



Question 1 (4 marks)

For each puzzle, **select** the correct puzzle piece with equivalent values, from the draggable options, and place it in the space provided.

Draggable puzzle pieces:

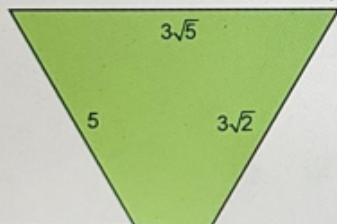
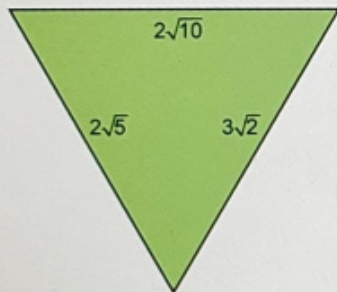
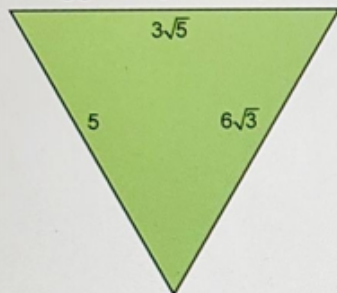
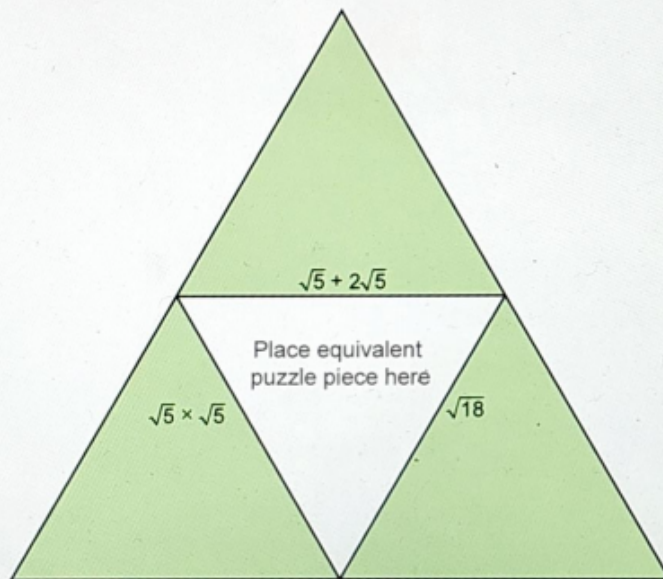


Diagram not to scale



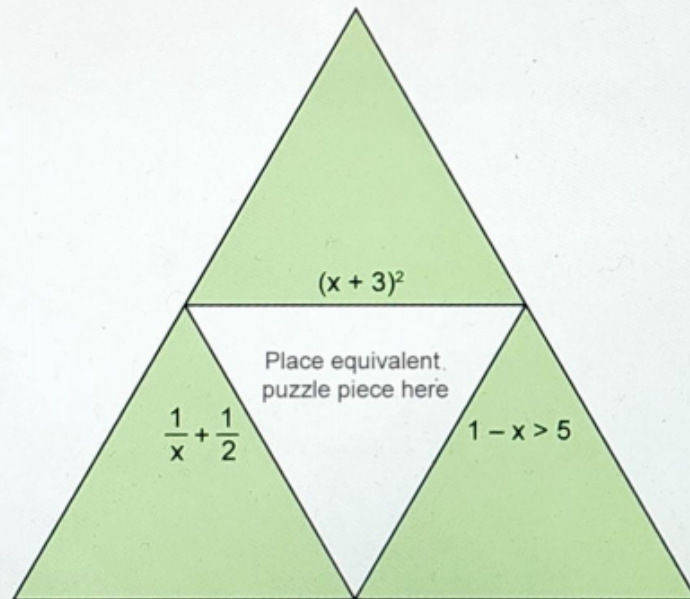
Draggable puzzle pieces:

$$x^2 + 6x + 9$$
$$\frac{2+x}{2x} \quad x < -4$$

$$x^2 + 6x + 9$$
$$\frac{1}{x+2} \quad x < -4$$

$$x^2 + 9$$
$$\frac{2+x}{2x} \quad x < -4$$

Diagram not to scale



Draggable puzzle pieces:

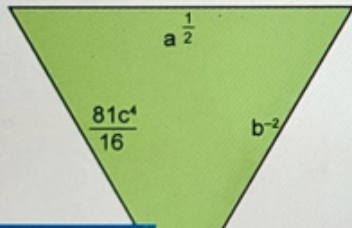
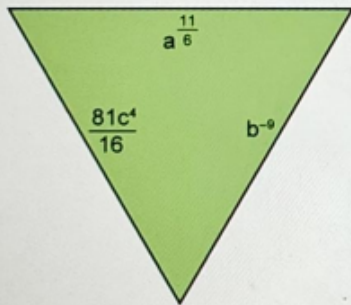
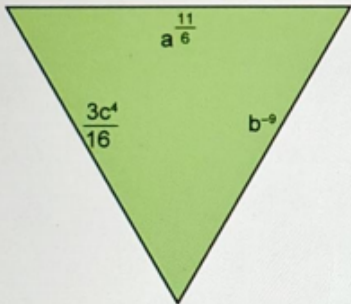
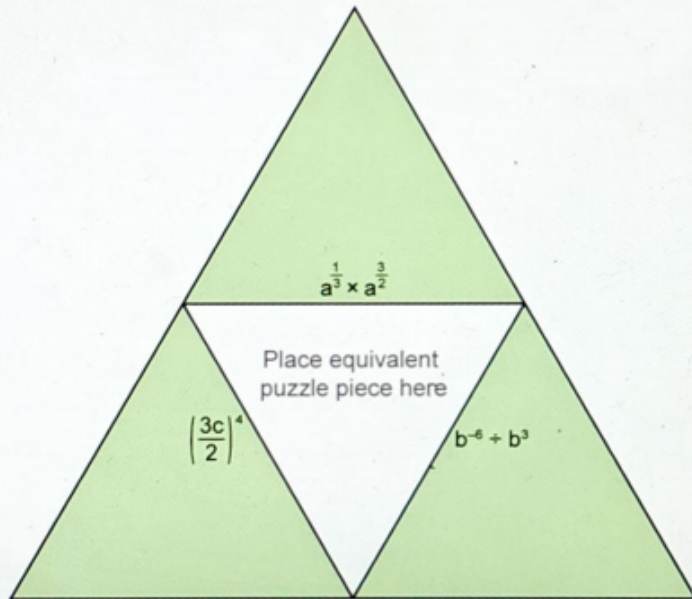


Diagram not to scale



Draggable puzzle pieces:

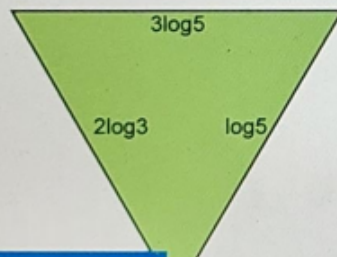
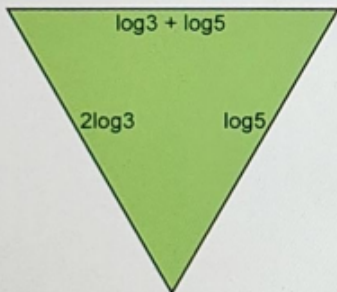
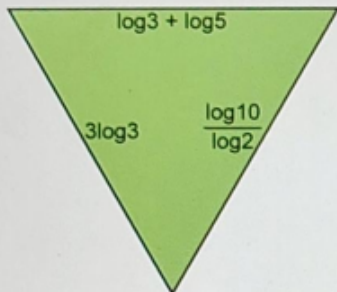
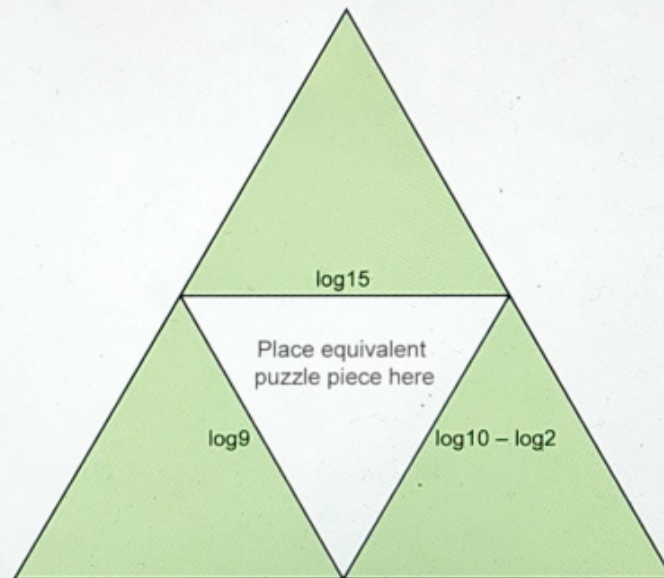


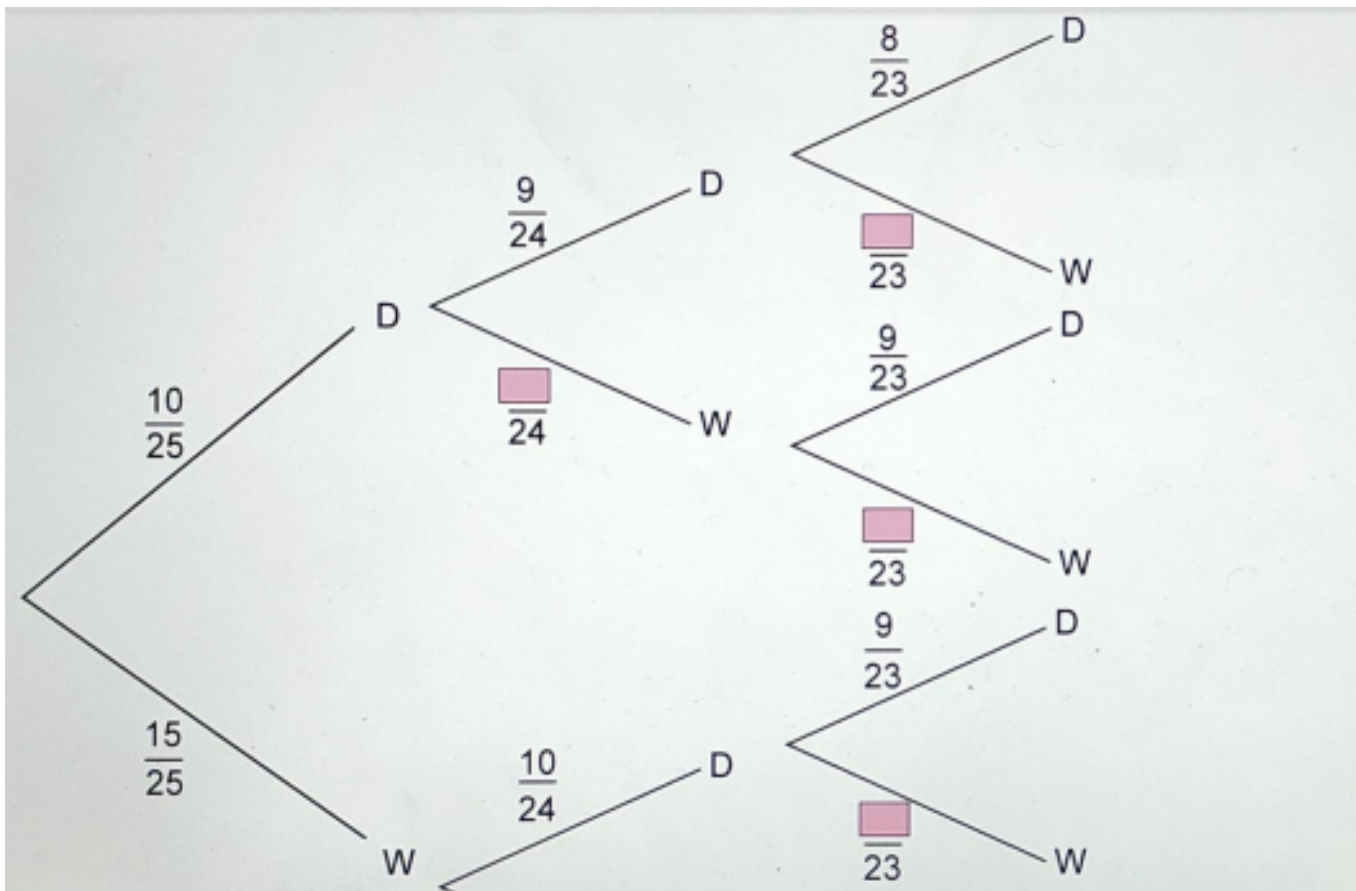
Diagram not to scale

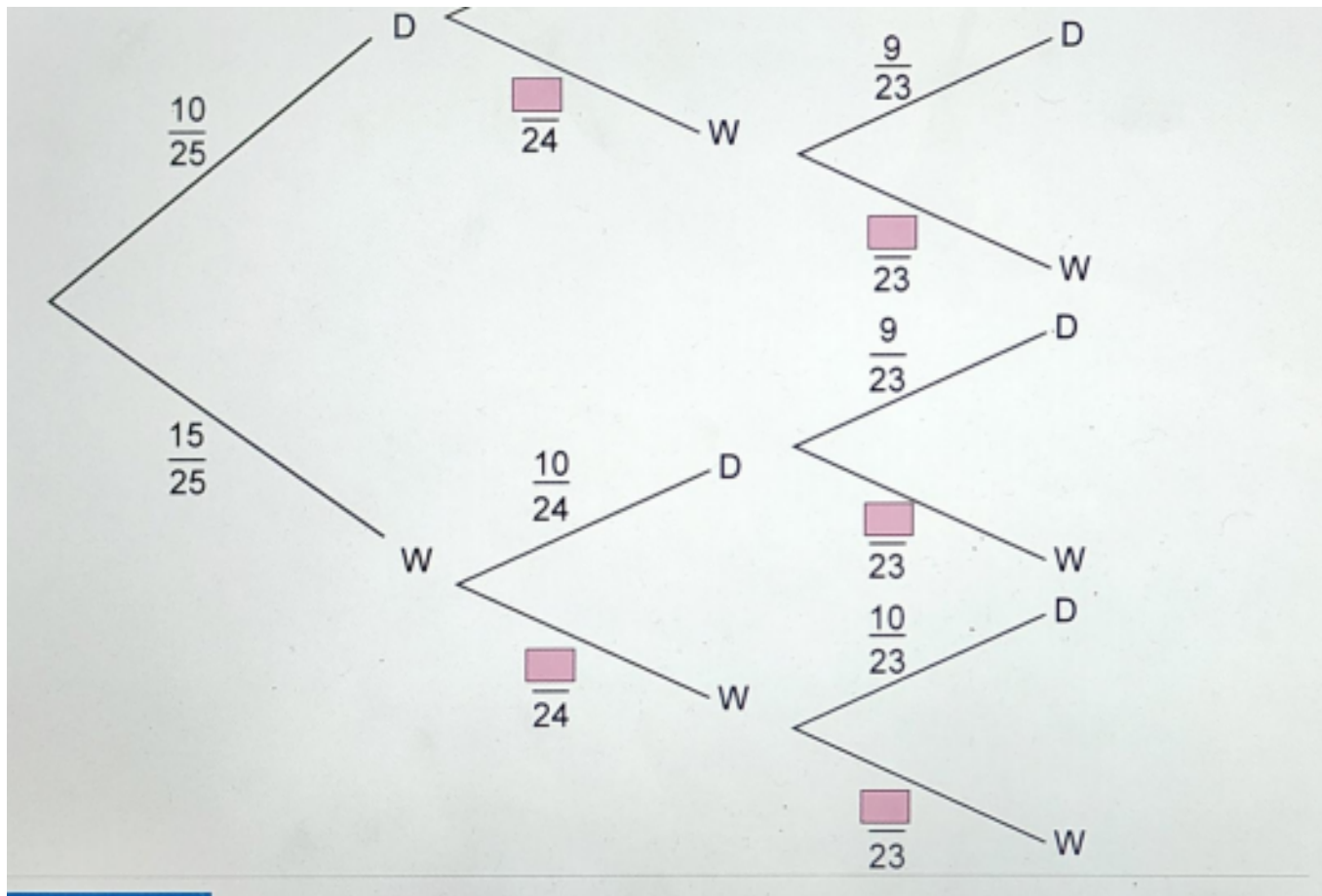




Question 2 (9 marks)

A bag contains 10 dark chocolates (D) and 15 white chocolates (W). Three chocolates are selected at random from the bag and not replaced.







Question 2b (3 marks)

Find the probability that exactly two dark chocolates are selected.

B *I* | ← → | U x_n x^a | \int $\frac{d}{dx}$ | Ω Σ

Styles -



Question 2c (2 marks)

Let A be the event that the first selected chocolate is white.

Let B be the event that exactly two dark chocolates are selected.

Determine $P(A|B)$.

B *I* | ← → | U x_n x^a | \int $\frac{d}{dx}$ | Ω Σ

Styles -



Question 2d (2 marks)

Show that the events A and B are not independent.

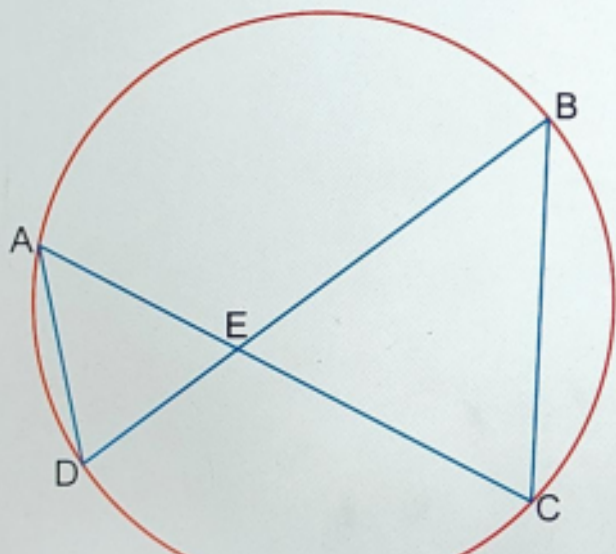
B *I* | ← → U x_* x^e ;= :: Ω Σ Styles -



Question 3a (2 marks)

Points A, B, C and D lie on the circumference of a circle and the chords AC and BD intersect at point E.

Diagram not to scale

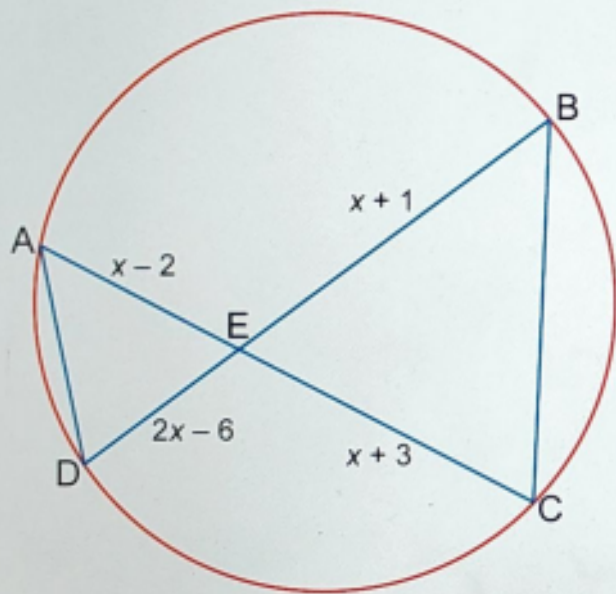


Prove that triangle AED is similar to triangle BEC.

B **I** ← → ×₂ ×² ∴ ∴ ∴ ∴ Ω Σ

Styles -

Diagram not to scale



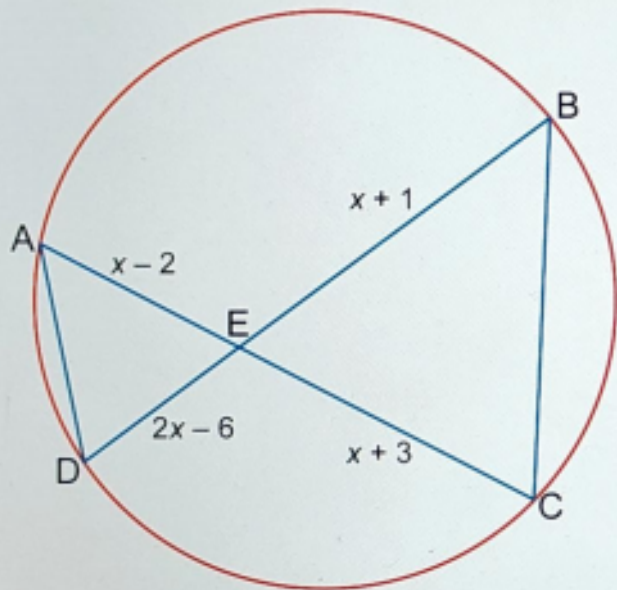
Question 3b (4 marks)

Hence, form and solve a quadratic equation to **show that** $x = 5$.

B *I* ← → \times \div $\sqrt{\quad}$ $\frac{\square}{\square}$ $\frac{\square}{\square}$ Ω Σ

Styles -

Diagram not to scale



Question 3c (4 marks)

Given that the size of angle BEC is 60 degrees and $BC = m\sqrt{n}$ units, **find** the values of m and n .

B *I* ← → U \times \times^2 \therefore \therefore Ω Σ

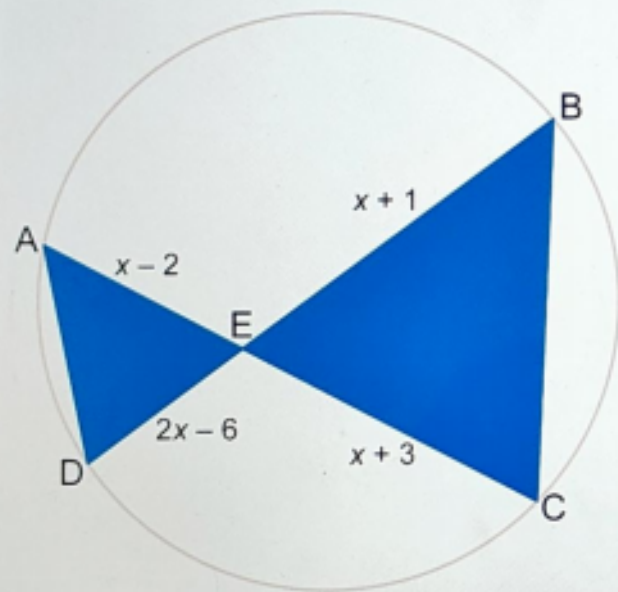
Styles -



Question 3d (3 marks)

Triangle AED is similar to triangle BEC.

$$x = 5$$



Hence, **find** the exact value of the perimeter of the shaded shape.

B *I* ← → U \times \times^2 $\therefore \therefore$ Ω Σ

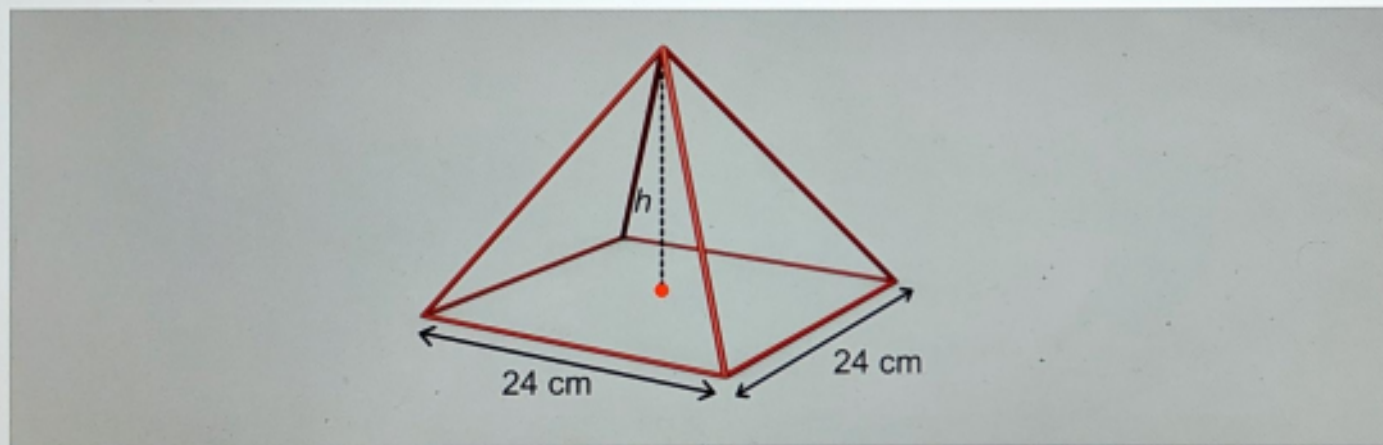
Styles -



Question 4 (9 marks)

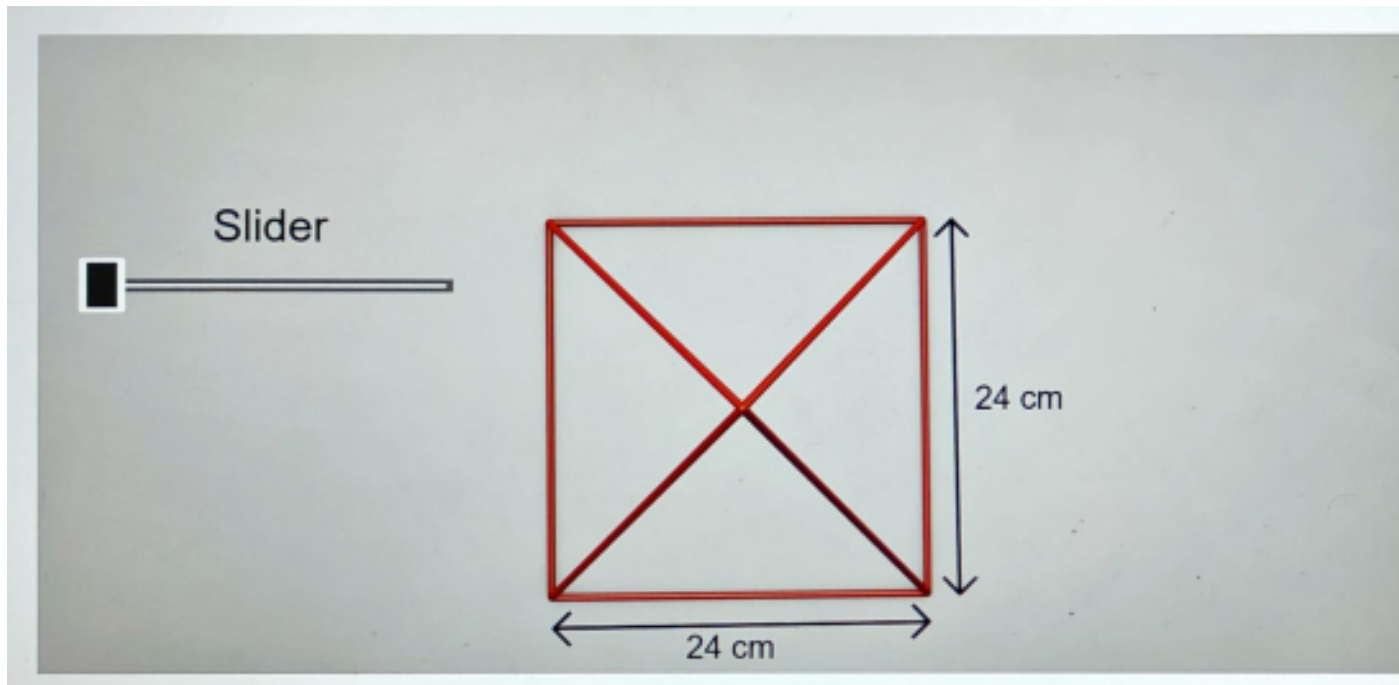
The diagram below shows a square-based pyramid of height h with four equilateral triangles of length 24 cm.

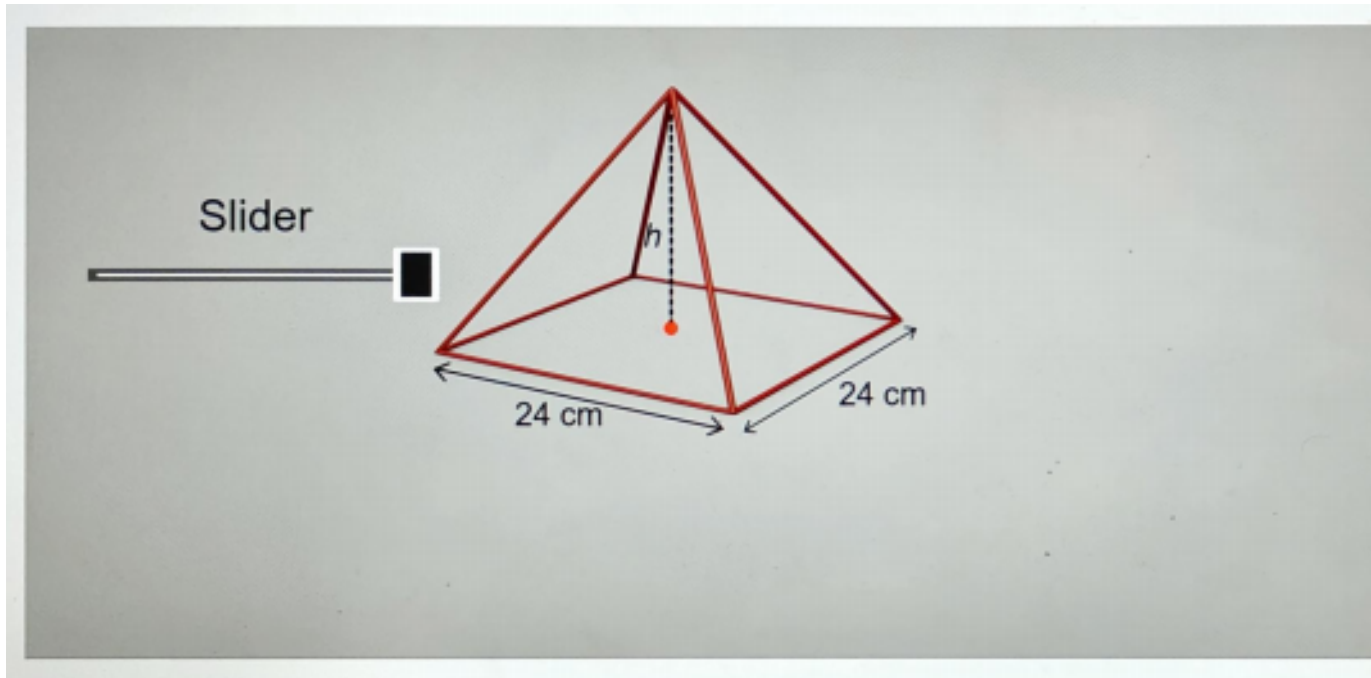
Diagram not to scale



Interact with the slider to see different faces of the pyramid

Diagram not to scale







Question 4a (4 marks)

Show that the height h is $12\sqrt{2}$ cm.

B *I* ← → U \times \times^2 \int \sum Ω Σ Styles



Question 4b (3 marks)

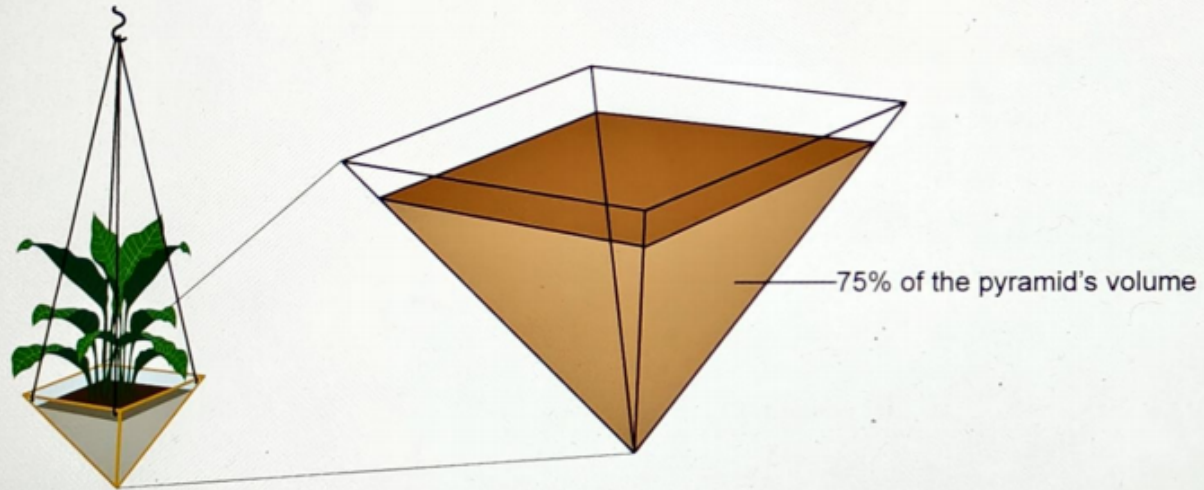
Find the volume of the pyramid. Give your answer to the nearest integer.

B *I* | ← → | U x_n x^e | $\frac{1}{2}$ $\frac{1}{3}$ | Ω Σ | Styles - |



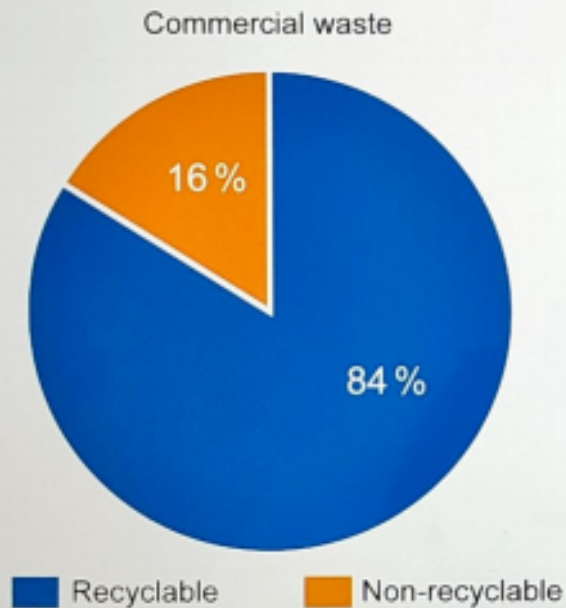
Question 4c (2 marks)

This square-based pyramid is used as a plant holder as shown in the diagram. Soil is added to the plant holder until it reaches 75 % of the volume of the plant holder.



Determine the height of the soil.

The pie chart below shows the type of commercial waste received by the organization in one month.



The total weight of commercial waste received was 4500 tonnes (t). **Determine** the weight of **non-recyclable** commercial waste.

Rich text editor toolbar with icons for Bold (B), Italic (I), Undo, Redo, Underline (U), Strikethrough (x), Superscript (x²), Bulleted List, Numbered List, Link (Ω), and Unlink (Σ). Below the toolbar is a text input area with a cursor and a "Styles" dropdown menu.



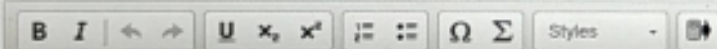


Question 5b (2 marks)

In the same month, the weight of **non-recyclable** waste received from the different categories was in the ratio of:

Domestic	:	Commercial	:	Industrial
15	:	8	:	3

Determine the weight of non-recyclable **industrial** waste.

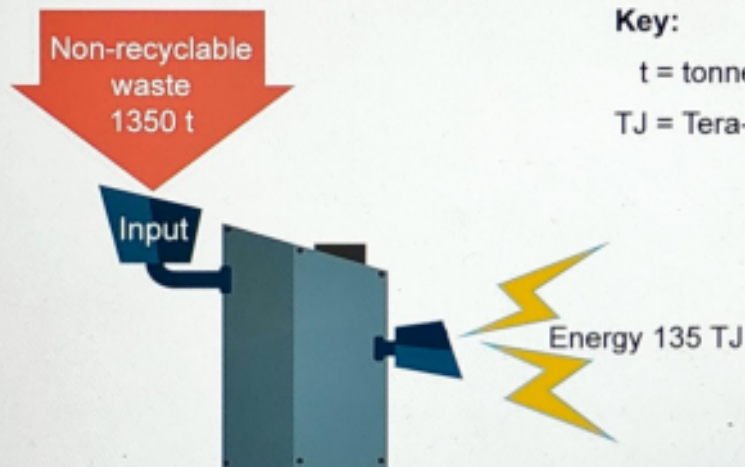




Question 5c (4 marks)

Energy is generated from the non-recyclable waste from each category. The image below shows the data for domestic waste.

Domestic



Key:

t = tonnes

TJ = Tera-joules = 1×10^{12} Joules

Determine the missing values in the table.

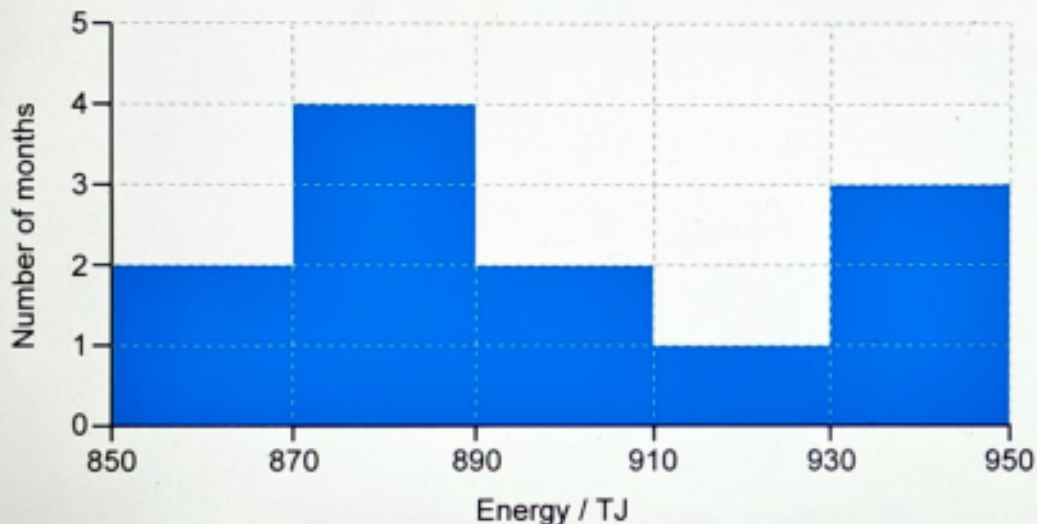
		Weight, tonnes (t)	Production ratio Energy per tonne (TJ/t)	Energy, Tera-joules (TJ)
Category	Domestic	1350	$r =$ <input type="text"/>	135
	Commercial	Answer from (a) <input type="text"/>	$r =$ <input type="text"/>	<input type="text"/>
	Industrial	Answer from (b) <input type="text"/>	$2r =$ <input type="text"/>	<input type="text"/>

Total energy produced by the organization this month



Question 5d (4 marks)

A town has 68 420 homes. The histogram shows the energy (E) used by the town in the year 2022.



Show that the estimate of the mean value of energy used per month by the town is 900 TJ, to the nearest 10 TJ.



Question 5e (3 marks)

Given that every month:

- 900 TJ of energy can provide power for 68 420 homes
- the organization produces a total energy of **your answer from part (c)**.

Find the maximum number of homes that can be powered by the organization every month.

B *I* | ← → | **U** x_0 x^* | ¶ ¶ | Ω Σ | Styles - |

There are many global initiatives for the reduction of gas emissions that contribute to climate change.

A key initiative for industrial organizations is the annual carbon emissions and carbon markets.

The government gives organizations an annual limit for the amount of carbon emissions they can produce.

Every year the annual limit for carbon emissions is reduced.

If an organization goes over their limit, they must buy more carbon units from the carbon market.

If they are under their limit, they can sell unused carbon units to the carbon market.

In order for organizations to stay within their limit they must invest in technology such as filters, renewable energy, carbon capture schemes and other innovations.

If they make good investment decisions, they may further reduce their emissions which means they can sell their surplus carbon units to the carbon market.

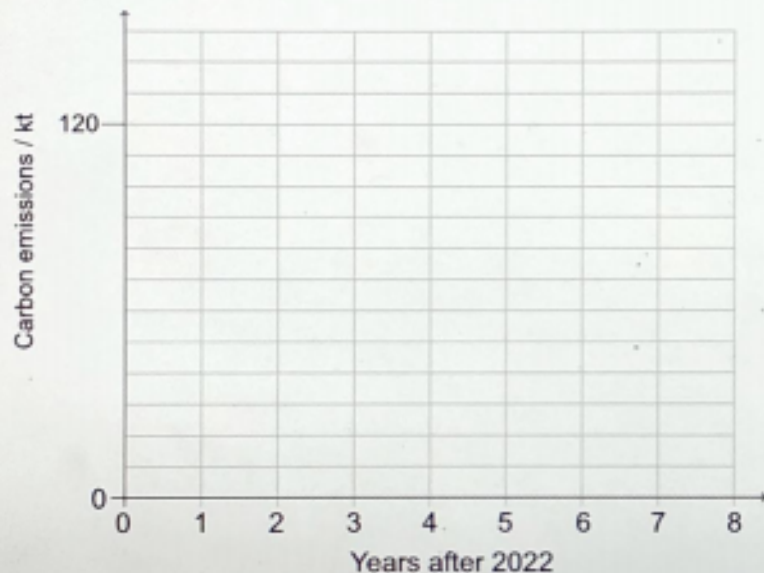
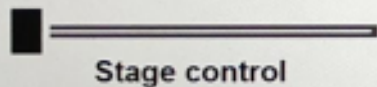
Organizations must consider the following costs:

- buying carbon units
- selling carbon units
- investment in technology to reduce emissions.

In this question you will analyse a financial scenario for an organization that needs to review its carbon emissions.

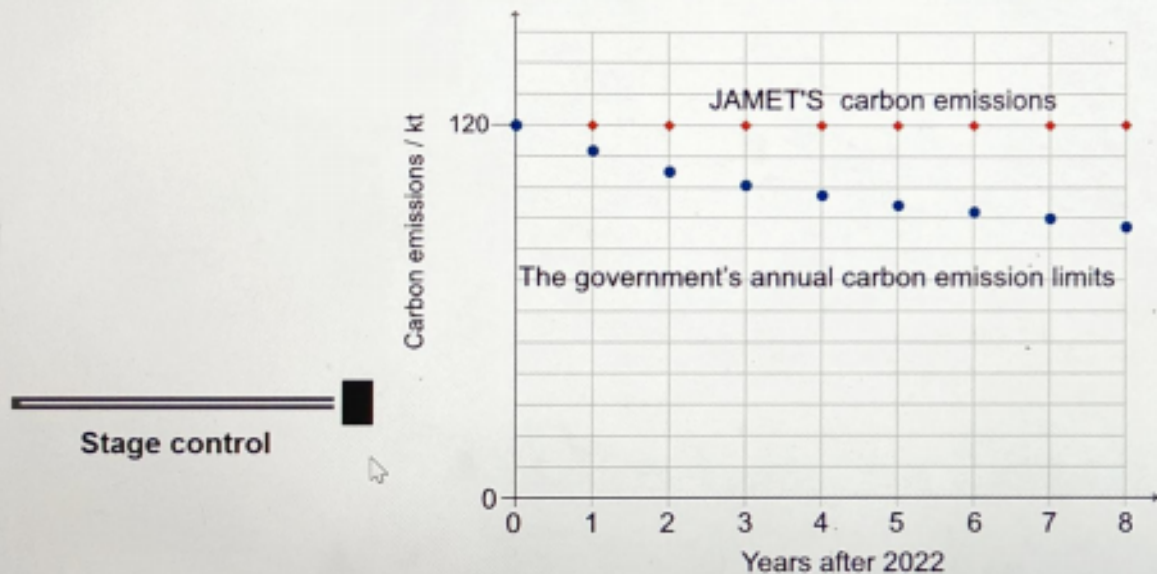
JAMET is an industrial organization that needs to review their carbon emissions. Based on historical data JAMET estimates that they will emit approximately 120 thousand tonnes (kt) every year.

The government has set a carbon emission limit for JAMET for the next few years in order to reach a reduced target by 2030. Drag the slider to see the emission data.



JAMET is an industrial organization that needs to review their carbon emissions. Based on historical data JAMET estimates that they will emit approximately 120 thousand tonnes (kt) every year.

The government has set a carbon emission limit for JAMET for the next few years in order to reach a reduced target by 2030. Drag the slider to see the emission data.



The government's annual carbon emission limits for JAMET can be modelled by the following equation.

$$E = \frac{a}{n+6} + 65, \quad 0 \leq n \leq 8$$

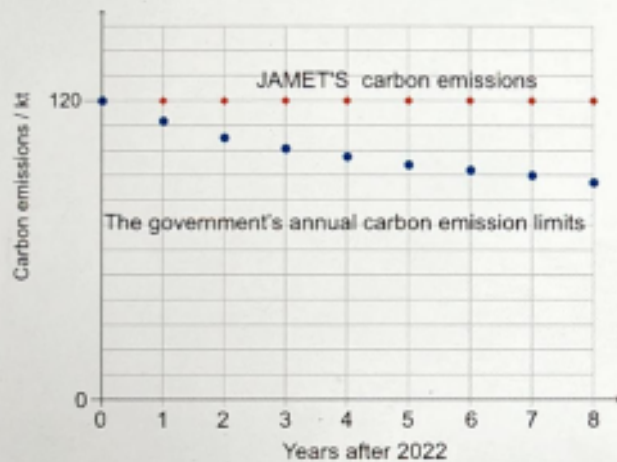
Where

E annual carbon emission limit in kt (thousand tonnes)

n number of years after 2022, where n is an integer

a constant

$$E = \frac{a}{n+6} + 65, \quad 0 \leq n \leq 8$$



Question 6a (2 marks)

Show that $a = 330$.

B *I* ← →

U × × ×

≡ ≡ ≡

Ω Σ

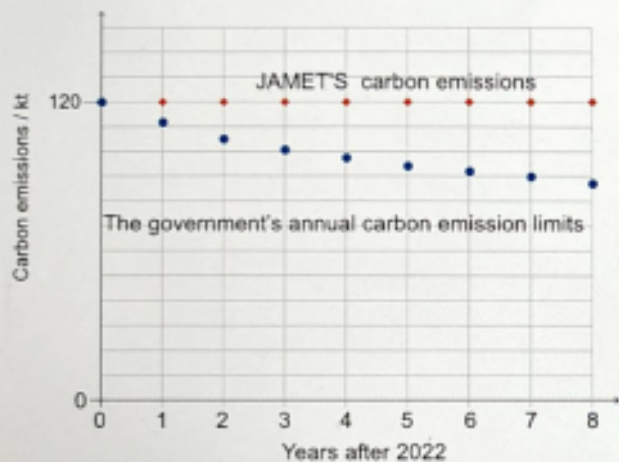
Styles - [icon]



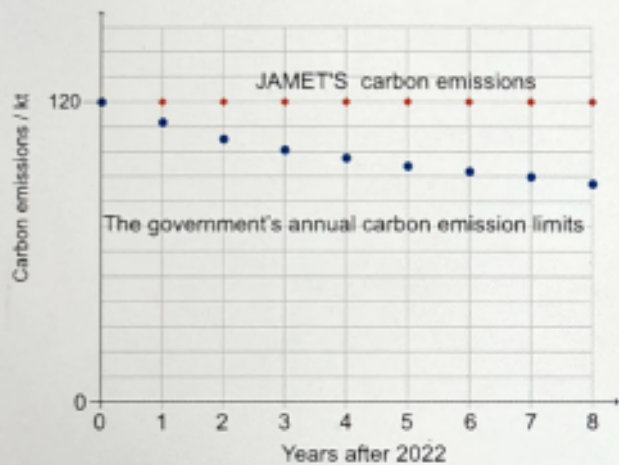
Question 6b (2 marks)

Hence, **determine** the annual carbon emission limit set by the government for JAMET in 2024.

$$E = \frac{a}{n+6} + 65, \quad 0 \leq n \leq 8$$



$$E = \frac{a}{n+6} + 65, \quad 0 \leq n \leq 8$$



Question 6c (2 marks)

If JAMET does not invest in technology, their carbon emissions will be **above** the limit set by the government. So, they will have to buy additional carbon units on the carbon market.

The cost of carbon units is \$60 000 per thousand tonnes (kt)

Determine the cost of the carbon units that JAMET will have to buy in 2024.

B *I* ← → U ×, x² ∑ ∏ Ω Σ

Styles -

JAMET has installed filters which reduced their annual carbon emissions to 95 kt. Installing filters will ensure that JAMET does not have to buy carbon units for a number of years.

The government's annual carbon emission limits for JAMET can be modelled by the following equation.

$$E = \frac{a}{n+6} + 65, \quad 0 \leq n \leq 8$$

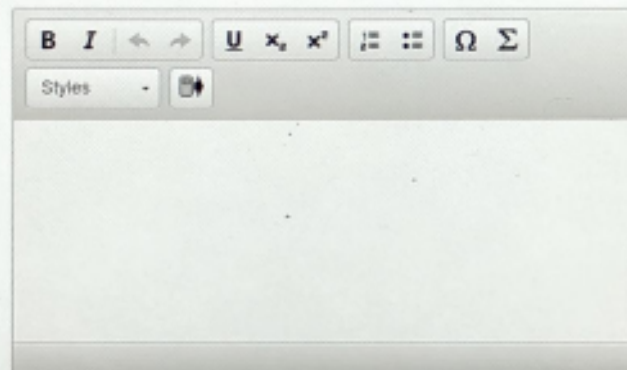
Where

E annual carbon emission limit in kt

n number of years after 2022, where n is an integer

a constant

Calculate the number of years that the carbon emissions are below the limit set by the government.





Question 6e (10 marks)

HAMJO is another organization reviewing its carbon emissions.

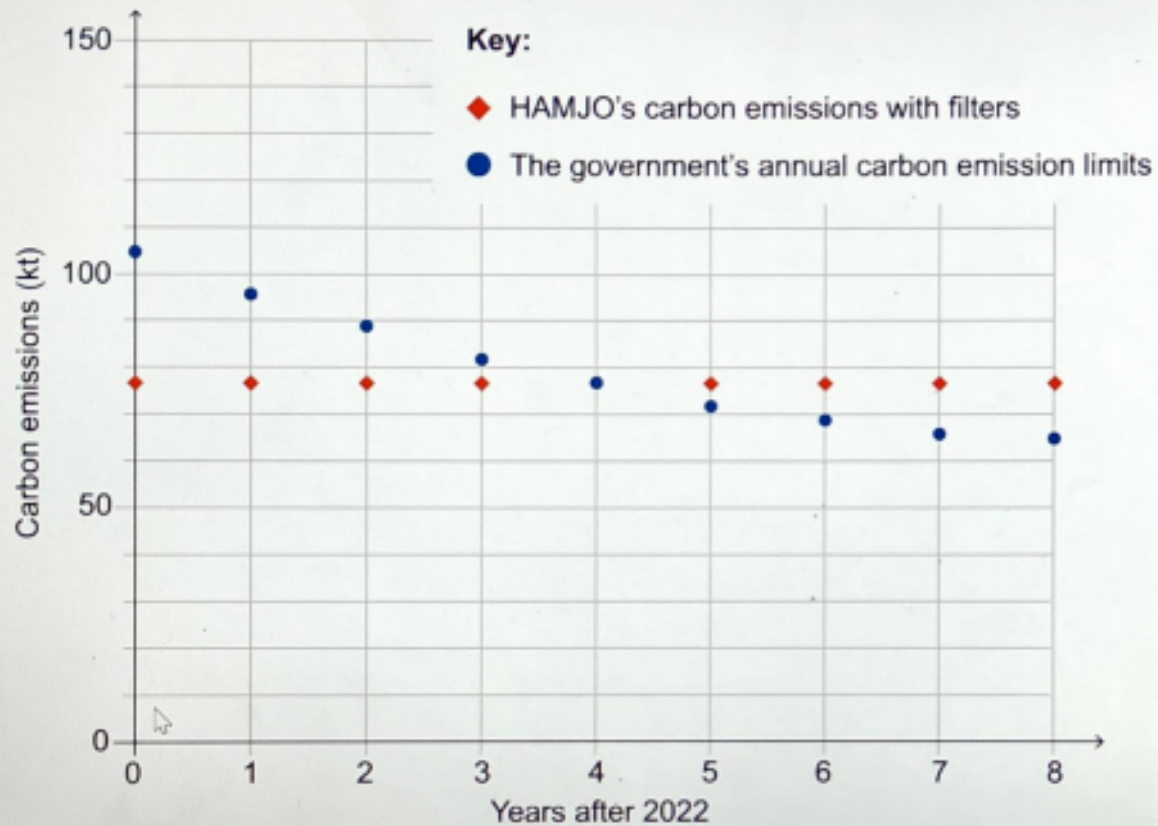
If HAMJO does not install filters in the next 8 years:

- they must buy a total of 222 kt of carbon units.

If HAMJO does install filters:

- it will cost 14 million dollars to install filters
- their carbon emissions reduce to 77 kt per year.

The interactive graph below illustrates the data they have to make a decision. Interact with the points on the graph to complete the table.



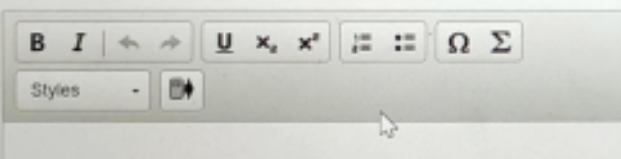
Year	2022	2023	2024	2025	2026	2027	2028	2029	2030
Difference in carbon emissions (kt)	28	19.5			0	4.5	8		
Value of difference in carbon emissions (\$ million)	1.68					0.27			
Buy or sell	sell	sell	sell	sell		buy	buy	buy	buy

Carbon units are approximately \$60 000 per kt to buy or sell.

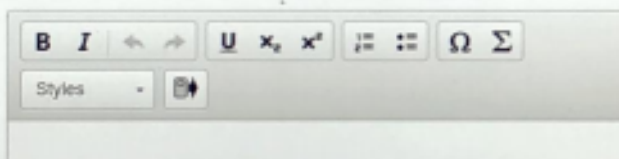
HAMJO needs to know if installing filters will help the organization save money. **Analyse** the data to make a recommendation to the organization. In your answer you should provide:

- **three** relevant factors
- calculations for selling and buying carbon units, with and without filters
- recommendations for whether to install filters
- a justification for the degree of accuracy in the context of the question.

Three relevant factors.



Calculations, recommendations and justification.





Question 7 (32 marks)

In part (a) to (d) you will investigate the number of triangles formed in each stage.

Click on each stage to see how the number of triangles (T) increases.

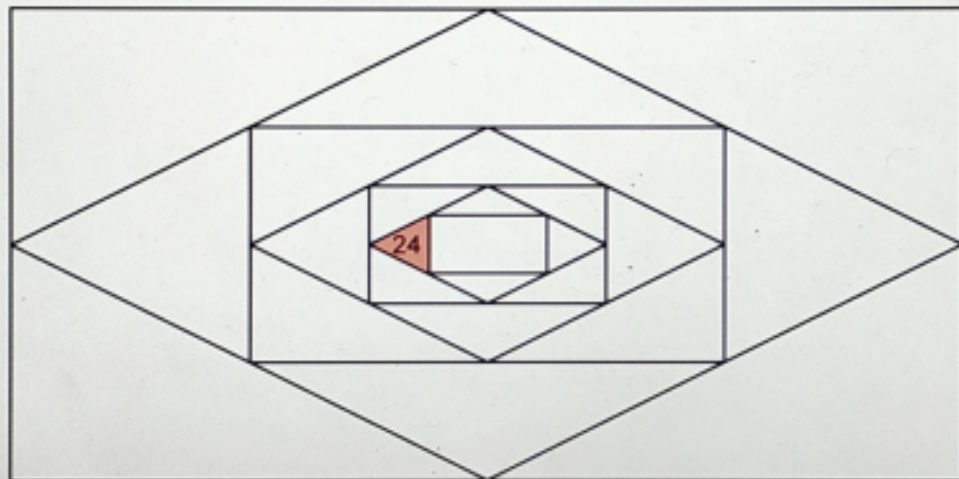
Stage 1

Stage 2

Stage 3

Stage 4

Stage number (n)	Number of triangles (T)
1	0
2	8
3	16
4	24





Question 7a (1 mark)

Write down the missing values in the table up to row 6.

Stage number (n)	Number of triangles (T)
1	0
2	8
3	16
4	24
5	
6	



Question 7b (2 marks)

Describe, in words, two patterns in the table for the number of triangles (T).

B *I* ← → u ×, ×' := :: Ω Σ

Styles -



Question 7a (1 mark)

Write down the missing values in the table up to row 6.

Stage number (n)	Number of triangles (T)
1	0
2	8
3	16
4	24
5	
6	



Question 7c (2 marks)

Write down, in simplest form, a general rule for T in terms of n .

B *I* ← → \times \times° \therefore \therefore Ω Σ

Styles -



Question 7a (1 mark)

Write down the missing values in the table up to row 6.

Stage number (n)	Number of triangles (T)
1	0
2	8
3	16
4	24
5	
6	



Question 7d (3 marks)

Verify your general rule for T .

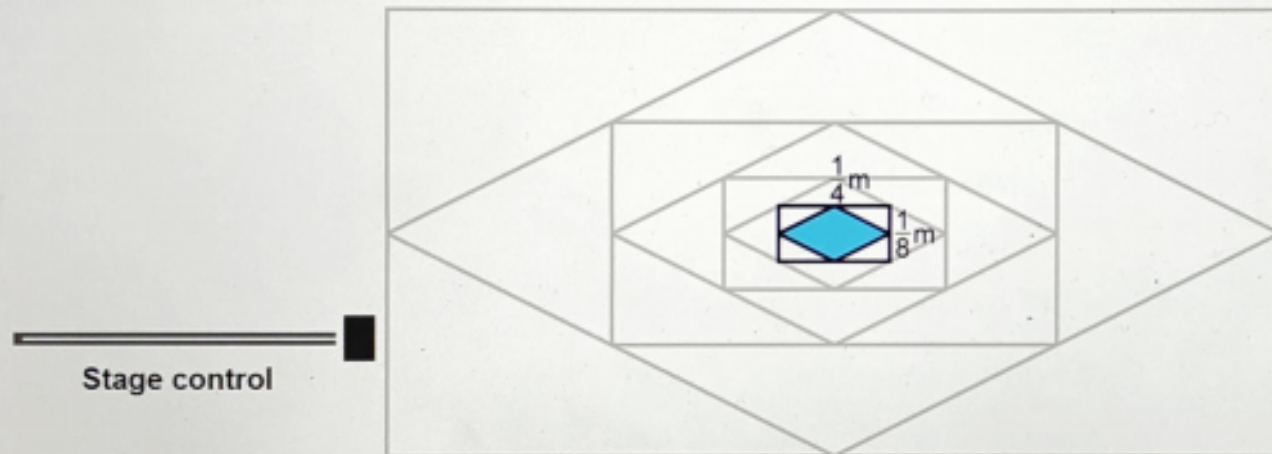
B **I** ← → U x , x^2 := :: Ω Σ

Styles -

The simulation below shows how smaller rhombuses are formed. Each time the dimensions of the rhombus are halved. The new rhombus is centred inside the previous one.

Interact with the stage control to see how the rhombuses are formed.

Stage 4:





Question 7e (1 mark)

Show that the area of the rhombus in stage 3 is $\frac{1}{16} \text{ m}^2$.

B *I* | ← → | ×₂ ×² | := :: | Ω Σ | Styles | ↕



Question 7f (23 marks)

Stage number (n)	Length of big diagonal (L)	Length of small diagonal (W)	Area of rhombus (A)
1	2	1	1
2	1	$\frac{1}{2}$	$\frac{1}{4}$
3	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{16}$
4	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{64}$
5			
6			

Investigate the values in the table to find a relationship for the area (A) of the rhombus in terms of n . In your answer, you should:

- predict more values and record these in the table
- describe in words a pattern in the table for area of rhombus A
- write down, in simplest form, a general rule for A in terms of n
- test and verify your general rule for A
- justify your general rule for A .