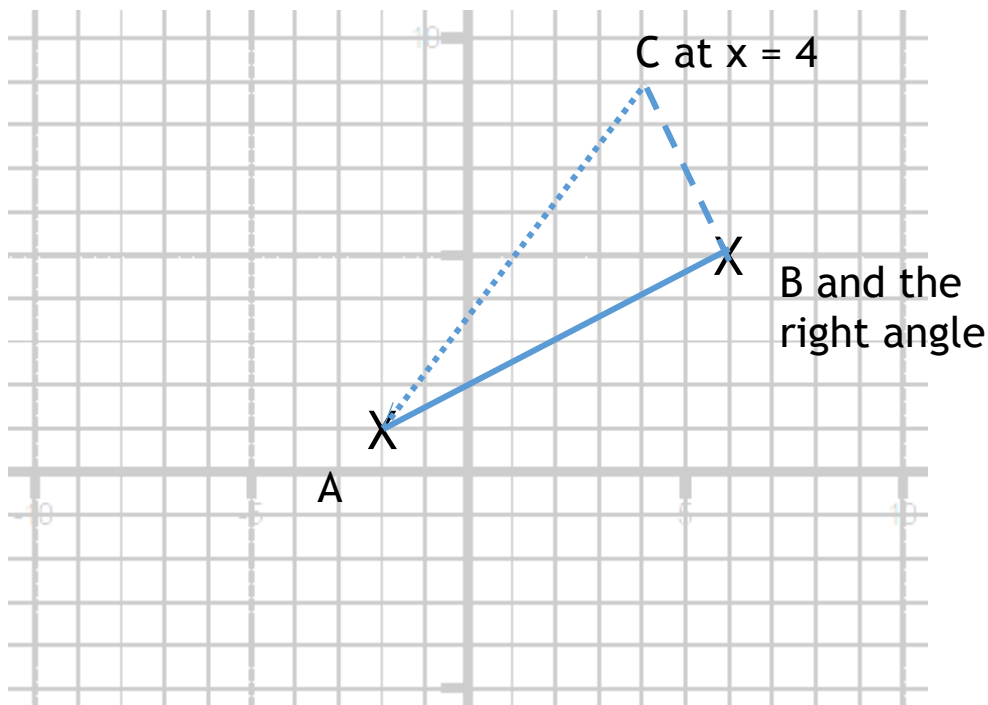
.....cm²

(Total is 3 marks)

$A(-2, 1)$, $B(6, 5)$ and $C(4, k)$ are the vertices of a right-angled triangle ABC .
Angle ABC is the right angle.

Find an equation of the line that passes through A and C .
Give your answer in the form $ay + bx + c$ where a , b and c are integers.

Hint: Draw a diagram



Line AB has gradient $\frac{1}{2}$ and y intercept $(0, 2)$
 $\angle B$ is a right angle, so line CB has gradient -2
 using gradient to track back to $x = 4 \Rightarrow y = 9$
 Line AC :

$$\text{Gradient} = \frac{9 - 1}{4 - (-2)} = \frac{8}{6} = \frac{4}{3}$$

and the intercept is at $\frac{11}{3}$

$$\text{so line } AC \ y = \frac{4}{3}x + \frac{11}{3} \text{ or } 3y - 4x - 11 = 0$$

(Total is 5 marks)

John has an empty box.

He puts some red counters and some blue counters into the box.

The ratio of the number of red counters to the number of blue counters is 1 : 4

Linda takes at random 2 counters from the box.

The probability that she takes 2 red counters is $\frac{6}{155}$

How many red counters did John put into the box?

Hint: call the number of red counters x

If red = x then blue = $4x$ and total = $5x$

$$P(RR) = \frac{x}{5x} \times \frac{x-1}{5x-1} = \frac{6}{155}$$

$$\frac{x(x-1)}{5x(5x-1)} = \frac{6}{155}$$

$$155(x^2 - x) = 6(25x^2 - 5x)$$

$$155x^2 - 155x = 150x^2 - 30x$$

$$5x^2 - 125x = 0$$

$$5x(x - 25) = 0$$

$$\text{So } 5x = 0 \text{ or } x - 25 = 0$$

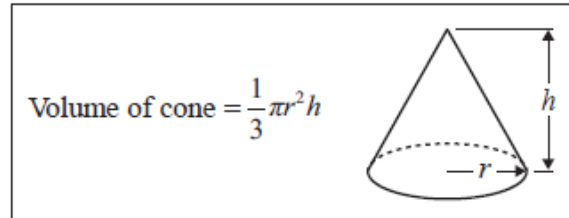
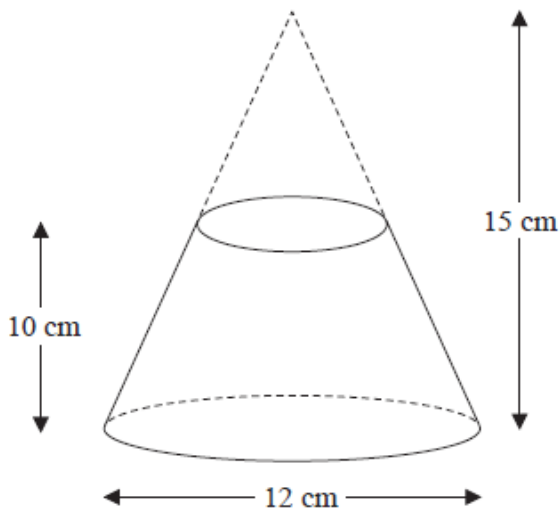
$$x = 0 \text{ or } x = 25$$

So there must be 25 red counters

.....

(Total is 4 marks)

A frustum is made by removing a small cone from a large cone as shown in the diagram.



The frustum is made from glass.
The glass has a density of 2.5 g / cm^3

Work out the mass of the frustum.
Give your answer to an appropriate degree of accuracy.

Hint: Try to work with numbers in terms of π

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

The cones are similar shapes $\therefore \frac{b}{s} \rightarrow s = \frac{1}{3}$

$$\text{Vol of big cone} = \frac{1}{3} \times \pi \times 6^2 \times 15 = 180\pi$$

$$\text{Vol of small cone} = \frac{1}{3} \times \pi \times \left(\frac{1}{3} \times 6\right)^2 \times 5 = \frac{20}{3}\pi$$

$$\text{Vol of frustum} = \left(180 - \frac{20}{3}\right)\pi$$

$$\text{Mass} = \text{density} \times \text{volume}$$

$$= 2.5 \times \left(180 - \frac{20}{3}\right)\pi = 1361.35681655 \dots$$

$$= 1361 \text{ g}$$

.....g

(Total is 5 marks)

Louis and Robert are investigating the growth in the population of a type of bacteria. They have two flasks A and B.
At the start of day 1, there are 1000 bacteria in flask A.
The population of bacteria grows exponentially at the rate of 50% per day.

- (a) Show that the population of bacteria in flask A at the start of each day forms a geometric progression.

Hint: Try to work with numbers in terms of π

Day	1	2	3	4
Bacteria	1000	1500	2250	3375
		$\times 1.5$	$\times 1.5$	$\times 1.5$

so geometric (2)

The population of bacteria in flask A at the start of the 10th day is k times the population of bacteria in flask A at the start of the 6th day.

- (b) Find the value of k .

$$1000 \times 1.5^9 = k \times 1000 \times 1.5^5$$

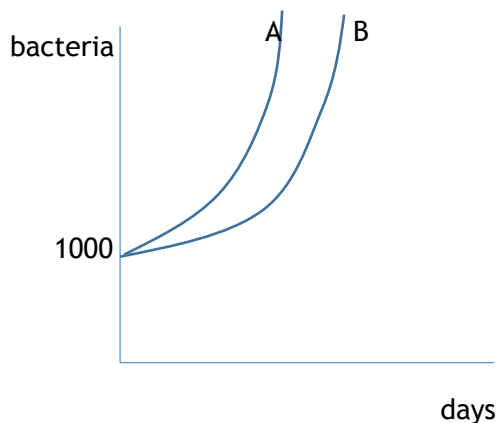
$$k = 1.5^4 = 5.0625$$

(2)

At the start of day 1 there are 1000 bacteria in flask B.

The population of bacteria in flask B grows exponentially at the rate of 30% per day.

- (c) Sketch a graph to compare the size of the population of bacteria in flask A and in flask B.



(1)

(Total is 5 marks)

In triangle RPQ ,

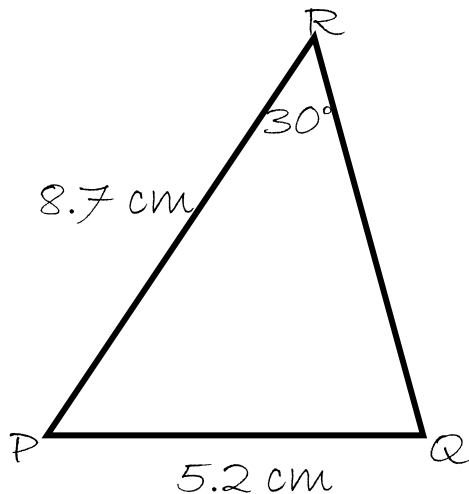
$$RP = 8.7 \text{ cm}$$

$$PQ = 5.2 \text{ cm}$$

$$\text{Angle } PRQ = 32^\circ$$

- (a) Assuming that angle PQR is an acute angle, calculate the area of triangle RPQ .
Give your answer correct to 3 significant figures.

Hint: Draw a diagram of the information



$$\begin{aligned}\frac{\sin Q}{8.7} &= \frac{\sin 32}{5.2} \\ Q &= \sin^{-1} \left(\frac{\sin 32 \times 8.7}{5.2} \right) \\ &= 62.4485318836 \\ &= 62.4^\circ \text{ to 1 dp}\end{aligned}$$

$$\text{So } P = 180 - 30 - 62.4 = 87.6^\circ$$

$$\begin{aligned}\text{Area of triangle} &= \frac{1}{2} \times 8.7 \times 5.2 \times \sin P \\ &= 22.5993479689 \dots \\ &= 22.6 \text{ cm}^2 \text{ to 1 dp}\end{aligned}$$

..... cm²
(4)

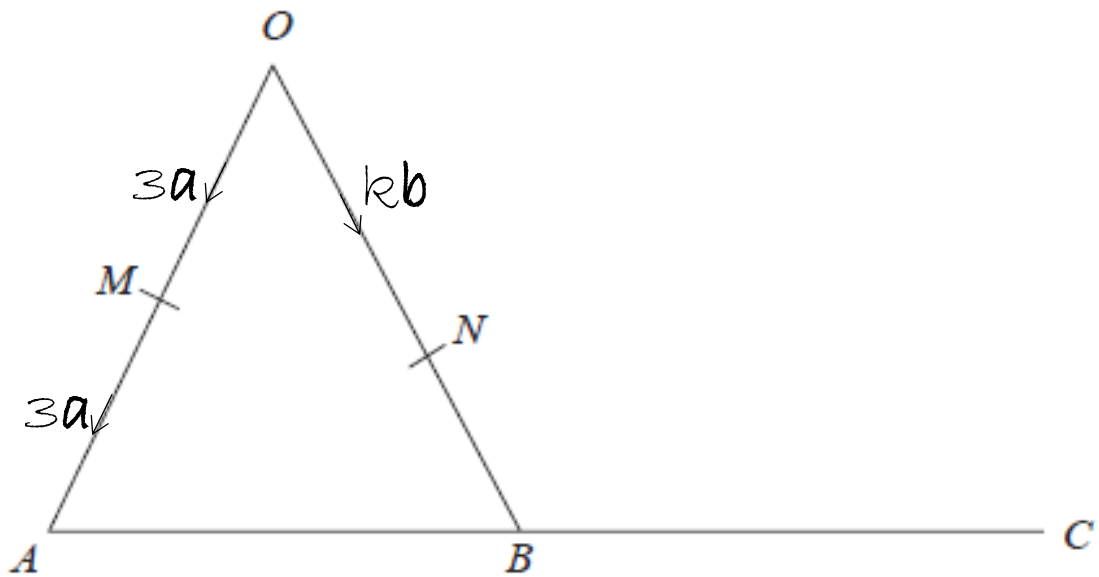
(b) If you did not know that angle PQR is an acute angle, what effect would this have on your calculation of the area of triangle RPQ ?

angle PRQ could be obtuse you would need to find area of two triangles.

.....

(1)

(Total is 5 marks)



OMA , ONB and ABC are straight lines.

M is the midpoint of OA .

B is the midpoint of AC .

$\vec{OA} = 6\mathbf{a}$ $\vec{OB} = 6\mathbf{b}$ $\vec{ON} = k\mathbf{b}$ where k is a scalar quantity.

Given that MNC is a straight line, find the value of k .

Hint: Find $\vec{MC}$ first

$$\vec{AB} = \vec{AO} + \vec{OB} = -6\mathbf{a} + 6\mathbf{b}$$

$$\text{So } \vec{BC} = -6\mathbf{a} + 6\mathbf{b}$$

$$\vec{MC} = \vec{MA} + \vec{AC} = 3\mathbf{a} - 12\mathbf{a} + 12\mathbf{b} = -9\mathbf{a} + 12\mathbf{b}$$

$$\vec{MN} = \vec{MO} + \vec{ON} = -3\mathbf{a} + k\mathbf{b}$$

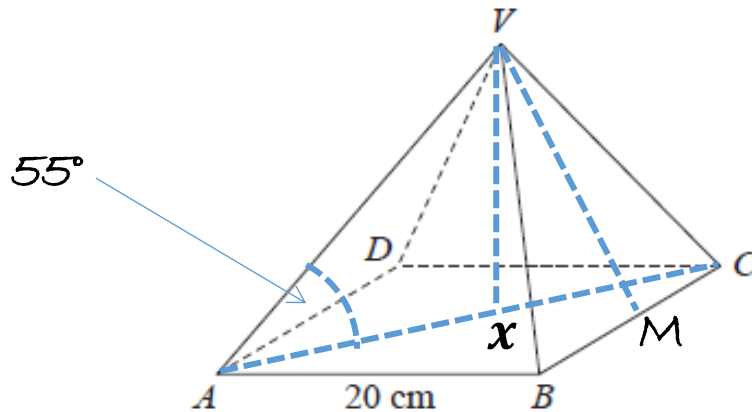
As M , N and C are on a straight line, $\vec{MC}$ is a multiple of $\vec{MN}$

$$\text{So } -9\mathbf{a} + 12\mathbf{b} = \text{something} \times (-3\mathbf{a} + k\mathbf{b})$$

That something must be 3 and so k must be 4

(Total is 5 marks)

$VABCD$ is a solid pyramid.



$ABCD$ is a square of side 20 cm.

The angle between any sloping edge and the plane $ABCD$ is 55°

Calculate the surface area of the pyramid.

Give your answer correct to 2 significant figures.

Hint: Add extra points and lines to the diagram of things you need to find in order to find the area of the triangular faces

$$AX^2 = 10^2 + 10^2 = 200$$

$$VX = AX \tan 55 = \sqrt{200} \times \tan 55$$

$$VM^2 = VX^2 + MX^2$$

$$= (\sqrt{200} \times \tan 55)^2 + 10^2$$

$$VM = 22.53711041 \dots$$

$$\text{Area of triangles} = 4 \times \frac{1}{2} \times VM \times 20$$

$$\text{Area of Base} = 20^2$$

$$\text{Total surface area} = 1301.484417 \dots$$

$$= 1301 \text{ cm}^2$$

.....cm²

(Total is 5 marks)



The equation of a straight line is $y = 4x + 7$

(a) Write down the gradient of the line.

Hint: $y = mx + c$

Gradient = 4

.....
(1)

(b) Write down the y-intercept of the line.

y-intercept = (0, 7)

.....
(1)

(Total 2 mark)



Work out $3\frac{1}{8} - 1\frac{2}{3}$

Hint: Change mixed numbers to improper fractions

$$\begin{aligned}
 3\frac{1}{8} - 1\frac{2}{3} &= \frac{25}{8} - \frac{5}{3} \\
 &= \frac{75}{24} - \frac{40}{24} \\
 &= \frac{35}{24}
 \end{aligned}$$

This can be converted back to a mixed number but doesn't have to be

$$1\frac{11}{24}$$

.....

(Total 3 marks)

Here are the ingredients needed to make 8 shortbread biscuits.



Shortbread biscuits
makes 8 biscuits
120 g butter
60 g caster sugar
180 g flour

Tariq is going to make some shortbread biscuits.
He has the following ingredients

330 g butter

200 g caster sugar

450 g flour

Work out the greatest number of shortbread biscuits that Tariq can make with his ingredients.
You must show all your working.

Hint: Look at all the ingredients to see which one is the limiter

Butter : Sugar : Flour

120 : 60 : 180

8 biscuits

240 : 120 : 360

16 biscuits

300 : 150 : 450

20 biscuits

Or

$$330 \div 120 = 2.75$$

$$200 \div 60 = 3 \frac{1}{3}$$

$$450 \div 180 = 2.5$$

So the multiplier that works for all ingredients
is 2.5, and $2.5 \times 8 = 20$

..... biscuits

(Total 3 marks)

Railtickets and Cheaptrains are two websites selling train tickets.



Each of the websites adds a credit card charge and a booking fee to the ticket price.

Railtickets

Credit card charge: 2.25% of ticket price

Booking fee: 80 pence

Cheaptrains

Credit card charge: 1.5% of ticket price

Booking fee: £1.90

Nadia wants to buy a train ticket.

The ticket price is £60 on each website.

Nadia will pay by credit card.

Will it be cheaper for Nadia to buy the train ticket from Railtickets or from Cheaptrains?

Hint: Deal with each way of paying separately

Railtickets

$$1\% \text{ of } £60 = £0.60$$

$$2\% \text{ of } £60 = £1.20$$

$$\frac{1}{4}\% \text{ of } £60 = £0.15$$

$$\text{So } 2.25\% \text{ of } £60 = £1.35$$

$$\text{Add the booking fee, Total} = £2.15$$

Cheaptrains

$$1\% \text{ of } £60 = £0.60$$

$$\frac{1}{2}\% \text{ of } £60 = £0.30$$

$$\text{So } 1.5\% = £0.90$$

$$\text{Add the booking fee, Total} = £2.80$$

So Railtickets is cheaper

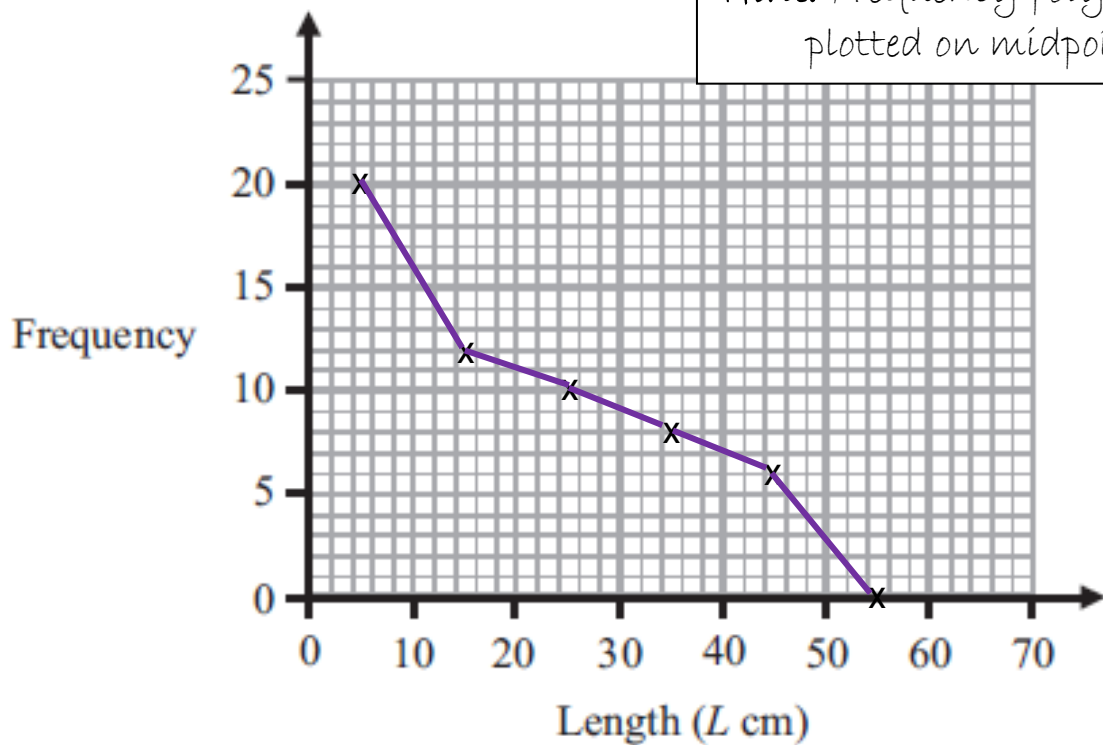
(Total 4 marks)

The table gives information about the lengths of the branches on a bush.

Length(Lcm)	Frequency	Midpoint
$0 \leq L < 10$	20	5
$10 \leq L < 20$	12	15
$20 \leq L < 30$	10	25
$30 \leq L < 40$	8	35
$40 \leq L < 50$	6	45
$50 \leq L < 60$	0	55

(a) Draw a frequency polygon to show this information.

Hint: Frequency polygons are plotted on midpoints



(2)

(b) Work out the total number of branches on the bush.

$$\text{Total} = 20 + 12 + 10 + 8 + 6 = 56$$

(2)

(c) Write down the modal class interval.

$$\text{Modal class interval} = 0 \leq L < 10$$

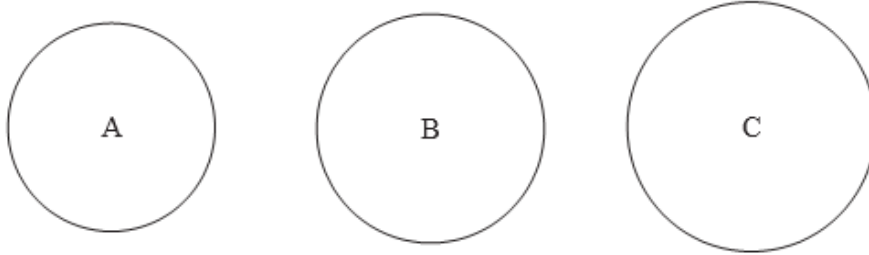
(1)

(Total 5 marks)

Here are three circles A, B and C.



Diagrams **NOT**
accurately drawn



The area of circle A is 200 cm^2 .

The area of circle B is 10% larger than the area of circle A.

The area of circle C is 10% larger than the area of circle B.

How much larger is the area of circle C than the area of circle A?

Hint: Think about your multipliers

Area A

Area B = $1.1 \times \text{area A}$

Area C = $1.1 \times \text{area B}$

$= 1.1 \times (1.1 \times \text{area A})$

$= 1.21 \times \text{area A}$

So Area C is 1.21 time bigger

This can also be expressed as 121%

(Total 4 marks)

(a) Expand and simplify $2(x + 3y) + 4(x - y)$



Hint: Factorise completely means there is more than one thing that can be taken outside the bracket

$$\begin{aligned} 2(x + 3y) + 4(x - y) &= 2x + 6y + 4x - 4y \\ &= 6x + 2y \end{aligned}$$

.....

(2)

(b) Factorise completely $8p - 12pq$

$$8p - 12pq = 4p(2 - 3q)$$

.....

(2)

(Total 4 marks)

The diagram shows a triangle.

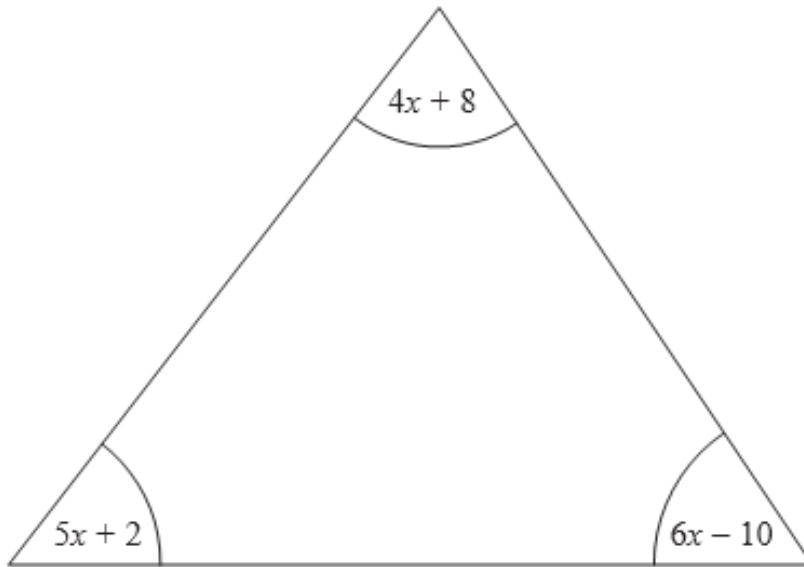


Diagram **NOT**
accurately drawn

All

the angles are measured in degrees.

Show that the triangle is isosceles.

Hint: Isosceles triangles have two angles the same size

Angles in a triangle add to 180°

$$4x + 8 + 6x - 10 + 5x + 2 = 180$$

$$15x = 180$$

$$x = 12^\circ$$

$$4x + 8 = 56^\circ$$

$$6x - 10 = 62^\circ$$

$$5x + 2 = 62^\circ$$

So 2 of the angles are the same size and the triangle is isosceles

(Total 5 marks)



(a) Find the Highest Common Factor (HCF) of 30 and 42.

Hint: Factor – numbers that divide in exactly
Multiple – in the times table

Factors 30: 1, 2, 3, 5, 6, 10, 15, 30

Factors 42: 1, 2, 3, 6, 7, 14, 21, 42

So HCF = 6

.....
(2)

(b) Find the Lowest Common Multiple (LCM) of 30 and 45.

Multiples of 30: 30, 60, 90, 120, ...

Multiples of 45: 45, 90, 135, ...

So LCM = 90

.....
(2)

(Total 4 marks)

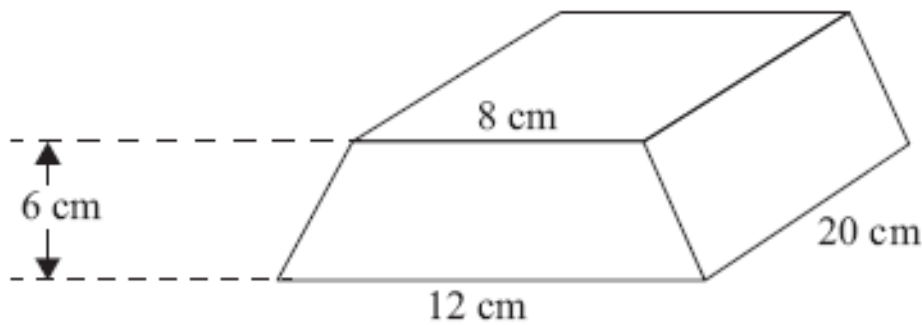


Diagram ~~NOT~~
accurately drawn

The diagram shows a solid prism made from metal.
The cross-section of the prism is a trapezium.

The parallel sides of the trapezium are 8 cm and 12 cm.
The height of the trapezium is 6 cm.
The length of the prism is 20 cm.

The density of the metal is 5 g/cm^3 .

Calculate the mass of the prism.
Give your answer in kilograms.

Hint: Look at the units of density to help remind you of the equation for density

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

$$\begin{aligned} \text{Volume of prism} &= \text{area of cross section} \times \text{length} \\ &= \frac{1}{2}(t + b) \times h \times l \\ &= \frac{1}{2}(8 + 12) \times 6 \times 20 \\ &= 1200 \text{ cm}^3 \end{aligned}$$

$$\begin{aligned} \text{Mass} &= \text{Density} \times \text{Volume} \\ &= 5 \times 1200 \\ &= 6000 \text{ g} \\ &= 6 \text{ kg} \end{aligned}$$

..... kg

(Total 5 marks)



(a) Write down the value of 25^0

Anything to the power 0 = 1

.....
(1)

(b) Write down the value of $49^{-\frac{1}{2}}$

Power $\frac{1}{2}$ means square root and a negative power means 1 over it

$$49^{-\frac{1}{2}} = \frac{1}{\sqrt{49}} = \frac{1}{7}$$

.....
(1)

(c) Write as a power of 2 $\frac{4 \times 8}{16^3}$

Hint: Take each power one at a time and convert to a power of 2

$$4 = 2^2 \quad 8 = 2^3 \quad 16 = 2^4$$

$$\frac{4 \times 8}{16^3} = \frac{2^2 \times 2^3}{(2^4)^3} = \frac{2^5}{2^{12}} = 2^{-7}$$

.....
(3)

(Total 5 marks)



There are 9 counters in a box.

4 of the counters are red.

2 of the counters are blue.

3 of the counters are yellow.

Pavinder takes at random two counters from the box.

Work out the probability that he takes at least one yellow counter.

Hint: This can be done by a probability tree or by considering all outcomes

$$P(RR)$$

$$P(RB)$$

$$P(RY) = \frac{4}{9} \times \frac{3}{8} = \frac{12}{72}$$

$$P(BR)$$

$$P(BB)$$

$$P(BY) = \frac{2}{9} \times \frac{3}{8} = \frac{6}{72}$$

$$P(YR) = \frac{3}{9} \times \frac{4}{8} = \frac{12}{72} \quad P(YB) = \frac{3}{9} \times \frac{2}{8} = \frac{6}{72} \quad P(YY) = \frac{3}{9} \times \frac{2}{8} = \frac{6}{72}$$

$$P(\text{at least one yellow}) = \frac{12}{72} + \frac{6}{72} + \frac{12}{72} + \frac{6}{72} + \frac{6}{72} = \frac{42}{72} = \frac{7}{12}$$

.....

(Total 4 marks)



Simplify fully $\frac{2x^2 - 7x + 3}{x^2 - 9}$

Hint: Have you recognised the difference of two squares?

$$\begin{aligned} \frac{2x^2 - 7x + 3}{x^2 - 9} &= \frac{(2x-1)(x-3)}{(x+3)(x-3)} \\ &= \frac{2x-1}{x+3} \end{aligned}$$

.....

(Total 3 marks)



Work out $(2 + \sqrt{3})(2 - \sqrt{3})$

Give your answer in its simplest form.

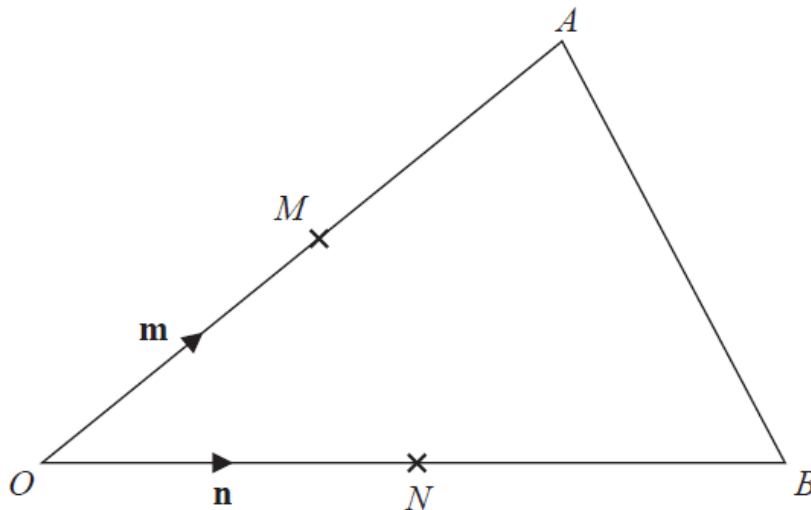
Hint: Be careful with the negative signs

$$\begin{aligned}(2 + \sqrt{3})(2 - \sqrt{3}) &= 4 - 2\sqrt{3} + 2\sqrt{3} - 3 \\ &= 1\end{aligned}$$

.....
(Total 2 marks)



Diagram **NOT**
accurately drawn



OAB is a triangle.
 M is the midpoint of OA .
 N is the midpoint of OB .

$$\overrightarrow{OM} = \mathbf{m}$$

$$\overrightarrow{ON} = \mathbf{n}$$

Show that AB is parallel to MN .

Hint: 2 lines are parallel if one vector is a multiple of the other vector

$$\overrightarrow{AB} = \overrightarrow{AO} + \overrightarrow{OB} = -\mathbf{a} + \mathbf{b}$$

$$\overrightarrow{MN} = \overrightarrow{MO} + \overrightarrow{ON} = -\frac{1}{2}\mathbf{a} + \frac{1}{2}\mathbf{b}$$

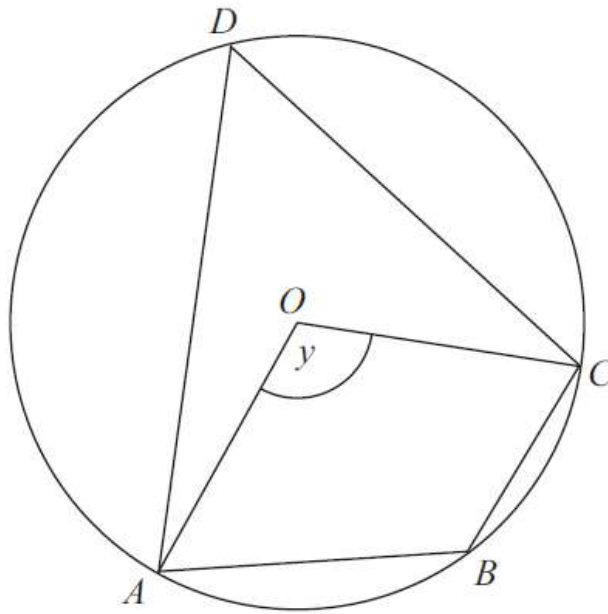
$$\text{So } \overrightarrow{AB} = 2 \times \overrightarrow{MN}$$

So the two lines are parallel

(Total 3 marks)



Diagram NOT
accurately drawn



A, B, C and D are points on the circumference of a circle, centre O.

Angle $AOC = y$.

Find the size of angle ABC in terms of y .
Give a reason for each stage of your working.

Hint: Remember your circle theorems

Angle at the centre = $2 \times$ the angle at circumference

So $\angle ADC = \frac{1}{2}y$

ABCD is a cyclic quadrilateral so opposite angles add to 180°

So $\angle ABC = 180 - \frac{1}{2}y$

OR

Angles at a point add to 360°

So reflex angle $O = 360 - y$

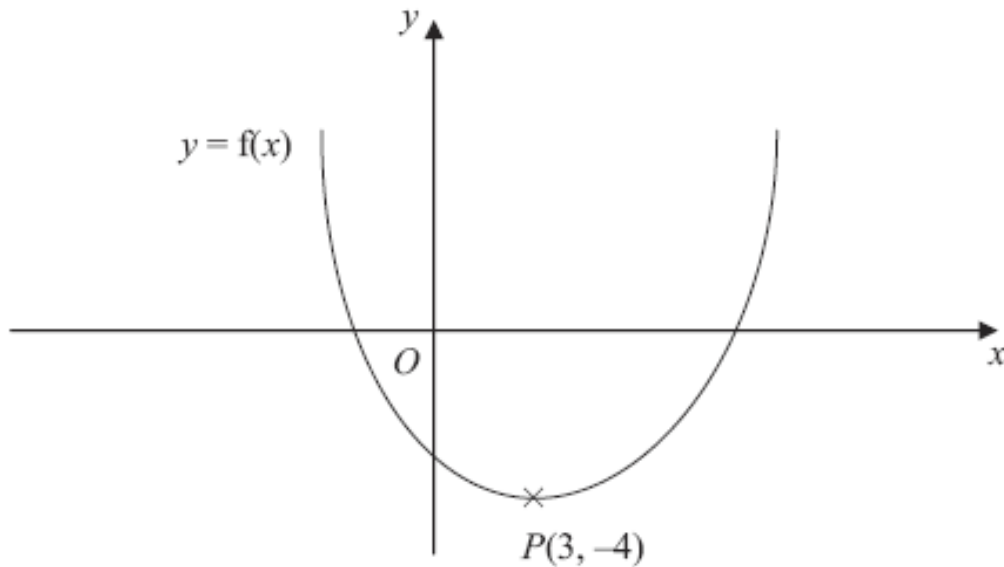
Angle at the centre = $2 \times$ the angle at circumference

So $\angle ABC = 180 - \frac{1}{2}y$

(Total 4 marks)



This is a sketch of the curve with the equation $y = f(x)$.
The only minimum point of the curve is at $P(3, -4)$.



- (a) Write down the coordinates of the minimum point of the curve with the equation $y = f(x - 2)$.

Hint: Think about how a particular value of x changes under the transformation

Add 2 to the x

$(5, -4)$

(.....,)

(2)

- (b) Write down the coordinates of the minimum point of the curve with the equation $y = f(x + 5) + 6$

Subtract 5 from the x and add 6 to the y

$(-2, 2)$

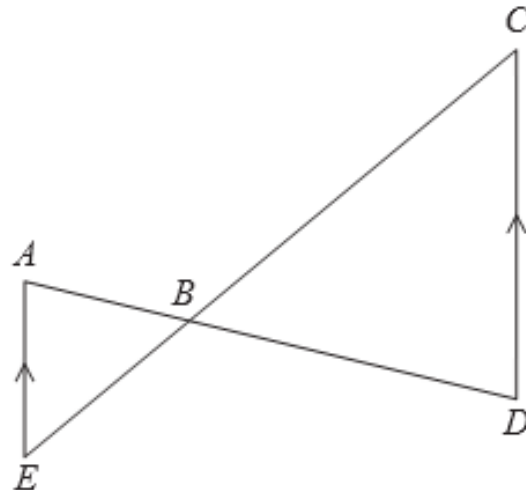
(.....,)

(2)

(Total 4 marks)



Diagram **NOT**
accurately drawn



AE is parallel to CD .
 ABD and EBC are straight lines.

Prove that triangle ABE is similar to triangle DBC .
Give reasons for each stage of your proof.

Hint: If they are similar then their angles will be the same

vertically opposite angles are the same

So $\angle ABE = \angle CBE$

Alternate angles on parallel lines are equal

So $\angle EAD = \angle ADC$ and $\angle AEC = \angle ECD$

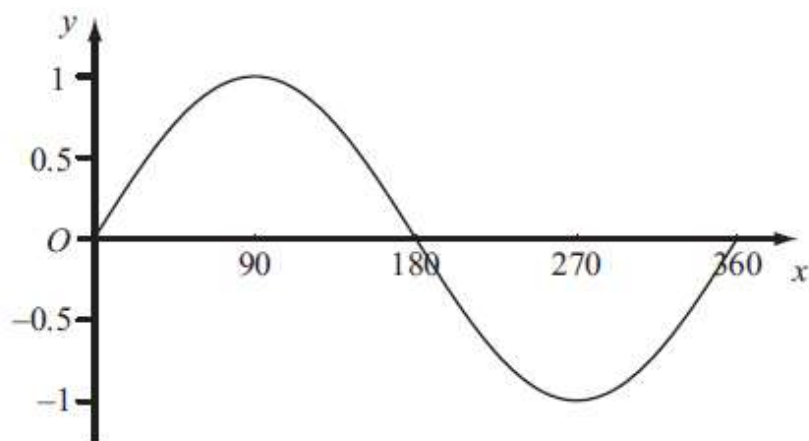
So each triangles has 3 angles that are the same in the other triangle

So they are similar

(Total 4 marks)



The diagram shows a sketch of the curve $y = \sin x^\circ$ for $0 \leq x \leq 360$



Hint: Draw lines on the graph to check your answers

The exact value of $\sin 60^\circ = \frac{\sqrt{3}}{2}$

(a) Write down the exact value of

(i) $\sin 120^\circ$, $\frac{\sqrt{3}}{2}$

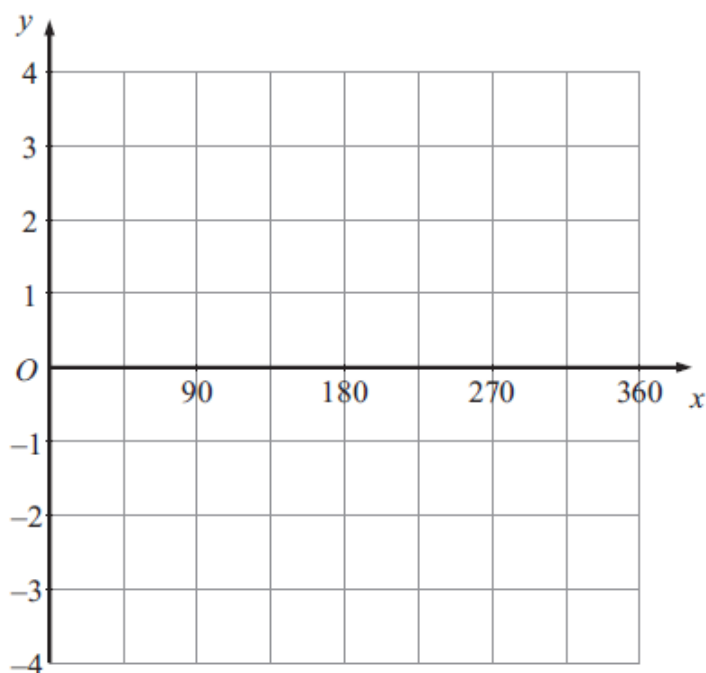
.....

(ii) $\sin 240^\circ$, $-\frac{\sqrt{3}}{2}$

.....

(2)

(b) On the grid below, sketch the graph of $y = \sin 2x^\circ$ for $0 \leq x \leq 360$



(2)

(Total 4 marks)

Prove algebraically that the difference between the squares of any two consecutive integers is equal to the sum of these two integers.



Hint: Think about what the generic expressions are for any two consecutive integers

Two consecutive integers are n and $n + 1$

Difference between their squares

$$= (n + 1)^2 - n^2$$

$$= n^2 + 2n + 1 - n^2$$

$$= 2n + 1$$

$$= n + n + 1$$

Which is the sum of n and $n + 1$

QED

(Total 4 marks)

Sketch the graph of $f(x) = -x^2 - 3x + 5$, showing the coordinates of the turning point and the coordinates of any intercepts with the coordinate axes.



Hint: What sort of x^2 ?
Can you find the roots?
What about the minimum or maximum?

$$f(x) = -x^2 - 3x + 5$$

negative x^2 so parabola is upside down

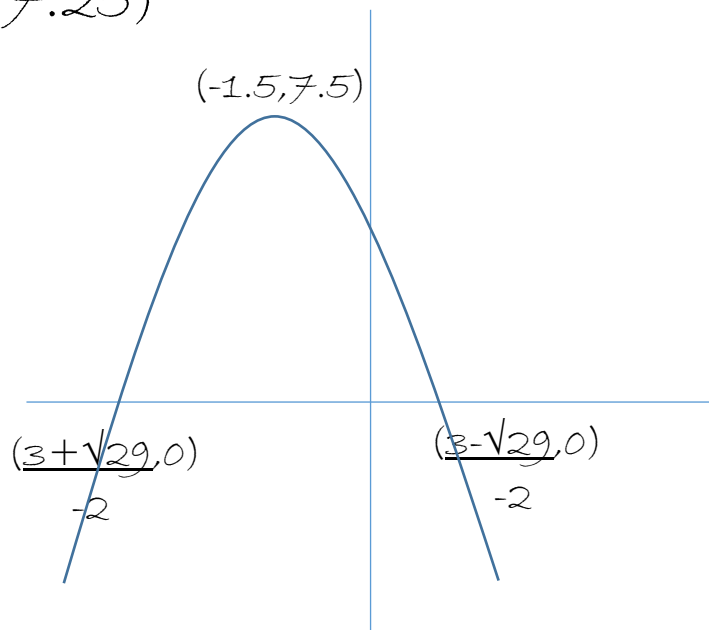
Doesn't factorise so using the quadratic formula

$$\frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{3 \pm \sqrt{9 + 20}}{-2} = \frac{3 \pm \sqrt{29}}{-2}$$

$\sqrt{29}$ is a bit more than 5, so the roots are a bit less than -4 and a bit more than 1

Completing the square

— $((x + 1.5)^2 - 7.25)$ means the maximum is at $(-1.5, 7.25)$



(Total 4 mark)

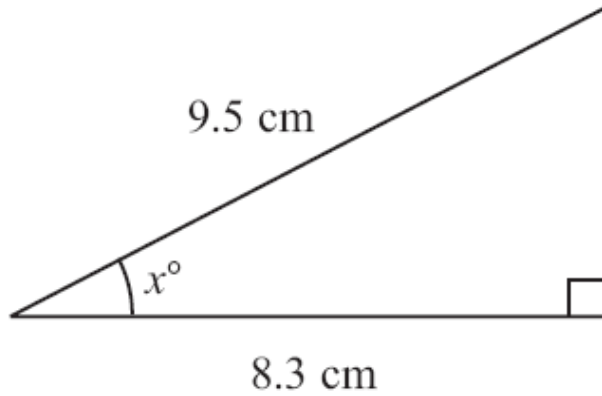


Diagram **NOT**
accurately drawn

Work out the value of x .
Give your answer correct to 1 decimal place.

Hint: Remember your trig formulae

$$\cos x = \frac{\text{Adj}}{\text{Hyp}}$$

$$= \frac{8.3}{9.5}$$

$$x = 29.11036718 \dots$$

$$= 29.1^\circ$$

$x = \dots\dots\dots$

(Total 3 marks)

On July 1st 2004, Jack invested £2000 at 5% per annum compound interest.
Work out the value of Jack's investment on July 1st 2006

Hint: This is compound interest

Amount £2000

Interest multiplier 1.05

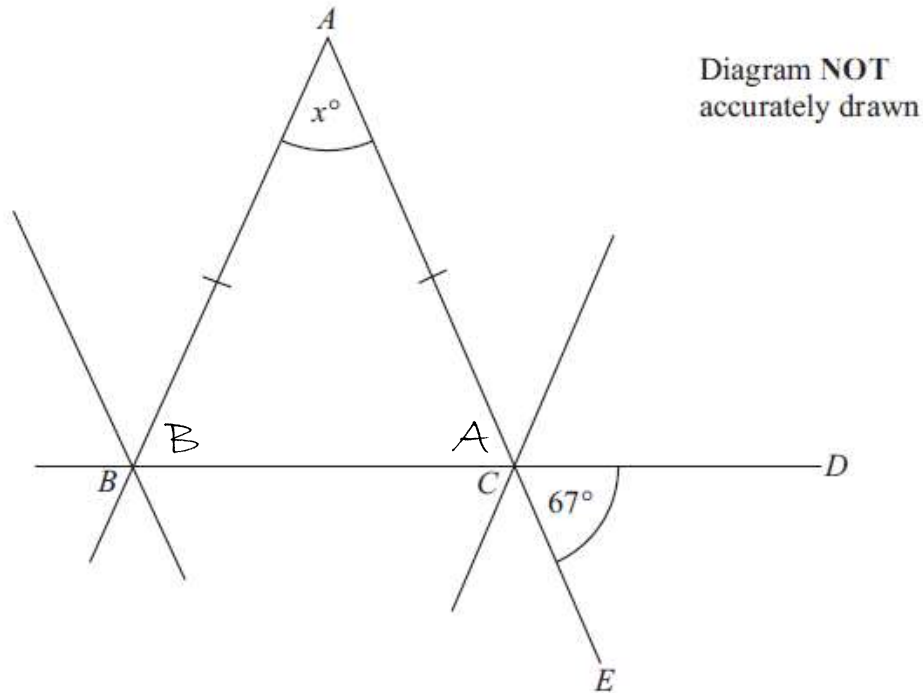
Years 2

$$\begin{aligned}\text{Amount} &= 2000 \times 1.05^2 \\ &= £2205\end{aligned}$$

£

(Total 3 marks)

The diagram shows part of the design of a stained glass window.



ABC is an isosceles triangle. BCD and ACE are straight lines. Angle $DCE = 67^\circ$.

Work out the size of the angle marked x° . Give reasons for your answer.

Hint: Have you noticed the isosceles triangle?

vertically opposite angles are equal

So angle $A = 67^\circ$

Base angles of an isosceles triangle are equal

So angle $B = 67^\circ$

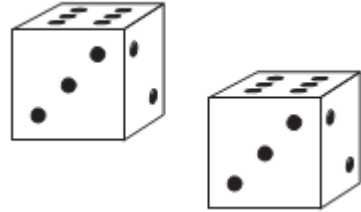
Angles in a triangle add to 180°

So angle $x = 46^\circ$

(Total 4 marks)

Naomi is playing a board game.
She must throw two fair dice.

She must get a 6 on each dice to start the game.



Work out the probability that she will not start the game on her first throw.

Hint: Do you remember the NOT rule?

$$P(6,6) = \frac{1}{6} \times \frac{1}{6} = \frac{1}{36}$$

$$\text{So } P(\text{not } 6,6) = 1 - \frac{1}{36} = \frac{35}{36}$$

.....
(Total 3 mark)

A company sells circular mirrors.

The price P pounds of a mirror is proportional to the square of its radius r cm.

A mirror with radius 20 cm has a price of £36

Find a formula for P in terms of r .

Hint: use the numbers given to find the proportion constant

$$P \propto r^2$$

$$\text{So } P = kr^2$$

$$36 = k \times 20^2$$

$$k = \frac{36}{400} = \frac{9}{100}$$

$$\text{So } P = \frac{9r^2}{100} \text{ or } 0.09r^2$$

$$P = \dots\dots\dots$$

(Total 3 marks)

The width of a rectangle is a whole number of centimetres.

The length of the rectangle is 9 cm longer than its width.

The perimeter of the rectangle is less than 200 cm.

Find the greatest possible width of the rectangle.

Hint: Try calling the width x

If the width is x the length is $x + 9$

$$\begin{aligned}\text{The perimeter} &= x + x + 9 + x + x + 9 \\ &= 4x + 18\end{aligned}$$

$$\text{So } 4x + 18 < 200$$

$$4x < 182$$

$$x < 45.5$$

So the greatest x must be 45 cm

..... cm

(Total 4 marks)

Hint: This is set theory - a Venn diagram might help

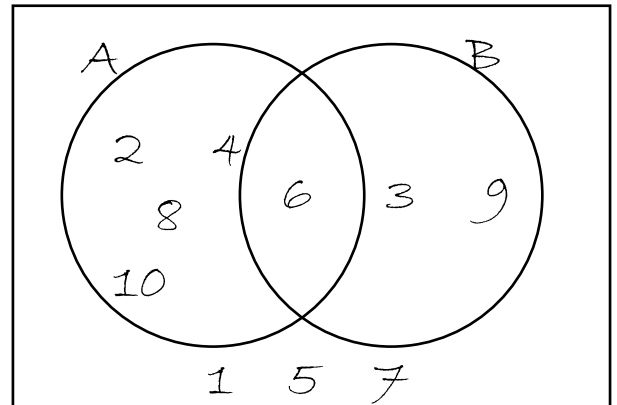
$$\mathcal{E} = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$$

$$A = \{\text{even numbers}\}$$

$$B = \{\text{multiples of 3}\}$$

(a) List the members of set B .

$$\text{Set } B = \{3, 6, 9\}$$



.....
(1)

(b) Find $A \cup B$

$$A \cup B = \{2, 3, 4, 6, 8, 9, 10\}$$

.....
(1)

(c) Find $A \cap B$

$$A \cap B = \{6\}$$

.....
(1)

x is a member of $\mathcal{E}$

$$x \in B$$

$$x \notin A$$

(d) What are the possible values of x ?

The possible values are 3 and 9

.....
(2)

(Total 5 marks)

The number of rabbits on a farm n months from now is R_n where

$$R_0 = 200$$

$$R_{n+1} = 1.2R_n - 35$$

How many rabbits will there be on the farm 3 months from now?

Hint: This is an iteration question – do it step by step

$$R_0 = 200$$

$$R_{n+1} = 1.2R_n - 35$$

$$\begin{aligned} \text{So } R_1 &= 1.2 \times 200 - 35 \\ &= 205 \end{aligned}$$

$$\begin{aligned} R_2 &= 1.2 \times 205 - 35 \\ &= 211 \end{aligned}$$

$$\begin{aligned} R_3 &= 1.2 \times 211 - 35 \\ &= 218.2 \end{aligned}$$

So there are 218 rabbits on the farm 3 months from now

.....
(Total 3 marks)

In a sale normal prices are reduced by 20%.

A washing machine has a sale price of £464

By how much money is the normal price of the washing machine reduced?

Hint: You have got to work out the original price
and then the reduction!

$$\text{Sale price} = 80\% = £464$$

$$\text{So } 10\% = £58$$

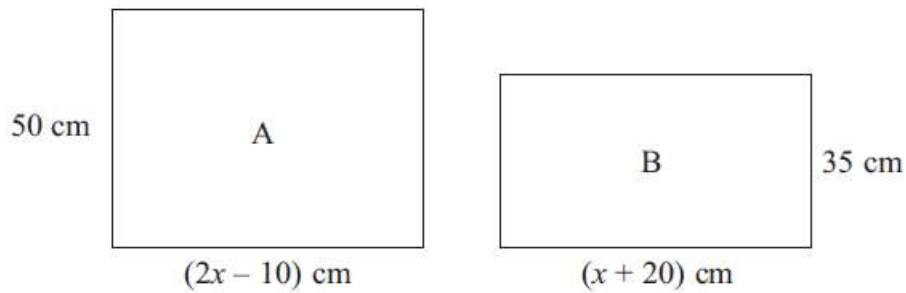
$$\text{So } 100\% = £580$$

So the machine was reduced by £116

£

(Total 3 marks)

The diagram gives information about two paintings, A and B.
Each painting is in the shape of a rectangle.



Painting A has an area 1725 cm^2 bigger than the area of painting B.

Work out the area of painting A.

Hint: Construct the equations for the area of both rectangles

$$\text{Area A} = 50(2x - 10) = 100x - 500$$

$$\text{Area B} = 35(x + 20) = 35x + 700$$

$$\text{Area A} = \text{Area B} + 1725$$

$$100x - 500 = 35x + 700 + 1725$$

$$100x - 500 = 35x + 2425$$

$$65x = 2925$$

$$x = 45 \text{ cm}$$

$$\text{So Area A} = 4000 \text{ cm}^2$$

.....
(Total 4 marks)

25 students in class A did a science exam.

30 students in class B did the same science exam.

The mean mark for the 25 students in class A is 67.8.

The mean mark for all the 55 students is 72.0.

Work out the mean mark for the students in class B.

Hint: Find out the total marks

$$\text{Mean} = \frac{\text{Total of marks}}{\text{Number of students}}$$

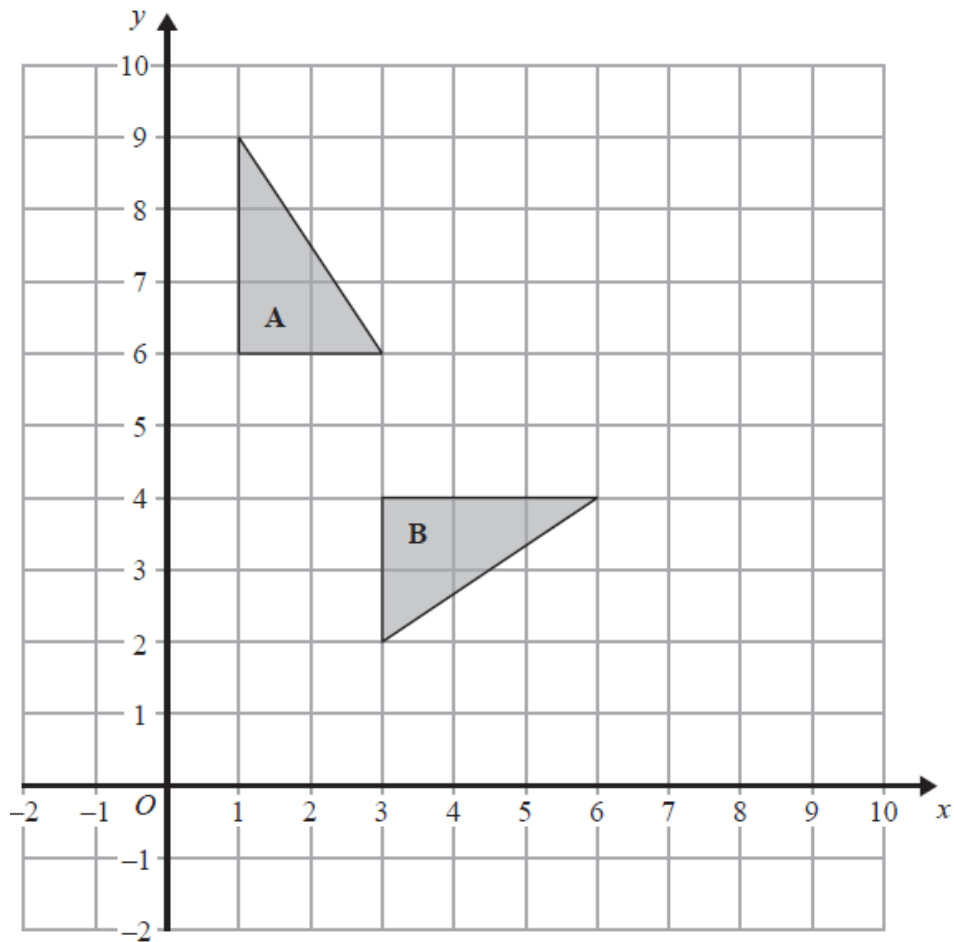
$$\text{Class A Total Marks} = 67.8 \times 25 = 1695$$

$$\text{All students total marks} = 72.0 \times 55 = 3960$$

$$\text{Class B Total Marks} = 3960 - 1695 = 2265$$

$$\text{Class B mean} = \frac{2265}{30} = 75.5$$

.....
(Total 3 marks)



Describe fully the single transformation that maps triangle **A** onto triangle **B**.

Hint: Make sure you give a full description – it's worth 3 marks

Rotation

90° clockwise

about centre of rotation (1, 4)

(Total 3 marks)

Fred has a solid brass model of an Egyptian pyramid.

The model has a volume of 3000 cm^3 .

The density of the brass is 8.5 g/cm^3 .

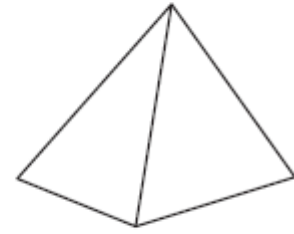
(a) Calculate the mass of the model.

Give your answer in kg.

Hint: Look at the units for density to remind you of the equation, and check the units of the answer



Model



Egyptian pyramid

Diagram **NOT**
accurately drawn

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

$$\begin{aligned} \text{Mass} &= \text{density} \times \text{volume} \\ &= 8.5 \times 3000 \\ &= 25500 \text{ g} \\ &= 25.5 \text{ kg} \end{aligned}$$

..... kg
(2)

The model and the Egyptian pyramid are mathematically similar. The length of the base of the model is 25 cm.

The length of the base of the Egyptian pyramid is 225 m.

(b) Calculate the volume of the Egyptian pyramid.

Give your answer in m^3 .

You can ignore the change in units from model to real in this question

$$\text{Linear SF model to real} = \frac{225}{25} = 9$$

$$\text{Volume SF model to real} = 9^3 = 729$$

$$\begin{aligned} \text{So volume of real pyramid} &= 729 \times 3000 \text{ m}^3 \\ &= 2187000 \text{ m}^3 \end{aligned}$$

(3)

(Total 5 marks)

Here is a rectangular sheet of metal.

A square hole is cut out of the metal.

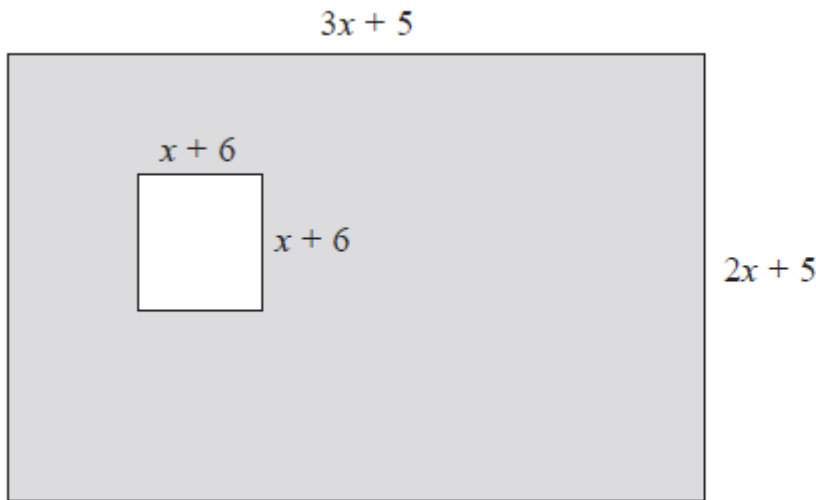


Diagram **NOT**
accurately drawn

The length of the rectangle is $3x + 5$

The width of the rectangle is $2x + 5$

The square has sides of length $x + 6$

All measurements are in centimetres.

Hint: Find expressions for the perimeters of the rectangle and the hole first

The perimeter of the square hole is $\frac{3}{5}$ of the perimeter of the rectangle.

Work out the length of a side of the square hole.

$$\begin{aligned} P \text{ Rectangle} &= 3x + 5 + 2x + 5 + 3x + 5 + 2x + 5 \\ &= 10x + 20 \end{aligned}$$

$$\begin{aligned} P \text{ Hole} &= x + 6 + x + 6 + x + 6 + x + 6 \\ &= 4x + 24 \end{aligned}$$

$$4x + 24 = \frac{3}{5}(10x + 20)$$

$$4x + 24 = 6x + 12$$

$$2x = 12$$

$$x = 6$$

so the side of square = 12 cm

..... cm

(Total 5 marks)

(a) Expand and simplify $(2x + 1)(x - 3)(x + 5)$

Hint: Take the first two brackets first

$$\begin{aligned}
 (2x + 1)(x - 3)(x + 5) &= (2x^2 - 6x + x - 3)(x + 5) \\
 &= (2x^2 - 5x - 3)(x + 5) \\
 &= (2x^3 + 10x^2 - 5x^2 - 25x - 3x - 15) \\
 &= 2x^3 + 5x^2 - 28x - 15
 \end{aligned}$$

.....
(3)

(b) Make r the subject of $5r + 1 = a(m + r)$

$$\begin{aligned}
 5r + 1 &= a(m + r) \\
 5r + 1 &= am + ar \\
 5r - ar &= am - 1 \\
 r(5 - a) &= am - 1 \\
 r &= \frac{am - 1}{5 - a}
 \end{aligned}$$

.....
(3)

(Total 6 marks)

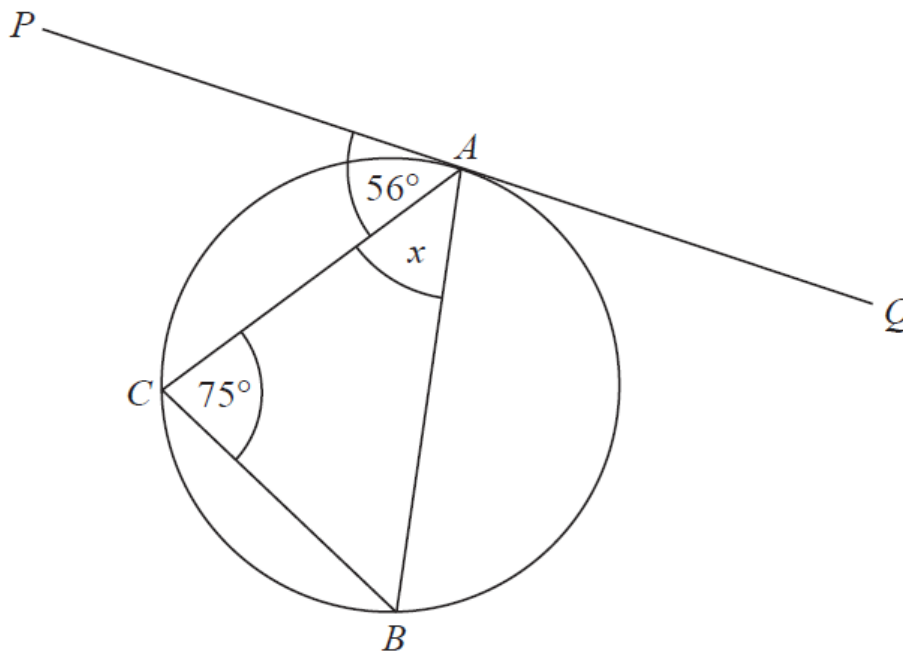


Diagram **NOT**
accurately drawn

A , B and C are points on the circumference of a circle.

The straight line PAQ is a tangent to the circle.

Angle $PAC = 56^\circ$

Angle $ACB = 75^\circ$

Work out the size of the angle marked x .

Give reasons for each stage of your working.

Hint: Make sure you quote the full reasons for each calculation

Alternate segment theorem

$$\angle ABC = 56^\circ$$

Angles in a triangle add to 180°

$$\text{So } x = 180 - 56 - 74 = 50^\circ$$

(Total 3 marks)

Diagram NOT
drawn accurately

There is a coastguard station at point A and at point B.

B is due East of A.

The distance from A to B is 12 km.

There is a rowing boat at point R.

R is on a bearing of 160° from A.

R is on a bearing of 220° from B.

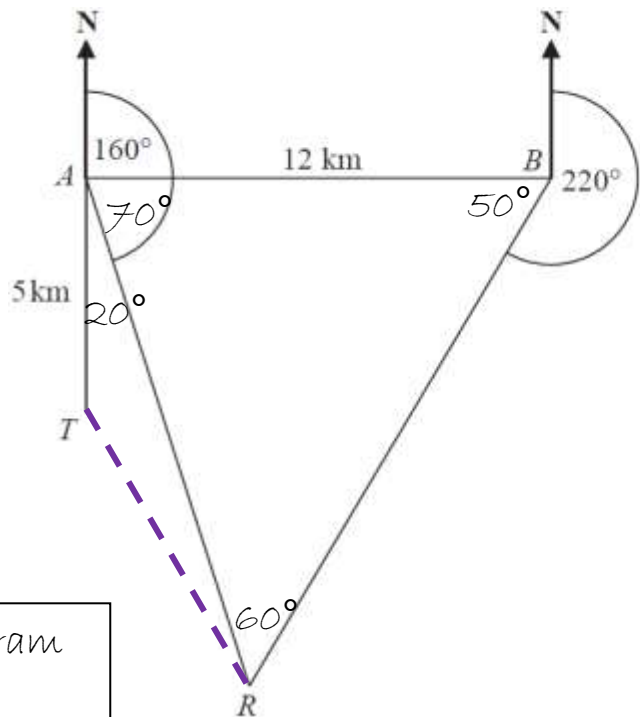
There is a speedboat at point T.

T is 5 km due South of A.

Work out the shortest distance from T to R.

Give your answer correct to 1 decimal place.

You must show all your working.



Hint: Add things to your diagram that will help

$$\angle RAB = 160 - 90 = 70^\circ$$

$$\angle RBA = 270 - 220 = 50^\circ$$

$\angle ARB = 180 - 70 - 50 = 60^\circ$ because angles in a triangle add to 180°

$$\angle TAR = 180 - 160 = 20^\circ$$

Sine Rule:

$$\frac{AR}{\sin 50} = \frac{12}{\sin 60} \quad \text{so } AR = \frac{12 \times \sin 50}{\sin 60}$$

$$= 10.6146231707 \dots$$

Cosine Rule:

$$TR^2 = 5^2 + 10.61^2 - 2 \times 5 \times 10.61 \times \cos 20$$

$$= 37.9253943967 \dots$$

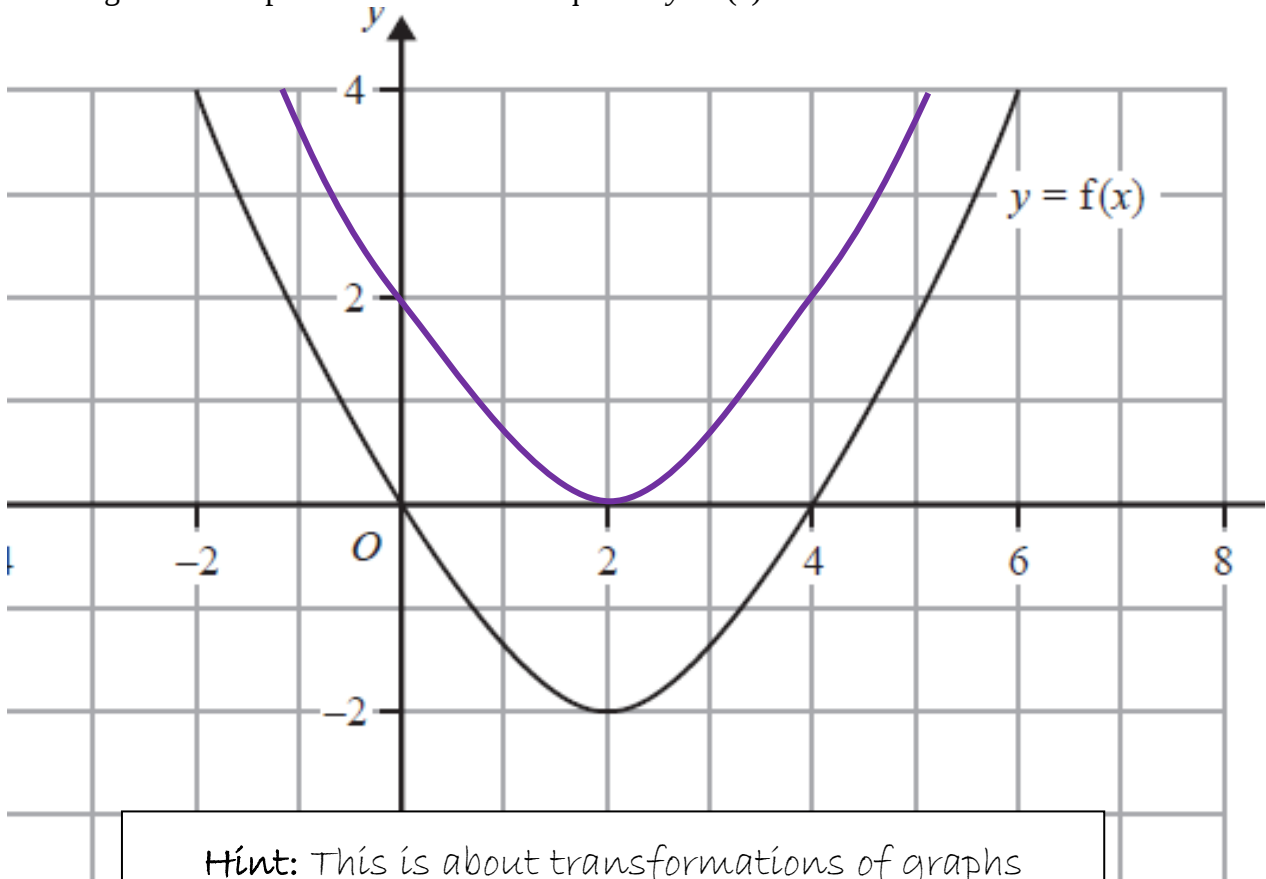
$$TR = 6.15835971641 \dots$$

$$= 6.16 \text{ (1 dp)}$$

.....km

(Total 5 marks)

The diagram shows part of the curve with equation $y = f(x)$.



Hint: This is about transformations of graphs

- (a) (i) Write down the coordinates of the points where the graph of $y = f(x - 2)$ crosses the x-axis.

A translation of 2 to the right

(2, 0) and (6, 0)

(..... ,) and (..... ,)

- (ii) Write down the coordinates of the point where the graph of $y = f(x - 2)$ crosses the y-axis.

(0, 4)

(..... ,)

(2)

- (b) On the diagram above, sketch the graph of $y = f(x) + 2$

A translation of 2 up

(2)

(Total 4 marks)

$$A : B : C = x + 1 : 3 : x - 1$$

$$A + B + C = 60$$

$$B = 30$$

Work out the value of x .

Hint: Have you noticed that B in the ratio is a number

In the ratio B is 3 but we are told that $B = 30$

$$\begin{aligned} \text{So } A : B : C &= 10(x + 1) : 30 : 10(x - 1) \\ &= 10x + 10 : 30 : 10x - 10 \end{aligned}$$

$$A + B + C = 10x + 10 + 30 + 10x - 10 = 60$$

$$\text{So } 20x + 30 = 60$$

$$20x = 30$$

$$x = 1.5$$

.....
(Total 5 marks)

Rhys has a beehive.

The number of bees in the beehive is decreasing.

Rhys counts the number of bees in the hive at the start of week 5. He counts the number of bees in the hive at the start of week 7.

Here are his results.

week	number of bees
5	1200
7	900

Assuming that the population of bees is decreasing exponentially, how many bees were there at the start of week 2?

You must show your working.

Hint: Decreasing exponentially means we are multiplying by a factor between 0 and 1 each week

Assume population decreases by a constant scale factor each week

So week 7 = week 5 $\times x^2$

$$900 = 1200 \times x^2$$

$$x^2 = \frac{3}{4}$$

$$x = \frac{\sqrt{3}}{2}$$

So to undo $\times \frac{\sqrt{3}}{2}$ we do the opposite which is $\times \frac{2}{\sqrt{3}}$

$$\text{So week 2} = 1200 \times \frac{2}{\sqrt{3}} \times \frac{2}{\sqrt{3}} \times \frac{2}{\sqrt{3}}$$

$$= 1847.52086141 \dots$$

$$= 1848 \text{ bees}$$

..... bees

(Total 5 marks)

A trapezium $ABCD$ has an area of $5\sqrt{6} \text{ cm}^2$.

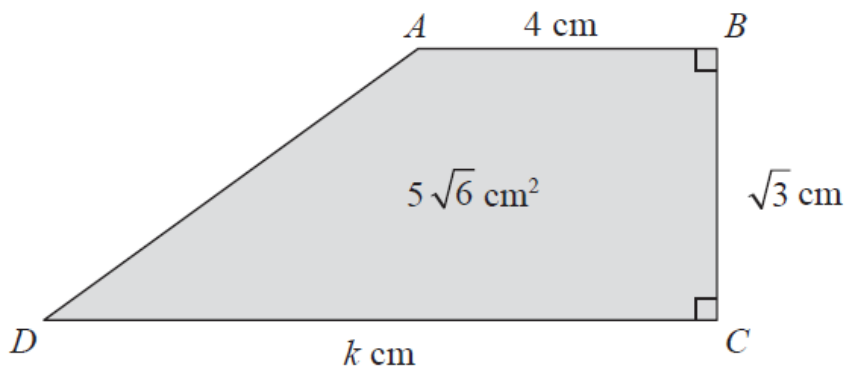


Diagram **NOT**
accurately drawn

$$AB = 4 \text{ cm.}$$

$$BC = \sqrt{3} \text{ cm.}$$

$$DC = k \text{ cm.}$$

Calculate the value of k , giving your answer in the form $a\sqrt{b} - c$,
where a , b and c are positive integers.

Show each step in your working.

Hint: Area of a trapezium = $\frac{1}{2}(a + b) \times h$

$$\text{Area} = \frac{1}{2} (4 + k) (\sqrt{3}) = 5\sqrt{6}$$

$$4 + k = \frac{10\sqrt{6}}{\sqrt{3}}$$

$$k = \frac{10\sqrt{6}}{\sqrt{3}} - 4$$

$$k = \frac{\sqrt{600}}{\sqrt{3}} - 4$$

$$k = \sqrt{200} - 4$$

$$k = 10\sqrt{2} - 4$$

$$k = \dots\dots\dots$$

(Total 3 marks)

$$-2 < n \leq 3$$

n is an integer.

(a) Write down all the possible values of n .

$-1, 0, 1, 2, 3$

.....
(2)

x is a number.

Another number is 9 greater than x .

Both numbers are whole numbers.

The total of the two numbers is less than 60

(b) Find the greatest possible value of x .

Hint: use algebra to form expressions and equations

The numbers are x and $x + 9$

$$x + x + 9 < 60$$

$$2x + 9 < 60$$

$$2x < 51$$

$$x < 25.5$$

.....
(3)

(Total 5 marks)

Prove that

$$(2n + 3)^2 - (2n - 3)^2 \text{ is a multiple of 8}$$

for all positive integer values of n .

Hint: This is a formal proof

$$\begin{aligned} & (2n + 3)^2 - (2n - 3)^2 \\ &= (2n + 3)(2n + 3) - (2n - 3)(2n - 3) \\ &= 4n^2 + 12n + 9 - (4n^2 - 12n + 9) \\ &= 4n^2 + 12n + 9 - 4n^2 + 12n - 9 \\ &= 24n \\ &= 8 \times 3n \\ &\text{So it is a multiple of 8} \end{aligned}$$

(Total 3 marks)

Alex and Ben go to a cafe with some friends.

Alex buys 4 cups of coffee and 3 cups of tea.
He pays a total of £6.95

Ben buys 5 cups of coffee and 2 cups of tea.
He pays a total of £7.20

Work out the cost of each cup of coffee and the cost of each cup of tea.

Hint: Construct your equations and solve them simultaneously

$$4x + 3y = 695$$

$$5x + 2y = 720$$

$$8x + 6y = 1390$$

$$15x + 6y = 2160$$

$$-8x - 6y = -1390$$

$$15x + 6y = 2160$$

$$7x = 770$$

$$x = 110 \text{ - coffee}$$

$$y = 85 \text{ - tea}$$

So coffee is £1.10 and tea is 85p

Cup of coffee

Cup of tea

(Total 5 mark)

Beth has 600 counters.

$\frac{3}{5}$ of the counters are yellow.

25% of the counters are red.

The rest of the counters are green.

Beth is given some more red counters.

Now the ratio of the number of green counters to the number of red counters is 1 : 2

How many red counters was Beth given?

Hint: First work out how many of each colour you have at the start

600 counters

$\frac{3}{5}$ are yellow = 60% = 360 yellow

25% are red = $\frac{1}{4}$ = 150

The rest = 90 are green

New ratio G : R

1 : 2

90 : x

x must be 180

Beth already had 150 red so she must have been given 30 more

.....

(Total 4 mark)

Work out $(9.5 \times 10^9) \div (3.8 \times 10^3)$
Give your answer in standard form.

Hint: Remember the format for standard form

$$\begin{aligned}(9.5 \times 10^9) \div (3.8 \times 10^3) &= 2500000 \\ &= 2.5 \times 10^6\end{aligned}$$

.....
(Total 2 marks)

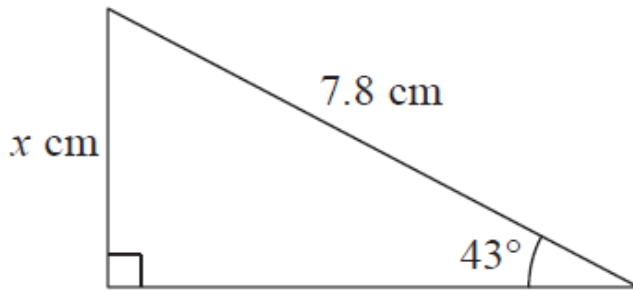


Diagram **NOT**
accurately drawn

Work out the value of x .
Give your answer correct to 3 significant figures.

Hint: Remember your trig formulas

$$\sin \theta = \frac{\text{Opp}}{\text{Hyp}}$$

$$\sin 43 = \frac{x}{7.8}$$

$$x = 7.8 \times \sin 43 = 5.31958720849 \dots$$

$$= 5.32 \text{ to 3 sig figs}$$

$x = \dots\dots\dots$

(Total 3 marks)

(a) $A = \{p, r, a, g, u, e\}$

$B = \{p, a, r, i, s\}$

$C = \{b, u, d, a, p, e, s, t\}$

Hint: $\cup$ means union and $\cap$ means intersection

List the members of the set

(i) $A \cap B$

Intersection are the letters in common in the two sets

$A \cap B = \{p, r, a\}$

(ii) $B \cup C$

union means all the letters in the two sets

$B \cup C = \{p, a, r, i, s, b, u, d, e, t\}$

(2)

(b) $D = \{r, o, m, e\}$

$E = \{l, i, s, b, o, n\}$

$F = \{b, e, r, l, i, n\}$

Put one of the letters D , E or F in the box below to make the statement correct.

$A \cap \boxed{E} = \emptyset$

Explain your answer.

$\emptyset$ means the empty set, ie. nothing, so you need a set that doesn't have any letters that overlap with A

(1)

(Total 3 marks)

Here is a formula used to work out the speed, v mph, of a car making an emergency stop.

$$v = \sqrt{21d}$$

d feet is the length of the mark the car's tyres make on the road when making an emergency stop.

A car makes an emergency stop.

The car's tyres make a mark 90 feet long.

(a) Work out the speed of the car.

Give your answer correct to the nearest whole number.

$$D = 90$$

$$v = \sqrt{21d} = \sqrt{21 \times 90} = \sqrt{1890}$$

$$= 43.4741302386 \dots$$

$$= 43 \text{ mph to the nearest whole number}$$

..... mph

(2)

A car made an emergency stop.

The car's speed was 50 mph.

(b) Work out the length of the mark on the road.

Give your answer correct to the nearest whole number.

Hint: undo your equation carefully

$$v = \sqrt{21d}$$

$$50 = \sqrt{21d}$$

$$2500 = 21d$$

$$d = \frac{2500}{21}$$

$$= 119.047610048 \dots$$

$$= 119 \text{ feet to the nearest whole number}$$

$$= 119 \text{ feet to the nearest whole number}$$

..... feet

(3)

(Total 5 marks)

The diagram shows a large tin of pet food in the shape of a cylinder.

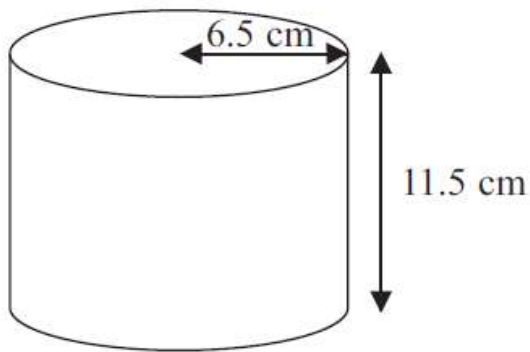


Diagram **NOT**
accurately drawn

The large tin has a radius of 6.5 cm and a height of 11.5 cm.

A pet food company wants to make a new size of tin.

The new tin will have a radius of 5.8 cm.

It will have the same volume as the large tin.

Calculate the height of the new tin.

Give your answer correct to one decimal place.

Hint: First work out the original volume

$$\text{Volume of a cylinder} = \pi r^2 h$$

$$\begin{aligned} \text{Original: } V &= \pi \times 6.5^2 \times 11.5 \\ &= 485.875\pi \end{aligned}$$

$$\text{New: } 485.875\pi = \pi \times 5.8^2 \times h$$

$$485.875 = 5.8^2 \times h$$

$$h = 485.875 \div 5.8^2$$

$$= 14.4433709869$$

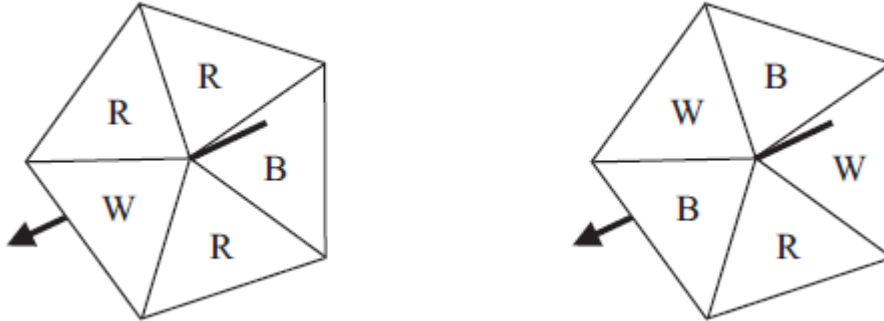
$$= 14.4 \text{ cm to 1 dp}$$

..... cm

(Total 3 marks)

Simon wants to raise money for charity.
He designs a game for people to play.

Simon uses two fair 5-sided spinners for the game.



People spin each spinner once.
A person wins the game when both spinners land on the same letter.

People pay 40p for each game they play. The prize for a win is £1.

Work out if Simon is likely to raise any money for charity with his game.

Hint: Make sure you quote the full reasons for each calculation

$$\begin{aligned}
 P(\text{win}) &= P(RR) + P(WW) + P(BB) \\
 &= \frac{3}{5} \times \frac{1}{5} + \frac{1}{5} \times \frac{2}{5} + \frac{1}{5} \times \frac{2}{5} \\
 &= \frac{3}{25} + \frac{2}{25} + \frac{2}{25} \\
 &= \frac{7}{25}
 \end{aligned}$$

$\frac{7}{25} \times £1 = 28\text{p}$ which is less than the 40p people pay to play, so yes he will make money

(Total 5 marks)

The value of a motor bike depreciates by 20% each year.

Brian says,

“After two years, the value of the motor bike will have reduced by 40%”.

He is **wrong**.

Explain why.

Hint: Think about what sort of calculation you would be doing here if you knew the value of the bike

20% per year means the value is multiplied by 0.8 for the first year and 0.8×0.8 for the second year $0.8 \times 0.8 = 0.64$, so the bike will have depreciated by 36% at the end of the second year

Or you can use a trial value and show it is not the same

The diagram shows a regular pentagon $ABCDE$.

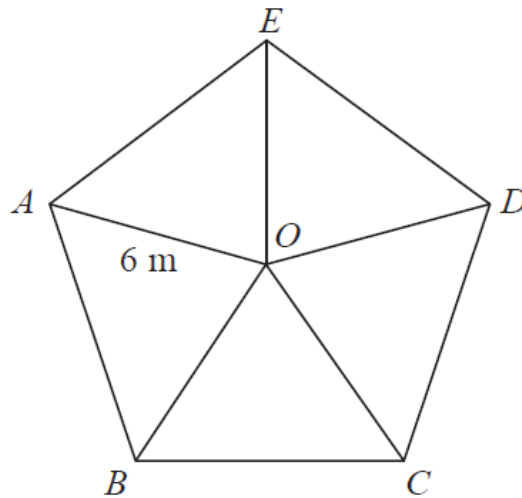


Diagram **NOT**
accurately drawn

The pentagon is divided into 5 isosceles triangles.
 $OA = OB = OC = OD = OE = 6 \text{ m}$

Work out the area of the pentagon.
 Give your answer correct to 1 decimal place.

Hint: Each triangle is isosceles

$$360 \div 5 = 72^\circ - \text{the angle at the centre}$$

$$\text{Area of triangle} = \frac{1}{2} \times 6^2 \times \sin 72$$

$$= 17.1190172933 \dots$$

$$= 17.12$$

$$\text{Area of 5 triangles} = 5 \times \text{one triangle}$$

$$= 85.5950864666 \dots$$

$$= 85.6 \text{ m}^2$$

..... m^2

(Total 4 marks)

The points $A(6, 1)$ and $B(-2, 5)$ are on the line with equation $y = -\frac{1}{2}x + 4$

M is the midpoint of AB .

Find an equation of the line through M that is perpendicular to $y = -\frac{1}{2}x + 4$

Hint: Make sure you quote the full reasons for each calculation

Midpoint is where $x = 2$, so $y = 3$

$y = -\frac{1}{2}x + 4$ has gradient $-\frac{1}{2}$

So the gradient of the perpendicular is 2

So equation of line through $(2, 3)$ with gradient 2

$$y = 2x + c$$

$$(2, 3) \quad 3 = 2 \times 2 + c$$

$$c = -1$$

$$\text{So } y = 2x - 1$$

.....
(Total 4 marks)

In the winter a farmer feeds his cows with hay each day.

The number of days, d , the hay will last is inversely proportional to the number of cows, c , the farmer has.

The farmer has enough hay to feed 280 cows for 25 days.

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

Hint: use the numbers given to find the constant of proportion

$$d \propto \frac{1}{c} \quad \text{so } d = \frac{k}{c} \quad 25 = \frac{k}{280} \quad \text{so } k = 7000$$

$$\text{so } d = \frac{7000}{c}$$

.....
(2)

The farmer has 350 cows.

(b) How many days will the farmer be able to feed all his cows with hay?

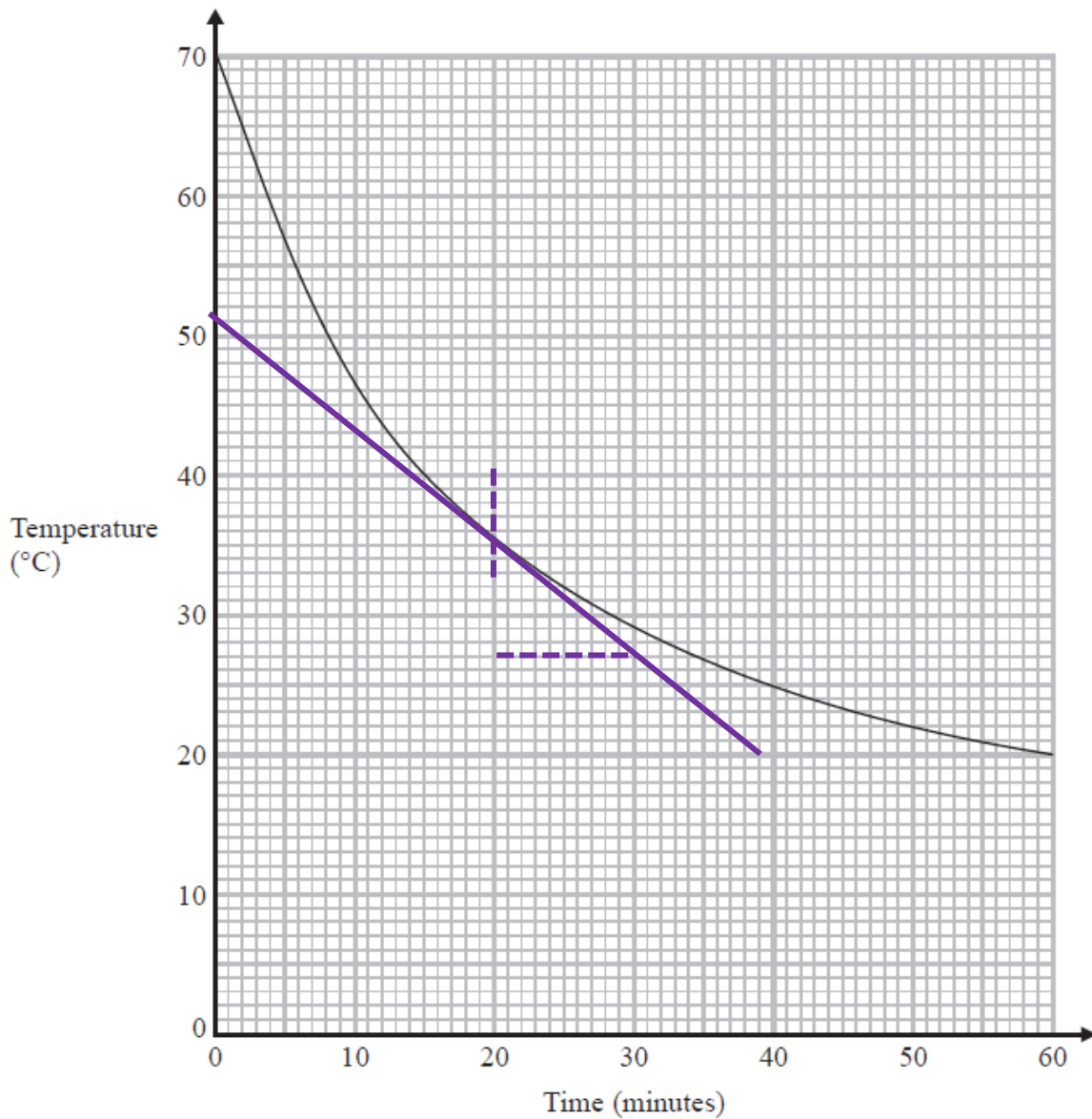
$$\text{so } d = \frac{7000}{350} = 20 \text{ days}$$

..... days
(2)

(Total 4 marks)

Hot drinks are served at a temperature of 70°C .

The graph shows the temperature of a hot drink as it cools in a china mug from the time it is served.



Work out the rate of cooling of the drink at time 20 minutes.

Hint: Rate of change is the gradient of a tangent to the curve

So rate of cooling = 0.8°C per min

..... $^{\circ}\text{C}$ per minute (Total 3 marks)

Adele grew 30 cabbages.

She gave fertiliser to 15 of the cabbages.

She did **not** gave fertiliser to the other 15 cabbages.

Here are the final weights, in kilograms, of the 15 cabbages Adele gave fertiliser to.

1.5	1.5	1.6	1.6	1.6	1.7	1.8	1.8
2.0	2.0	2.0	2.0	2.2	2.5	2.6	

Here is some information about the final weights, in kilograms, of the 15 cabbages Adele did **not** give fertiliser to.

Smallest	1.0	
Largest	2.1	
Median	1.4	
Lower quartile	1.2	$IQR = 0.4$
Upper quartile	1.6	

Compare the two distributions of weights.

Hint: Comparison of data needs a comparison of a measure of central tendency and a comparison of a measure of spread and in context

Fertilised

Smallest = 1.5

Largest = 2.6

Median = 1.8

LQ = 2.0

UQ = 1.6

$IQR = 0.4$

Each batch have the same IQR so they performed with the same consistency, but the fertilised ones had a higher median than the unfertilised, so were heavier cabbages

(Total 2 marks)

A field is in the shape of a rectangle.

The width of the field is 28 metres, measured to the nearest metre.

(a) Work out the upper bound of the width of the field.

$$\text{upper bound width} = 28.5 \text{ m}$$

..... metres

(1)

The length of the field is 145 metres, measured to the nearest 5 metres.

(b) Work out the upper bound for the perimeter of the field.

$$\text{upper bound length} = 147.5 \text{ m}$$

So upper bound for perimeter

$$= 2 \times 28.5 + 2 \times 147.5 = 352 \text{ m}$$

..... metres

(3)

Hint: Make sure you quote the full reasons for each calculation

(Total 4 marks)

The tables show some information about the population of the United Kingdom (UK) in 2003 and in 2008.

2003		
	Area (km ²)	Number of people per km ²
England	130 281	383
Northern Ireland	13 576	125
Scotland	77 925	65
Wales	20 732	142

2008	
	Percentage of total UK population
England	84%
Northern Ireland	4%
Scotland	9%
Wales	3%

In 2008, the total population of the UK was 61 million.

The population of **England** increased between 2003 and 2008

Work out this increase.

Give your answer correct to 2 significant figures.

Hint: Take each year separately

$$\begin{aligned}
 \text{2008 England population} &= 0.84 \times 61 \text{ million} \\
 &= 51.24 \text{ million people}
 \end{aligned}$$

$$\begin{aligned}
 \text{2003 England population} &= 383 \times 130281 \\
 &= 109\,175\,478 \text{ people}
 \end{aligned}$$

$$\begin{aligned}
 51240000 - 109175478 &= 1342377 \\
 &= 1300000 \text{ to 2 sig figs}
 \end{aligned}$$

(Total 5 marks)

Here is a triangle ABC .

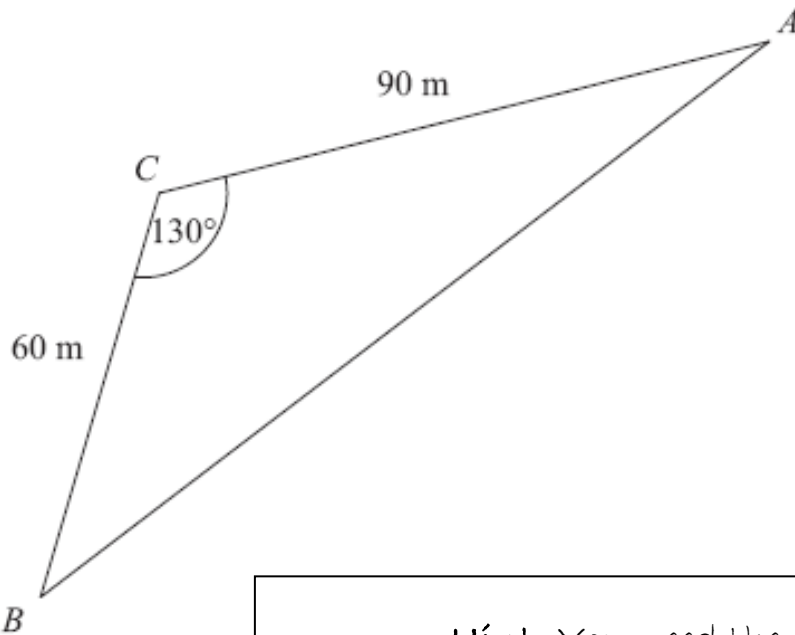


Diagram **NOT**
accurately drawn

Hint: You need the cosine rule

$AC = 90$ m.
 $BC = 60$ m.
 Angle $ACB = 130^\circ$.

Calculate the perimeter of the triangle.
 Give your answer correct to one decimal place.

$$c^2 = 60^2 + 90^2 - 2 \times 60 \times 90 \times \cos 130^\circ$$

$$c^2 = 18642.1061846 \dots$$

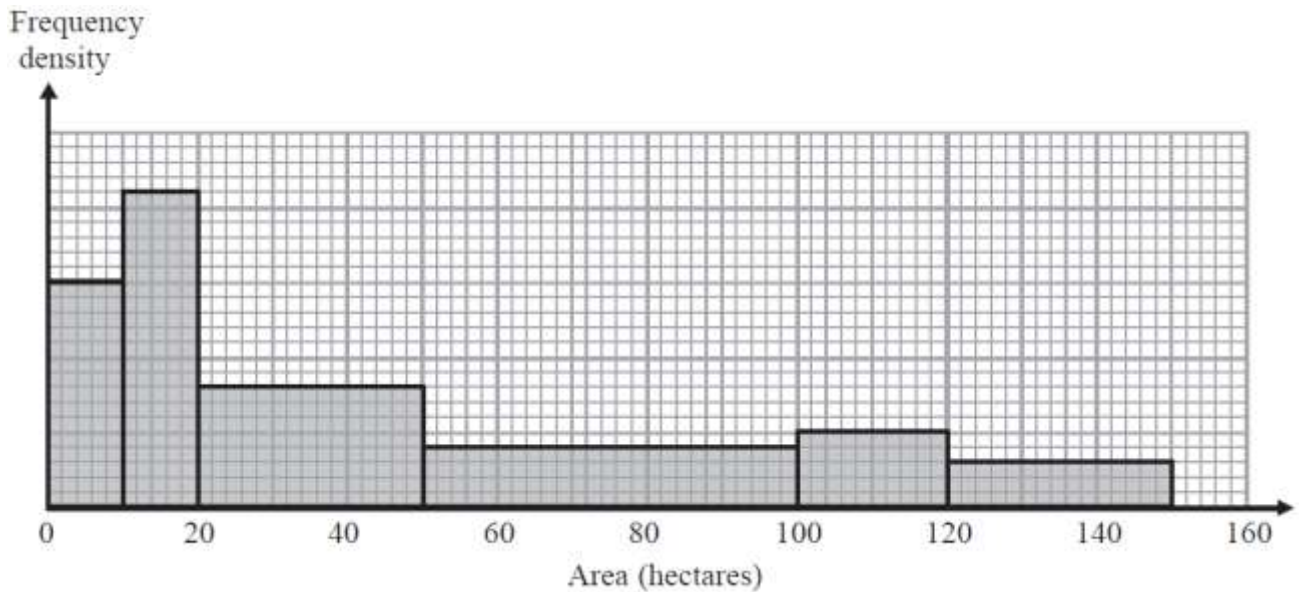
$$c = 136.536098467 \dots$$

$$\begin{aligned} \text{Perimeter} &= 60 + 90 + 136.536 \\ &= 286.536098467 \dots \\ &= 286.5 \text{ m to 1 dp} \end{aligned}$$

..... m

(Total 4 marks)

The histogram shows information about the areas of some farms.



90 of the farms have an area of 10 hectares or less.

60% of the farms with an area of 100 hectares or less are arable farms.

$\frac{1}{2}$ of the farms with an area of more than 100 hectares are arable farms.

Work out an estimate for the total number of arable farms.

Hint: Find the scale from the first column and work out the frequencies first

Interval	FD	frequency
$0 \leq A < 10$	15 high = 9 so 1 high = 0.6	$9 \times 10 = 90$
$10 \leq A < 20$	21 high = 12.6	$12.6 \times 10 = 126$
$20 \leq A < 50$	8 high = 4.8	$4.8 \times 30 = 144$
$50 \leq A < 100$	4 high = 2.4	$2.4 \times 50 = 120$
$100 \leq A < 120$	5 high = 3	$3 \times 20 = 60$
$120 \leq A < 150$	3 high = 1.8	$1.8 \times 30 = 54$

$$60\% \text{ of } (90 + 126 + 144 + 120) = 288$$

$$\frac{1}{2} \text{ of } (60 + 54) = 57$$

$$\text{So estimate arable farms} = 345 \dots\dots\dots$$

(Total 5 marks)

Solve $\frac{5(2x+1)^2}{4x+5} = 5x - 1$

Hint: start by multiplying by $4x + 5$

$$\frac{5(2x + 1)^2}{4x + 5} = 5x - 1$$

$$5(2x + 1)^2 = (5x - 1)(4x + 5)$$

$$5(4x^2 + 4x + 1) = 20x^2 + 25x - 4x - 5$$

$$20x^2 + 20x + 5 = 20x^2 + 21x - 5$$

$$20x + 5 = 21x - 5$$

$$x = 10$$

.....

(Total 5 marks)