

Surname <i>StemUp Model Solution</i>	Centre Number	Candidate Number
Other Names		0



GCSE – NEW

3310U50-1



**MATHEMATICS – NUMERACY
UNIT 1: NON-CALCULATOR
HIGHER TIER**

THURSDAY, 25 MAY 2017 – MORNING

1 hour 45 minutes

ADDITIONAL MATERIALS

The use of a calculator is not permitted in this examination.
A ruler, a protractor and a pair of compasses may be required.

INSTRUCTIONS TO CANDIDATES

Use black ink or black ball-point pen. Do not use gel pen or correction fluid.

You may use a pencil for graphs and diagrams only.

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.

If you run out of space, use the continuation page at the back of the booklet, taking care to number the question(s) correctly.

Take π as 3.14.

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.

In question 1(b), the assessment will take into account the quality of your linguistic and mathematical organisation, communication and accuracy in writing.

For Examiner's use only		
Question	Maximum Mark	Mark Awarded
1.	9	
2.	3	
3.	5	
4.	4	
5.	6	
6.	6	
7.	8	
8.	5	
9.	11	
10.	13	
11.	10	
Total	80	

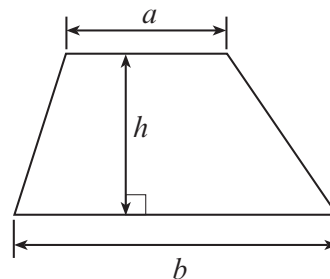
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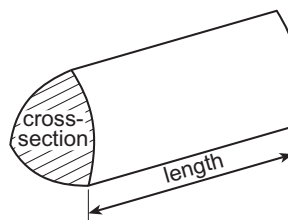
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Formula List - Higher Tier

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

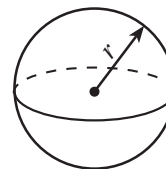


Volume of prism $= \text{area of cross-section} \times \text{length}$



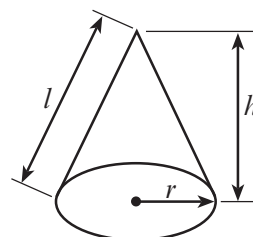
Volume of sphere $= \frac{4}{3}\pi r^3$

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



Volume of cone $= \frac{1}{3}\pi r^2 h$

Curved surface area of cone $= \pi r l$

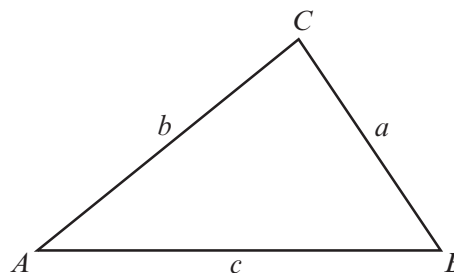


In any triangle ABC

Sine rule $\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$

Cosine rule $a^2 = b^2 + c^2 - 2bc \cos A$

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



The Quadratic Equation

The solutions of $ax^2 + bx + c = 0$ where $a \neq 0$ are given by $x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Annual Equivalent Rate (AER)

AER, as a decimal, is calculated using the formula $\left(1 + \frac{i}{n}\right)^n - 1$, where i is the nominal interest rate per annum as a decimal and n is the number of compounding periods per annum.



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1.



- (a) Jasmine entered herself, Sophie and Bryn as a group in a talent contest. Bryn only had a minor part.

Bryn, Sophie and Jasmine won the contest.
They shared the prize money in the ratio 2 : 6 : 7, with Bryn getting the smallest share.
Jasmine won £560, the largest share.

How much money did Bryn and Sophie each win?

[4]

$$\text{Total parts} = 2 + 6 + 7 = 15$$

$$\text{Jasmine has 7 parts} = £560$$

$$1 \text{ part} = £560 \div 7 = £80$$

$$\text{Bryn} = 2 \times £80 = £160$$

$$\text{Sophie} = 6 \times £80 = £480$$

Bryn receives £ 160

Sophie receives £ 480



- (b) In this part of the question, you will be assessed on the quality of your organisation, communication and accuracy in writing.

The talent contest is held once a year.

Every year, the cost of putting on the talent contest increases by 10% of the previous year's cost.

In summer 2014 the cost was £6600.

Calculate the cost of putting on the summer 2017 talent contest.

You must show all your working.

[3 + 2 OCW]

The cost goes up by 10% of the previous year's cost each year.

$$10\% \text{ of } £6600 = 6600 \div 10 = £660$$

$$\text{Cost in 2015} = 6600 + 660 = £7260$$

$$10\% \text{ of } £7260 = 7260 \div 10 = £726$$

$$\text{Cost in 2016} = 7260 + 726 = £7986$$

$$10\% \text{ of } £7986 = 7986 \div 10 = £798.60$$

$$\text{Cost in 2017} = 7986 + 798.60 = £8784.60$$

$$\text{Check: } 6600 \times 1.1^3 = 6600 \times 1.331 = 8784.6$$

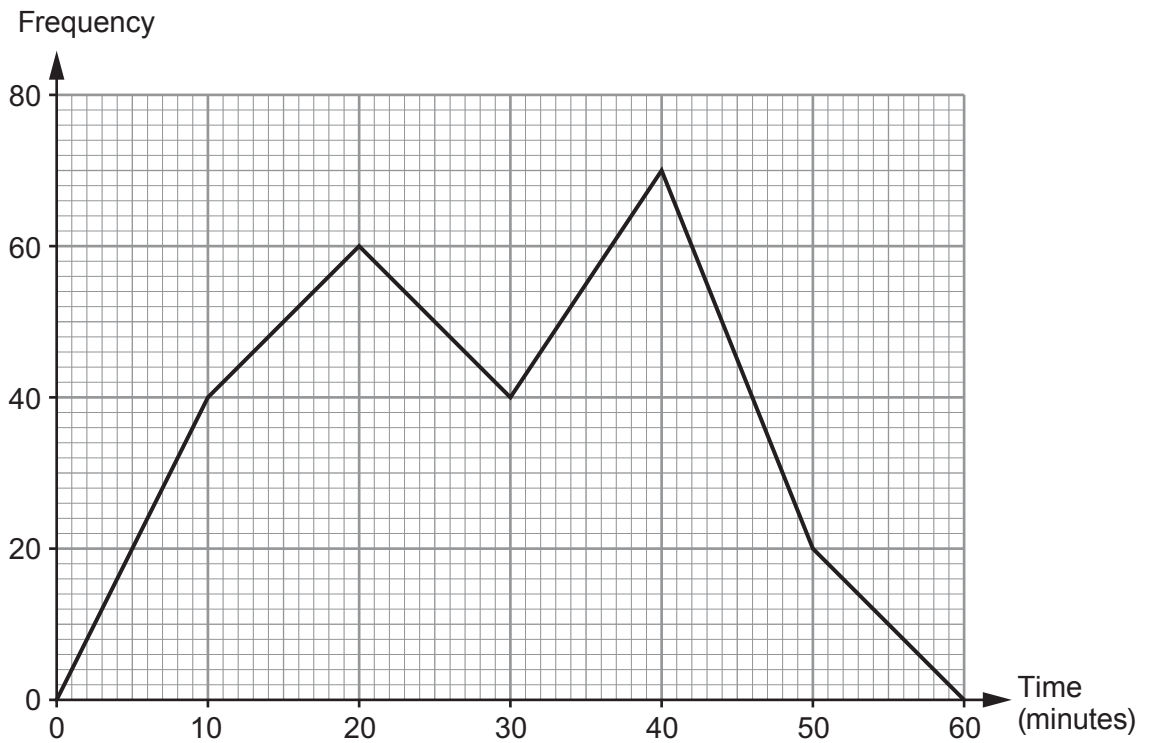
The cost of putting on the summer 2017 talent contest is

£8784.60.



2. A survey was carried out to find how much time a group of 16-year-old students and a group of 18-year-old students spent using social media. The frequency polygons below, which use equal time intervals, illustrate the results.

16-year-old students



18-year-old students



- (a) How many 16-year-old students took part in the survey?
Circle your answer.

[1]

60

70

210

230

2300

- (b) How many more 16-year-old students than 18-year-old students spent between 15 minutes and 25 minutes using social media?
Circle your answer.

[1]

20

40

60

100

250

- (c) Wesley says,

'The 16-year-old students generally spent about the same time using social media as the 18-year-old students.'

Using the frequency polygons, how would you explain to Wesley that his statement is not true?

[1]

His statement is not true. The 18-year-olds generally spent

longer: from 30 minutes onwards there are more 18-year-olds,

e.g. at 50 minutes there are 60 18-year-olds but only 20

16-year-olds, so the 18-year-olds' polygon leans to the greater times.



3. Bethan builds a rectangular sheep pen.



- (a) The perimeter fence of the sheep pen is 18 m long.
The length of Bethan's sheep pen is two times its width.
Find the length and width of this sheep pen.
You must show your working.

[2]

$$\text{Let width} = x, \text{ length} = 2x$$

$$\text{Perimeter: } x + 2x + x + 2x = 18$$

$$6x = 18, x = 18 \div 6 = 3$$

$$\text{Width} = 3 \text{ m, length} = 2 \times 3 = 6 \text{ m}$$

Length is 6..... metres

Width is 3..... metres



- (b) Bethan decides to build a new sheep pen.
The perimeter fence of the new sheep pen is 16 m long.
The length of the new sheep pen is 3 metres longer than the width.

Form an equation and solve it to find the dimensions of this new sheep pen. [3]

$$\text{Let width} = x \text{ m, so length} = x + 3 \text{ m}$$

$$\text{Perimeter: } x + (x + 3) + x + (x + 3) = 16$$

$$4x + 6 = 16$$

$$4x = 16 - 6 = 10$$

$$x = 10 \div 4 = 2.5$$

$$\text{Width} = 2.5 \text{ m}$$

$$\text{Length} = 2.5 + 3 = 5.5 \text{ m}$$

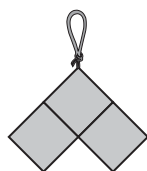
Length is 5.5..... metres

Width is 2.5..... metres

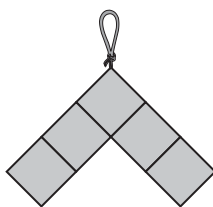


4. Josef has a job in a workshop that makes decorations.

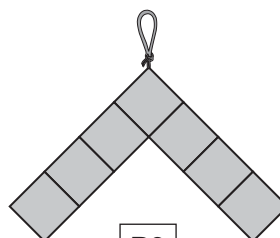
He has made the following three decorations using small squares of stained glass.



P1



P2



P3

Josef labels these patterns P1, P2 and P3 in order.

Josef continues to make decorations following the pattern he has started.

- (a) How many **more** squares would he need to make pattern P22 than to make pattern P18? [1]

Each pattern has 2 more squares than the one before.

P22 – P18: 4 patterns $\times$ 2 = 8 more squares

- (b) Josef has 22 squares.

Josef states,

'I think I can make one complete decoration using **all** 22 squares, with none left over.'

Is Josef correct?

Yes

☐

No

☒

Give a reason for your answer.

[1]

No. Every pattern has an odd number of squares ($2n + 1$):

P10 uses 21 squares and P11 uses 23, so 22 cannot be used exactly.



- (c) Each small square of stained glass measures 0.5 cm by 0.5 cm.
The perimeter of one of Josef's decorations is 10 cm.
Complete the label that Josef would use for this decoration.

[2]

P 4

Number of small square edges on the perimeter = $10 \div 0.5 = 20$

P_n has $2n + 1$ squares and $2(2n + 1) + 2 = 4n + 4$ edges round it

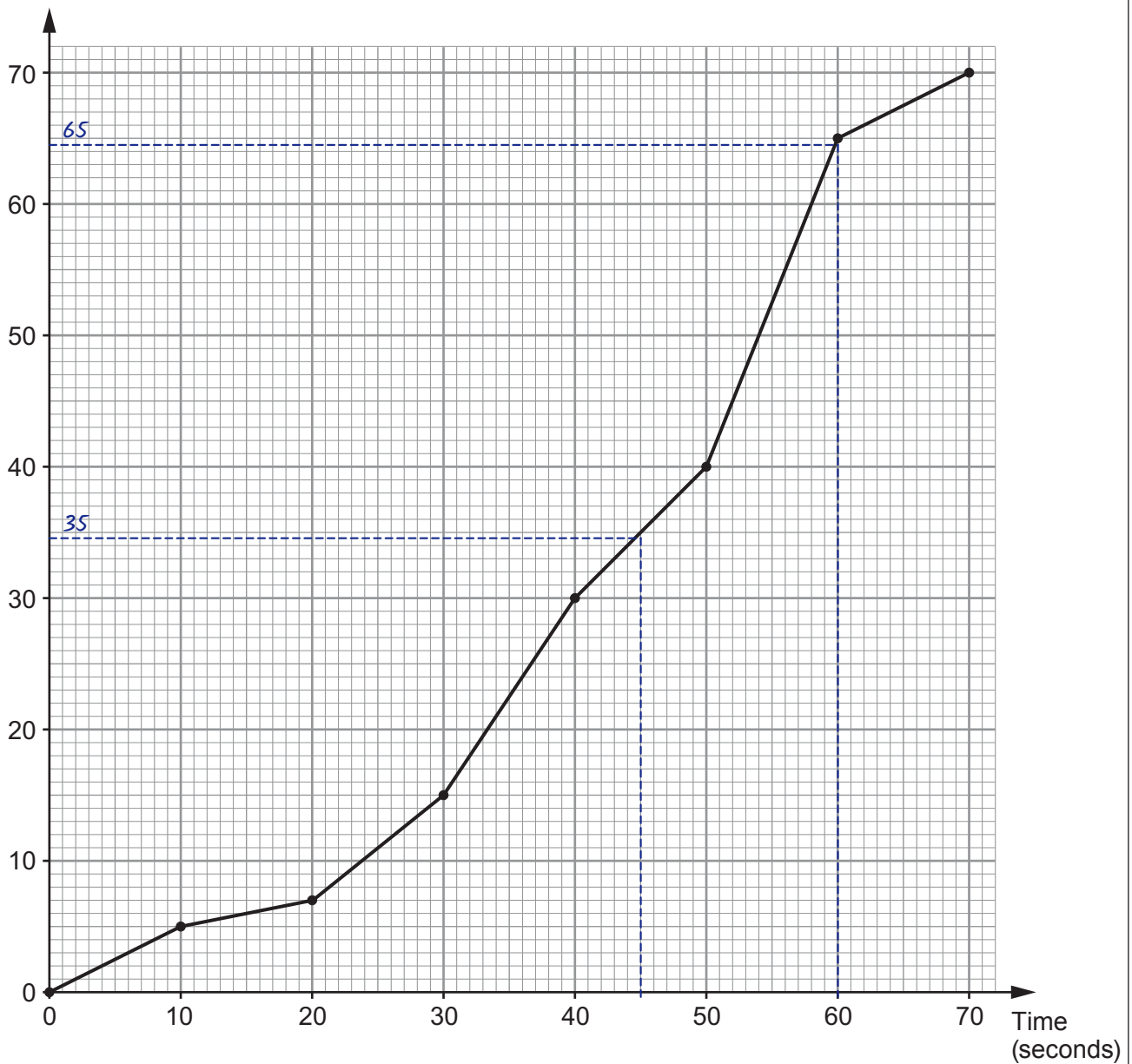
$4n + 4 = 20$, $4n = 16$, $n = 4$

(P_4 has 9 squares, 5 on each side)



5. Cambria Airlines has planes that can carry up to 70 passengers. For safety, the crew practise the emergency exit procedures with a group of 70 passengers. Every 10 seconds the safety officer records the total number of passengers who have left the plane. He has displayed the results in the cumulative frequency diagram shown below.

Cumulative frequency



- (a) Estimate the median time taken by the passengers to leave the plane.

[1]

.....45..... seconds



- (b) How many passengers took more than 50 seconds to leave the plane?
Circle your answer.

[1]

10

20

30

40

50

- (c) Cambria Airlines has a policy that states the following.

'In the event of an emergency exit procedure, at least 90% of the 70 passengers must have left the plane within 1 minute.'

Did the practice emergency exit procedure meet the requirements of the airline's policy?
You must show all your working.

[4]

$90\% \text{ of } 70 \text{ passengers} = 0.9 \times 70 = 63 \text{ passengers}$

From the graph, at 60 seconds (1 minute) the cumulative

frequency is 65, so 65 passengers had left within 1 minute.

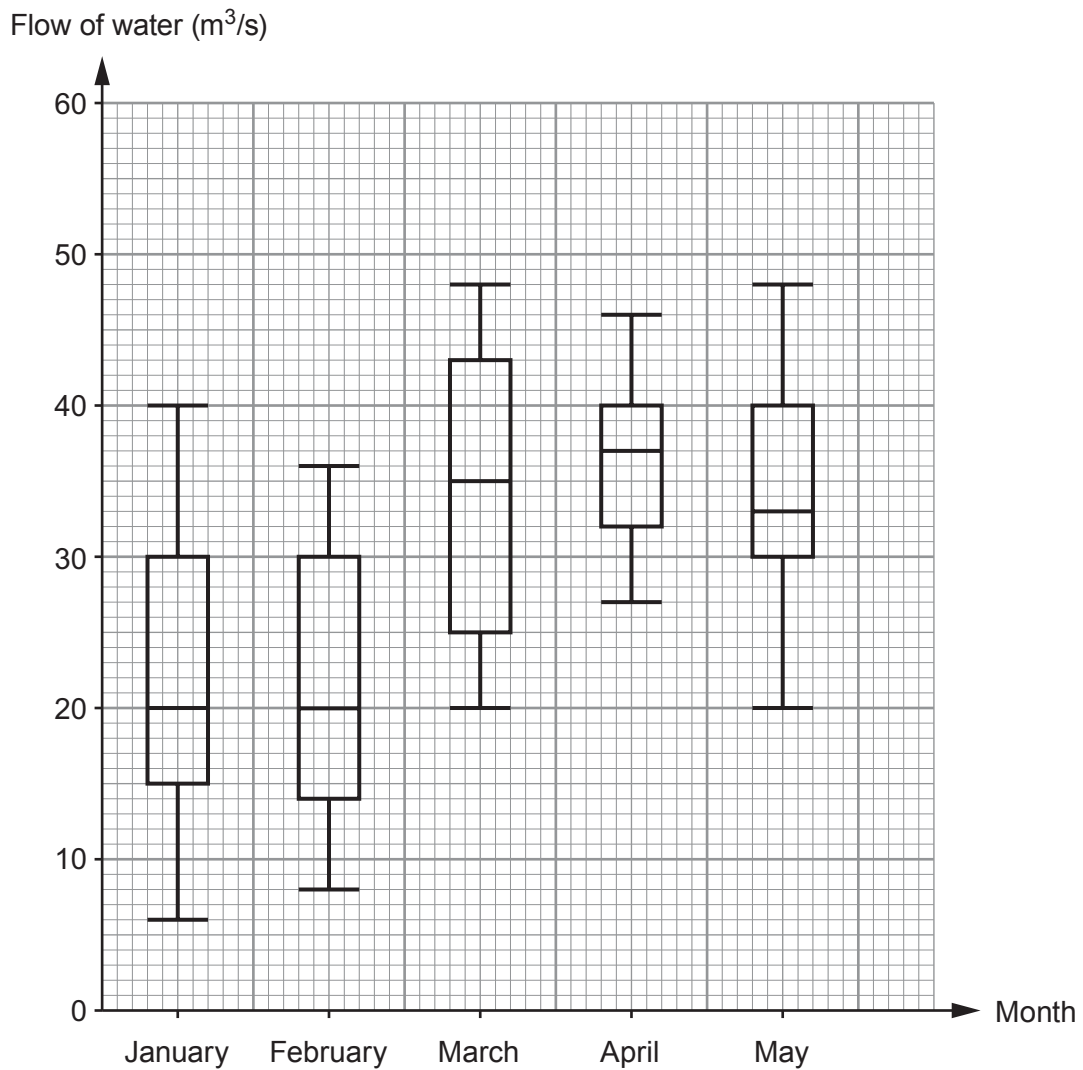
$65 \text{ as a percentage of } 70 = 65/70 \times 100 \approx 93\%$

$65 > 63$ ($93\% > 90\%$), so at least 90% of the passengers left
within 1 minute.

Yes, the practice met the requirements of the airline's policy.



6. The following box and whisker plots show the flow of water through a drain, measured in m^3/s . The flow of water was measured at 11 a.m. each day for the first 5 months of the year.



- (a) In which of the five months was the median flow of water the greatest?

[1]

April



- (b) In which of the five months was the range of the flow of water the greatest? [1]

January

- (c) Iona is writing some statements for a report on the flow of water through the drain. Complete each of the statements given below.

- (i) 'Both the upper quartiles and medians in the months of *January* and *February* were the same.' [1]

- (ii) '25% of the results in March show the flow of water was greater than *43* m³/s.' [1]

- (d) Circle either TRUE or FALSE for each of the following statements. [2]

25% of the results in January show the flow of water was less than 6 m ³ /s.	TRUE	<u>FALSE</u>
The units, m ³ /s, measure the volume of water passing through the drain each second.	<u>TRUE</u>	FALSE
The mean flow of water in April was certainly greater than 36 m ³ /s.	TRUE	<u>FALSE</u>
The month with the greatest difference between the lower quartile and the median was May.	TRUE	<u>FALSE</u>



7. (a) A standard piece of A4 paper is usually 0.08 mm thick.
What is 0.08 mm written in **metres** in standard form?
Circle your answer.

[1]

8×10^4

8×10^{-4}

8×10^{-3}

8×10^3

8×10^{-5}

$$0.08 \text{ mm} = 0.08 \div 1000 \text{ m} = 0.00008 \text{ m} = 8 \times 10^{-5} \text{ m}$$

- (b) A piece of card is 1 mm thick.
A stack of these pieces of card is 3×10^{-2} metres high.

- (i) Calculate how many pieces of card there are in the stack.

[2]

$$3 \times 10^{-2} \text{ m} = 0.03 \text{ m}$$

$$0.03 \text{ m} = 0.03 \times 1000 \text{ mm} = 30 \text{ mm}$$

$$\text{Number of pieces} = 30 \text{ mm} \div 1 \text{ mm}$$

$$= 30 \text{ pieces of card}$$

- (ii) What assumption have you made in answering (b)(i)?

[1]

That there are no gaps between the pieces of card and every
piece is exactly 1 mm thick.



- (c) In 2012 it was recorded that
- the total mass of the paper used for printing newspapers, in the world, was 2.88×10^7 tonnes,
 - the world population was approximately 7.2×10^9 people.

Use this information to calculate the mass of paper per person used to print newspapers in 2012.

Give your answer in **kg per person**.

[4]

$$1 \text{ tonne} = 1000 \text{ kg}$$

$$\text{Total mass in kg} = 2.88 \times 10^7 \times 1000 = 2.88 \times 10^{10} \text{ kg}$$

$$\text{Mass per person} = 2.88 \times 10^{10} \div (7.2 \times 10^9)$$

$$= (2.88 \div 7.2) \times 10^{10-9}$$

$$= 0.4 \times 10^1$$

$$= 4 \text{ kg per person}$$

$$(2.88 \div 7.2 = 28.8 \div 72 = 0.4)$$

Mass of paper: 4..... kg per person



8. On a new housing estate, teams of painters paint the walls and ceilings of houses once they are built.

- (a) It takes a team of 5 painters 10 hours to paint a house that has a total wall and ceiling area of 500 m^2 .

A new house on the estate has a total wall and ceiling area of 600 m^2 .
This house has to be painted in 8 hours.

Calculate the least number of painters needed.
You must show all your working.

[4]

5 painters $\times$ 10 hours = 50 painter-hours for 500 m^2

So 1 painter paints $500 \div 50 = 10 \text{ m}^2$ in 1 hour

In 8 hours 1 painter paints $8 \times 10 = 80 \text{ m}^2$

Painters needed for $600 \text{ m}^2 = 600 \div 80 = 7.5$

You cannot have half a painter, so round up.

Least number of painters needed = 8 painters

- (b) What assumption have you made in answering part (a)?

[1]

*All the painters work at the same rate (each paints 10 m^2
in an hour).*



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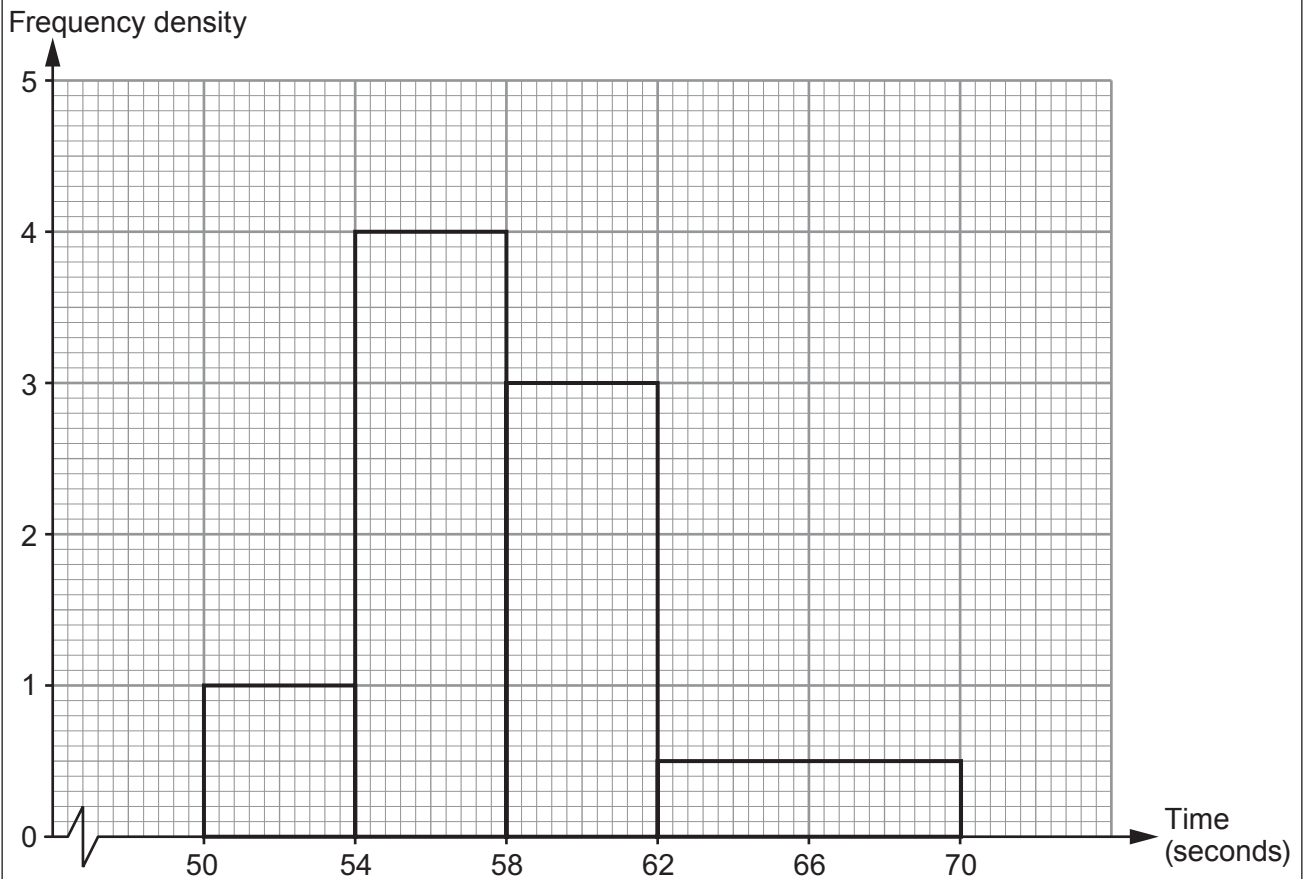
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9. The time taken to run 400 m was recorded for each member of a running club.

- (a) A histogram of the results for the members who are under 30 years of age is shown below.



- (i) Calculate how many members of the running club are under 30 years of age. [2]

$$\text{Frequency} = \text{FD} \times \text{class width}$$

$$4 \times 1 + 4 \times 4 + 4 \times 3 + 8 \times 0.5 = 4 + 16 + 12 + 4 = 36 \text{ members}$$

- (ii) Calculate an estimate of the median time taken by the under-30s to run 400 m. [4]

$$\text{Median} = 36 \div 2 = 18\text{th value}; 4 + 16 = 20 \text{ so median is in } 54 \text{ to } 58$$

$$18 - 4 = 14 \text{ into the } 54 \text{ to } 58 \text{ group, which has } 16 \text{ people}$$

$$\text{FD} = 4, \text{ so } 4 \times x = 14, x = 3.5 \text{ s (or } \frac{14}{16} \times 4 = 3.5)$$

$$\text{Estimated median} = 54 + 3.5 = 57.5 \text{ seconds}$$



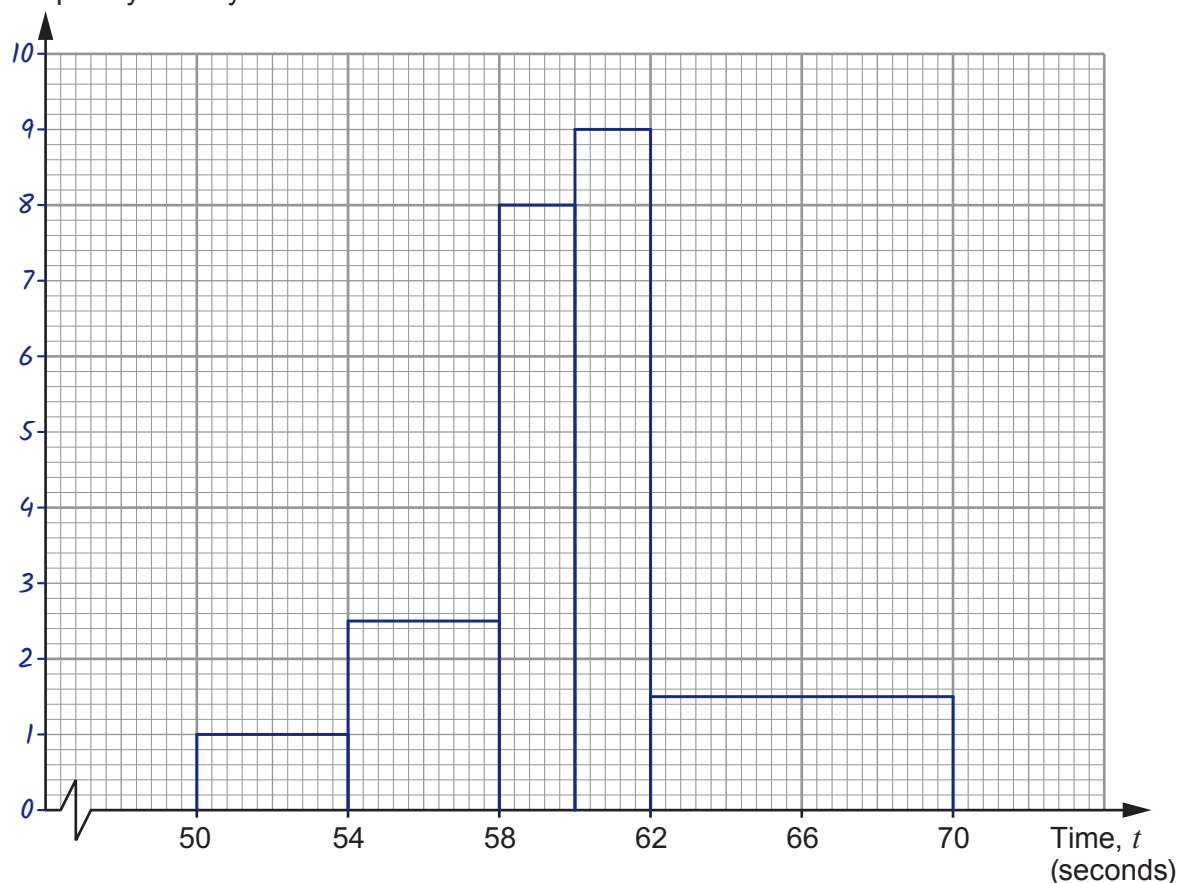
- (b) The frequency table below shows the results for the members who are 30 years of age or over.

Time, t (seconds)	$50 < t \leq 54$	$54 < t \leq 58$	$58 < t \leq 60$	$60 < t \leq 62$	$62 < t \leq 70$
Number of people	4	10	16	18	12
Frequency density	1	2.5	8	9	1.5

Complete the table, and draw a histogram to illustrate this data on the graph paper below. [4]

FD = number of people $\div$ class width: $4 \div 4$, $10 \div 4$, $16 \div 2$, $18 \div 2$, $12 \div 8$

Frequency density



- (c) On average, which of the two groups was faster at running 400m?
Give a reason for your answer.
Your reason must be based on your interpretation of the histograms. [1]

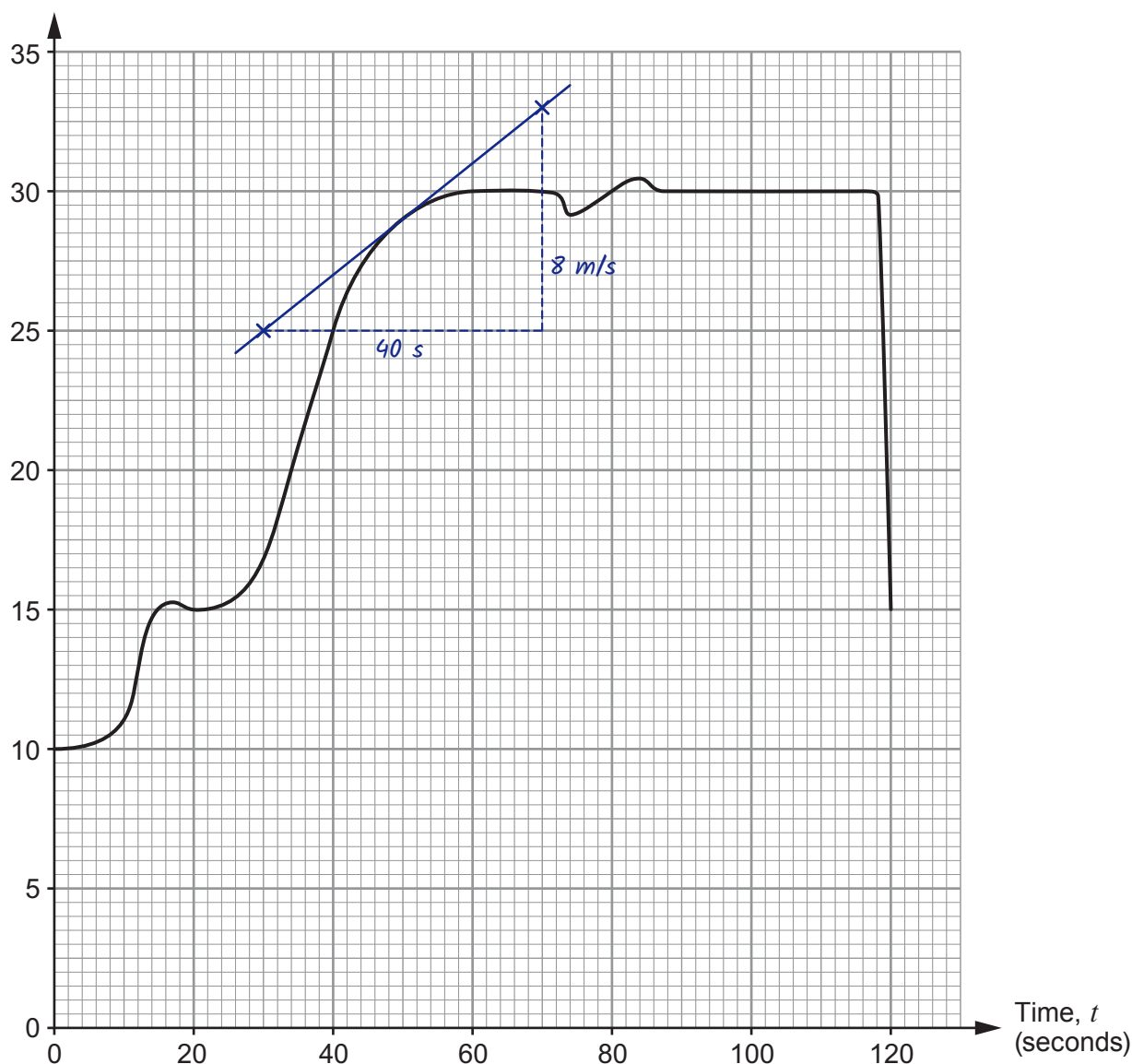
The under-30s were faster. A higher proportion of the under-30s took

less than 58 s (20 out of 36) than the 30-and-overs (14 out of 60).



10. The graph below shows a 120-second section of lestyn's car journey to work this morning.

Speed (metres per second)



- (a) (i) At $t = 50$ seconds, estimate the acceleration of lestyn's car in m/s^2 .
Leave your answer as a fraction.

[3]

Tangent through (30, 25) and (70, 33)

$$\text{Acceleration} = \text{gradient} = \frac{\text{increase in speed}}{\text{increase in time}} = \frac{33 - 25}{70 - 30}$$

$$= \frac{8}{40} = \frac{1}{5} \text{ m/s}^2$$



- (ii) At another time, Iestyn calculated the acceleration of the car to be $0.2\dot{4} \text{ m/s}^2$. Write this recurring decimal as a fraction. [2]

$$x = 0.2444... \quad 10x = 2.444... \quad 100x = 24.444...$$

$$100x - 10x = 24.444... - 2.444...$$

$$90x = 22 \quad x = \frac{22}{90} = \frac{11}{45}$$

- (b) (i) Calculate an estimate of the distance travelled by Iestyn's car in the first 80 seconds of his journey. You must consider the speed of the car when $t = 0, 20, 40, 60$ and 80 seconds. [4]

$$\text{Speeds: } t = 0: 10, \quad t = 20: 15, \quad t = 40: 25, \quad t = 60: 30, \quad t = 80: 30 \text{ (m/s)}$$

Split into 4 trapezia, each 20 s wide:

$$\text{Area 1} = \frac{1}{2} \times (10 + 15) \times 20 = 250$$

$$\text{Area 2} = \frac{1}{2} \times (15 + 25) \times 20 = 400$$

$$\text{Area 3} = \frac{1}{2} \times (25 + 30) \times 20 = 550$$

$$\text{Area 4} = \frac{1}{2} \times (30 + 30) \times 20 = 600$$

$$\text{Distance} \approx 250 + 400 + 550 + 600$$

$$= 1800 \text{ m}$$

- (ii) Hence, calculate an estimate of the average speed of Iestyn's car for this entire 120-second section of his car journey. Give your answer in m/s. [4]

From 80 s to about 119 s the car travels at 30 m/s:

$$\text{Distance} = 30 \times 39 = 1170 \text{ m}$$

$$\text{Total distance} \approx 1800 + 1170 = 2970 \text{ m}$$

$$\text{Average speed} = \text{total distance} \div \text{total time}$$

$$= 2970 \div 120$$

$$= 24.75 \text{ m/s}$$



11. The diagram below shows a wooden end-piece for a curtain pole. It is in the shape of a cone with measurements as shown in the diagram.

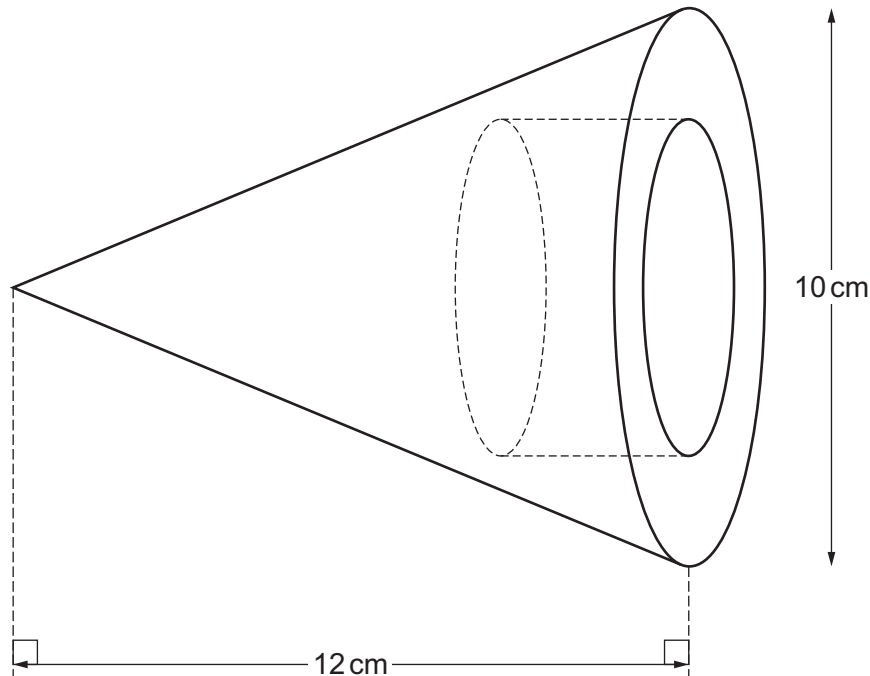


Diagram not drawn to scale

The curtain pole sits in a cylindrical hole that has been drilled into the end-piece. The hole is of radius 3 cm and depth 4 cm.

- (a) Show that the volume of wood that remains is $64\pi \text{ cm}^3$.

[4]

$$\text{Volume of cone} = \frac{1}{3} \pi r^2 h = \frac{1}{3} \times \pi \times 5^2 \times 12 = 100\pi$$

$$\text{Volume of hole (cylinder)} = \pi r^2 h = \pi \times 3^2 \times 4 = 36\pi$$

$$\text{Volume of wood remaining} = 100\pi - 36\pi$$

$$= 64\pi \text{ cm}^3 \text{ as required}$$



- (b) The surface area of the end-piece is to be painted, except for the area inside the hole. Calculate the surface area that is to be painted. Give your answer in terms of π . [6]

$$\text{Radius of base} = 10 \div 2 = 5 \text{ cm, height} = 12 \text{ cm}$$

$$\text{Slant length } l^2 = 12^2 + 5^2 = 144 + 25 = 169$$

$$l = \sqrt{169} = 13 \text{ cm}$$

$$\text{Curved surface area} = \pi r l = \pi \times 5 \times 13 = 65\pi$$

$$\text{Area of circular base} = \pi \times 5^2 = 25\pi$$

$$\text{Area of hole opening (not painted)} = \pi \times 3^2 = 9\pi$$

$$\text{Painted area} = 65\pi + 25\pi - 9\pi$$

$$\text{Surface area to be painted} = 81\pi \text{ cm}^2$$

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