

Question 1 (4 marks)

Below is an example of a mathematical wall clock.



©

In the process of designing a new mathematical wall clock, four values have been inserted in the correct place on Diagram 1 below and there are four more values that need to be placed on

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In the process of designing a new mathematical wall clock, four values have been inserted in the correct place on Diagram 1 below and there are four more values that need to be placed on the diagram.

**Label** the mathematical clock by placing the values in the correct places.



Draggable values:

$$2\cos^2 \theta + 2\sin^2 \theta$$

$$\log_2 16$$

$$\left| 8^{\frac{1}{3}} - 25^{\frac{1}{2}} \right|$$




$$\frac{14x^2 + 7x}{2x^2 + x}$$



**Question 2** (5 marks)

A group consisting of 120 students from MYP year 1 and MYP year 5 chose their favourite free-time activity from the following list: playing sport, gaming, and interacting on social media.

Their choices have been organized in the table below.

<b>Favourite activity</b> <b>Year group</b>	 <b>Playing sport</b>	 <b>Gaming</b>	 <b>Interacting on social media</b>	<b>Total</b>
<b>MYP year 1</b>	46	16	10	72
<b>MYP year 5</b>	8	16	24	48
<b>Total</b>	54	32	34	120



**Question 2a** (1 mark)

A student is selected at random from MYP year 5. **Write down** the probability that this student chose gaming as their favourite activity.

**B** *I* | ↶ ↷ | U  $x_2$   $x^2$  | ☰ ☷ | Ω Σ | Styles ▾ | 📱



**Question 2b** (2 marks)

**Examine** the following statement:

“MYP year 1 and MYP year 5 students are equally likely to choose gaming as their favourite activity.”

**B** *I* | ← → | U  $x_2$   $x^2$  |  $\frac{1}{2}$   $\frac{3}{4}$  |  $\Omega$   $\Sigma$  | Styles ▾ |



**Question 2c** (2 marks)

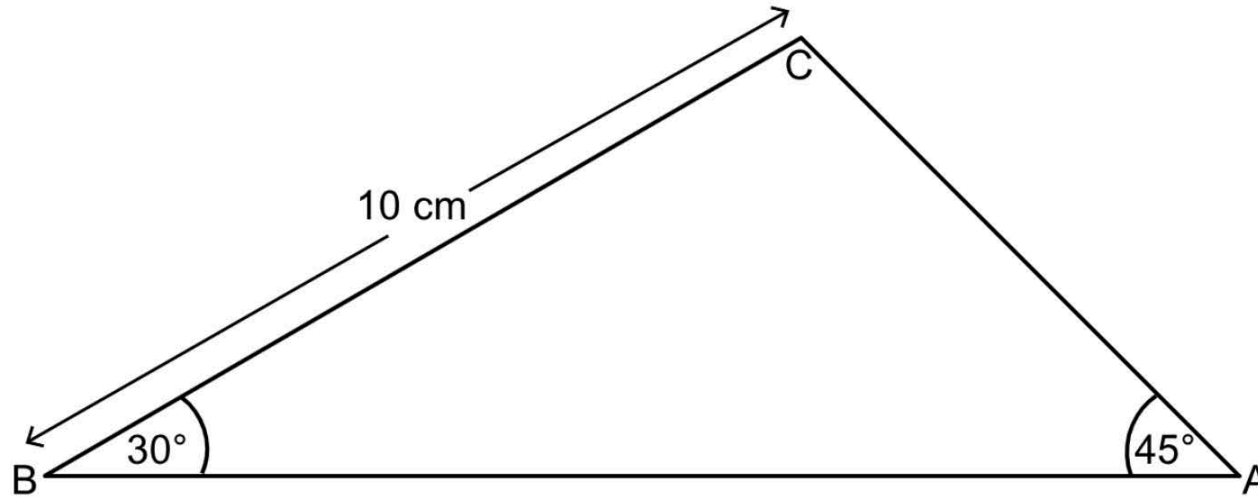
Two students are selected at random from the whole group. Given that the first student is in MYP year 5 and chose playing sport as their favourite activity, **determine** the probability that the second student also chose playing sport.

**B** *I* | ← → | U  $x_2$   $x^2$  |  $\frac{1}{2}$   $\frac{3}{4}$  |  $\Omega$   $\Sigma$  | Styles ▾ |

Question 3 (8 marks)

Question 3a (3 marks)

In the diagram below, angle  $ABC = 30^\circ$ , angle  $BAC = 45^\circ$ , and the length  $BC$  is 10 cm.



**Show that** the length of  $AC$  is  $5\sqrt{2}$  cm.

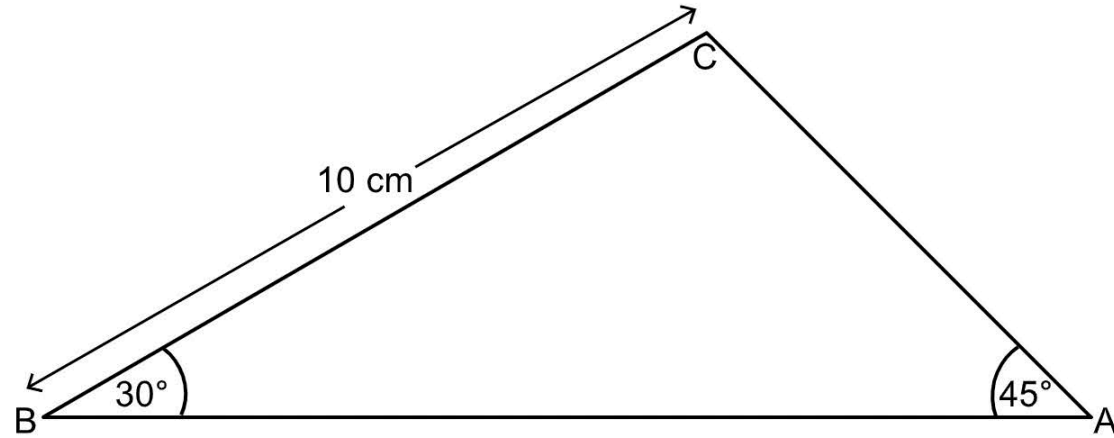
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**Question 3b** (5 marks)

The side BC is extended by 5 cm which is demonstrated by the animation below.

Start



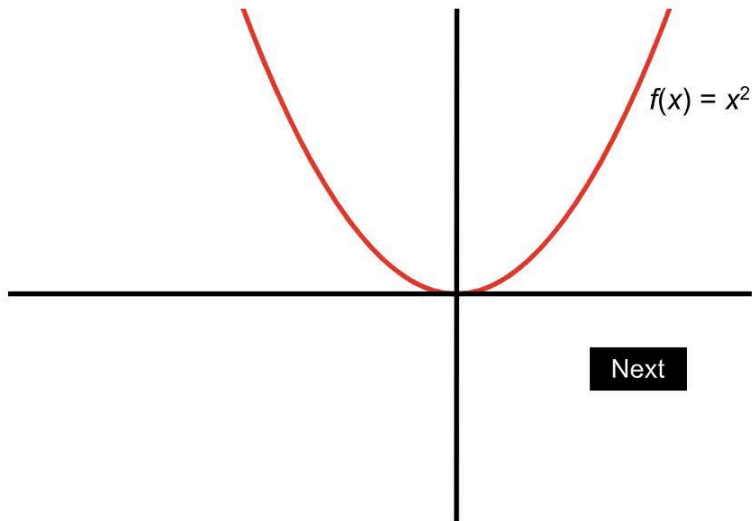
Hence, **find** the length of AD to the nearest cm.

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### Question 4a (4 marks)

This media is interactive



Next

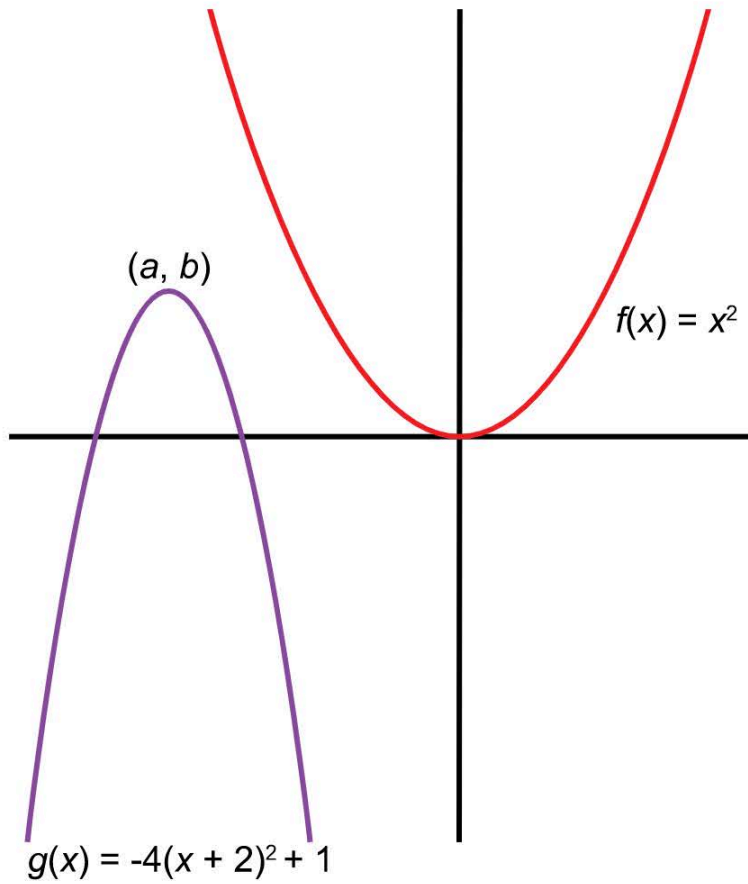
Given that  $f(x) = x^2$  and  $g(x) = -4(x + 2)^2 + 1$ , **identify** the stages that transform  $f(x)$  onto  $g(x)$ .

**B** *I* | ← → |  x<sub>2</sub> x<sup>e</sup> | ≡ ≡ | Ω Σ

Styles ▾ | 📄 ↕



Question 4b (4 marks)



Given that  $x = \frac{-3}{2}$  is one solution for  $g(x) = 0$ , **find** the value of the other solution.

**B** *I* | ← → | U  $x_2$   $x^2$  | ☰ ☷ |  $\Omega$   $\Sigma$

Styles ▾ | 📄 ↕



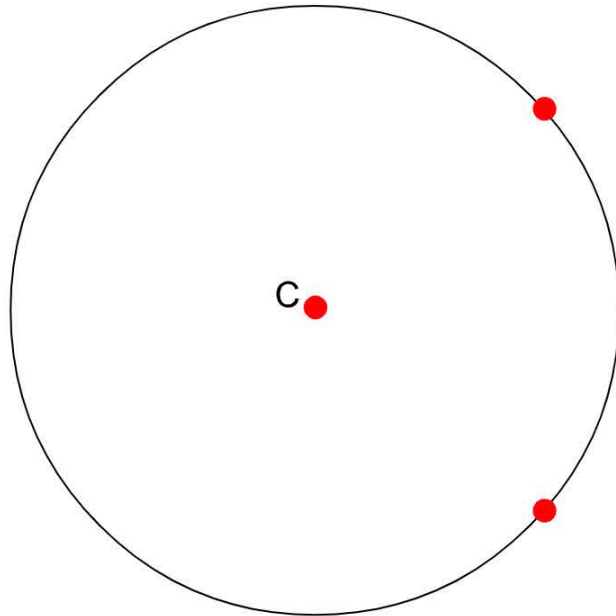
**Question 5** (11 marks)

**Question 5a** (2 marks)

The diagram shows a circle of radius 4 cm. The angle ACB is  $\frac{\pi}{2}$  radians.

This media is interactive

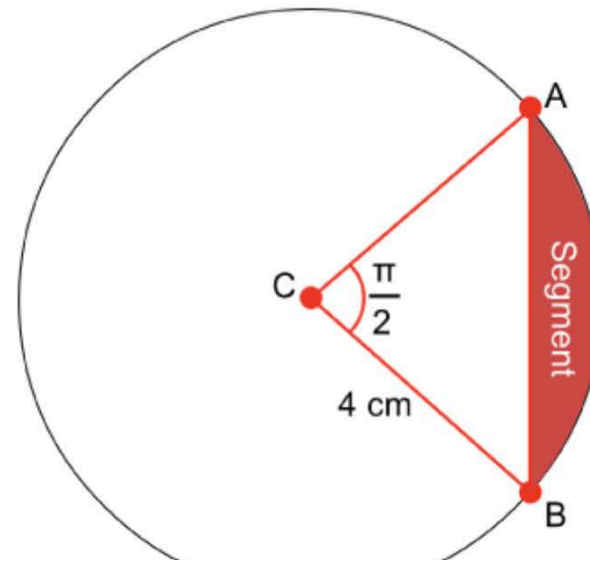
Start



Determine the area of triangle ACB.

**B** *I* | ← → |  x<sub>2</sub> x<sup>2</sup> | ≡ ≡ | Ω Σ | Styles ▾ | 📄 ↕

🖱️ | ✍️ | 🖋️ | T | → | 🗑️ | ↶

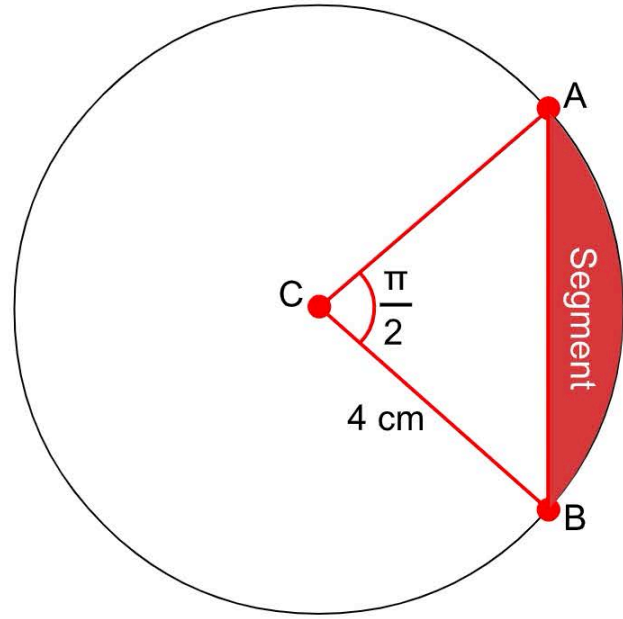




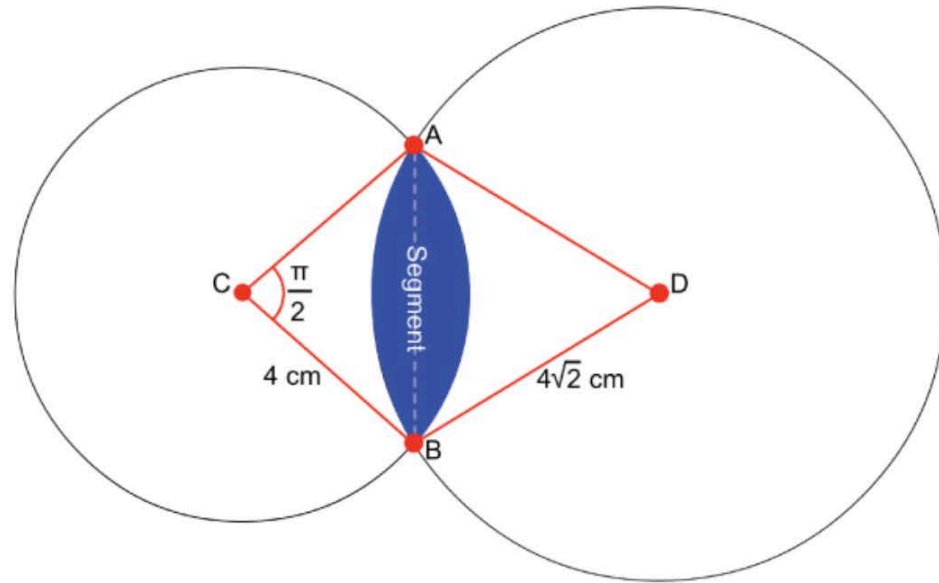
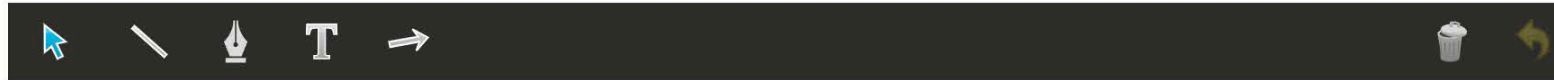
**Question 5b** (3 marks)

**Show that** the area of the shaded segment is  $4(\pi - 2)$ .

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



Hence, **find** the area of the shaded region. Give your answer to one decimal place.



There are many health benefits of exercise, whether it is getting active through fun activities or doing more serious structured workouts, exercise helps you stay fit and healthy.

Exercise has many other benefits. Exercise is not just good for the body, but it is also good for your mind and general feeling of well-being.

Studies have shown that exercising is a great self-esteem booster that can help you feel good about yourself all day long. You may feel more relaxed and less stressed.

In this question, you will review an exercise programme for a sixteen-year-old student. You will be provided with information about maximum heart rate. Heart rate is measured in beats per minute, otherwise called bpm. An effective exercise programme is reached when the heart rate is at least eighty percent of the maximum heart rate and a safe exercise programme is achieved when the heart rate is below the maximum heart rate.

The information provided in the question will help you review an exercise programme.

The maximum heart rate ( $H$ ) in beats per minute (bpm) is calculated in terms of age, ( $a$ ) in years, using the formula  $H = 208 - 0.7a$

A safe exercise is one that stays below the maximum heart rate.



**Question 6a** (1 mark)

**Show that** the maximum heart rate of a 16-year-old is 197 bpm to the nearest beat.

**B** *I* | ← → |  x<sub>2</sub> x<sup>2</sup> |  $\frac{1}{2}$   $\frac{3}{4}$  |  $\Omega$   $\Sigma$  | Styles ▾ |



**Question 6b** (2 marks)

Research has shown that physical exercise is most effective when the heart rate reaches 80 % of the maximum heart rate and this should be maintained for 15 minutes.

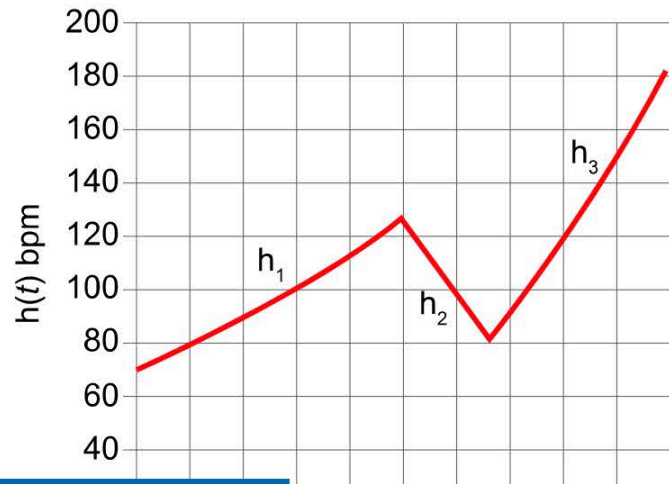
**Determine** the heart rate of a 16-year-old for the most effective physical exercise. Give your answer in bpm to the nearest beat.

**B** *I* | ← → |  x<sub>2</sub> x<sup>2</sup> | ☰ ☷ | Ω Σ | Styles ▾ | 📱 ↕

The heart rate of a 16-year-old student was monitored whilst doing 30 minutes of exercise.

The changes in heart rate during the exercise are modelled by the function shown below, where  $t$  is the elapsed time from the beginning of the exercise, in minutes and  $h(t)$  is the heart rate, in bpm.

$t$	$h(t)$	
$0 \leq t \leq 15$	$h(t) = 70 \times (1.04)^t$	$h_1$
$15 \leq t \leq 20$	$h(t)$ Heart rate decreases every minute by 9 beats per minute.	$h_2$
$20 \leq t \leq 30$	$h(t) = 0.2025t^2$	$h_3$



### Question 6c (4 marks)

The heart rate reached 108 bpm for the first time when  $108 = 70 \times (1.04)^t$ .

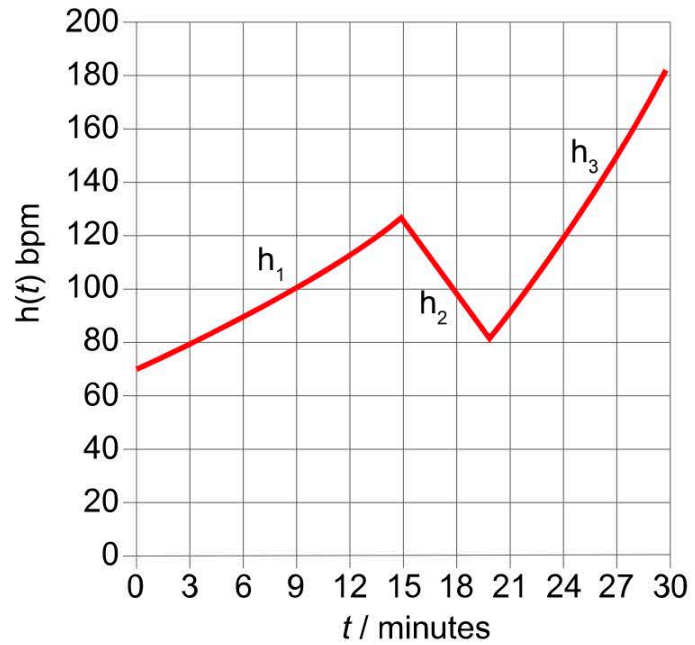
**Calculate** the time  $t$ .

Rich text editor interface with the following toolbar:

- Buttons for Bold (B), Italic (I), Undo, and Redo.
- Buttons for Underline (U), subscript ( $x_2$ ), and superscript ( $x^2$ ).
- Buttons for bulleted list, numbered list, and link.
- Buttons for Insert link, Insert image, and Insert table.
- A "Styles" dropdown menu and a mobile device icon.

The main area of the editor is currently blank.

$t$	$h(t)$	
$0 \leq t \leq 15$	$h(t) = 70 \times (1.04)^t$	$h_1$
$15 \leq t \leq 20$	$h(t)$ Heart rate decreases every minute by 9 beats per minute.	$h_2$
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### Question 6c (4 marks)

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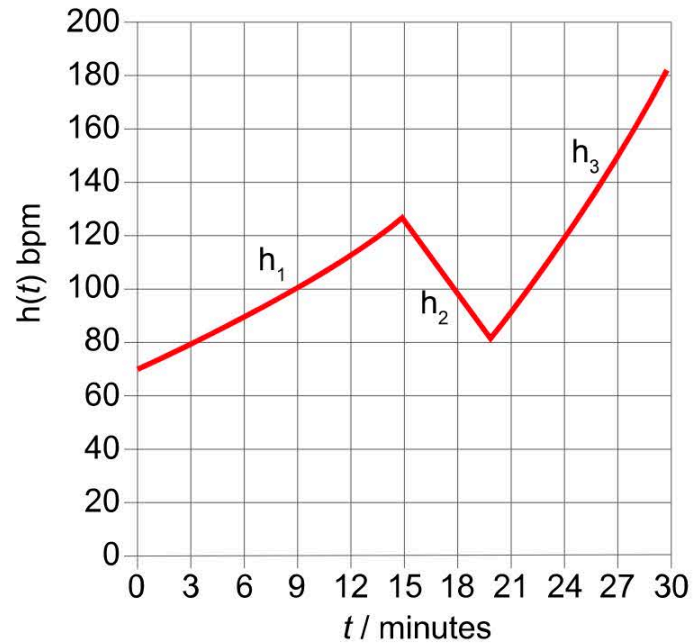
**Calculate** the time  $t$ .

**B** *I*
← →
U  $\times_e$   $\times^e$ 
☰ ☷
Ω Σ

Styles ▾
📱

### Question 6d (3 marks)

$t$	$h(t)$	
$0 \leq t \leq 15$	$h(t) = 70 \times (1.04)^t$	$h_1$
$15 \leq t \leq 20$	$h(t)$ Heart rate decreases every minute by 9 beats per minute.	$h_2$
$20 \leq t \leq 30$	$h(t) = 0.2025t^2$	$h_3$



### Question 6d (3 marks)

Based on the behaviour of the graph, **discuss** the effectiveness and safety of this 30-minute exercise.

**B** *I*
↶ ↷
U  $x_2$   $x^2$ 
☰ ☱
Ω Σ

Styles ▾
📱

## Question 7 (23 marks)

Video

Script

A balanced diet and regular exercise contribute to a healthy lifestyle. The intake of nutrients and energy comes from the food and drink consumed. The output of energy is achieved by every day activities and the amount of exercise we take. A healthy lifestyle has the appropriate balance of nutrients and energy.

Human beings need a certain amount of nutrients and energy for their bodies to function well.

The nutrients can be divided into three main categories: proteins, fats and carbohydrates. This pie chart shows an example of a recommended division of nutrients.

When nutrients and energy are balanced our bodies perform at their best and an imbalance of nutrients and energy can lead to poor performance.

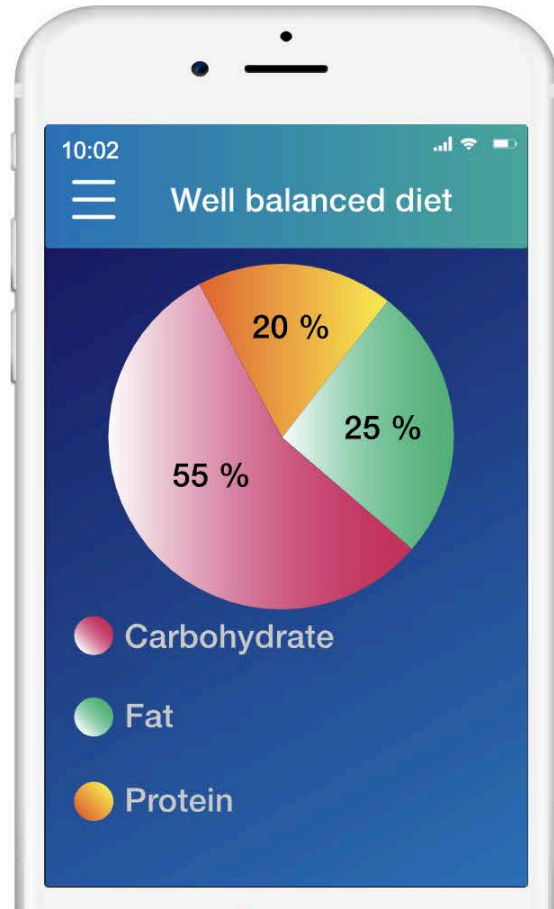
In this question, you will examine how to balance different factors to help lead a healthy lifestyle.



### Question 7a (2 marks)

This media is interactive

Hover over the pie chart sectors for details



A 180 gram (g) steak provides the correct amount of protein and fat. **Determine**, in grams, the amount of carbohydrates to be included with the steak for a balanced meal.

Rich text editor toolbar with the following icons: 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 text area is currently empty.





**Question 7b** (3 marks)

Daily average energy intake for children aged 13–18 years		
Age in years	Energy intake in kiloJoules (KJ)	
	Boys	Girls
13	10 100	9 300
14	11 000	9 800
15	11 800	10 000
16	12 400	10 100
17	12 900	10 300
18	13 200	10 300

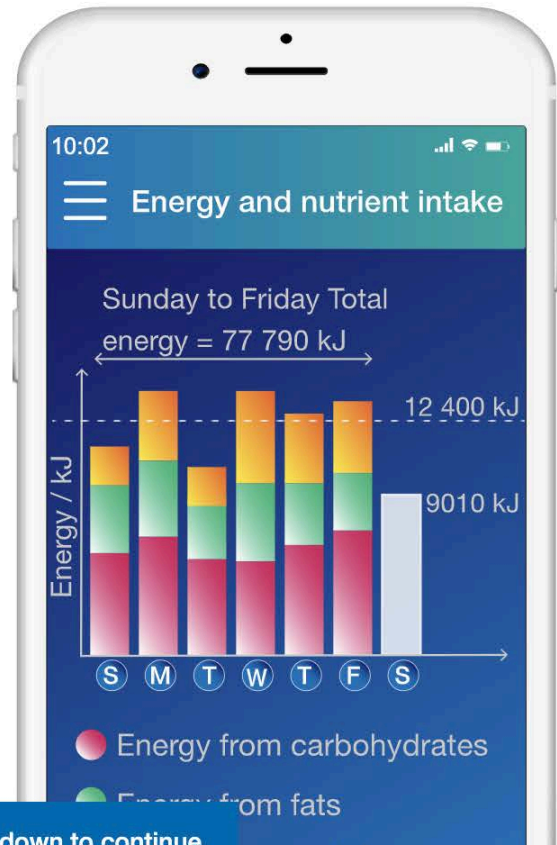
Gerry is a 16-year-old boy. He wants to divide his daily intake of energy over three meals in the following ratio:

Breakfast	Mid-day meal	Evening meal
2	: 3	: 4

**Find** the total amount of energy, in kJ, Gerry should have for his mid-day meal and evening meal to the nearest kJ.

**Question 7c** (2 marks)

The bar chart shows Gerry's energy and nutrient intake over six days, Sunday to Friday. The total intake of energy is 77 790 kJ. He knows that the average intake per day should be 12 400 kJ.

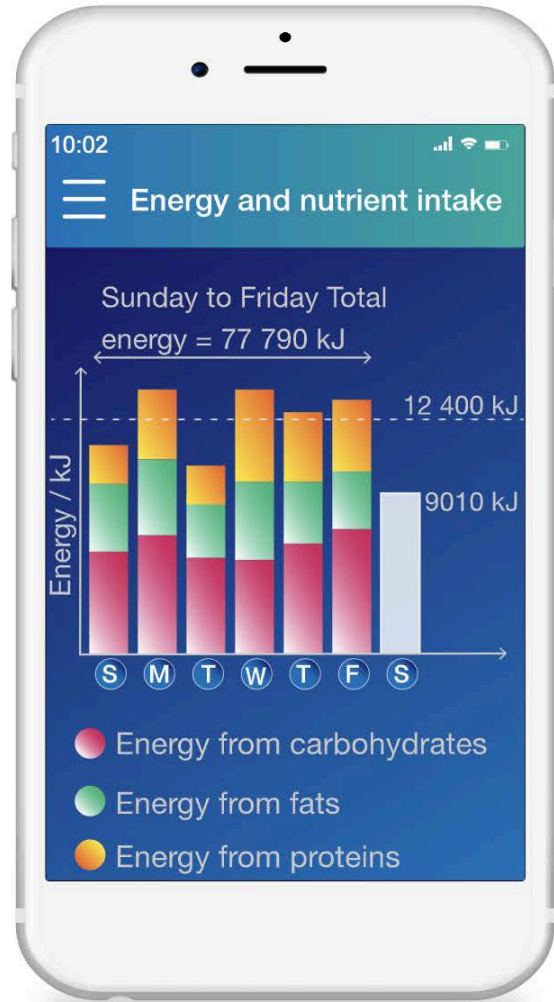


**Show that** he should intake only 9010 kJ on Saturday the last day of the week.

**B** *I* ← → U  $\times_2$   $\times^2$   $\frac{1}{x}$   $\frac{1}{x^2}$   $\Omega$   $\Sigma$

Styles





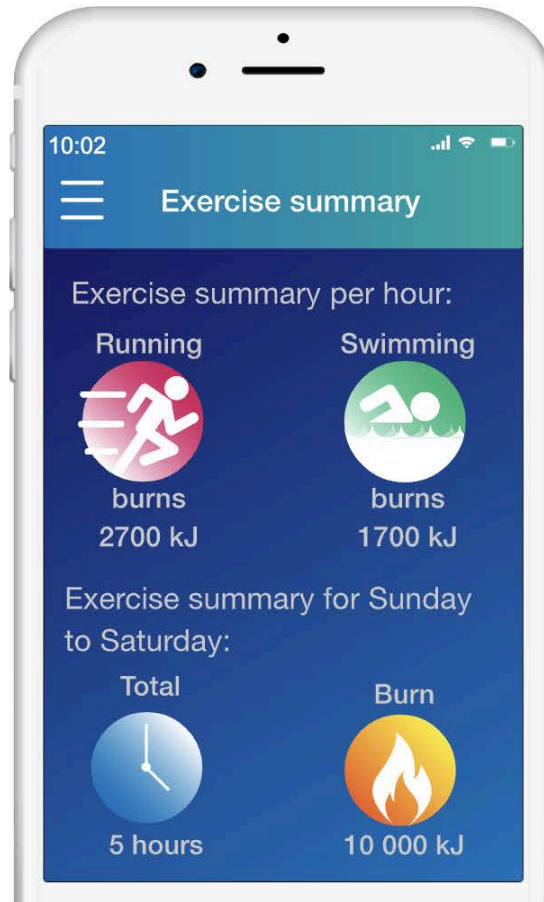
**Show that** he should intake only 9010 kJ on Saturday the last day of the week.

Rich text editor toolbar with the following icons: Bold (B), Italic (I), Undo, Redo, Underline (U), Subscript ( $x_2$ ), Superscript ( $x^2$ ), Bulleted List, Numbered List, Link (Ω), and Unlink (Σ). Below the toolbar is a "Styles" dropdown menu and a mobile device icon.



**Question 7d** (6 marks)

Gerry wants to make healthy lifestyle choices. In the infographic below you can see his exercise summary.



**Find** the number of hours of running ( $r$ ) and number of hours of swimming ( $s$ ) that will allow Gerry to achieve his goal of burning exactly 10 000 kJ.

Rich text editor toolbar with the following icons: Bold (B), Italic (I), Undo, Redo, Underline (U), Subscript ( $x_2$ ), Superscript ( $x^2$ ), Bulleted list, Numbered list, Link (Ω), and Unlink (Σ). Below the toolbar is a "Styles" dropdown menu and a mobile device icon.



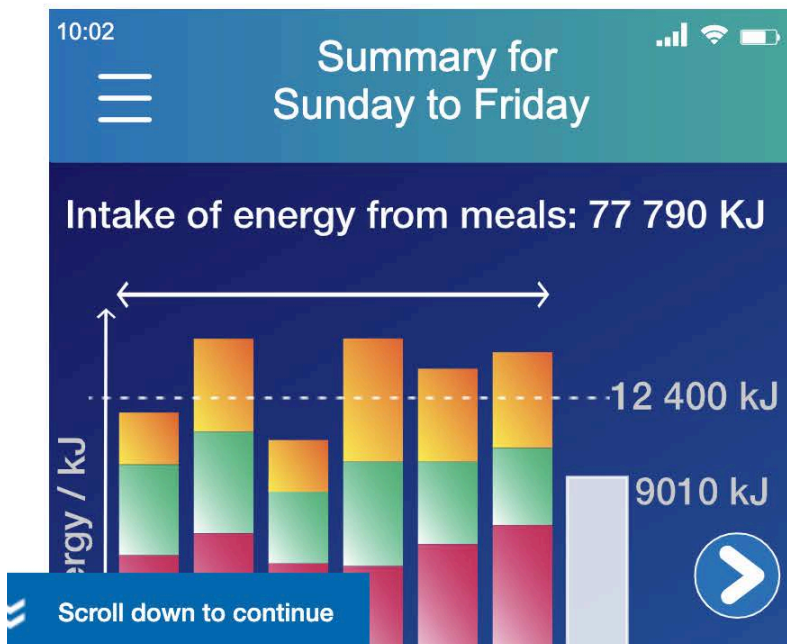


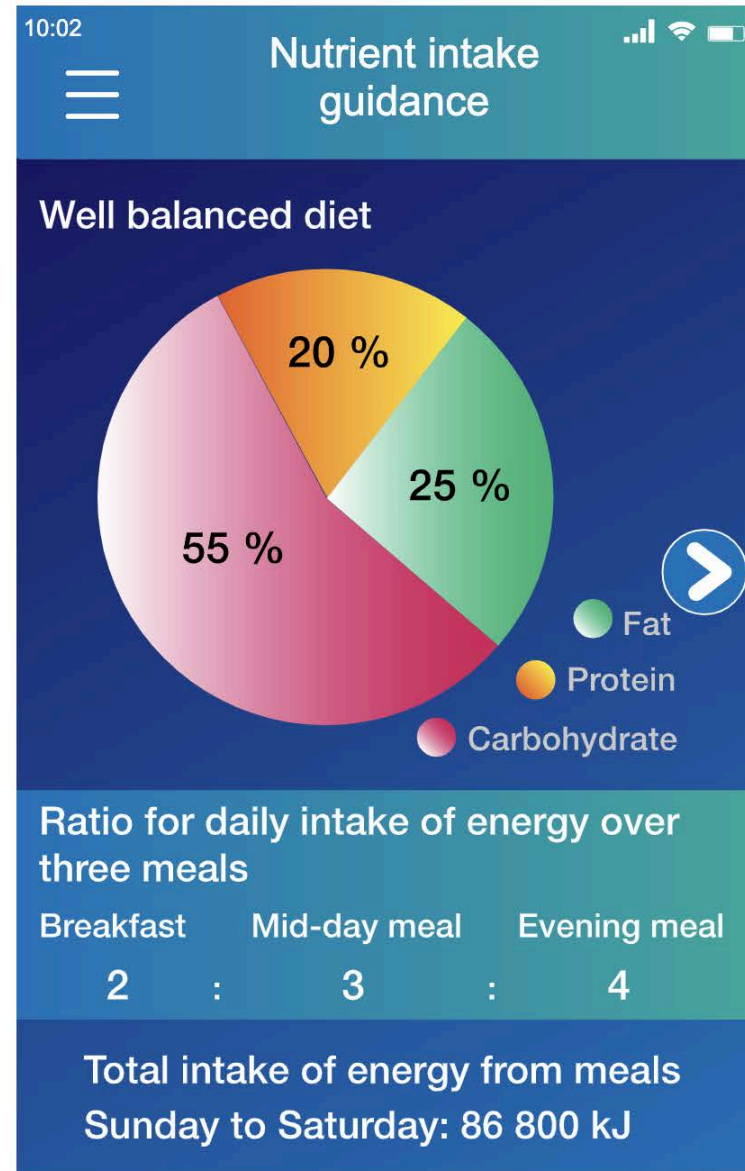
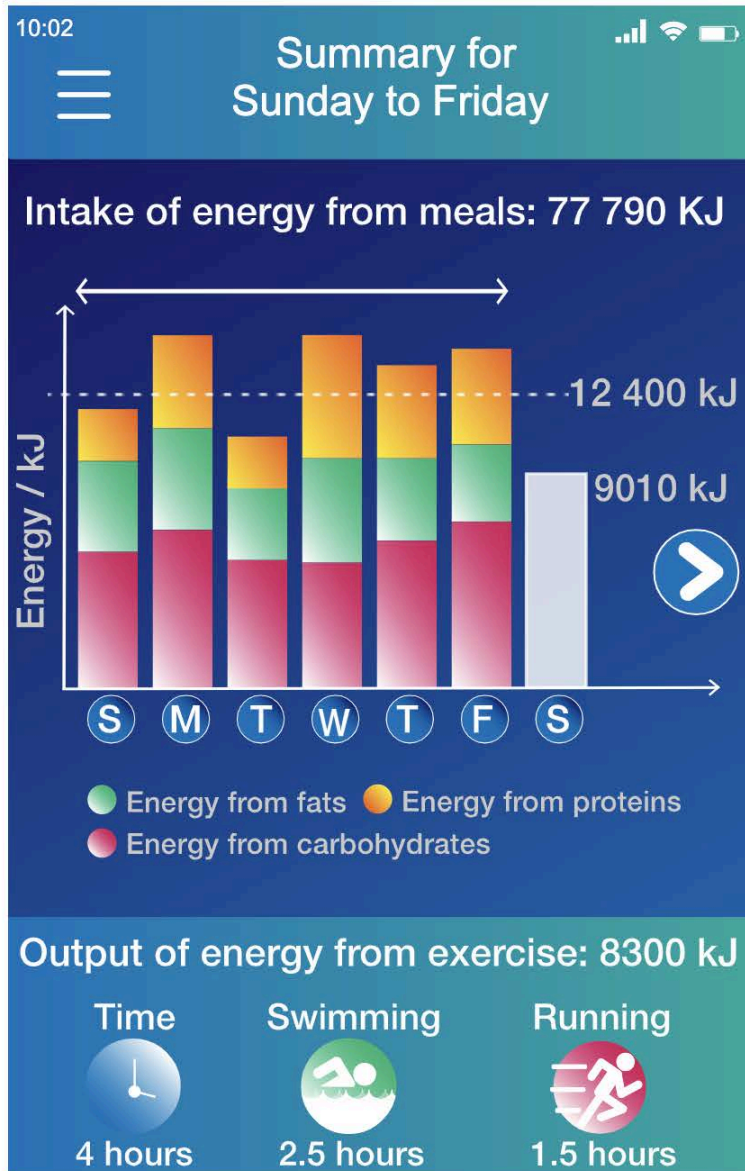
### Question 7e (10 marks)

Gerry has decided to use a mobile application (app) to record his activities on a weekly basis. He is on the final day, Saturday, of his first week. He has already had his breakfast and mid-day meal and has taken no exercise today. He hopes to complete the week having achieved his healthy lifestyle goal.

This media is interactive

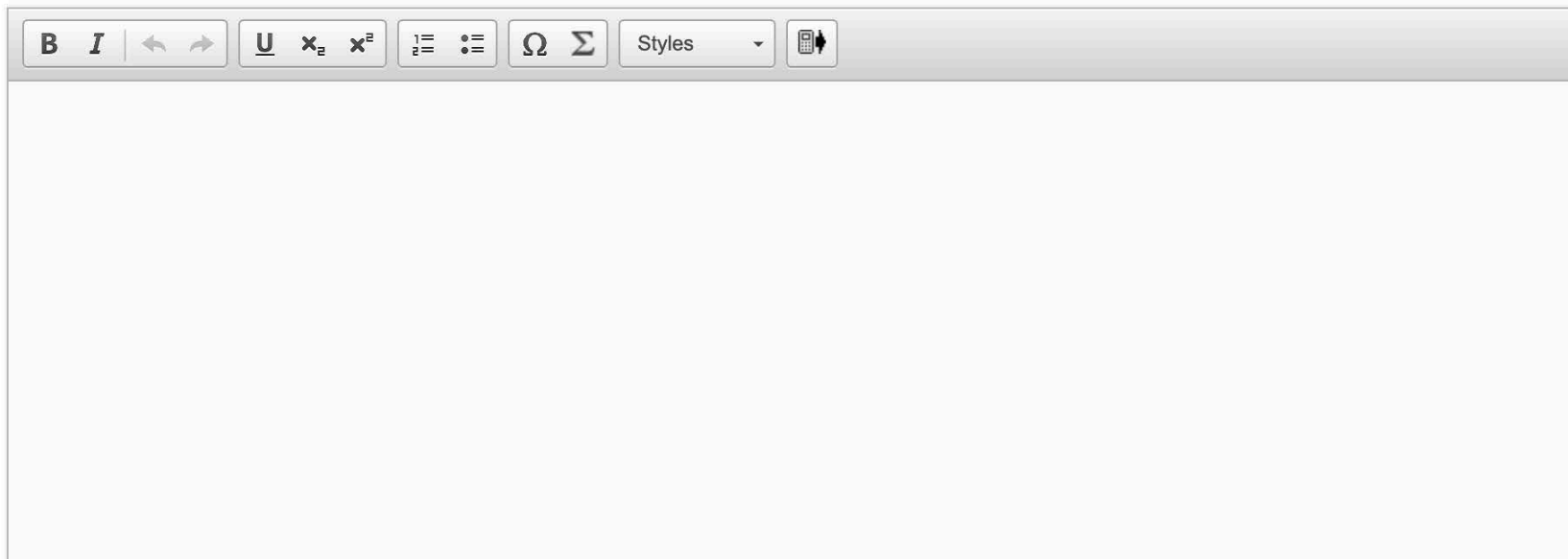
To toggle between pages in the App, use the   buttons.





**Evaluate** Gerry's progress towards a healthy lifestyle. Use the information provided in the mobile app. In your answer, you should:

- identify four factors to be considered for a healthy lifestyle
- calculate the remaining nutrition and energy for Saturday
- justify the degree of accuracy of your results
- suggest advice for Gerry on his approach to a healthy lifestyle
- explain how the advice makes sense for a healthy lifestyle.

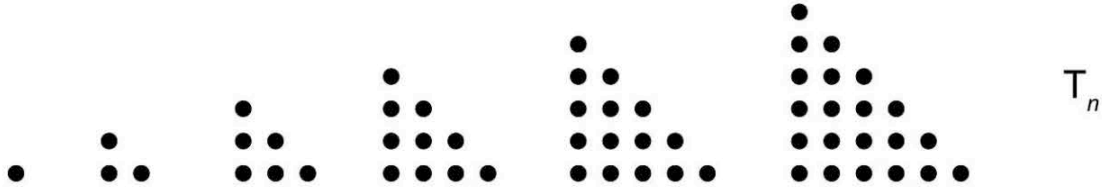


A rich text editor toolbar with the following icons from left to right: Bold (B), Italic (I), Undo (left arrow), Redo (right arrow), Underline (U), Subscript (x<sub>2</sub>), Superscript (x<sup>2</sup>), Bulleted List (three horizontal lines with a dot), Numbered List (three horizontal lines with numbers), Link (Ω), Unlink (Σ), Styles (a dropdown menu labeled 'Styles'), and Mobile View (a smartphone icon with a double-headed arrow).

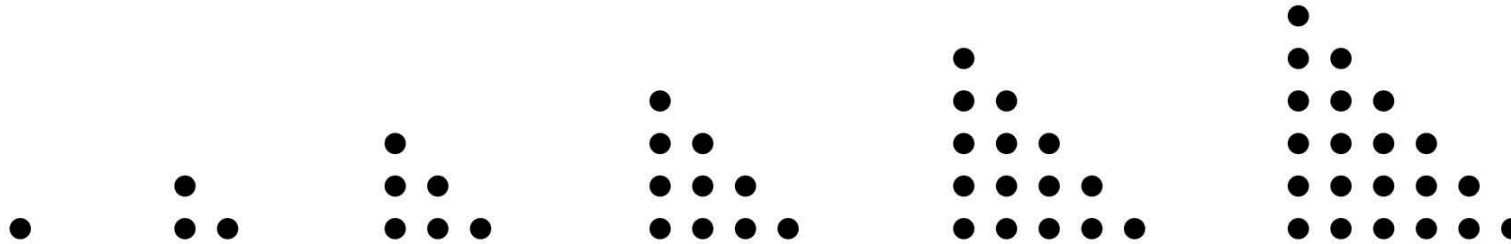
**Question 8** (31 marks)

The animation below shows how square numbers can be formed from triangular numbers.

This media contains no audio



Here are the first five triangular numbers illustrated with dots.





Question 8a (3 marks)

$n$	$T_n$	$T_{n-1}$	$T_n + T_{n-1} = n^2$	
1	1			
2	3	1	4	
3	6	3	9	
4		6		

Reset



Verify the general rule for the triangular numbers  $T_n = \frac{n(n+1)}{2}$ .

Rich text editor toolbar with buttons for Bold (B), Italic (I), Undo, Redo, Underline (U), Subscript (x<sub>2</sub>), Superscript (x<sup>2</sup>), Bulleted List, Numbered List, Insert Link (Ω), and Insert Table (Σ). Below the toolbar is a text input area.



$n$	$T_n$	$T_{n-1}$	$T_n + T_{n-1} = n^2$	
1	1			
2	3	1	4	
3	6	3	9	
4		6		

Reset



Question 8b (4 marks)

Use  $T_n = \frac{n(n+1)}{2}$  to **prove** that the sum of two successive triangular numbers will always be a square number.

Rich text editor toolbar with buttons for Bold (B), Italic (I), Undo, Redo, Underline (U), subscript (x₂), superscript (x²), Bulleted list, Numbered list, Insert link (Ω), and Insert image (Σ). Below the toolbar is a text input area.

[Video](#)

[Script](#)

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Here is an equilateral triangle with sides of 2 units.

Three more triangles are added.

A perpendicular bisector is drawn to join A to M. The length of AM is square root 3.

$d_1$  is the length of  $AC_1$ .

Here we have a right-angled triangle  $AMC_1$ .

$d_2$  is the length of  $AC_2$ .

Here we have a right-angled triangle  $AMC_2$ .

And so on...



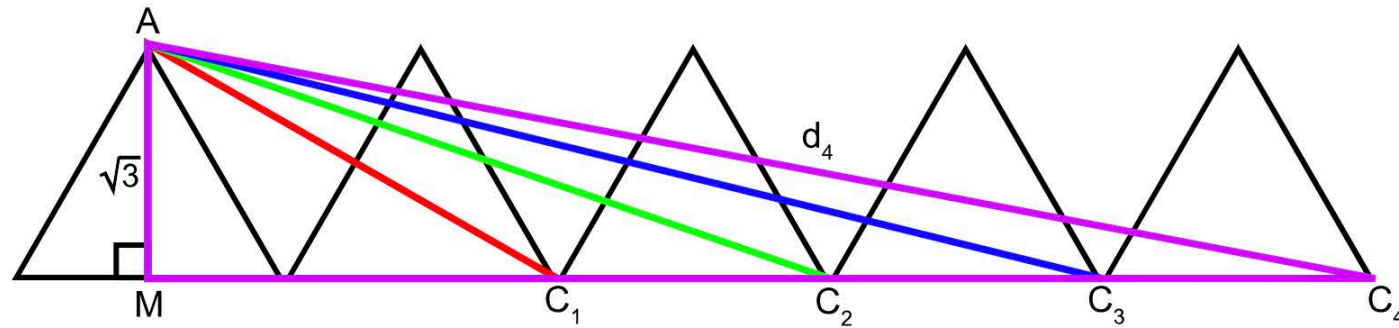
Question 8c (2 marks)

Show that  $d_4 = 2\sqrt{21}$ .



Equilateral triangles of side 2

$$AM = \sqrt{3}$$





### Question 8d (22 marks)

**Investigate** the values in the table to find a relationship for length  $d_n$  in terms of  $n$ . In your answer, you should:

- predict more values and record these in the table below
- describe in words any patterns you see in the table
- find a general rule for  $l_n$  in terms of  $n$
- find a general rule for  $d_n$  in terms of  $n$
- test your general rule for  $d_n$
- prove or verify and justify your general rule for  $d_n$
- ensure that you communicate all your working appropriately.

$n$	Length $MC_n$ ( $l_n$ )	Length $AC_n$ ( $d_n$ )	
1	3	$2\sqrt{3}$	
2	5	$2\sqrt{7}$	
3	7	$2\sqrt{13}$	
4		$2\sqrt{21}$	
5			
6			