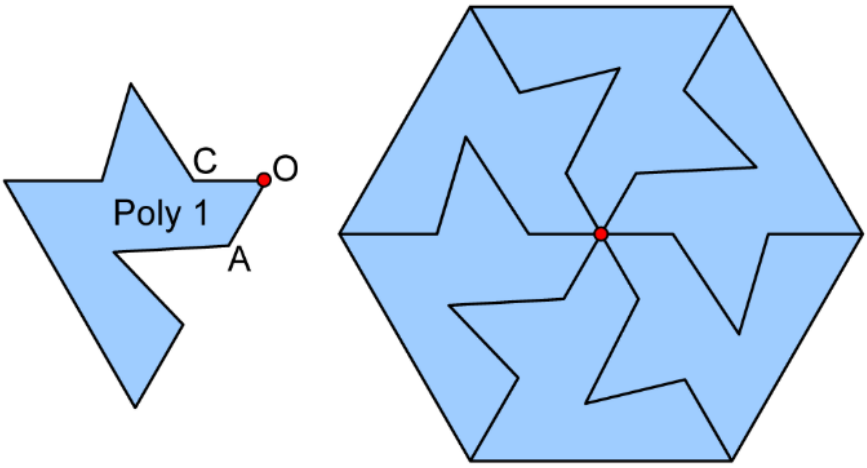
**Question 1a** (1 mark)

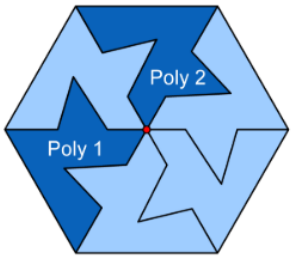
of angle AOC.

A regular tessellation is made up of one repeating shape. The tile Poly 1 creates a regular tessellation to form a regular hexagon.




**Question 1b** (1 mark)

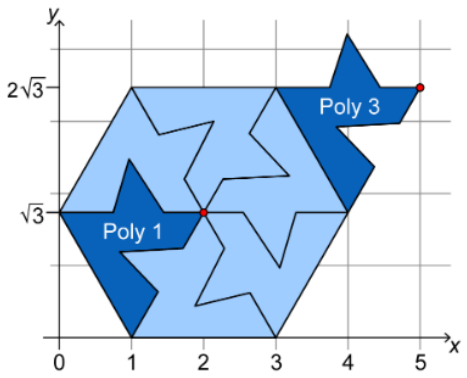
Poly 1 is rotated clockwise by an angle θ to create Poly 2.




**Write down** the value of angle θ.

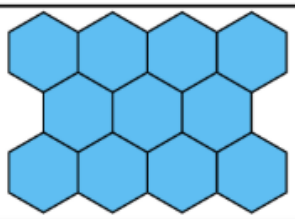
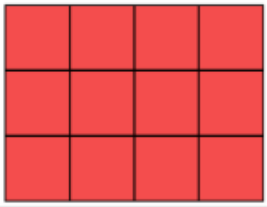
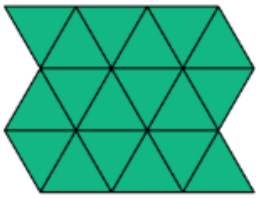
Styles

**Question 1c** (2 marks)



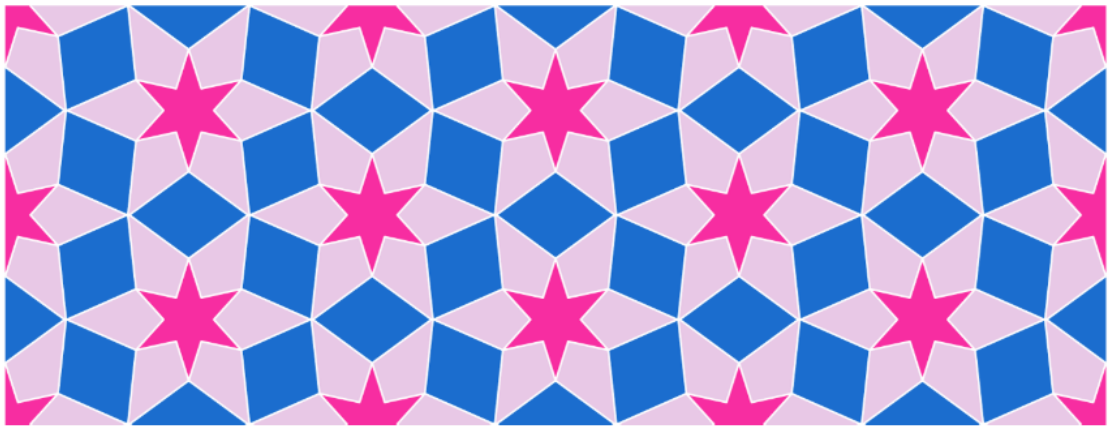

**Write down** the full transformation that maps Poly 1 onto Poly 3.

**Question 1d** (2 marks)

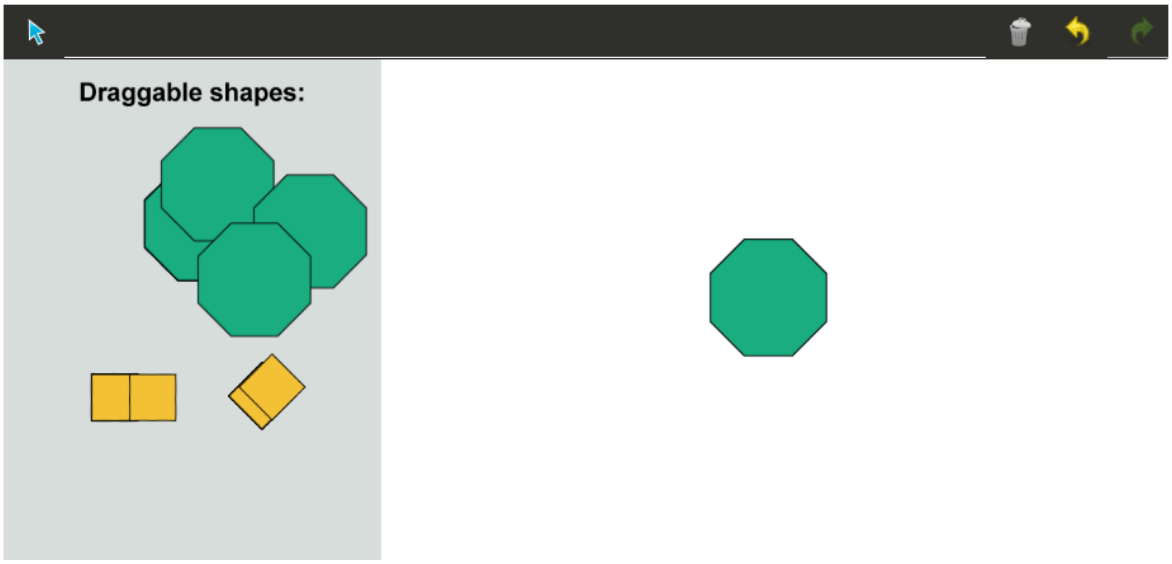
| Regular shape | Regular tessellations |
|---|---|
| Hexagon |  |
| Square |  |
| Equilateral triangle |  |

Using angles, **show that** each of the regular shapes produces a regular tessellation.

A semi-regular tessellation is made up of two or more shapes as shown in the image below.

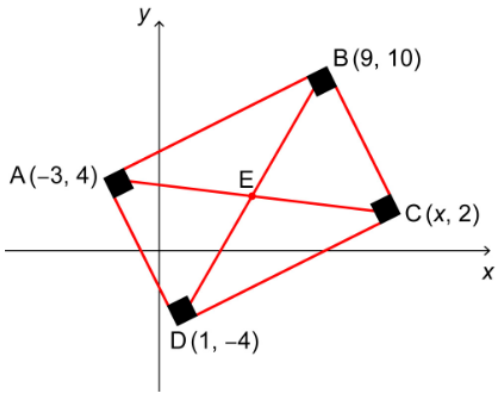


**Construct** a semi-regular tessellation on the canvas below. Your design **must** have exactly eight octagons.



**Question 2** (11 marks)

ABCD is a rectangle with the given coordinates of vertices.




The diagonals of the rectangle intersect at point E.

**Question 2a** (2 marks)

**Show that** triangle AED and triangle BEC are congruent.

B I U $x_2$ $x^2$ Ω Σ

Styles

**Question 2b** (2 marks)

**Determine** the gradient of AB.

B I U $x_2$ $x^2$ Ω Σ

Styles

**Question 2c** (2 marks)

**Determine** the *x* coordinate of point C.

**Question 2d** (3 marks)

**Calculate** the length of AB, give your answer in simplest surd form.

B I U $x_2$ $x^2$ Ω Σ

Styles

**Question 2e** (2 marks)

**Determine** the coordinates of point E.

**Question 3** (7 marks)

The map below shows cycle paths and visitor sites in a woodland park.

**Woodland map**

**Diagram not to scale**


**Key:**

- Cycle paths
- Woodland
- Lake

**Visitor sites**

- A Car park
- B Sculpture park
- C View point
- D Restaurant

The length of the cycle path AB + BD is 12 km

The length of the cycle path AB + BC + CD is 19 km

**Question 3a** (5 marks)

By solving simultaneous equations, **find** the values of $x$ and $y$.

Styles

**Question 3b** (2 marks)

A visitor cycles the outer cycle paths only, a total distance of 33 km. They cycle at an average speed of 10 km/h.

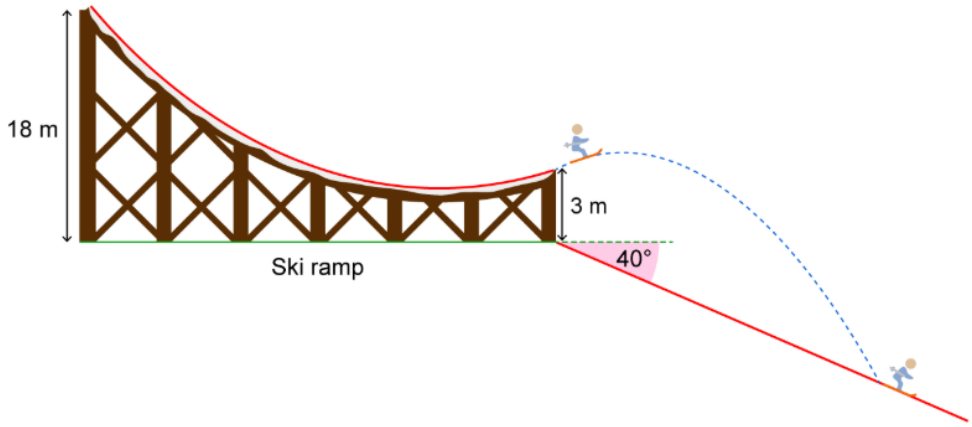
**Determine** the time it takes to complete the route. Give your answer in hours and minutes.

Hours Minutes

## Question 4 (9 marks)

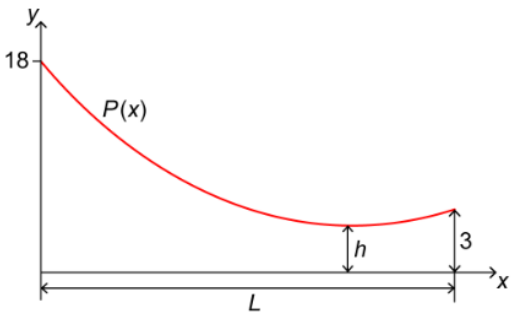
A ramp is built for a jump in a freestyle ski event shown in the image below. The start of the ramp is at a height of 18 metres (m) and the end of the ramp is at a height of 3 metres (m). Skiers land on an inclined surface with an angle of depression of 40 degrees.

**Image 1**




The cross-section of the ramp is shown in the image below. The curved path is modelled as a parabola with equation $P(x) = a(x - 20)^2 + 2$.

$P(x)$ represents the height of the ramp and $x$ represents the horizontal distance from the start of the ramp.
Dimensions in metres.




### Question 4a (1 mark)

**Write down** the minimum height ($h$) of the ramp.

### Question 4b (2 marks)

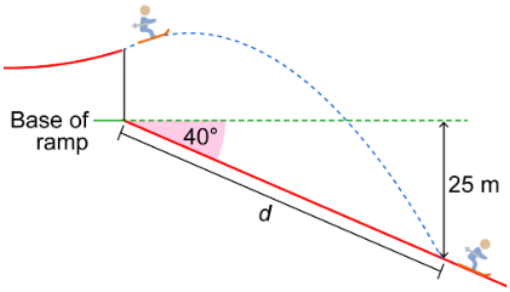
**Show that** $a = 0.04$.

### Question 4c (4 marks)

Hence, **find** the horizontal length ($L$) of the ramp.

**Question 4d** (2 marks)

The recorded distance ($d$) for the jump is measured from the base of the ramp to the place where the skier lands.




**Calculate** the distance ($d$).

**Question 5** (16 marks)

**Question 5a** (2 marks)

In this question you will explore relationships between genes and hair colour of people in a community.

Identity and relationships are important aspects of belonging within a community. In this question you will explore how hair colour can be linked to communities and hereditary traits.

It is estimated that around 1–2 % of the world's population have natural red hair.

The map illustrates areas of the world where red hair is located.

From the map you can see that in some parts of the world, red hair is more common.

Research has shown that the likelihood of a person having red hair is attributed to the genes inherited from each parent.

One gene from each parent.

However, there are other factors involved.

If a child inherits two red hair genes, one from each parent, they are likely to have red hair however this is not a certainty.

If a child inherits only one or no red hair genes, they are less likely to have red hair but it is possible.

A research group (A) is exploring relationships between genes and red hair in a community.
A random sample of 1500 people from the community are studied.

The probability tree diagram below illustrates the results from the sample group.

**Key:**

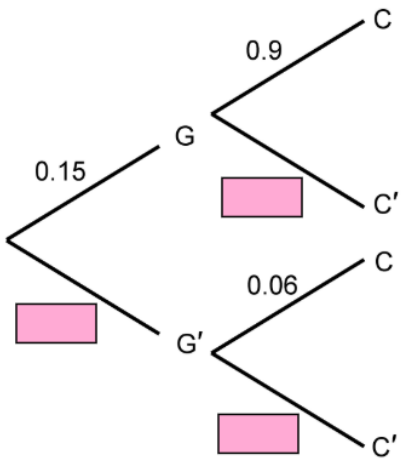
Event G represents people that have two red hair genes
Event G' represents people that do not have two red hair genes
Event C represents people that have red hair
Event C' represents people that do not have red hair

**Write down** the missing items in the table below.

| Probability notation | Description in the context |
|---|---|
| $P(G \cap C)$ | Probability of selecting a person who has two red hair genes and has red hair |
| $P(G \cap C')$ | Probability of selecting a person who has two red hair genes and does not have red hair |
| $P(\square \cap \square)$ | Probability of selecting a person who does not have two red hair genes and has red hair |
| $P(G' \cap C')$ | Probability of selecting a person who |

**Question 5b** (1 mark)

**Write down** the missing values in the probability tree diagram below.




**Key:**

Event G represents people that have two red hair genes
Event G' represents people that do not have two red hair genes
Event C represents people that have red hair
Event C' represents people that do not have red hair

**Question 5c** (2 marks)

**Determine** the probability that a person selected at random from the community has two red hair genes and has red hair.

**Question 5d** (3 marks)

**Find** the probability that a person selected at random from the community has red hair P(C).

## Question 5e (2 marks)

The community has a population of 15 500.

**Estimate** the number of people with red hair in this community.

**Question 5f** (1 mark)

A different research group B conducts the same study with the same community, however they sample 800 people.

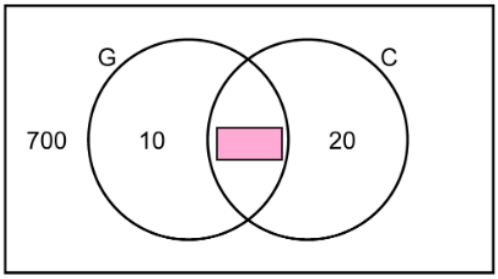
| Research group | Sample size |
|---|---|
| A | 1500 |
| B | 800 |

**Outline** which study could be considered better. Give one reason for your answer.

**Question 5g** (1 mark)

The Venn diagram below illustrates the results from the research group B.

**Write down** the missing value in the Venn diagram




**Key:**

Event G represents people that have two red hair genes.

Event C represents people that have red hair.

**Question 5h** (3 marks)

Research group B makes the following conclusion

"Approximately, 1 in N people from this community have red hair."

Given that N is a whole number, **find** the value of N.

**Question 5i** (1 mark)

**Write down** the percentage difference between the probability P(C) of the two research groups.

**Question 6** (19 marks)

Buildings designed for apartment living provide homes for many individuals and families within a defined space.

The table below shows information about the number of residents in each age group in a building.

| Age group (A) in years | Number of residents |
|---|---|
| $0 < A \leq 10$ | 59 |
| $10 < A \leq 20$ | 72 |
| $20 < A \leq 30$ | 54 |
| $30 < A \leq 40$ | 126 |
| $40 < A \leq 50$ | 15 |
| $50 < A \leq 60$ | 5 |
| **Total Number of residents** | 331 |

**Question 6a** (1 mark)

**Write down** the modal class of age of residents.

**Question 6b** (4 marks)

**Calculate** an estimate for the arithmetic mean age of residents.

**Question 6c** (2 marks)

The building also provides an opportunity for residents to come together as a community in a recreational area.

The recreational area is divided into a children's playground and a fitness centre with age restrictions as follows.


The residents in the age group $10 < A \leq 20$, are in the ratio:

$$10 < A \leq 14 \quad : \quad 14 < A \leq 20$$
$$7 \quad : \quad 2$$

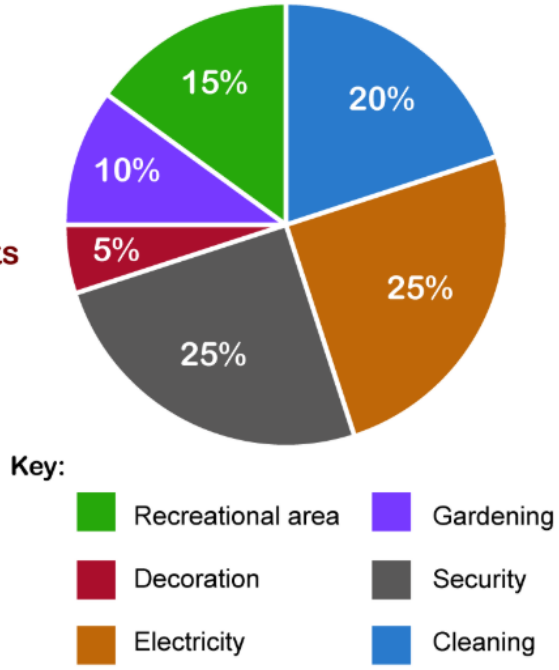
**Show that** 115 children are allowed in the playground.

You are responsible for making calculations for the recreational area in order to stay within an allocated budget.

## Building maintenance budget


Residents pay an annual fee which provides the budget to pay for maintenance of the building.

The pie chart below shows how the maintenance budget is distributed

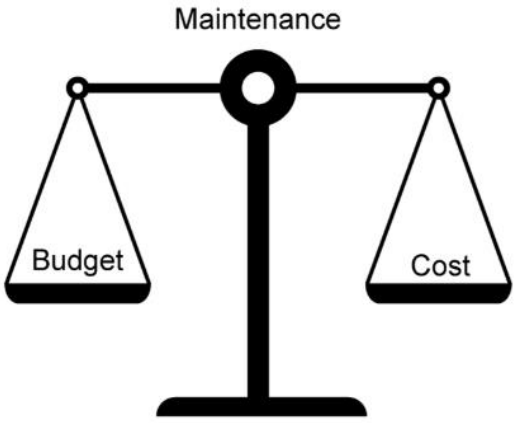



**Question 6d** (2 marks)

**Determine** the annual maintenance budget for the recreational area.

**Question 6e** (10 marks)

The maintenance budget and maintenance cost need to balance for the recreational area.



The monthly maintenance cost of the recreational area is calculated using the information given in the Playground and Fitness tabs below.

Playground | Fitness


Use your results from earlier parts and the information provided.

**To what extent** is the maintenance budget suitable for the recreational area? In your answer you should:

- clearly identify **three** relevant factors
- make calculations for the playground
- make calculations for the total maintenance cost of the recreational area
- show suitable rounding in your working and results
- justify the suitability of the maintenance budget for the recreational area.

Three relevant factors:

Calculations and justification:

**Question 7** (30 marks)

In this part you will investigate geometric patterns formed by squares of side 1 cm.

Interact with the stage control to see how the perimeter of the shape increases.

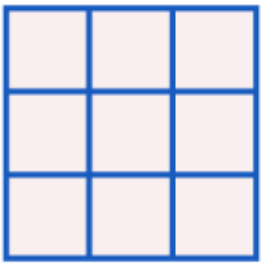
**Stage control**

**Stage 1**

Perimeter = 4 cm

Stage control

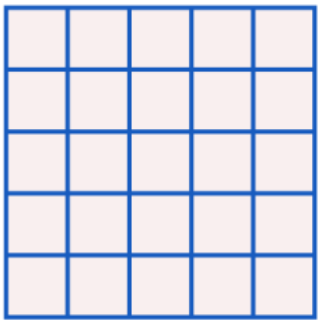
Stage 2



Perimeter = 12 cm

Stage control

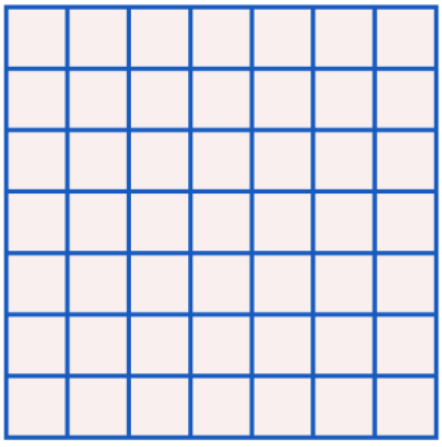
Stage 3



Perimeter = 20 cm

Stage control

Stage 4



Perimeter = 28 cm

## Question 7a (1 mark)

**Show that** the perimeter of the shape in stage 4 is 28.

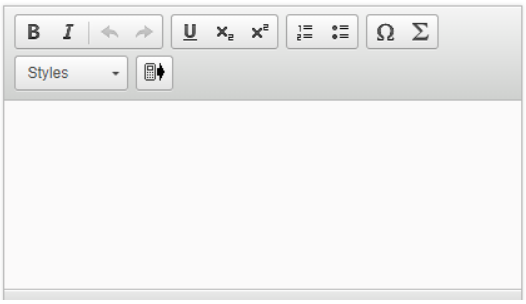
## Question 7b (1 mark)

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

| Stage number ($n$) | Perimeter ($P$) |
|---|---|
| 1 | 4 |
| 2 | 12 |
| 3 | 20 |
| 4 | 28 |
| 5 | |
| 6 | |

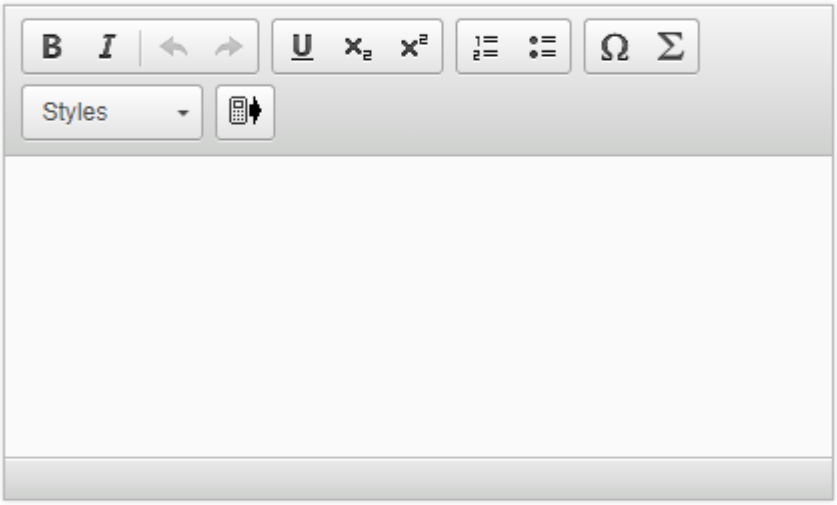
## Question 7c (2 marks)

**Describe**, in words, two patterns in the table for the perimeter ($P$).



**Question 7d** (2 marks)

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




**Question 7e** (3 marks)

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

Based on the previous geometric shape, another shape is also formed from squares of side 1 cm. You are going to investigate the area of the shape ($A$) formed in each stage.

Interact with the stage control to see how the area of the shape increases.

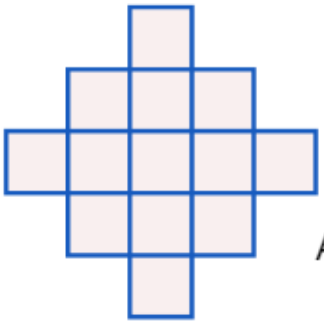
**Stage control**

**Stage 1**

Area = 5 cm²

**Stage control**

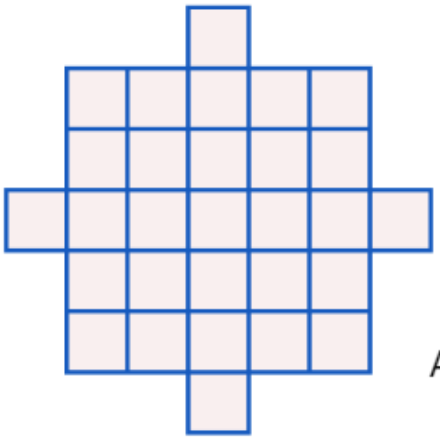
**Stage 2**



Area = 13 cm²

Stage control

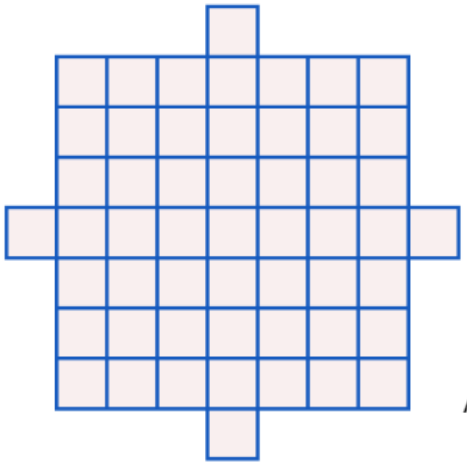
Stage 3



Area = 29 cm²

Stage control

Stage 4



Area = 53 cm²

**Question 7f** (1 mark)

**Show that** the area of the shape in stage 4 is 53 $cm^2$.

**Question 7g** (20 marks)

| Stage number ($n$) | Area of shape ($A$) | |
|---|---|---|
| 1 | 5 | |
| 2 | 13 | |
| 3 | 29 | |
| 4 | 53 | |
| 5 | | |
| 6 | | |
| | | |
| | | |
| | | |
| | | |

Reset

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

- predict more values and record these in the table
- describe in words two patterns in the table for the area of the shape ($A$)
- 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 $A$ in relation to the squares.