GCSE LINKED PAIR PILOT

4361/02

APPLICATIONS OF MATHEMATICS
UNIT 1: Applications 1
HIGHER TIER

A.M. FRIDAY, 14 June 2013

2 hours

ADDITIONAL MATERIALS

A calculator will be required for this paper.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen.

Write your name, centre number and candidate number in the spaces at the top of this page.

Answer **all** the questions in the spaces provided.

Take π as 3·14 or use the π button on your calculator.

INFORMATION FOR CANDIDATES

You should give details of your method of solution when appropriate.

Unless stated, diagrams are not drawn to scale.

Scale drawing solutions will not be acceptable where you are asked to calculate.

The number of marks is given in brackets at the end of each question or part-question.

You are reminded that assessment will take into account the quality of written communication (including mathematical communication) used in your answer to question **7**(c)(ii).

	For Examiner's use only	
Question	**Maximum Mark**	**Mark Awarded**
1	5	
2	11	
3	3	
4	10	
5	8	
6	4	
7	12	
8	11	
9	10	
10	4	
11	5	
12	8	
13	9	
TOTAL MARK		

1. Huw has designed a new clothes hook.

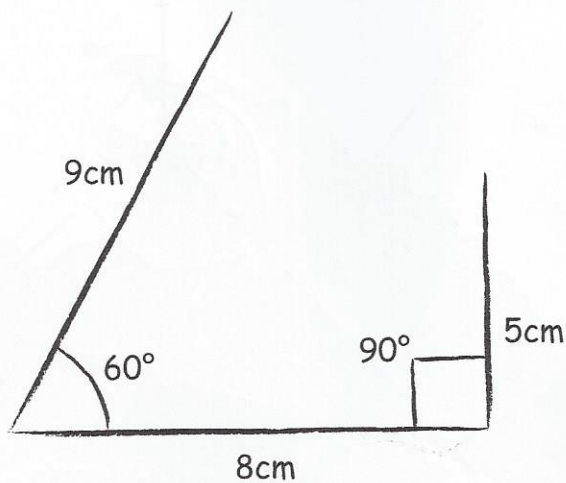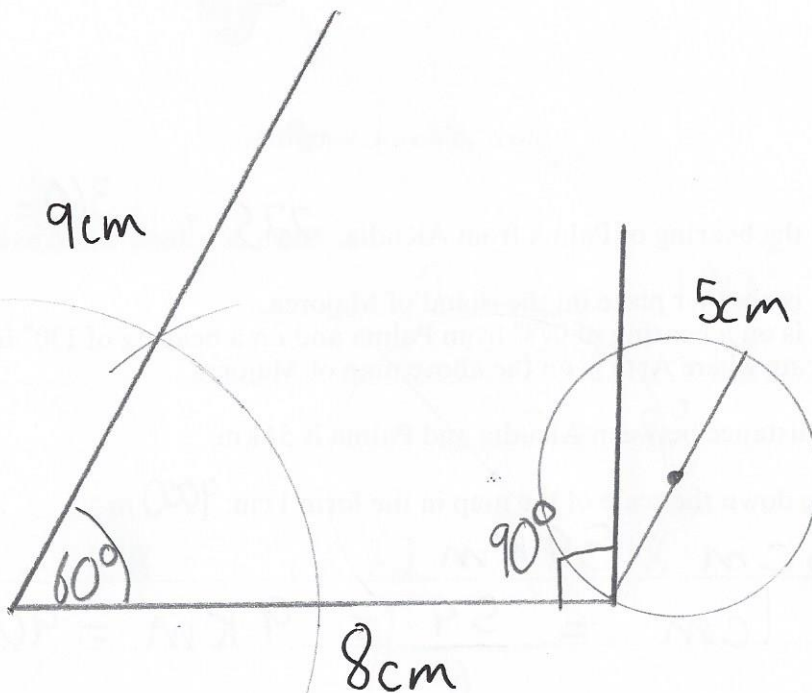He has made a rough sketch as shown below.

9cm

60°

90°

5cm

8cm

Diagram not drawn to scale

Use a pair of compasses and a ruler only to construct an accurate drawing of Huw's design.
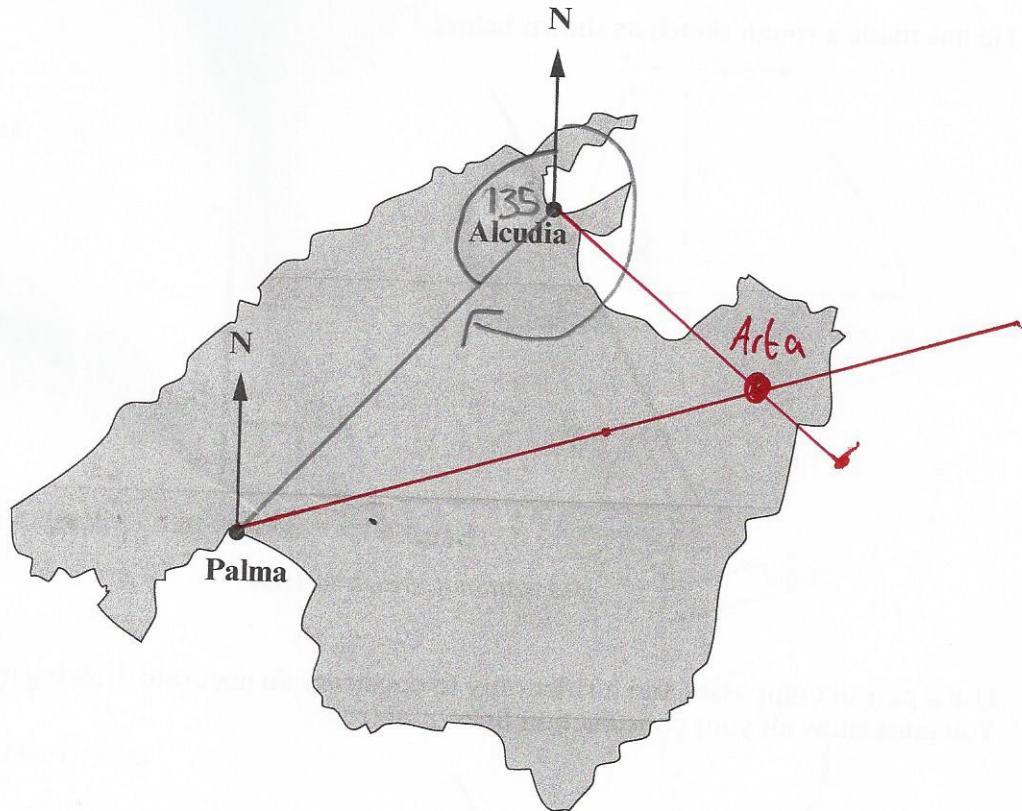You **must** show all your construction lines.

[5]

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9cm

5cm

60°

90°

8cm

[Search : Measuring 60° and 90° with a compass.]

Turn over.

2. The map below shows the island of Majorca.

(a) Find the bearing of Palma from Alcudia. **225** °   360 - 135 = 225   [1]

(b) Arta is another place on the island of Majorca.
Arta is on a bearing of 073° from Palma and on a bearing of 130° from Alcudia.
Indicate where Arta is on the above map of Majorca.   [3]

(c) The distance between Alcudia and Palma is 54 km.

Write down the scale of the map in the form 1 cm: **9000** m

6cm : 54km

=> 1cm = $\frac{54}{6}$ = 9km = 9000m

1 cm: **9000** m   [3]

(d) A new runway site is being planned for a different island.
A diagram of the plan for the runway site is shown below.

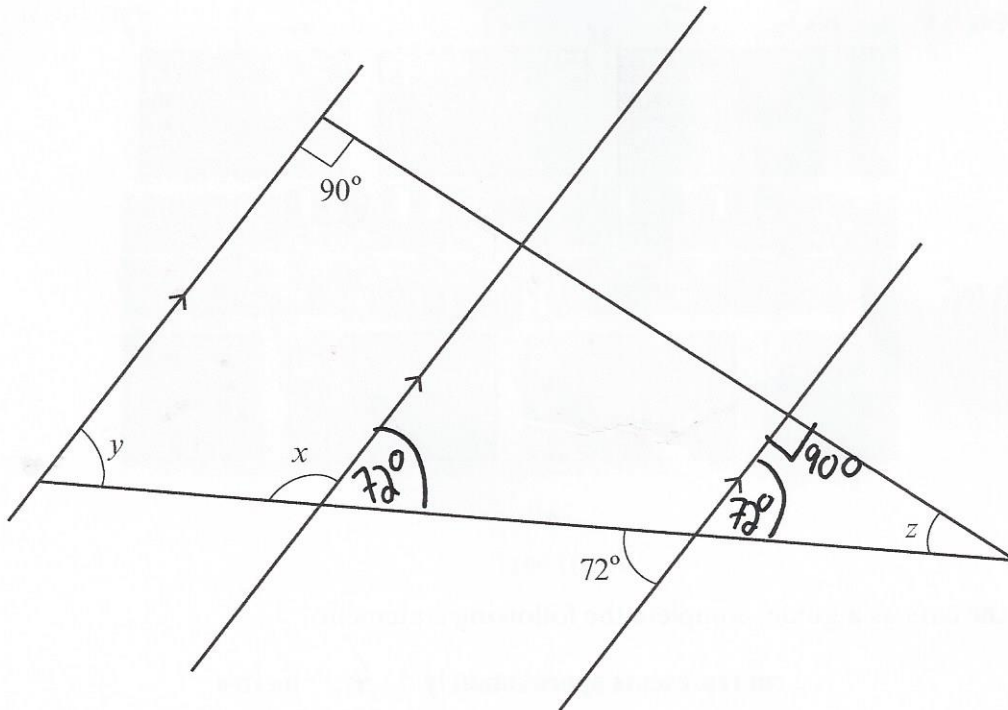*Diagram not drawn to scale*

Find the size of the angles *x*, *y* and *z*.

Triangle $= 180^\circ$

$\Rightarrow z = 180^\circ - 72 - 90$

$\therefore z = 18^\circ$

$x = $ **108** ° $\qquad y = $ **72** ° $\qquad z = $ **18** °

[4]

Straight Line
$180 - 72 = 108$

$180 - x$
$\Rightarrow 180 - 108 = 72^\circ$

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3.   (a)   The diagram shows an aerial view of some cars parked in a street in Spain.
The scale of the map is not shown.
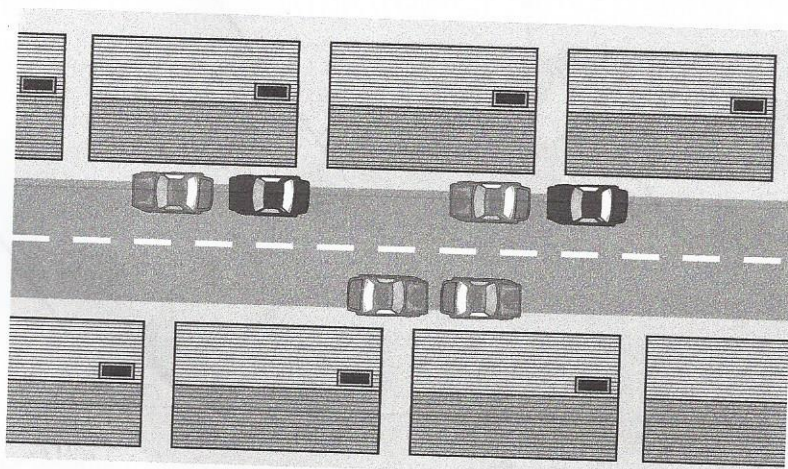
Using the cars as a guide, complete the following statement.

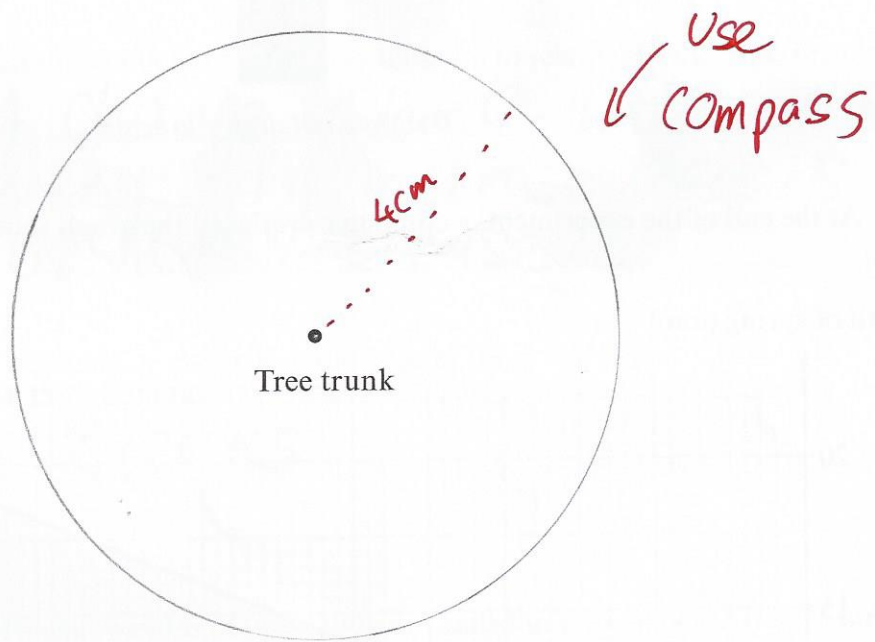1 cm represents approximately ....4........ metres

[1]

Car is roughly 4m Long

(b) A different aerial view shows a tree with its branches spreading 2 metres in all directions from the tree trunk.

The tree has many branches and many, many leaves.

Using a scale of 1 cm to represent 0·5 metres, show how this tree would look from an aerial view. [2]

1 cm → 0·5m ⇒ 2m = 4cm

Tree trunk

4cm

Use compass

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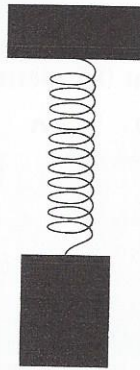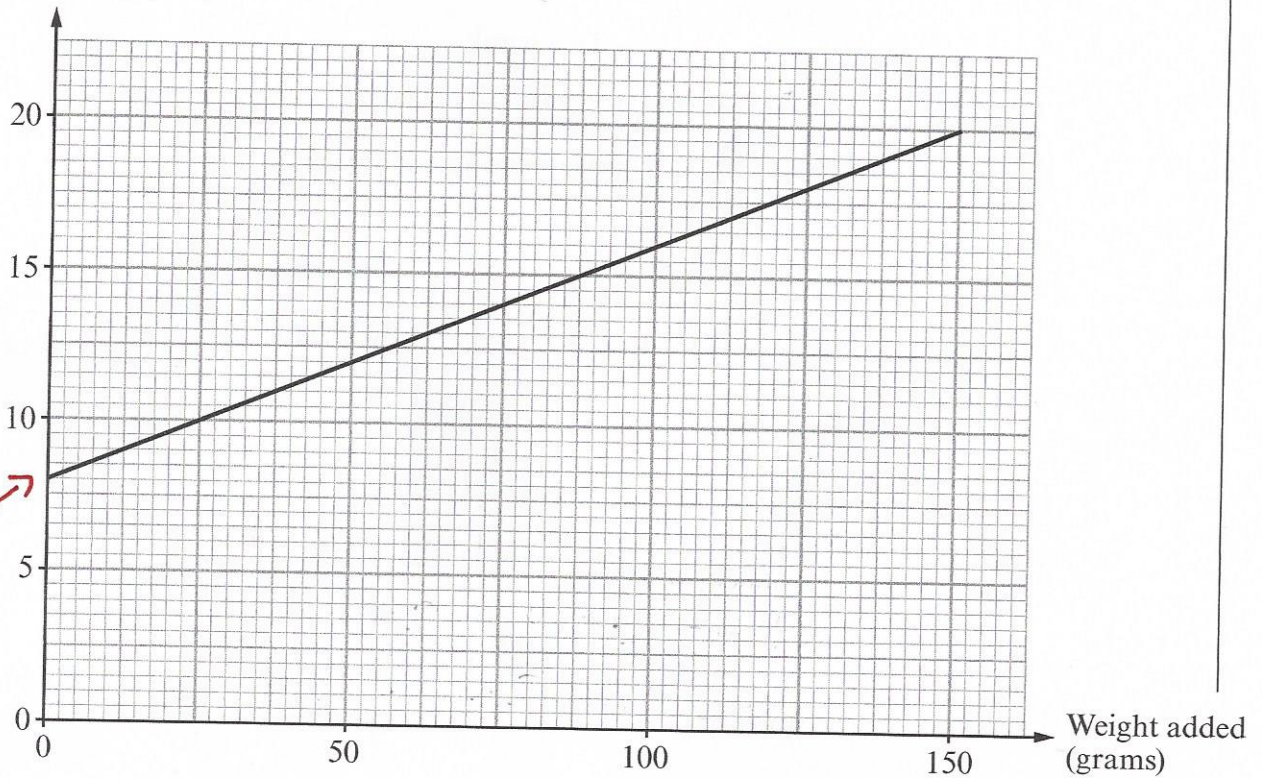4. In an experiment, the weight added to the end of a vertical spring is gradually increased.

Diagram not drawn to scale

At the end of the experiment, a computer produced the graph shown below.

Length of spring (mm)

Weight added (grams)

(a) Write down the length of the spring without any weight added.

8 mm

[2]

(b) (i) Calculate the gradient of the straight line drawn on the graph.

$$Grad = \frac{\Delta Y}{\Delta x} = \frac{12}{150} = 0.08$$

[2]

(ii) Explain what the gradient of this graph tells you in relation to the experiment.

Rate of change of length with weight, for every 1g increase there is a 0.08mm increase

[2]

(c) The straight line stops before the right-hand edge of the graph paper. Why do you think this might be?

Spring Breaks

[1]

(d) In a similar experiment, weights of up to 100 g are added to the end of a different spring. The following data is recorded.

Weight added, W (grams)	0	100
Length of spring, L (mm)	35	235

Using the data given above, complete the formula to give the length of the spring, L mm, for different weights added, W g.

We know $L = \cancel{m} \, K W + 35$

unknown Constant

$$\Rightarrow K = \frac{L - 35}{W} = \frac{235 - 35}{100} = 2$$

$$\therefore L = 2W + 35$$

$L = \underline{2} \ W + \underline{35}$ ← As length when no weight added (original length)

[3]

5. *Dees Print*, a graphic design company, finds that they use 2 yellow, 8 red and 20 black cartridges each week. So, *Dees Print* always orders yellow, red and black cartridges in the ratio 2 : 8 : 20 respectively.

(a) *Dees Print* orders 210 cartridges in total.
How many cartridges of each of the colours yellow, red and black are there in this order?

Total Parts = 2 + 8 + 20 = 30

⇒ 1 Part of 210 = $\frac{210}{30}$ = 7

∴ Yellow = 2 × 7 = 14   2 : 8 : 20
 Red = 8 × 7 = 56
 Black = 20 × 7 = 140

Number of yellow cartridges ___14___

Number of red cartridges ___56___

Number of black cartridges ___140___

[3]

(b) In another order, *x* yellow cartridges are ordered, along with the corresponding number of red and black cartridges.
T is the total number of cartridges in the order.
Write down a formula for *T* in terms of *x*.
Give your answer in its simplest form.

x $4x$ $10x$

½ Ratio 2 : 8 : 20 ⇒ 1 : 4 : 10

Total = $x + 4x + 10x$

$T = 15x$

[3]

6. Iona needs to give a presentation to her work team.
Her boss has asked her to include a box-and-whisker plot in her presentation.
Iona works in a sales team, selling new telephone systems to large companies.
She had been given some sales data by her boss, as shown below.

Cheapest system sold	£30	LR ✓
Most expensive system sold	£140	UR ✓
Median price of systems sold	£60	Med ✓
Lower quartile price of a system	£50	LQ ✓
Upper quartile price of a system	£100	UQ

On the graph paper below, draw a box-and-whisker plot using the data that Iona has been given.

....

....
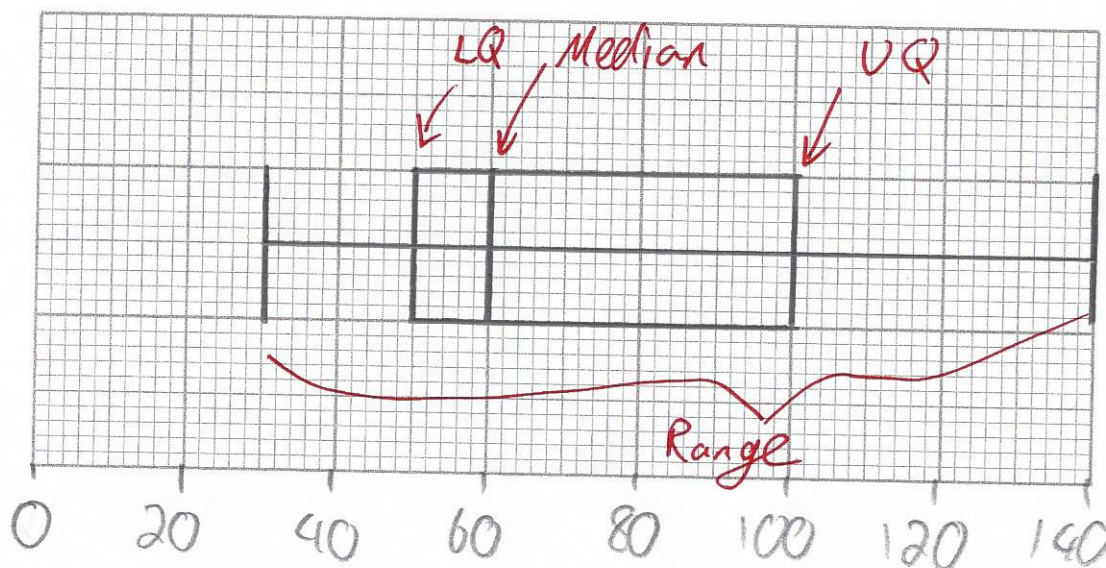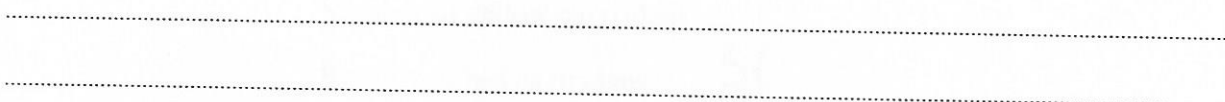

[4]

7. A chemical factory makes a liquid that is used in the production of a waterproof fabric. A cylindrical tank is used to collect the liquid made in the factory.

The moment the tank is full, it starts to empty the liquid into a tanker in readiness for delivery to a company which makes the waterproof fabric.

This process is continuous during the week, but the production stops at weekends for maintenance.

The graph shows the process of the tank being filled and emptied into the tanker.

Depth of liquid in the tank (metres)

Time (hours)
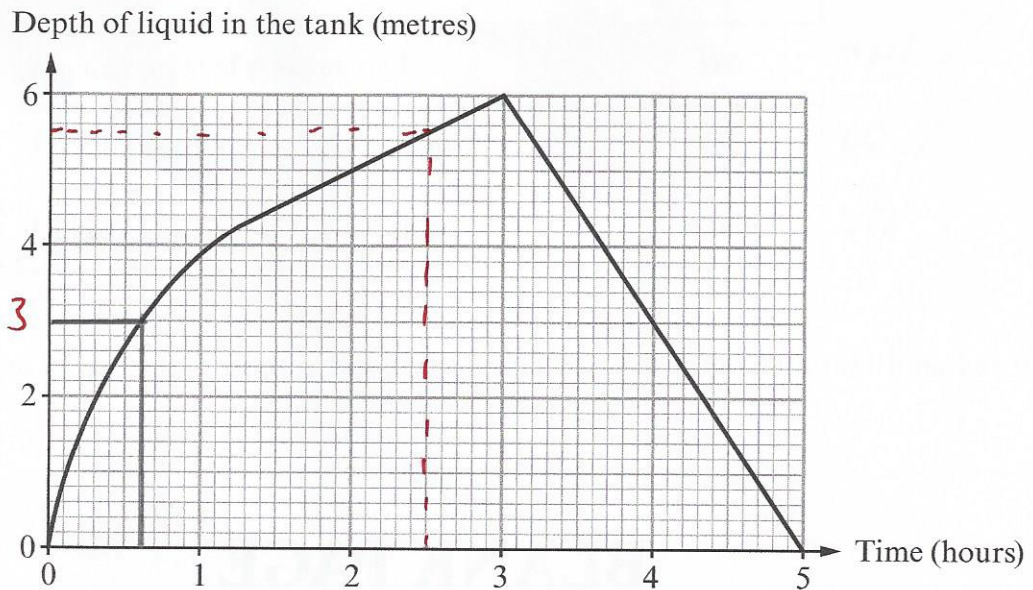
(a) What is the depth of the liquid in the tank $2\frac{1}{2}$ hours into the process?

5.5 metres

[1]

(b) How long, in minutes, does it take to half fill the cylindrical tank?

0.6 hours

=> 0.6 × 60 = 36 mins

[2]

(c) The tank is left empty over the weekend.
The continuous process starts each Monday at 07:00 by filling the tank.
This process of filling and emptying the tank continues until shutdown on Friday.

(i) Explain what is happening at 20:00 on Monday, giving the depth of the liquid in the tank.

Time to fill and empty is 5 hours
07:00 → 20:00 is 13 hours
⇒ 3 hours into cycle
Depth is 6m at 3 hours into cycle
(full Tank)

[3]

(ii) *You will be assessed on the quality of your written communication in this part of the question.*

The process has to shut down with the tank empty as soon after, but not before, 19:00 on a Friday. At what time should the process shut down on a Friday? You must show all your working.

Hours between 07:00 monday to friday 19:00
(24 × 4) + 12 = 108 hours
Needs to be multiple of 5 for end
time of process.
⇒ 110 hours needed   ↑ As process
(110/5 = 22 cycles)   takes 5 hours
∴ finish time for process is 2
hours longer 19:00 + 2 = 21:00
∴ 9 pm

[6]

8. A potato producer uses a machine to sort his potatoes.
The potato producer carried out a survey to investigate the probability of oversized potatoes passing through his sorting machine.
The relative frequency of oversized potatoes passing through the machine was calculated after a total of 100, 200, 300, 400, 500 and 600 potatoes.
The results are plotted on the graph below.

Relative frequency of oversized potatoes

Number of potatoes passing through the machine
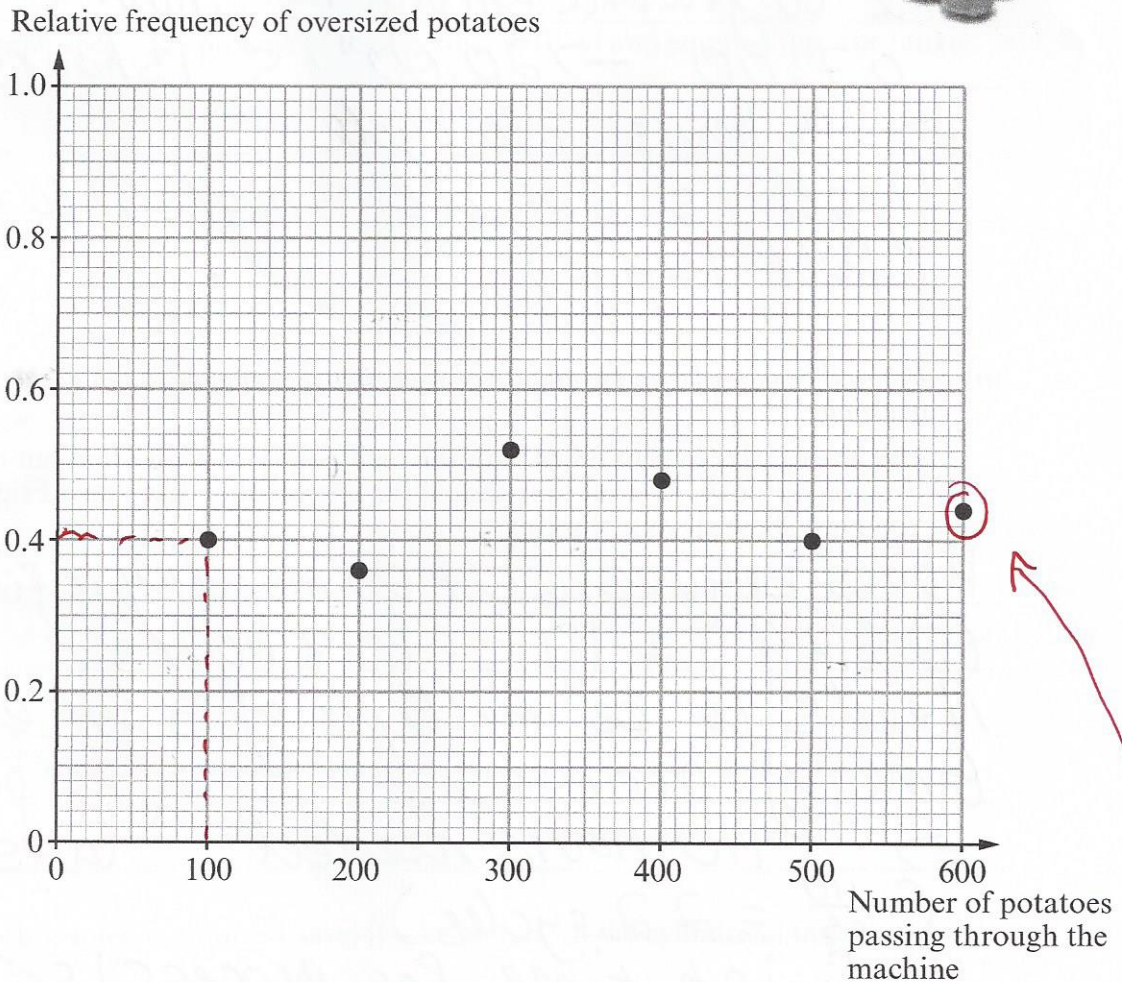
(a) Write down the best estimate for the probability that one of these potatoes, selected at random, will be oversized.
You must give a reason for your answer.

Last reading is best estimate as more potatoes have been checked
∴ 0.44

[2]

Using Graph

(b) A trader offers to buy oversized potatoes at 15p each.
How much would the potato producer receive if he decided to sell, to the trader, all the oversized potatoes in the first 100 potatoes sorted by the machine?

100 potatoe have 0.4 probability of being oversized
=> 100 × 0.4 = 40 oversized potato
Price = 40 × 0.15 = £6

[3]

(c) The potato producer decides not to sell his potatoes to the trader.
He sells 900 potatoes to a market stall holder.
The potato producer sells these potatoes for £4.50 per 100 potatoes.
He has agreed with the market stall holder that he will give a 2p refund per oversized potato discovered.
What would your best estimate be for the amount you would expect the potato producer to make from this transaction?

Probability of oversized potato is 0.44 (from a/.)
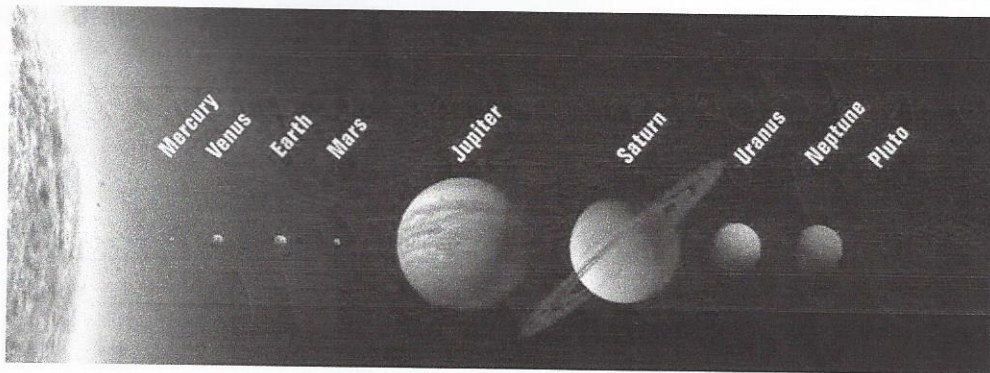=> Amount of oversized potatoes out of 900 = 900 × 0.44
= 396
Price of 396 oversized potatoe (refund) = 396 × 0.02   2p in £
= £7.92

9 × 4.5 = £40.50   (Total Price)

Profit = Total Price - refund = 40.5 - 7.92 = £32.58

[6]

9.

Some data is found on two different websites, **www.sciencenow.com** and **www.planetalong.uk** about some of the planets.
The data found varies slightly between the two websites.

www.sciencenow.com		
Planet	**Radius, km**	**Mass, kg**
Mercury	2439	$3 \cdot 30 \times 10^{23}$
Venus	6052	$4 \cdot 87 \times 10^{24}$
Earth	6378	$5 \cdot 98 \times 10^{24}$
Mars	3397	$6 \cdot 42 \times 10^{23}$
Jupiter	71 492	$1 \cdot 90 \times 10^{27}$

www.planetalong.uk		
Planet	**Radius, km**	**Mass, kg**
Mercury	2439	$3 \cdot 3 \times 10^{23}$
Venus	6052	$4 \cdot 9 \times 10^{24}$
Earth	6378	$6 \cdot 0 \times 10^{24}$
Mars	3394	$6 \cdot 4 \times 10^{23}$
Jupiter	71 398	$1 \cdot 9 \times 10^{27}$

(a)   Write down the radius of Mars, in km, correct to three significant figures in standard form for both of the websites.

....

....

....

....

www.sciencenow.com ......$3 \cdot 40 \times 10^{3}$...... km

www.planetalong.uk ......$3 \cdot 39 \times 10^{3}$...... km

[3]

(b) Use the data found at **www.sciencenow.com** to complete the statement below.
Give your answer correct to two significant figures.

Mass of Venus = _____ x (15) × Mass of Mercury

$$V = x M$$

$$\Rightarrow x = \frac{V}{M} = \frac{4.87 \times 10^3}{3.3 \times 10^{23}} = 14.757\ldots$$

$$\therefore x = 15$$

[3]

(c) (i) The masses of the planets are recorded differently on the two websites.
Explain fully this difference.

First table is to 3 sig fig.
Second table is to 2 sig fig.
∴ Different Masses

[2]

(ii) Calculate the difference between the values stated on the two websites for the mass of Mars.
Give your answer, in kg, in standard form.

$$6.42 \times 10^{23} - 6.4 \times 10^{23} = 2.0 \times 10^{21}$$

[2]

10. Raul has been asked to look at some data.
He is asked to write the data in the form 2^n, where n is a whole number or a decimal.
Write the following numbers in the form 2^n.

(a) $\dfrac{1}{2^3}$

2^{-3}

$\dfrac{1}{x^n} = x^{-n}$

[1]

(b) $(2^{0.3})^{0.4}$

$2^{0.12}$
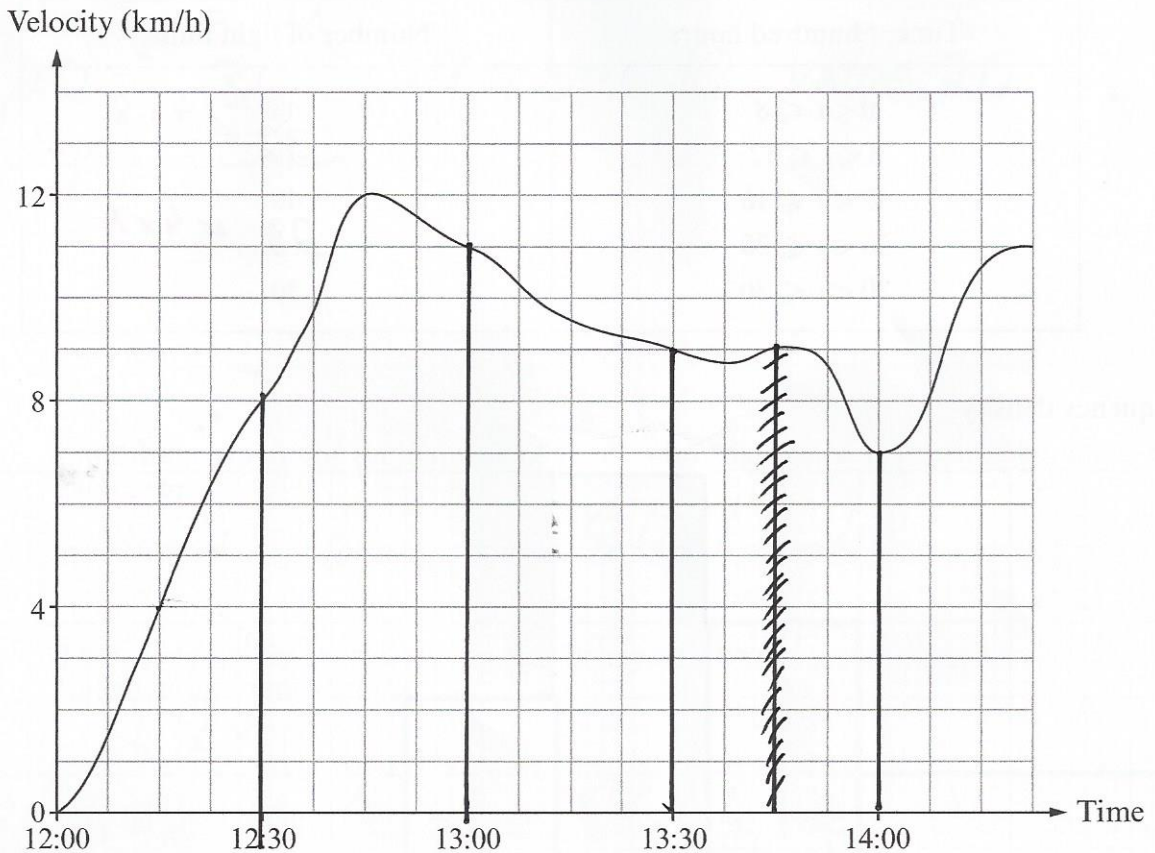
$(x^a)^b = x^{a \times b}$

[1]

(c) $(\sqrt[4]{8})^{12}$

$(\sqrt[4]{8})^{12} = 8^{\frac{12}{4}} = 8^3$

$x^{\frac{1}{2}} = \sqrt[2]{x}^{1}$

$\Rightarrow \quad 8^3 = (2^3)^3 = 2^9$

[2]

11. Sue rode her bike along a cycle path.
She started her ride at 12:00.
The graph shows information about her cycle ride.

Velocity (km/h)

By considering every $\frac{1}{2}$ hour of Sue's cycle ride, use the trapezium rule to calculate an estimate for the total distance travelled in the first 2 hours.
Give the units of your answer.

= 0.5 as $\frac{1}{2}$ hour

Distance = Area under line = $\frac{1}{2}(a+b)h$

⇒Distance = $\frac{1}{2}(0+8)\times0.5 + \frac{1}{2}(8+11)\times0.5$
$+ \frac{1}{2}(11+9)\times0.5 + \frac{1}{2}(9+7)\times0.5$
= $2 + 4.75 + 5 + 4$

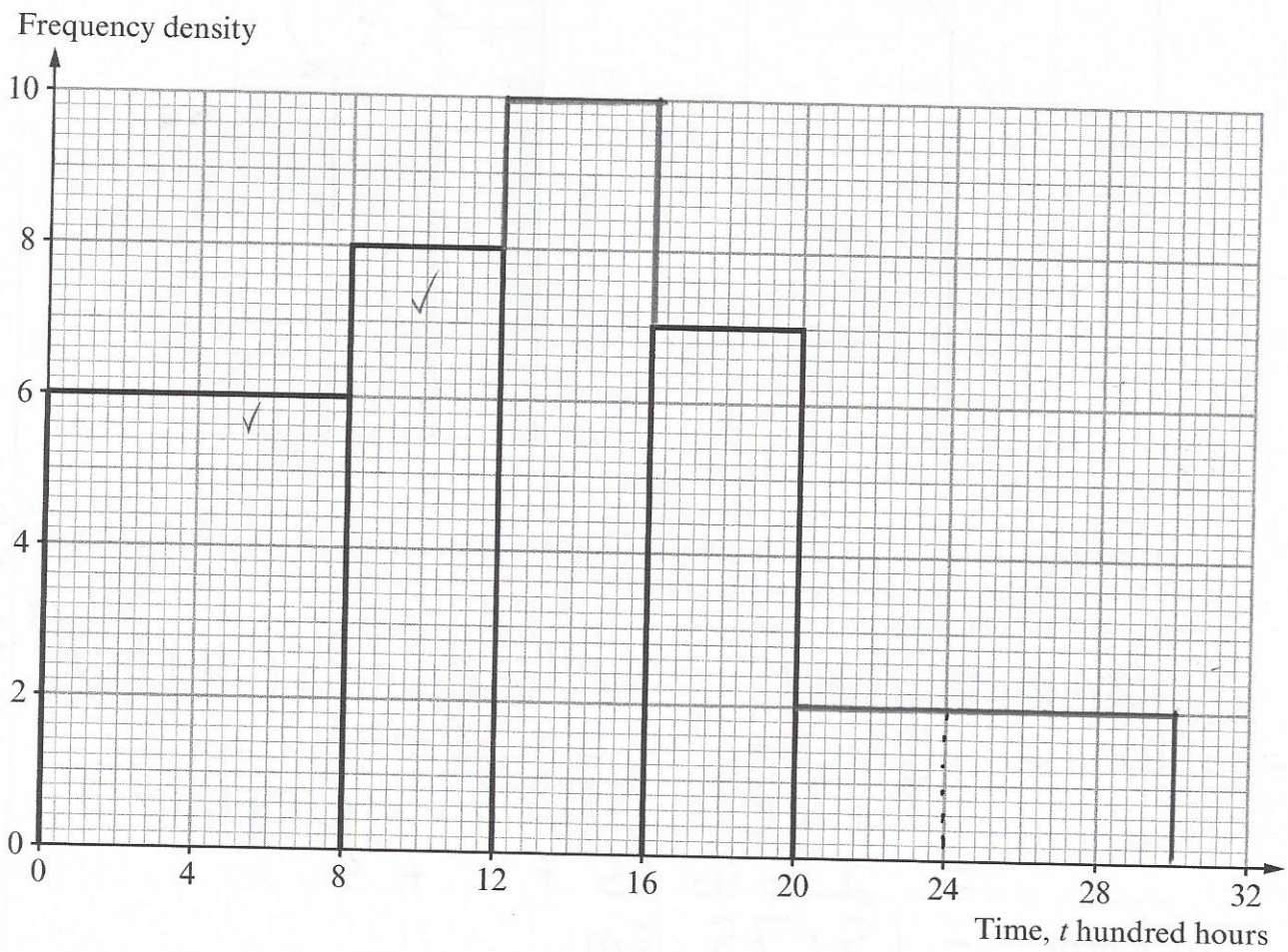∴ Distance = 15.75 Km

[5]

12. The histogram and frequency table show some information about the time, in hundreds of hours, that a number of similar light bulbs lasted.

Time, t hundred hours	Number of light bulbs
$0 < t \leqslant 8$	48 ← 4 × 8
$8 < t \leqslant 12$	32
$12 < t \leqslant 16$	40
$16 < t \leqslant 20$	28 ← 4 × 7
$20 < t \leqslant 30$	20

(a)   Complete the frequency table and the histogram shown opposite.

• $12 \Rightarrow 16$, Difference 4. Value 40

height $= \frac{40}{4} = 10$

• $20 \rightarrow 30$, Difference 10. Value 20

height $= \frac{20}{10} = 2$

[4]

(b)   Find the estimate for the number of light bulbs that lasted between 2000 hours and 2400 hours.

Area $\rightarrow$ $4 \times 2 = 8$ ∴ 8 light bulbs

[1]

(c)   There are 56 bulbs that lasted less than y hundred hours.
Calculate an estimate for y.

$56 < Y$

56 lies in range $(8) < t \le 12$

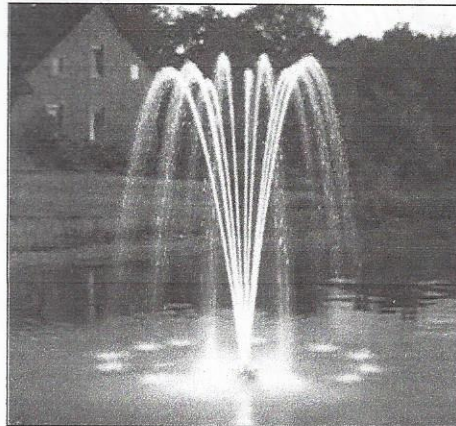Value in table $\quad \cancel{32} \; \dfrac{(8)}{\rightarrow 32} = \dfrac{1}{4}$

∴ $y =$

[Unsure on this question, ask teacher in school]

[3]

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13. A fountain has jets of water that start from water level and reach different heights.

Rosie has taken a photograph of the fountain.
She has also recorded some information about one of the jets of water.

She finds
- the maximum height of the jet of water is 6·25 metres
- at its maximum height it is at a horizontal distance of 2·5 metres from the start of the jet of water
- the shape of the path of the water is a symmetrical curve
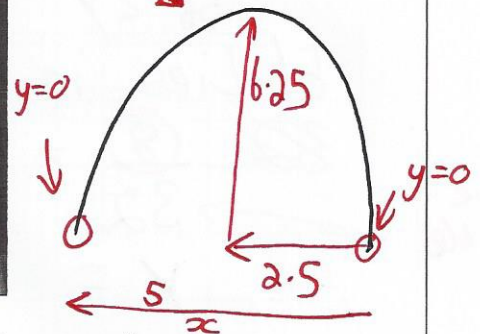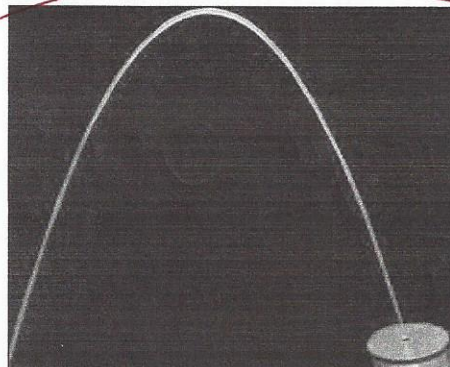
Rosie finds that the path of this jet of water is represented by $y = -x^2 + bx$, where y is the vertical height, x is the horizontal distance and b is a constant.

(a) Find the equation that represents the path of this jet of water.

$y = -x^2 + bx$ $\therefore y = -x^2 + 5x$

when $y = 0$ $x = 5$

$\Rightarrow 0 = -(5)^2 + 5b$

$0 = -25 + 5b$

$5b = 25$

$b = 5$

Equation is $y = -x^2 + 5x$

[4]

(b) The path of a different jet of water is represented by $y = -x^2 + cx$, where y is the vertical height, x is the horizontal distance and c is a constant.
This jet of water hits the surface of the water in the fountain 6 metres away.
The path of the jet of water is symmetrical.

Draw a sketch of the path of this jet of water.

You must indicate on your sketch
- the horizontal distance measured as the jet of water reaches its maximum height
- the maximum height of the jet of water

$y = (-)x^2 + cx$

[5]
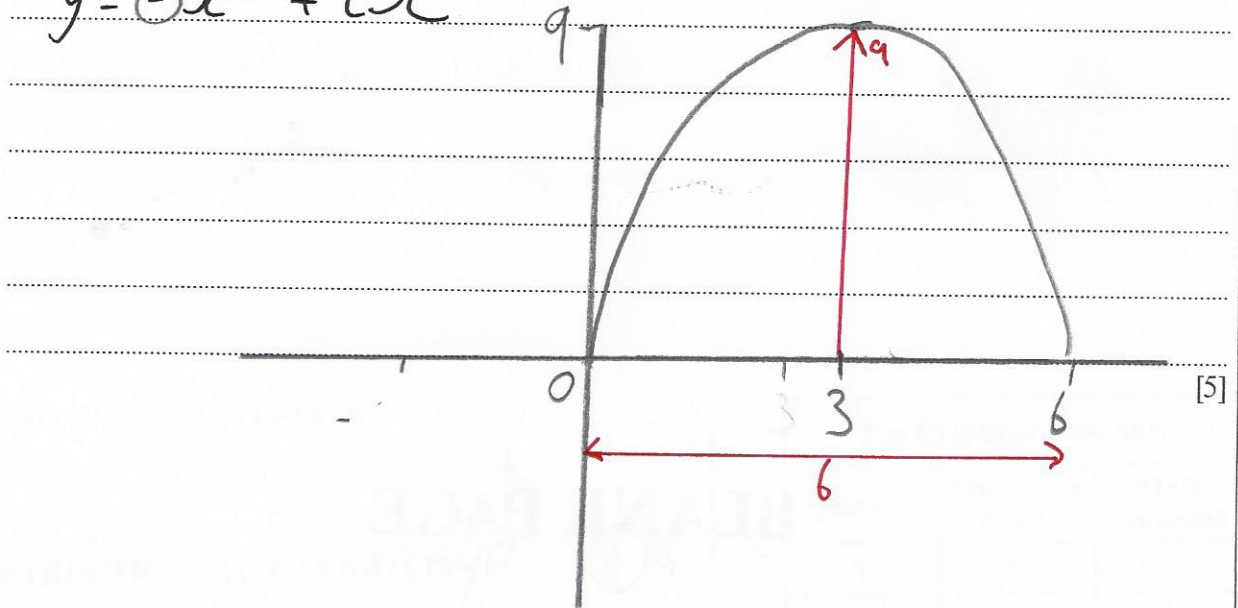
when $y = 0$ $x = 6$ [Horiz]

$\Rightarrow 0 = -(6)^2 + 6c$

$\Rightarrow 36 = 6c$

$\Rightarrow c = 6$

$\therefore y = -x^2 + 6x$

When $x = 3$ $y = -(3)^2 + 6(3)$ [Vert]
$y = -9 + 18 = 9$ Max y

Because maximum y occurs halfway

END OF PAPER

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