

1 Factorise fully.

(a)  $6x^2 + 9x$

$3x(2x+3)$  ✓✓ [2]

(b)  $x^2 + 8x + 15$

115 ✓

$(x+3)(x+5)$  ✓ [2]

2 You may use these kinematics formulae to answer these questions.

$v = u + at$

$v^2 = u^2 + 2as$

A moving particle accelerates at  $2 \text{ m/s}^2$  for 8 seconds.

The particle's final velocity after the 8 seconds is 21 m/s.

(a) Show that the velocity of the particle at the start of the 8 seconds is 5 m/s. [2]

$a = 2$

$21 = u + 2 \times 8$

✓

$t = 8$

$u = 21 - 16 = 5$

✓

$v = 21$

(b) Work out the distance travelled by the particle during the 8 seconds.

$21^2 = 5^2 + 2 \times 2 \times s$

✓

$s = \frac{441 - 25}{4}$

✓

$= 104$

✓

(b) ..... m [3]

3 (a)  $N$  is a number such that:

- $N = 3 \times 5 \times k$ , where  $k$  is a prime number
- $N$  is greater than 400.

Find the smallest possible value of  $N$ .

$K = 23$   $\times$  etc, too small

$K = 31$  ✓

$K = 29$  ✓

$$3 \times 5 \times 29 = 435$$

(a)  $N = \dots$  [3]

(b)  $a$  and  $b$  are different prime numbers.

Explain why  $a \times b$  is not a prime number.

a and b would be factors

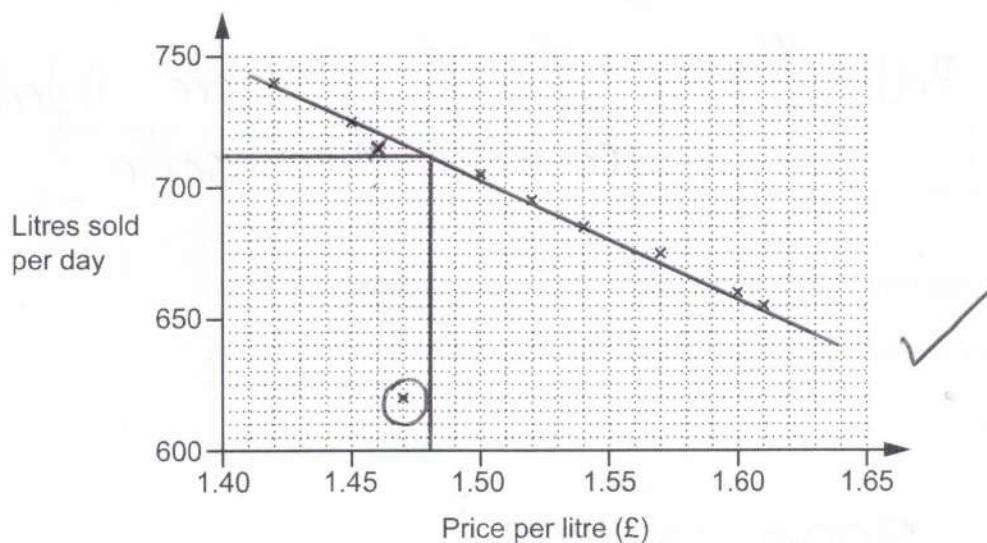
[1]

4 Each week the manager of a petrol station records the average daily sales, in litres, and the average price, in pounds, of a litre of petrol for that week.

The table shows their results for ten weeks.

| Week                | 1    | 2    | 3    | 4    | 5    | 6    | 7    | 8    | 9    | 10   |
|---------------------|------|------|------|------|------|------|------|------|------|------|
| Price per litre (£) | 1.42 | 1.45 | 1.47 | 1.50 | 1.54 | 1.60 | 1.57 | 1.52 | 1.61 | 1.46 |
| Litres sold per day | 740  | 725  | 620  | 705  | 685  | 660  | 675  | 695  | 655  | 715  |

The results for the first nine weeks are plotted on the scatter diagram.



(a) Plot the result for week 10.



[1]

(b) Describe the type of correlation shown in the scatter diagram.

(b) negative

[1]

(c) In one week, there was a delay with petrol deliveries.

Circle the most likely point on the scatter diagram for that week.



[1]

(d) (i) On the scatter diagram, draw a line of best fit.

[1]

(ii) Use the line of best fit to estimate the average daily sales when the price per litre of petrol is £1.48.

712



(d)(ii) litres [1]

(accept any from good LoBF)

(e) The manager says,

As the sales go down, the total amount of money we take stays roughly the same.

Find evidence to support this statement.

$$\text{wk2} \Rightarrow 725 \times 1.45 = £1051.25 \quad \checkmark$$

$$\text{wk9} \Rightarrow 655 \times 1.61 = £1054.55 \quad \checkmark$$

Both = £1050 (3sf) so are indeed  
roughly the same

[3]

5 A person invests £8000 at a rate of 5% per year compound interest.

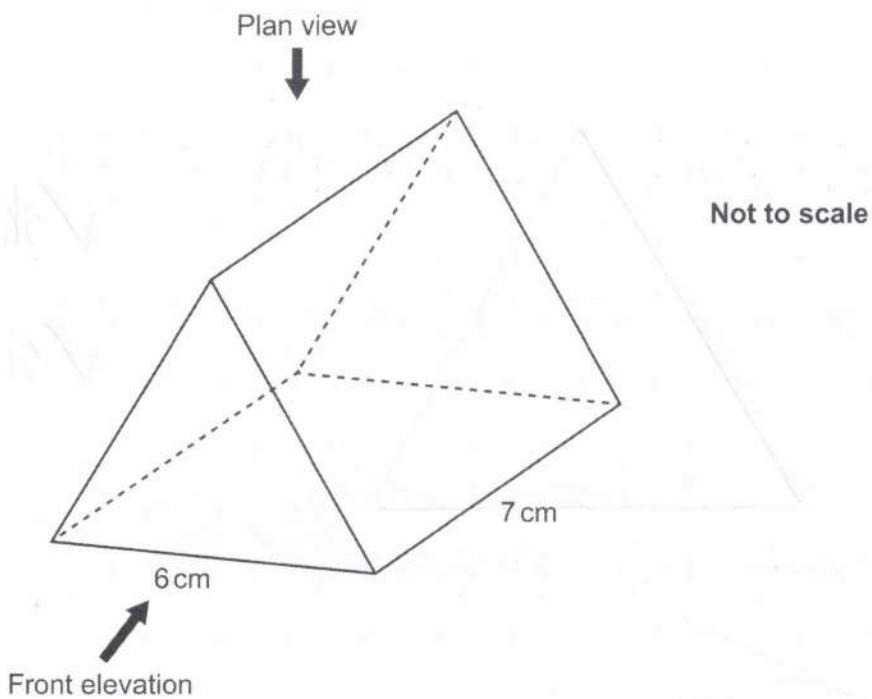
Calculate the total amount of **interest** earned after 3 years.

$$8000 \times 1.05^3 \\ = 9261$$

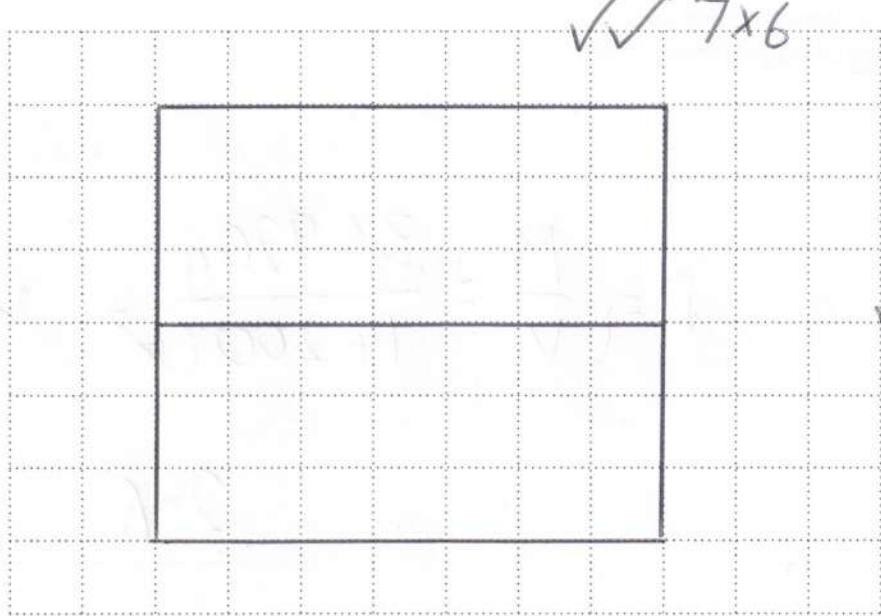
$$9261 - 8000$$

$$£ 1261 \quad [3]$$

6 The diagram shows an equilateral triangular prism.  
Each side of the equilateral triangle is 6 cm and the length of the prism is 7 cm.



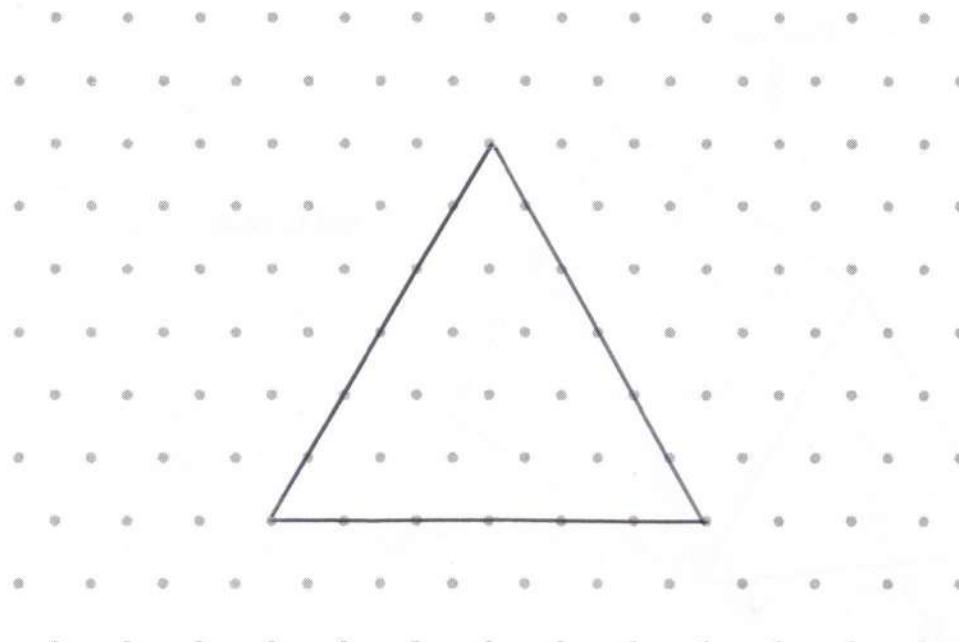
(a) Draw an accurate plan view of the prism on the one-centimetre square grid below.



[3]

✓ any rectangle

(b) Draw an accurate front elevation of the prism on the one-centimetre isometric grid below.



✓ shape

✓ size = 6

[2]

7 A rock has a mass of 36 920 g and a volume of  $14\ 200\ \text{cm}^3$ .

Work out the density of the rock.  
Give the units of your answer.

$\textcircled{D}$  M  
V

$$D = \frac{M}{V} = \frac{36\ 920\ \text{g}}{14\ 200\ \text{cm}^3}$$

2.6  $\text{g/cm}^3$  [3]

✓

✓

8 There is a total of 354 balls in a bag.  
There are white balls, red balls and green balls only.

The ratio of white balls to red balls is 3:4.  
The ratio of red balls to green balls is 5:6.

Work out the number of green balls in the bag.

| W  | R  | G  |
|----|----|----|
| 3  | 4  |    |
| ↓  | ↓  |    |
| 15 | 20 | 24 |

✓

|   |    |   |
|---|----|---|
| ↑ | x4 | ↑ |
| 5 |    | 6 |

$$\text{Green} = \frac{24}{59} \times 354$$

✓✓

$$= 144$$

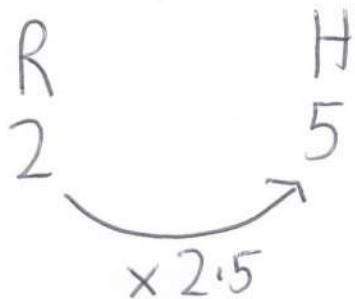
✓

[4]

9 A cylinder has a radius of 8.4 cm.

The ratio of the radius of the cylinder to the height of the cylinder is 2:5.

Find the volume of the cylinder.



$$8.4 \times 2.5 = 21$$

$$V = \pi r^2 h = \pi \times 8.4^2 \times 21$$

$$= 4655.0863\dots$$

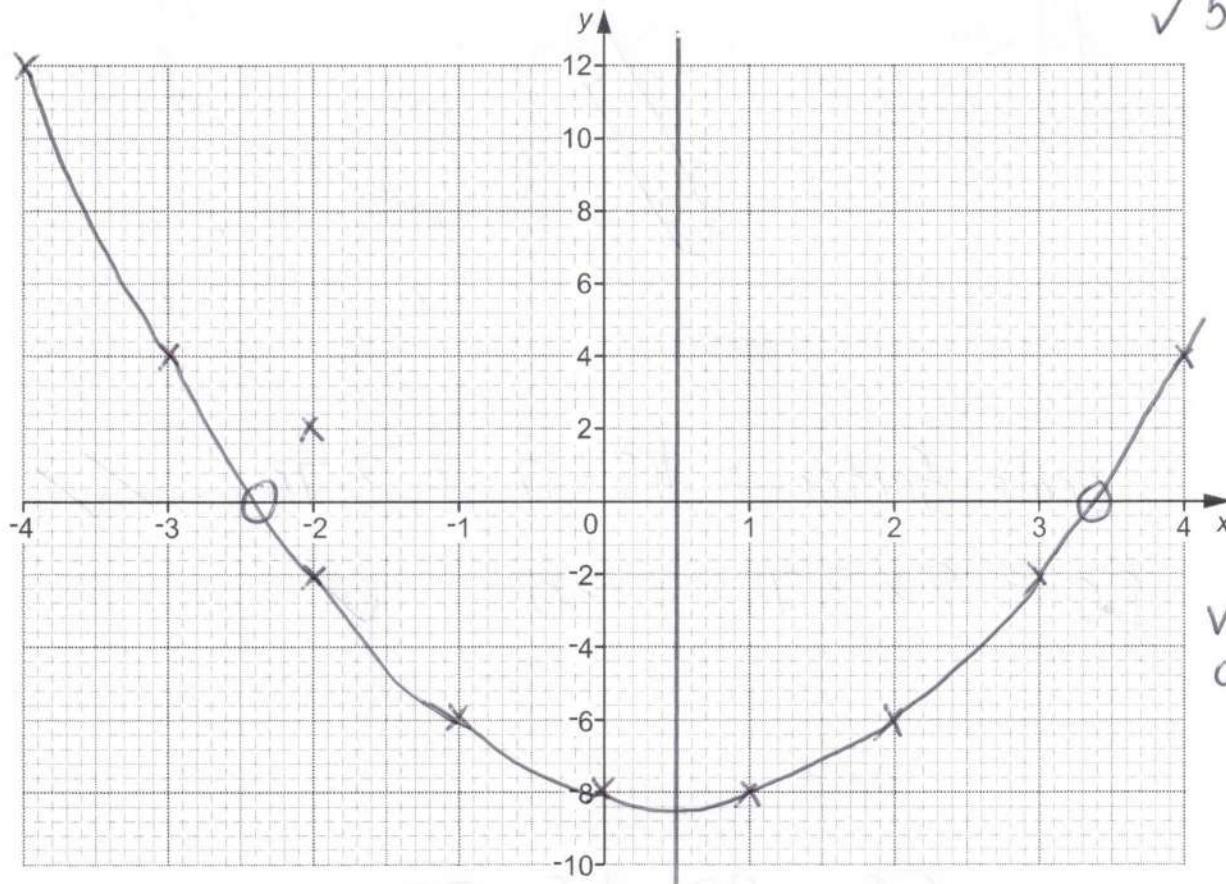
$$= 4655.1 \text{ cm}^3 \quad \boxed{4}$$

$[\text{ms: } 4655 \rightarrow 4655.7]$

10 Here is a table of values for  $y = x^2 - x - 8$ .

|     |    |    |    |    |    |    |    |    |   |
|-----|----|----|----|----|----|----|----|----|---|
| $x$ | -4 | -3 | -2 | -1 | 0  | 1  | 2  | 3  | 4 |
| $y$ | 12 | 4  | -2 | -6 | -8 | -8 | -6 | -2 | 4 |

(a) Draw the graph of  $y = x^2 - x - 8$  for  $-4 \leq x \leq 4$ .



✓✓✓ 8 plots  
✓✓ 5 plots

✓✓✓  
all  $\pm \frac{1}{2}$

[3]

(b) Write down the equation of the line of symmetry of the graph.

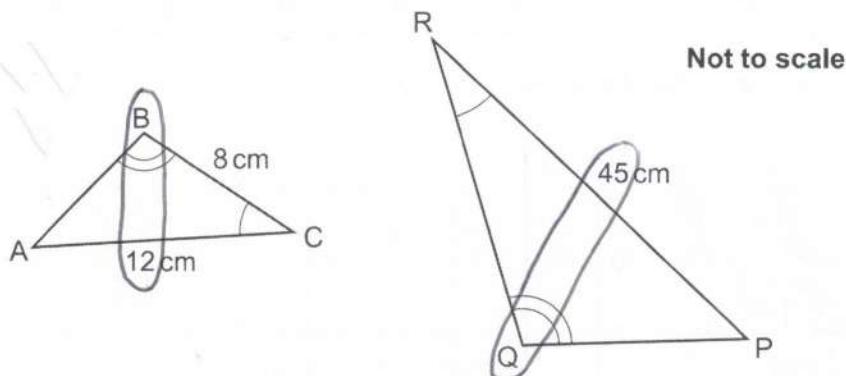
(b)  $x = \frac{1}{2}$  [1] ✓

(c) Use the graph to solve the equation  $x^2 - x - 8 = 0$ .  
Give your answers to 1 decimal place.

(c)  $x = -2.4$  or  $x = 3.4$  [2] ✓

ms  $-2.3 \rightarrow -2.4$  /  $3.3 \rightarrow 3.4$

11 Triangles ABC and PQR are mathematically similar.  
 Angle ACB = Angle PRQ.  
 Angle ABC = Angle PQR.



The perimeter of triangle PQR is 99 cm.

Find the length of PQ.

$$\text{scale factor} = 45 \div 12 = 3.75 \quad \checkmark$$

$$RQ = 8 \times 3.75 = 30 \quad \checkmark$$

$$QP = 99 - 45 - 30$$

$$PQ = 24 \quad \checkmark$$

cm [4]

12  $y$  is directly proportional to the square of  $t$ .  
 $y = 14$  when  $t = 2$ .

$t$  is directly proportional to  $x$ .  
 $t = 12$  when  $x = 3$ .

Find a formula for  $y$  in terms of  $x$ .  
Give your answer in its simplest form.  
You must show your working.

$$\begin{aligned}y &= K \times t^2 & \checkmark \\14 &= K \times 2^2 \\K &= \frac{14}{4} = 3.5 & \checkmark \\y &= 3.5t^2\end{aligned}$$

$$\begin{aligned}t &= Cx \\12 &= C \times 3 \\C &= 4 \\t &= 4x\end{aligned}$$

$$\begin{aligned}\text{so } y &= 3.5(t)^2 & \checkmark \\y &= 3.5 \times (4x)^2 \\y &= 56x^2 & \checkmark \\y &= \dots \dots \dots \quad [6]\end{aligned}$$

13 A water company is laying pipes to cover a distance of 37 metres, correct to the nearest metre.  
Each pipe has a length of 2.3 metres, correct to 1 decimal place.  
Assume the pipes are laid end to end with no gaps or overlaps.

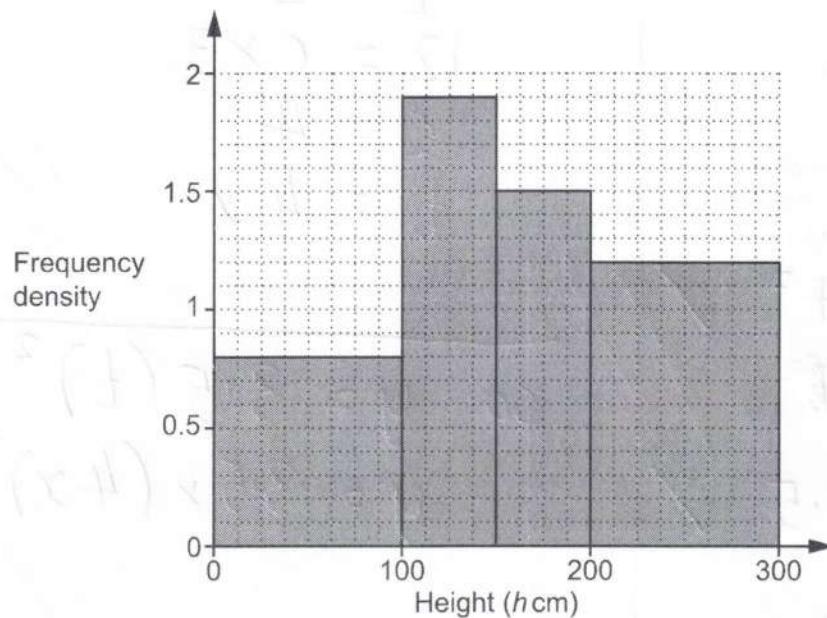
Work out the minimum number of pipes the water company needs to be sure of covering that distance.  
You must show your working.

$$\begin{array}{ccc}37 & < & \frac{37.5}{36.5} & \checkmark & 2.3 & < & \frac{2.35}{2.25} & \checkmark\end{array}$$

$$37.5 \div 2.25 = 16.6$$

$$= 17 \quad \checkmark$$

14 The histogram summarises the heights,  $h$  cm, of some plants in a garden centre.



(a) Show that there are 80 plants with a height in the interval  $0 < h \leq 100$ .

[1]

$$\text{Area} = 100 \times 0.8 = 80$$



(b) The value, in pounds, of each plant depends on the plant's height.  
The table below shows this information.

| Height (h cm)      | Value (£) |
|--------------------|-----------|
| $0 < h \leq 100$   | 2.50      |
| $100 < h \leq 150$ | 3.40      |
| $150 < h \leq 200$ | 5.00      |
| $200 < h \leq 300$ | 6.30      |

Area | Frequency

80

$$50 \times 1.9 = 95$$

$$50 \times 1.5 = 75$$

$$100 \times 1.2 = 120$$



Use this information to find the **total** value of the plants represented in the histogram.

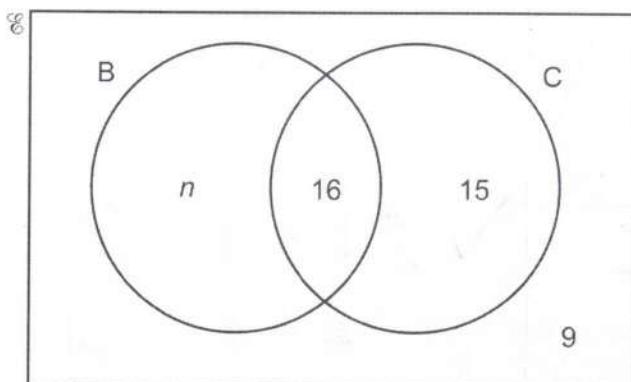
$$\begin{aligned} \text{Total value} &= (80 \times 2.5) + (95 \times 3.4) \\ &+ (75 \times 5) + (120 \times 6.3) \end{aligned}$$

1654

(b) £ ..... [4]



15 In a survey, some students were asked whether they had travelled to school by bus (B) or by car (C) in the last week.  
The Venn diagram shows some of the results.



(a) One of the students is chosen at random.

The probability that, in the last week, this student had travelled to school by bus and by car is  $\frac{1}{4}$ .

Find the value of  $n$ .

$$\frac{16}{\text{Total}} = \frac{1}{4} \quad \text{so total} = 64$$

$$64 - 16 - 15 - 9$$

$$(a) \quad n = \dots \quad 24 \quad [3]$$

(b) One of the students is chosen at random.

Find the probability that, in the last week, this student had travelled to school by car given that they had also travelled to school by bus.

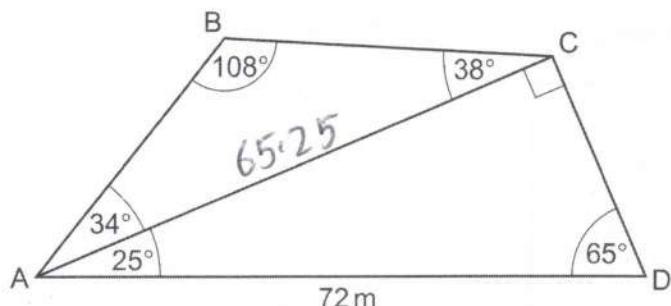
$$P(\text{Bus}) = \frac{40}{64}$$

$$\frac{16}{40}$$

$$(b) \quad \dots \quad [2]$$

$$\text{or } \frac{8}{20} \rightarrow \frac{4}{10} \rightarrow \frac{2}{5}$$

16 AC is a diagonal of the quadrilateral ABCD.



Not to scale

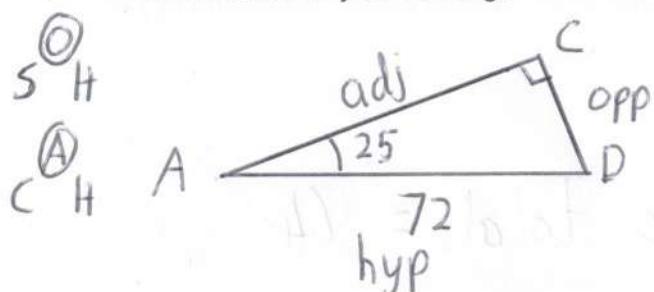
$$AD = 72 \text{ m.}$$

$$\text{Angle } ABC = 108^\circ, \text{ angle } BCA = 38^\circ \text{ and angle } BAC = 34^\circ.$$

$$\text{Angle } ACD = 90^\circ, \text{ angle } CDA = 65^\circ \text{ and angle } CAD = 25^\circ.$$

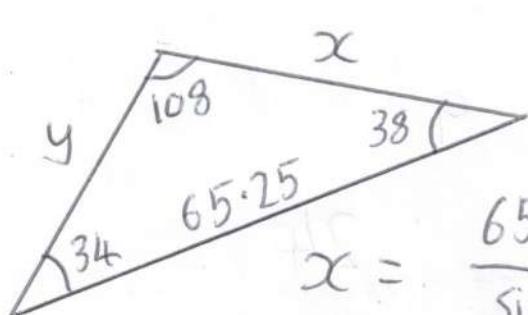
Find the area of ABCD.

You must show your working.



$$CD = 72 \times \sin 25 = 30.43$$

$$AC = 72 \times \cos 25 = 65.25$$



$$\frac{65.25}{\sin 108} = \frac{x}{\sin 34} = \frac{y}{\sin 38}$$

$$x = \frac{65.25}{\sin 108} \times \sin 34 = 38.37$$

$$y = \frac{65.25}{\sin 108} \times \sin 38 = 42.24$$

$$\text{Area} = \left( \frac{1}{2} \times 65.25 \times 30.43 \right) + \left( \frac{1}{2} \times 38.37 \times 42.24 \times \sin 108 \right)$$

$$1763.49$$

$\text{m}^2$  [6]

$[\text{ms: } 1763 \text{ or } 1763.4 \rightarrow 1763.5]$

17 An app's passcode consists of three digits. Each of the digits is a number from 0 to 9. A digit can be used more than once.

Find the fraction of the possible passcodes that contain at least one 5.

$$\text{Total codes} = 10^3 = 1000$$



$$\begin{array}{l} \text{Contains} \\ \text{NO 5s} \end{array} = 9 \times 9 \times 9 = 729$$



$$\begin{array}{l} \text{Hence contains} \\ \text{at least one 5} \end{array} = 1000 - 729 = 271$$



$$\frac{271}{1000}$$

[4]

**18** Some sequences are defined using this term-to-term rule.

$$u_{n+1} = 5u_n - 8.$$

(a) If  $u_3 = 22$ , show that  $u_4 = 102$ .

[1]

$$\begin{aligned}
 V_4 &= 5 \times 22 - 8 \\
 &= 110 - 8 \\
 &= \underline{102}
 \end{aligned}
 \quad \boxed{\checkmark}$$

(b) If  $u_3 = 22$ , work out  $u_2$ .

$$U_2 = \frac{22+8}{5} \quad \checkmark$$

(b)

[3]

(c) If  $u_1 = 2$ , write down the value of  $u_{50}$ .  
Give a reason for your answer.

$$u_{50} = 2 \quad \text{because } v_2 = 5 \times 2 - 8 = 2 \quad \text{so ALL terms} = 2$$

2

$u_{50} = \dots$ , because

$$V_2 = 5 \times 2 - 8 = 2 \text{ so ALL terms} = 2$$

[2]

19 Two ornaments, A and B, are mathematically similar.  
The table shows information about the two ornaments.

|                               | Ornament A | Ornament B |
|-------------------------------|------------|------------|
| Height (m)                    | $h$        | 12         |
| Surface area ( $\text{m}^2$ ) | 216        | $A$        |
| Volume ( $\text{m}^3$ )       | 240        | 3750       |

Find the value of  $h$  and the value of  $A$ .  
You must show your working.

$$\text{Volume scale factor} = \frac{3750}{240} = \frac{125}{8} \quad \checkmark$$

$$\text{Linear sf} = \sqrt[3]{\frac{125}{8}} = \frac{5}{2} \quad \checkmark$$

$$\text{Area sf} = \left(\frac{5}{2}\right)^2 = \frac{25}{4}$$

$$\text{so } A = 216 \times \frac{25}{4} = 1350 \quad \checkmark \text{ A} \checkmark$$

$$\text{and } h = 12 \div \frac{5}{2} = 4.8 \quad \checkmark \text{ A} \checkmark$$

$$h = \dots \quad 4.8$$

$$A = \dots \quad 1350$$

[6]

20 (a) Show that the equation  $x^3 - 3x - 4 = 0$  has a solution between  $x = 2$  and  $x = 3$ .

[3]

$$f(2) = 2^3 - 3 \times 2 - 4 = -2$$

✓

$$f(3) = 3^3 - 3 \times 3 - 4 = 14$$

✓

change of sign so solution must  
lie between 2 and 3

(b) Use  $x = 2.5$  to find a smaller interval for the solution to  $x^3 - 3x - 4 = 0$ .  
You must show your working.

$$f(2.5) = 2.5^3 - 3 \times 2.5 - 4 = 4.125$$

✓

$$2 < x < 2.5$$

(b)

[2]

(c) Find this solution correct to 1 decimal place.  
You must show your working.

$$f(2.2) = 0.048$$

✓

$$f(2.1) = -1.039$$

$$f(2.15) = -0.51163$$

✓

$$\text{so } 2.15 < x < 2.2$$

$$2.2$$

(c)  $x = \dots$  [3]