



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.



Question 1a (1 mark)

Draggable puzzle pieces:

0.24 km  
5.15 m 0.042 m

0.24 km  
51.5 cm 42 000 m

2400 cm

Diagram not to scale

240 m  
515 mm 42 km  
Place equivalent puzzle piece here

Detailed description: The interface for Question 1a shows a 'Draggable puzzle pieces' panel on the left and a 'Diagram not to scale' panel on the right. The draggable panel contains three inverted triangles. The top triangle has values 0.24 km, 5.15 m, and 0.042 m. The middle triangle has values 0.24 km, 51.5 cm, and 42 000 m. The bottom triangle has the value 2400 cm. The diagram panel shows a large green triangle with a smaller white inverted triangle inside it. The top side of the large triangle is labeled 240 m. The left side is labeled 515 mm and the right side is labeled 42 km. The white inverted triangle has the text 'Place equivalent puzzle piece here' inside it.



Question 1b (1 mark)

Reading Time

Draggable puzzle pieces:

$2.3 \times 10^7$   
0.0015  $4 \times 10^{-2}$

$2.3 \times 10^7$   
1500  $4 \times 10^{-2}$

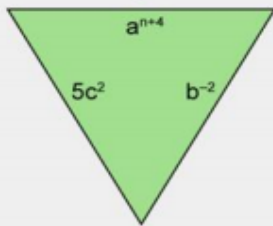
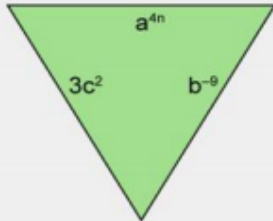
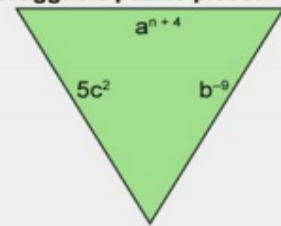
$2.3 \times 10^{-7}$   
1500  $4 \times 10^2$

Diagram not to scale

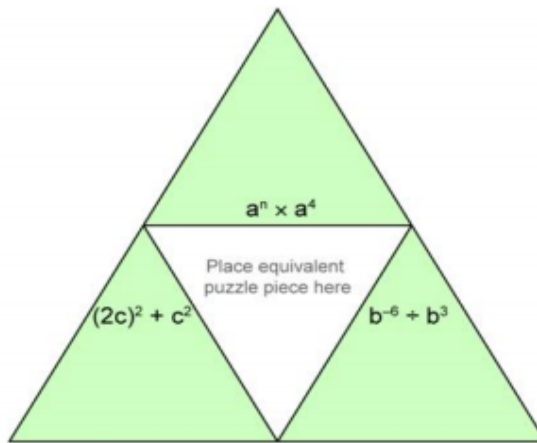
23 000 000  
 $1.5 \times 10^3$  0.04  
Place equivalent puzzle piece here

Detailed description: The interface for Question 1b shows a 'Draggable puzzle pieces' panel on the left and a 'Diagram not to scale' panel on the right. The draggable panel contains three inverted triangles. The top triangle has values  $2.3 \times 10^7$ , 0.0015, and  $4 \times 10^{-2}$ . The middle triangle has values  $2.3 \times 10^7$ , 1500, and  $4 \times 10^{-2}$ . The bottom triangle has values  $2.3 \times 10^{-7}$ , 1500, and  $4 \times 10^2$ . The diagram panel shows a large green triangle with a smaller white inverted triangle inside it. The top side of the large triangle is labeled 23 000 000. The left side is labeled  $1.5 \times 10^3$  and the right side is labeled 0.04. The white inverted triangle has the text 'Place equivalent puzzle piece here' inside it.

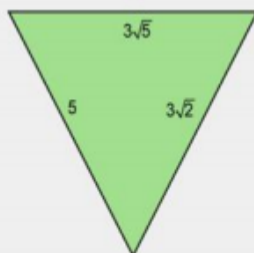
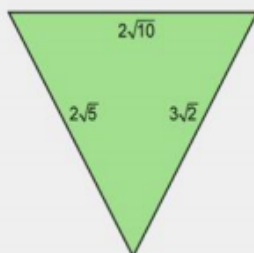
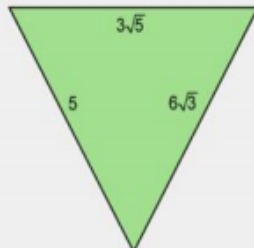
**Draggable puzzle pieces:**



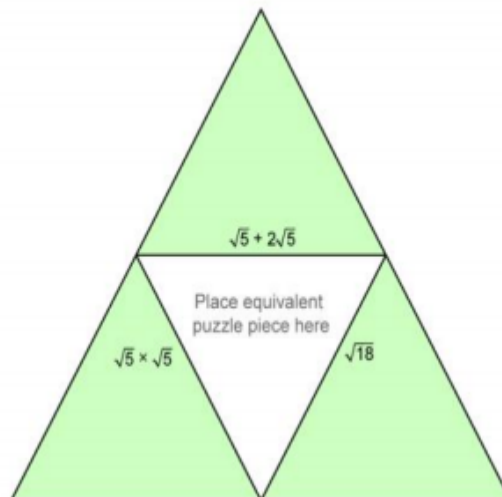
**Diagram not to scale**



**Draggable puzzle pieces:**



**Diagram not to scale**





Question 3 (10 marks)

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

Determine the missing angles in the diagram below.

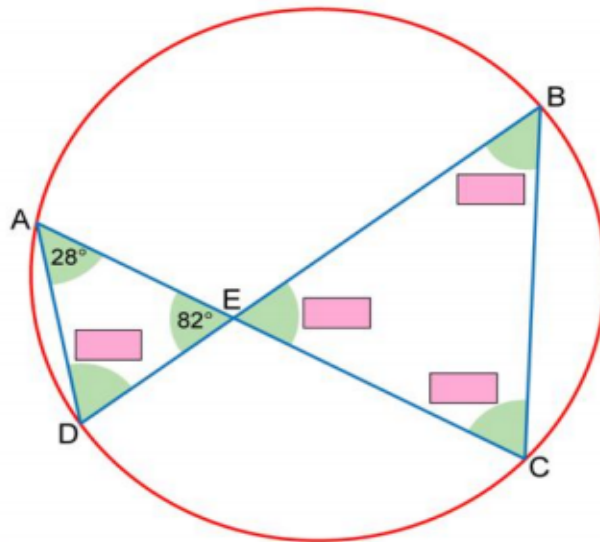
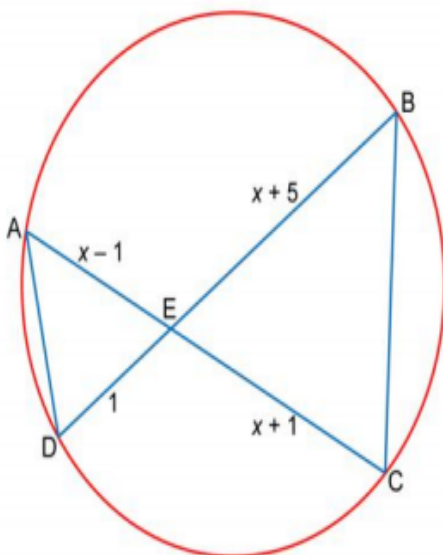


Diagram not to scale



Question 3b (1 mark)

Triangle AED is similar to triangle BEC.  
State the reason.

Rich text editor interface with a toolbar containing icons for bold, italic, text color, background color, bulleted list, numbered list, link, unlink, and a text box for the answer.

Question 3c (4 marks)

Hence, form and solve a quadratic equation to show that  $x = 3$ .

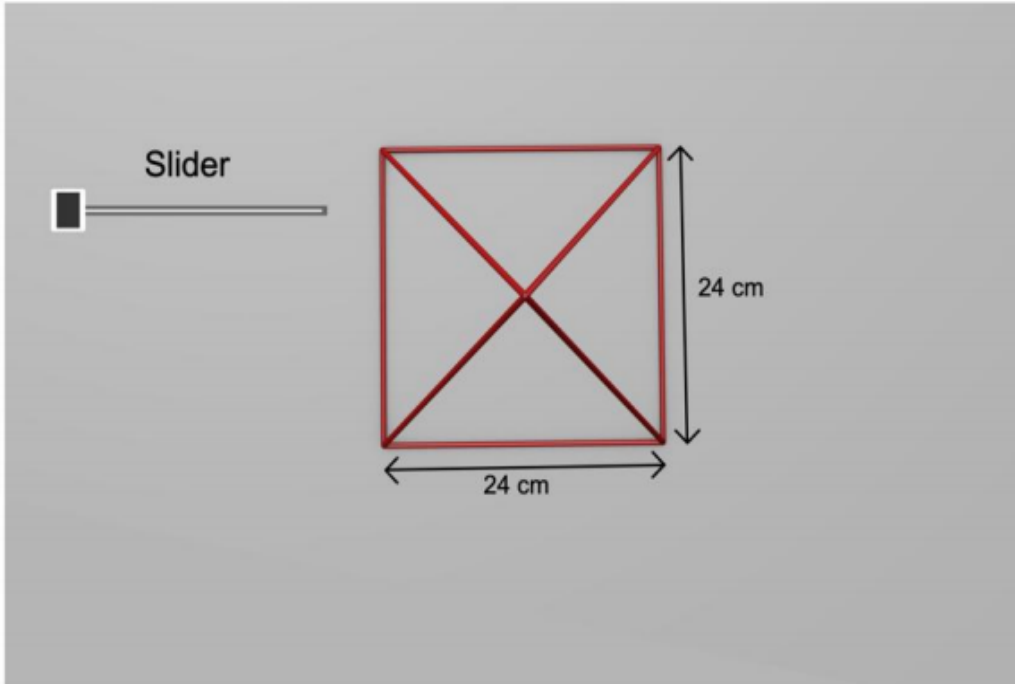
Rich text editor interface with a toolbar containing icons for bold, italic, text color, background color, bulleted list, numbered list, link, unlink, and a text box for the answer.



The isosceles triangle PQR above, is used to form the four faces of the square-based pyramid shown in the diagram below.

Interact with the slider to see different faces of the pyramid

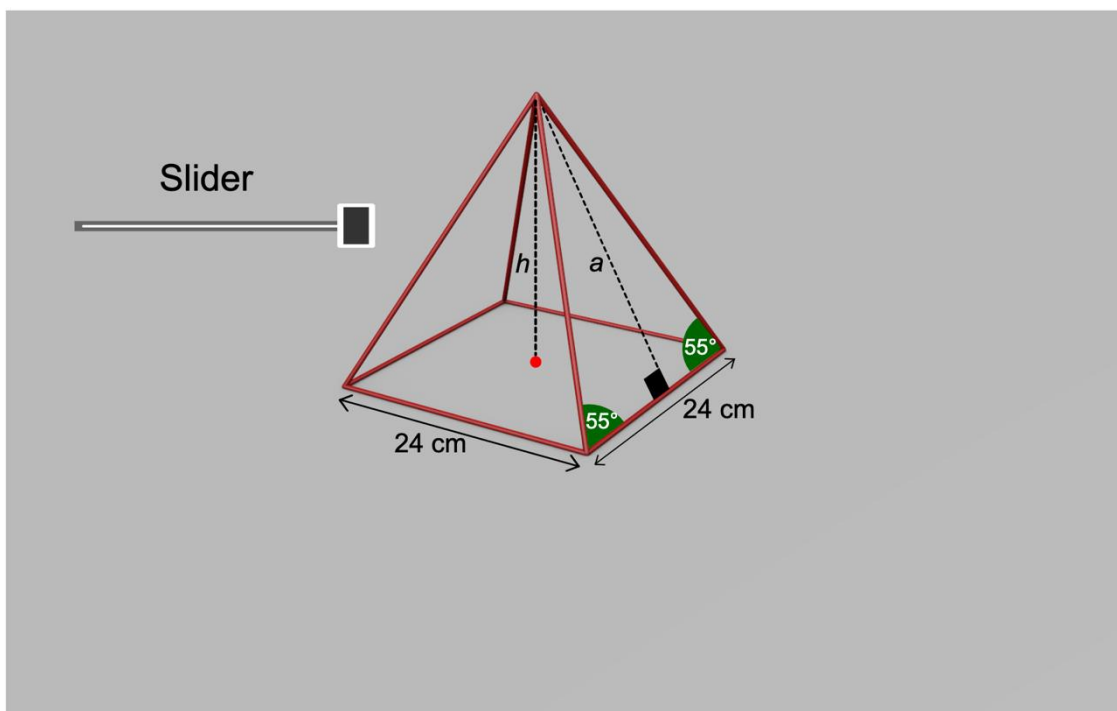
Diagram not to scale



The isosceles triangle PQR above, is used to form the four faces of the square-based pyramid shown in the diagram below.

Interact with the slider to see different faces of the pyramid

Diagram not to scale





**Question 4b** (2 marks)

**Determine** the value of the height  $h$ .

**B** **I**   $x_2$   $x^2$   $\frac{1}{2}$   $\frac{3}{4}$   $\Omega$   $\Sigma$     
 Styles



**Question 4c** (3 marks)

**Calculate** the volume of the pyramid.  
Give your answer to the nearest integer.

**B** **I**   $x_2$   $x^2$   $\frac{1}{2}$   $\frac{3}{4}$   $\Omega$   $\Sigma$     
 Styles



**Question 4d** (3 marks)



**Question 4d** (3 marks)

A larger pyramid is created by increasing all of the dimensions by 10 %.

**Find** the percentage increase of the volume.

**B** **I**   $x_2$   $x^2$   $\frac{1}{2}$   $\frac{3}{4}$   $\Omega$   $\Sigma$   Styles





Question 5a (1 mark)

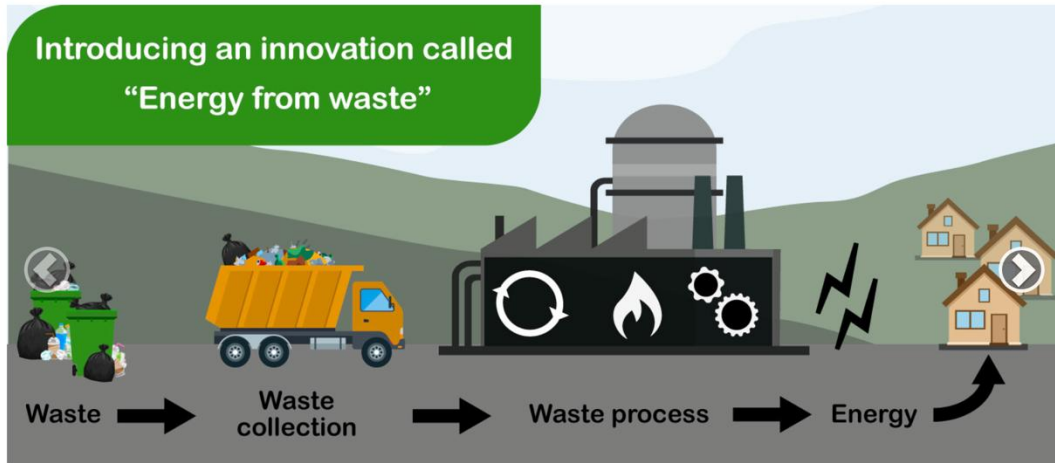


●○○○○○

Question 5 (14 marks)

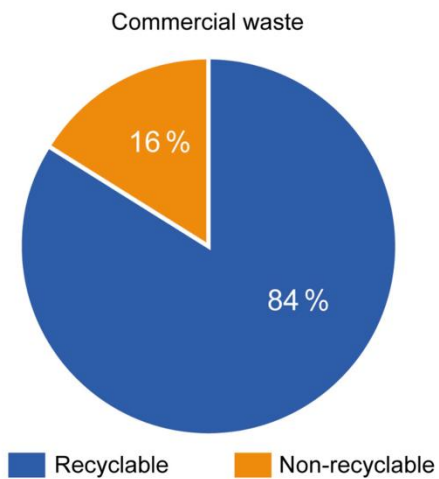
The following infographic shows how an organization produces energy from non-recyclable waste.

Question 5a (1 mark)



○●○○○○

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 options for Bold (B), Italic (I), Undo, Redo, Underline (U), Text color (x<sub>c</sub>), Background color (x<sup>#</sup>), Bulleted list, Numbered list, Link (Ω), and Unlink (Σ). Below the toolbar is a text input area.





**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.

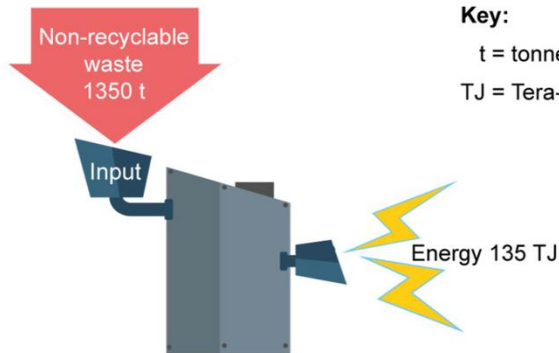
B I ← → U x<sub>2</sub> x<sup>2</sup> ☰ ☷ Ω Σ Styles ↓ 📄



**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 =  $1 \times 10^{12}$  Joules

**Determine** the missing values in the table.

		Weight, tonnes (t)	Production ratio Energy per tonne (TJ/t)	Energy, Tera-joules (TJ)
Category	<b>Domestic</b>	1350	r = <input style="width: 50px; height: 20px;" type="text"/>	135
	<b>Commercial</b>	Answer from (a) <input style="width: 50px; height: 20px;" type="text"/>	r = <input style="width: 50px; height: 20px;" type="text"/>	<input style="width: 50px; height: 20px;" type="text"/>
	<b>Industrial</b>	Answer from (b) <input style="width: 50px; height: 20px;" type="text"/>	2r = <input style="width: 50px; height: 20px;" type="text"/>	<input style="width: 50px; height: 20px;" type="text"/>



Scroll down to continue

	<b>Industrial</b>	Answer from (b) <input style="width: 100%;" type="text"/>	$2r =$ <input style="width: 100%;" type="text"/>	<input style="width: 100%;" type="text"/>
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Total energy produced by the organization this month

**Question 5d** (4 marks)

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

<b>Number of months</b>	2	4	2	1	3
<b>Energy (TJ)</b>	$850 < E \leq 870$	$870 < E \leq 890$	$890 < E \leq 910$	$910 < E \leq 930$	$930 < E \leq 950$

**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<sub>2</sub> x<sup>2</sup> Ω Σ Styles

The following video explains how carbon markets aim to reduce carbon emissions for industrial organizations.

Video Script

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.

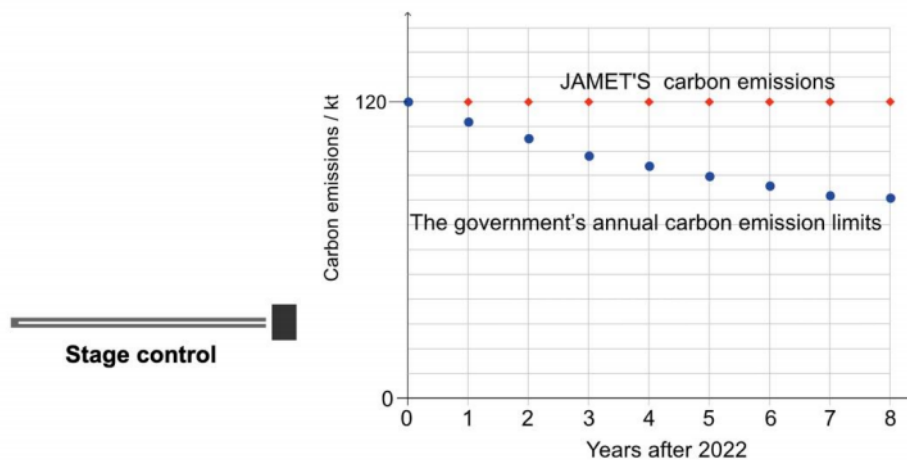
Organizations must consider the following costs:

- 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.



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

equation.

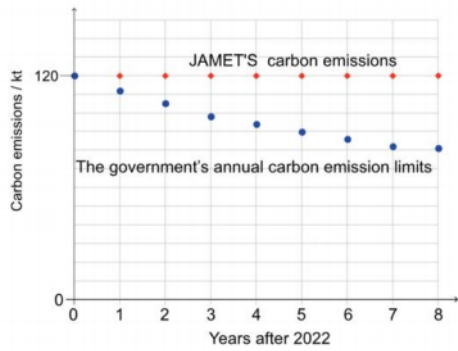
$$E = a(10 - n)^2 + 80, 0 \leq n \leq 8$$

Where

$E$  annual carbon emission limit in kt (thousand tonnes)

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

$a$  constant



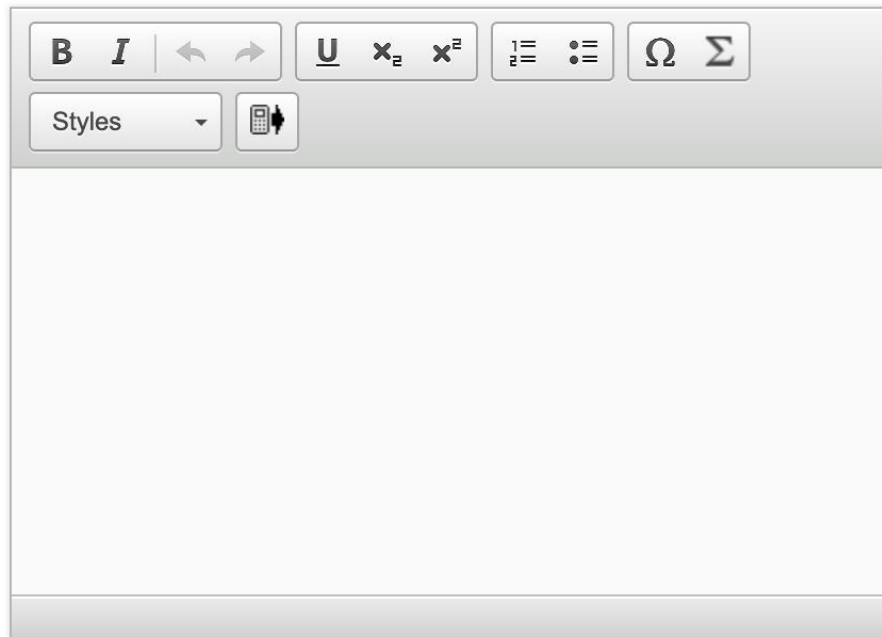
Question 6a (2 marks)

Show that  $a = 0.4$ .

Rich text editor toolbar with buttons for Bold (B), Italic (I), Undo, Redo, Underline (U), Text color (x), Background color (x^n), Bulleted list, Numbered list, Link (Ω), and Unlink (Σ). Below the toolbar is a text input area.



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



The image shows a rich text editor interface. The top toolbar contains icons for bold (B), italic (I), undo, redo, underline (U), subscript (x<sub>2</sub>), superscript (x<sup>2</sup>), bulleted list, numbered list, link (Ω), and unlink (Σ). Below the toolbar is a 'Styles' dropdown menu and a mobile device icon. The main area is a large, empty white box for text entry.



### 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.



### 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.



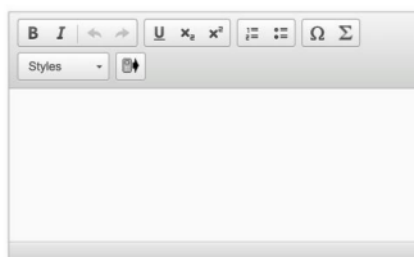
The government's annual carbon emission limits for JAMET can be modelled by the following equation.

$$E = a(10 - n)^2 + 80, 0 \leq n \leq 8$$

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 6d (4 marks)

JAMET has installed filters which reduced their annual carbon emissions to 90 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.

$$E = a(10 - n)^2 + 80, 0 \leq n \leq 8$$

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.

Rich text editor toolbar with buttons for Bold (B), Italic (I), Underline (U), Text color (x), Background color (x²), Bulleted list (•), Numbered list (1), Link (Ω), and Unlink (Σ). Below the toolbar is a text input area.



Question 6e (10 marks)

HAMJO is another organization reviewing its carbon emissions.

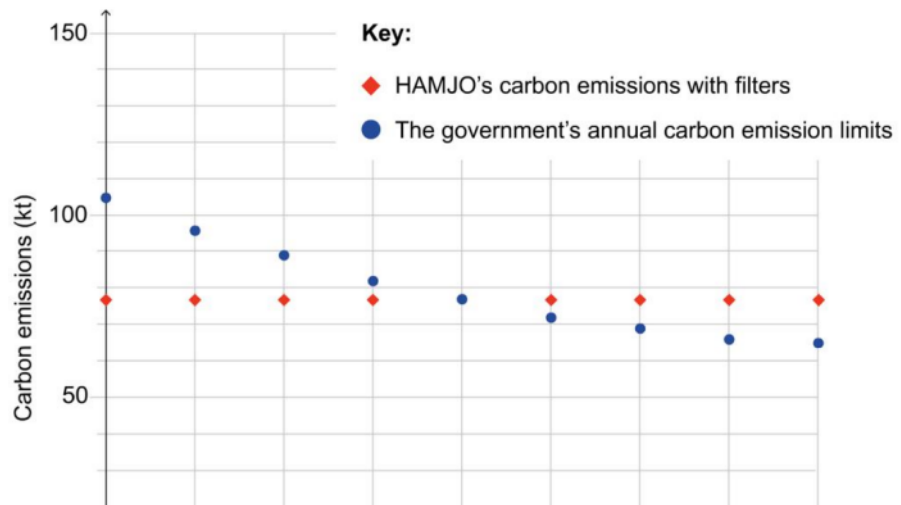
If HAMJO does not install filters in the next 8 years:

- 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:

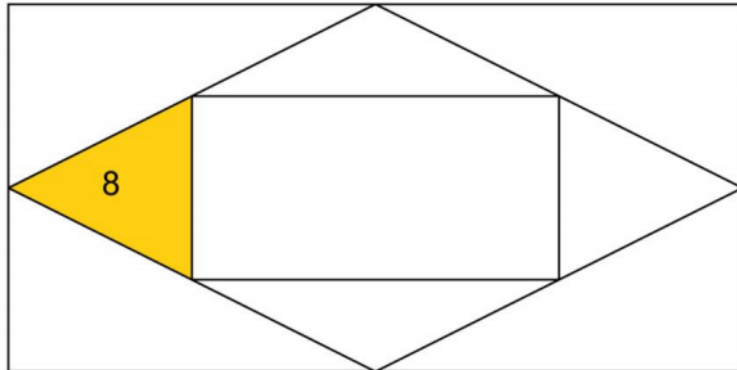
- **three** relevant factors
  - calculations for selling and buying carbon units, with and without filters
  - recommendations for whether to install filters
  - a justification for the degree of accuracy in the context of the question.
-

**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

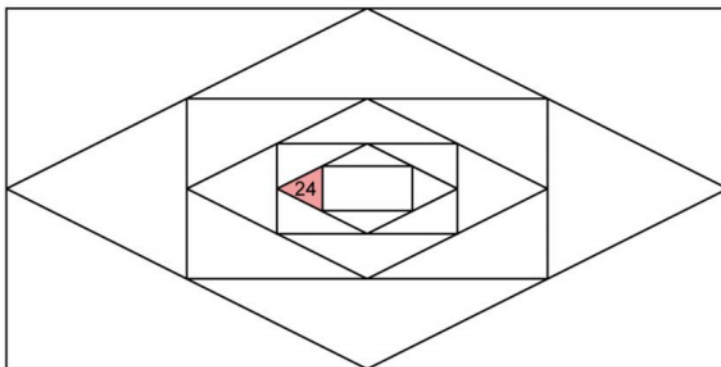


**Question 7** (32 marks)

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	

Reset



### Question 7b (2 marks)

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


**B** *I* ← → U  $\times_2$   $\times^2$   $\int$   $\sum$   $\Omega$   $\Sigma$

Styles



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

**B** *I* | ← → | U  $x_2$   $x^2$  |  $\frac{1}{2}$   $\frac{3}{2}$  |  $\Omega$   $\Sigma$


Styles ▾ 



### Question 7d (3 marks)

**Verify** your general rule for  $T$ .

**B** *I* | ← → | U  $x_2$   $x^2$  |  $\frac{1}{2}$   $\frac{3}{2}$  |  $\Omega$   $\Sigma$

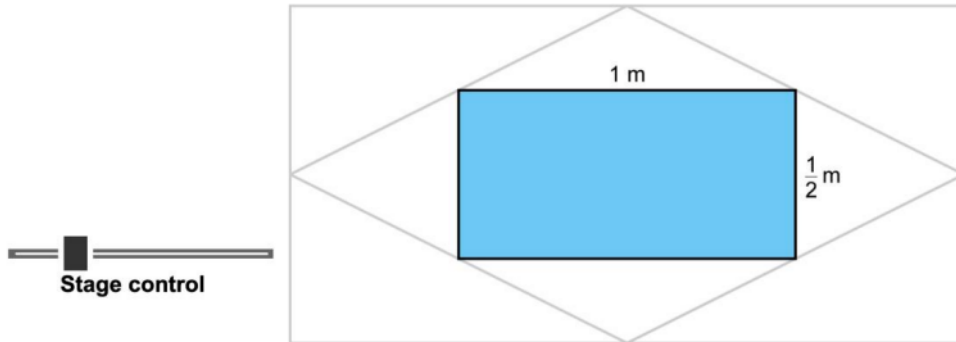
Styles ▾ 



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

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

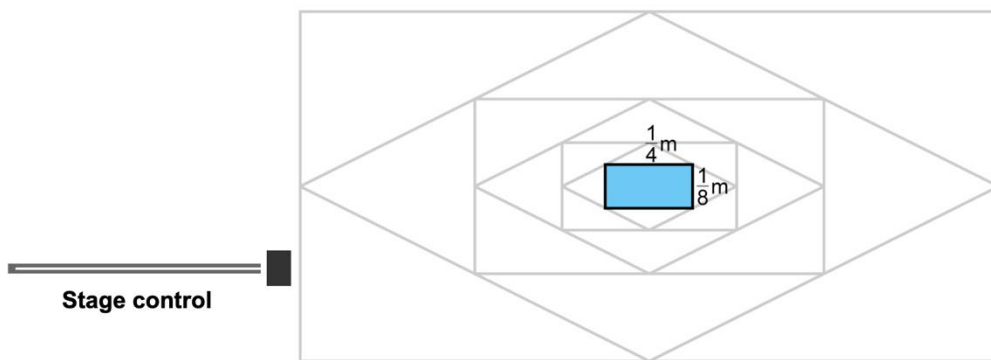
Stage 2:



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

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

Stage 4:





Question 7e (1 mark)

Show that  $\frac{1}{4} \times \frac{1}{8} = 2^{-5}$ .

Rich text editor toolbar with buttons for Bold (B), Italic (I), Undo, Redo, Underline (U), Subscript (x<sub>e</sub>), Superscript (x<sup>a</sup>), Bulleted List, Numbered List, Omega (Ω), Sum (Σ), Styles, and a document icon.



Question 7f (23 marks)



Question 7f (23 marks)

Stage number ( $n$ )	Length ( $L$ )	Width ( $W$ )	Area of rectangle ( $A$ )	Area ( $A$ ) in index form
1	2	1	2	$2^1$
2	1	$\frac{1}{2}$	$\frac{1}{2}$	$2^{-1}$
3	$\frac{1}{2}$	$\frac{1}{4}$	$\frac{1}{8}$	$2^{-3}$
4	$\frac{1}{4}$	$\frac{1}{8}$	$\frac{1}{32}$	$2^{-5}$
5				
6				

Reset

**Investigate** the values in the table to find a relationship for the area ( $A$ ) of the rectangle 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 rectangle
- 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  $A$ .

Remember, you should communicate in an organized and coherent manner.