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Core

Fifth edition

Ric Pimentel
Frankie Pimentel
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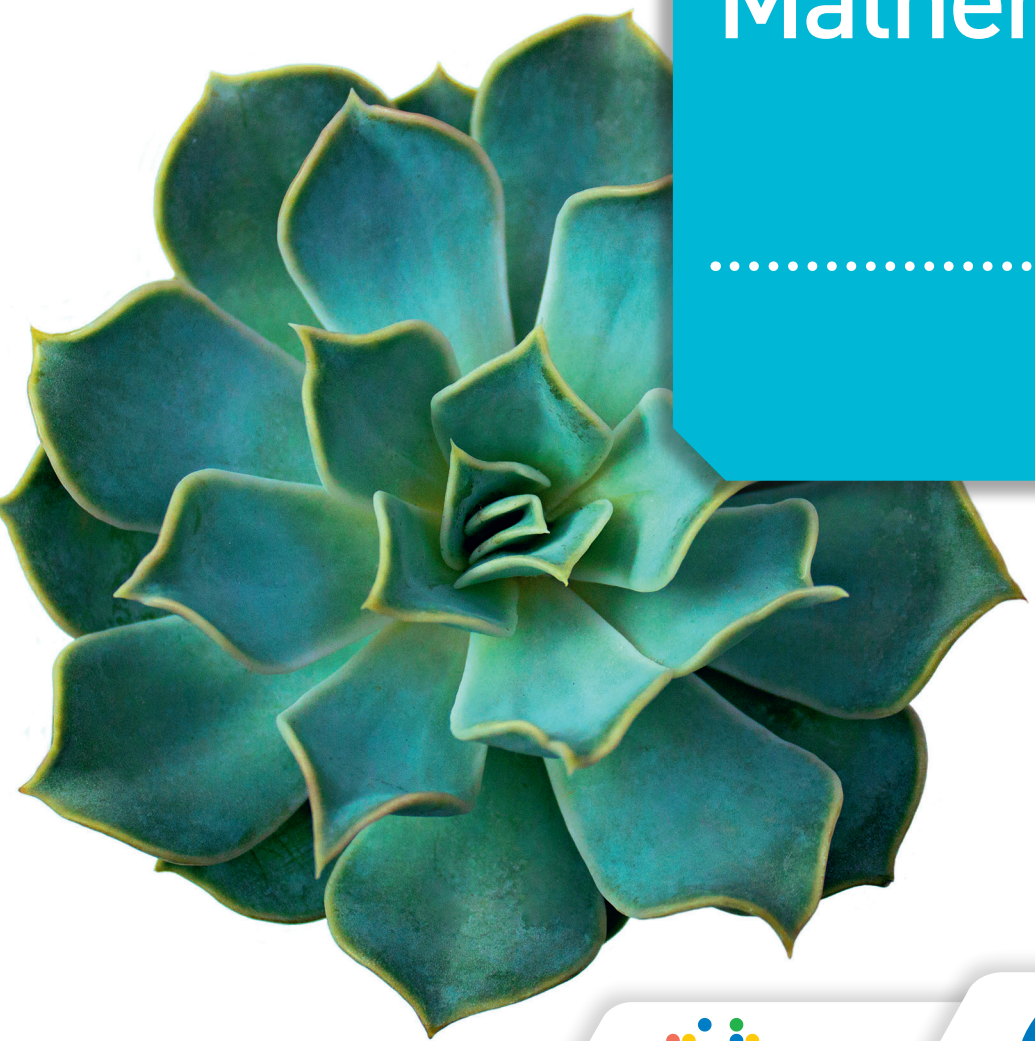

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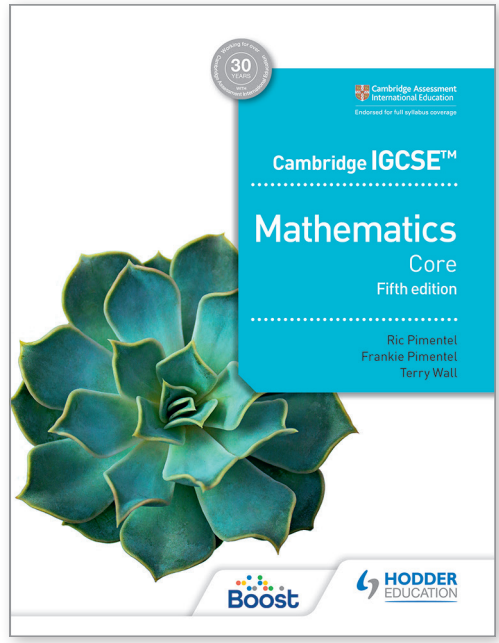

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Contents

19 Geometrical constructions and scale drawings

Measuring lines

A straight line can be drawn and measured accurately using a ruler.

Exercise 19.1

1 Using a ruler, measure the length of these lines to the nearest mm:

a

b

c

d

e

f

2 Draw lines of the following lengths using a ruler:

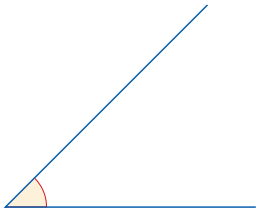
a 3 cm **b** 8 cm **c** 4.6 cm

d 94 mm **e** 38 mm **f** 61 mm

Measuring angles

An angle is a measure of **turn**. When drawn, it can be measured using either a protractor or an angle measurer. The units of turn are degrees (°). Measuring with a protractor needs care, as there are two scales marked on it – an inner one and an outer one.

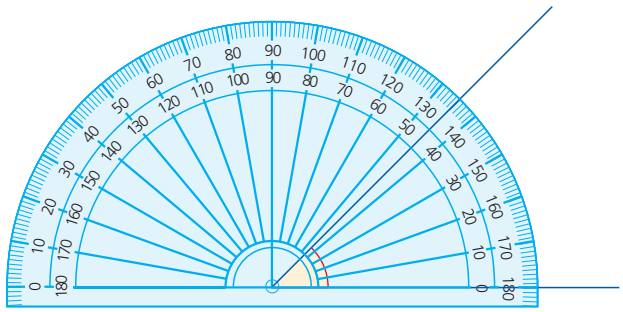
Worked examples



1 Measure the angle using a protractor:

Place the protractor over the angle so that the cross lies on the point where the two lines meet.

Align the 0° with one of the lines:



Decide which scale is appropriate. In this case, it is the inner scale as it starts at 0°.

Measure the angle using the inner scale.

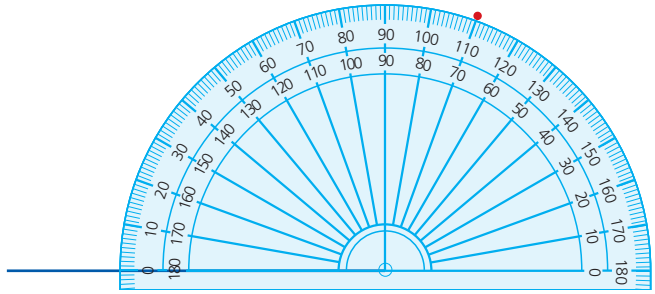
The angle is 45°.

2 Draw an angle of 110°.

Start by drawing a straight line.

Place the protractor on the line so that the cross is on one of the end points of the line.

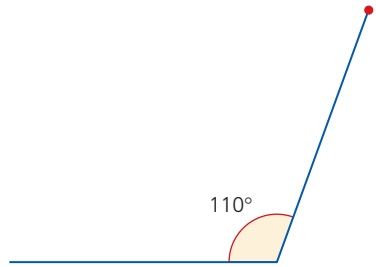
Ensure that the line is aligned with the 0° on the protractor:



Decide which scale to use. In this case, it is the outer scale as it starts at 0°.

Mark where the protractor reads 110°.

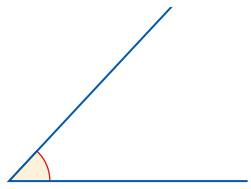
Join the mark made to the end point of the original line.



Exercise 19.2

1 Measure each angle:

a



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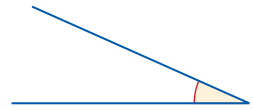

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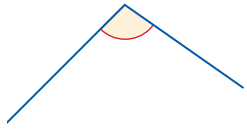
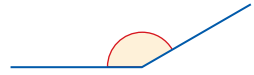
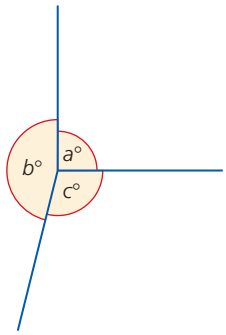


d



2 Measure each angle:

a



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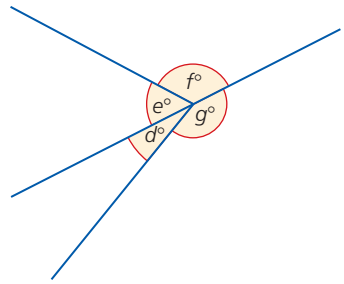

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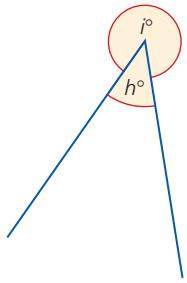

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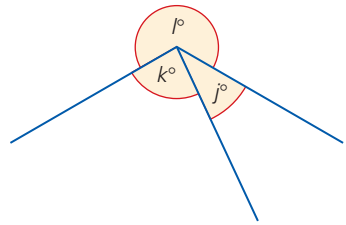
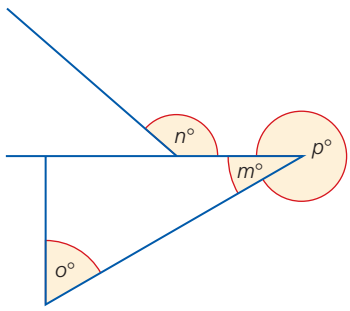
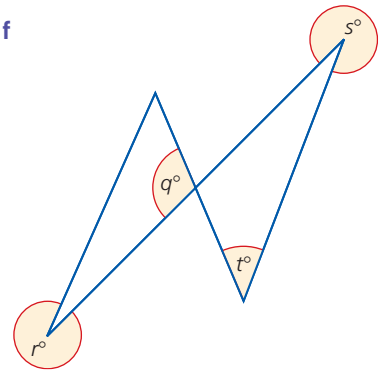


e



f



3 Draw angles of the following sizes:

a 20°	**b** 45°	**c** 90°	**d** 120°
e 157°	**f** 172°	**g** 14°	**h** 205°
i 311°	**j** 283°	**k** 198°	**l** 352°

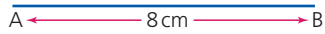
Constructing triangles

Triangles can be drawn accurately by using a ruler and a pair of compasses. This is called **constructing** a triangle.

Worked example

Construct the triangle ABC given that:
AB = 8 cm, BC = 6 cm and AC = 7 cm

Draw the line AB using a ruler:

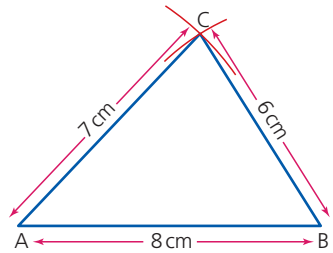


Open up a pair of compasses to 6 cm. Place the compass point on B and draw an arc:

Note that every point on the arc is 6 cm away from B.

Open up the pair of compasses to 7 cm. Place the compass point on A and draw another arc, with centre A and radius 7 cm, ensuring that it intersects the first arc. Every point on the second arc is 7 cm from A. Where the two arcs intersect is point C, as it is both 6 cm from B and 7 cm from A.

Join C to A and C to B:



Exercise 19.3

Using only a ruler and a pair of compasses, construct the following triangles:

a ΔABC where AB = 10 cm, AC = 7 cm and BC = 9 cm
b ΔLMN where LM = 4 cm, LN = 8 cm and MN = 5 cm
c ΔPQR, an equilateral triangle of side length 7 cm
d **i** ΔABC where AB = 8 cm, AC = 4 cm and BC = 3 cm
ii Is this triangle possible? Explain your answer.

Scale drawings

Scale drawings are used when an accurate diagram, drawn in proportion, is needed. Common uses of scale drawings include maps and plans. The use of scale drawings involves understanding how to scale measurements.

Worked examples

1 A map is drawn to a scale of 1 : 10000. If two objects are 1 cm apart on the map, how far apart are they in real life? Give your answer in metres.

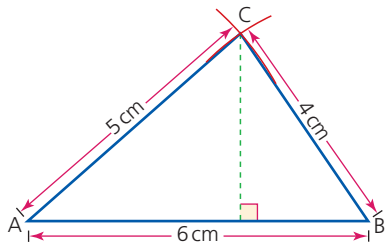
A scale of 1 : 10000 means that 1 cm on the map represents 10000 cm in real life.

Therefore the distance = 10000 cm
= 100 m

2 A model boat is built to a scale of 1 : 50. If the length of the real boat is 12 m, calculate the length of the model boat in cm.

A scale of 1 : 50 means that 50 cm on the real boat is 1 cm on the model boat.
12 m = 1200 cm
Therefore the length of the model boat = 1200 ÷ 50 cm
= 24 cm

3 **a** Construct, to a scale of 1 : 1, a triangle ABC such that AB = 6 cm, AC = 5 cm and BC = 4 cm.



b Measure the perpendicular length of C from AB.

Perpendicular length is 3.3 cm.

c Calculate the area of the triangle.

$$\text{Area} = \frac{\text{base length} \times \text{perpendicular height}}{2}$$

$$\text{Area} = \frac{6 \times 3.3}{2}\text{cm} = 9.9\ \text{cm}^2$$

Exercise 19.4

1 In the following questions, both the scale to which a map is drawn and the distance between two objects on the map are given.
Find the real distance between the two objects, giving your answer in metres.

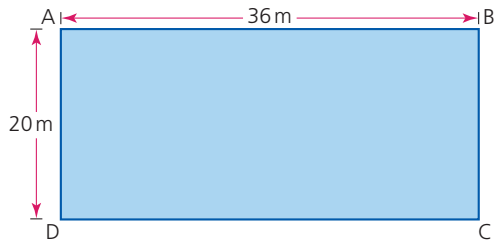
a 1 : 10 000, 3 cm
b 1 : 10 000, 2.5 cm
c 1 : 20 000, 1.5 cm
d 1 : 8000, 5.2 cm

2 In the following questions, both the scale to which a map is drawn and the true distance between two objects are given.
Find the distance between the two objects on the map, giving your answer in cm.

a 1 : 15 000, 1.5 km
b 1 : 50 000, 4 km
c 1 : 10 000, 600 m
d 1 : 25 000, 1.7 km

Exercise 19.4 (cont)

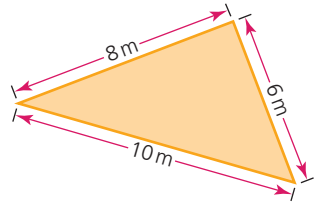
3 A rectangular pool measures 20 m by 36 m as shown below:



a Construct a scale drawing of the pool, using 1 cm for every 4 m.

b A boy sets off across the pool from D in such a way that his path is in the direction of a point which is 40 m from D and 30 m from C. Work out the distance the boy swam.

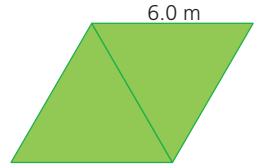
4 A triangular enclosure is shown in the diagram:

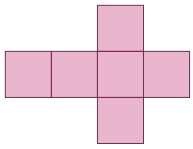


a Using a scale of 1 cm for each metre, construct a scale drawing of the enclosure.

b Calculate the true area of the enclosure.

5 An area of lawn is in the shape of a rhombus consisting of two equilateral triangles, of edge length 6.0 m, arranged side by side as shown.
Construct the rhombus using a scale of 1 cm for each metre.



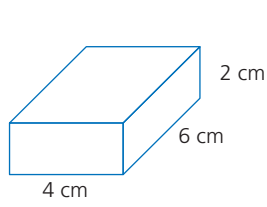


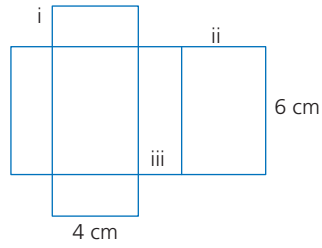
Nets

The diagram is the **net** of a cube. It shows the faces of the cube opened out into a two-dimensional plan. The net of a three-dimensional shape can be folded up to make that shape.

Exercise 19.5

1 The diagrams below show a cuboid and its net:

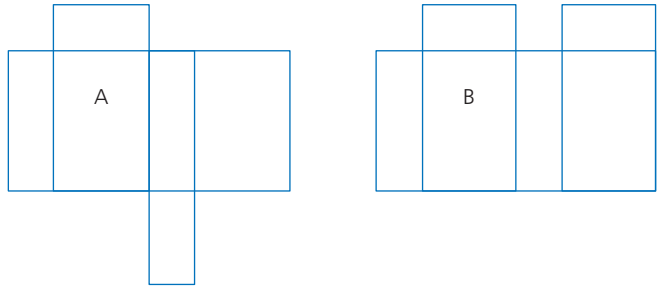




a Write down the lengths of the sides marked i, ii and iii on the net.

Exercise 19.5 (cont)

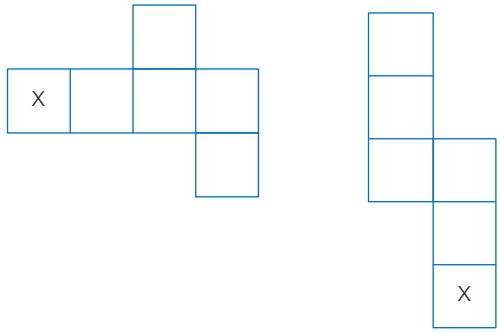
b Two other nets A and B are shown below:



i Which of the two nets cannot be folded to make a cuboid?
ii Give a reason for your answer.

c Draw a different possible net for the cuboid.

2 Two possible nets of a cube are shown below. On each one a face has been labelled X.

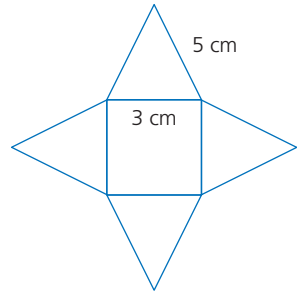


Sketch each of the nets above and mark with the letter Y the face that would be opposite the face labelled X if the net was assembled to form a cube.

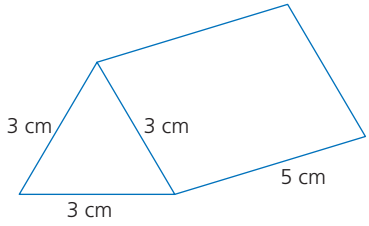
3 The diagram shows net of a shape:

a Give the name of the 3D shape it makes.

b Using a ruler and a pair of compasses, construct a full-size net of the shape.



4 A triangular prism is given below:



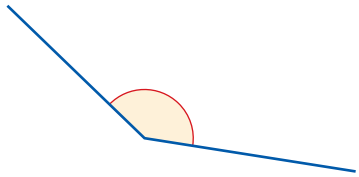
Using a ruler and a pair of compasses, construct a possible net of the prism.

Student assessment 1

1 **a** Using a ruler, measure the length of the line:

b Draw a line 4.7 cm long.

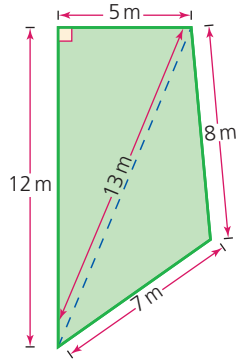
2 **a** Using a protractor, measure the angle shown:



b Draw an angle of 300°.

3 Construct ΔABC such that AB = 8 cm, AC = 6 cm and BC = 12 cm.

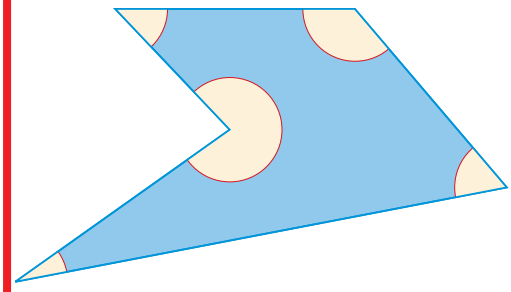
4 A plan of a living room is shown:



a Using a pair of compasses, construct a scale drawing of the room using 1 cm for every metre.

b Using a set square if necessary, calculate the total area of the actual living room.

5 Measure each of the five angles of the pentagon:



6 Draw, using a ruler and a protractor, a triangle with angles of 40°, 60° and 80°.

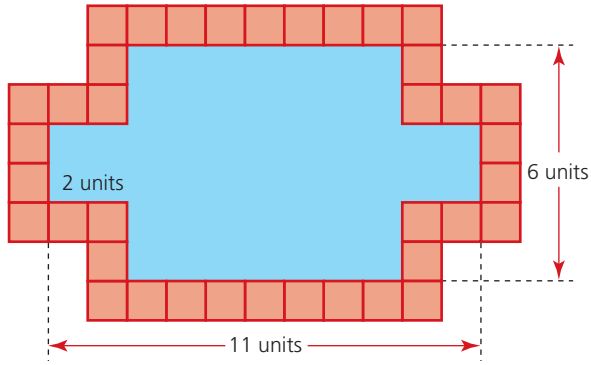
7 In the following questions, both the scale to which a map is drawn and the true distance between two objects are given.
Find the distance between the two objects on the map, giving your answer in cm.

a 1 : 20 000, 4.4 km **b** 1 : 50 000, 12.2 km

Mathematical investigations and ICT 4

Fountain borders

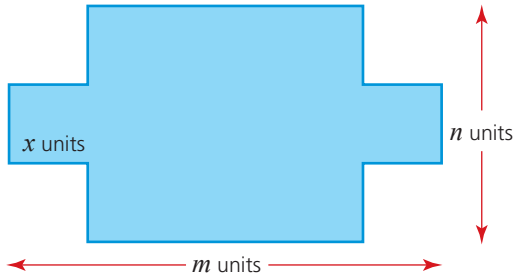
The Alhambra Palace in Granada, Spain, has many fountains which pour water into pools. Many of the pools are surrounded by beautiful ceramic tiles. This investigation looks at the number of square tiles needed to surround a particular shape of pool.



The diagram above shows a rectangular pool of 11×6 units, in which a square of dimension 2×2 units is taken from each corner.

The total number of unit square tiles needed to surround the pool is 38.

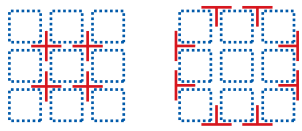
The shape of the pool can be generalised as shown below:



1. Investigate the number of unit square tiles needed for different sized pools. Record your results in an ordered table.
2. From your results, write an algebraic rule in terms of m, n and x (if necessary) for the number of tiles T needed to surround a pool.
3. Justify, in words and using diagrams, why your rule works.

Tiled walls

Many cultures have used tiles to decorate buildings. Putting tiles on a wall takes skill. These days, to make sure that each tile is in the correct position, 'spacers' are used between the tiles.



You can see from the diagram that there are +-shaped and T-shaped spacers.

1. Draw other sized squares and rectangles, and investigate the relationship between the dimensions of each shape (length and width) and the number of +-shaped and T-shaped spacers.
2. Record your results in an ordered table.
3. Write an algebraic rule for the number of +-shaped spacers c in a rectangle l tiles long by w tiles wide.
4. Write an algebraic rule for the number of T-shaped spacers t in a rectangle l tiles long by w tiles wide.

ICT activity

In this activity, you will use a spreadsheet to calculate the sizes of interior and exterior angles of regular polygons.

Set up a spreadsheet as shown below:

	A	B	C	D	E	F
1	**Regular Polygons**					
2	Number of sides	Name	Sum of exterior angles	Size of an exterior angle	Size of an interior angle	Sum of interior angles
3	3					
4	4					
5	5					
6	6					
7	7					
8	8					
9	9					
10	10					
11	12		↑	↑	↑	↑
12	20					
13						
14						
15			Use formulae to generate the results in these columns			
16						

1. By using formulae, use the spreadsheet to generate the results for the sizes of the interior and exterior angles.
2. Write down the general formulae you would use to calculate the sizes of the interior and exterior angles of an n-sided regular polygon.

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