Regular and irregular polygons

Lesson plan and teacher's notes · Form 2 Mathematics · 1 period of 40 minutes

School	(write school name)	**Teacher**	(write name)
Date	(date)	**Class**	Form 2
Subject	Mathematics	**Enrolment**	Boys ___ Girls ___ Total ___
Time	40 minutes	**Topic**	Regular and irregular polygons

Learners tell regular polygons from irregular polygons, identify interior and exterior angles, use the rules for the angles of polygons, and link polygons to everyday objects. Examples come from a football, pavers, windows and sticks joined at the ends.

Specific outcomes

By the end of the lesson, learners should be able to:

1. Tell regular polygons from irregular polygons
2. Identify interior and exterior angles
3. Use the rules for interior and exterior angles of polygons
4. Use polygons in designs of everyday objects

Prior knowledge

- A vertex is where two sides meet
- Angles on a straight line add up to 180 degrees
- Division of whole numbers

Teaching and learning materials

- sticks or strips of cardboard with pins or string to join the ends
- rulers
- chalk and board
- exercise books

References

Ministry of Education (CDC) Form 2 Mathematics syllabus and module; 25Schools learners' note: Regular and irregular polygons.

Lesson development

Stage and time	Teacher activities	Learner activities
Introduction 5 min	Ask where learners see shapes with straight sides: pavers, road signs, windows, patterns on fabric and the shapes on a football. Tell them that these are polygons.	Name shapes they see and copy the title and key words.
Development: regular and irregular polygons 10 min	Define polygon, regular polygon and irregular polygon. Draw a square, an equilateral triangle and a regular hexagon beside an irregular shape and compare their sides and angles.	Draw one regular and one irregular polygon and label them.
Development: sides and angles 10 min	Build a polygon from sticks joined at the ends to show that the number of sides equals the number of angles. Extend one side at each vertex to show an exterior angle. Show that the interior and exterior angles add up to 180 degrees and that the exterior angles add up to 360 degrees.	Mark an interior and an exterior angle on a drawing and write the two rules.
Development: calculating angles 12 min	Work the hexagon example step by step: exterior angle is 360 divided by 6, and interior angle is 180 minus the exterior angle. Then let learners try a square and an equilateral triangle.	Calculate the exterior and interior angles of two more regular polygons.
Conclusion 3 min	Ask what the exterior angles of any polygon add up to and how to find each interior angle. Set the homework.	Answer orally and copy the homework.

Teacher's content notes

Read these before the lesson. They are what you need to know, not what to copy onto the board.

Regular and irregular polygons

A polygon is a closed two-dimensional shape with straight sides. A regular polygon has equal sides, so all sides are the same length. It also has equal angles, so every interior angle is the same size, and it has several lines of symmetry. A square, an equilateral triangle and a regular hexagon are regular polygons. The shapes on a football are an example of regular polygons. An irregular polygon has unequal sides, with at least two sides of different lengths, or unequal angles. Many shapes on the walls and windows of buildings are irregular polygons.

Sides and angles of a polygon

If you build a polygon with sticks joined at the ends, each stick is a side and each joint is a corner. You will find that the number of sides equals the number of angles. An interior

angle is an angle inside a polygon at a vertex. Extend one side at each vertex to make an exterior angle. At each vertex the interior angle and its exterior angle add up to 180 degrees, because they lie on a straight line. The exterior angles of any polygon always add up to 360 degrees. As the number of sides increases, the interior angles get bigger and the exterior angles get smaller.

Working out angles of regular polygons

In a regular polygon all exterior angles are equal. Since they add up to 360 degrees, each one is 360 divided by the number of sides. The interior angle is then 180 degrees minus the exterior angle.

Worked example: a regular hexagon

A hexagon has 6 sides. The exterior angle is 360 divided by 6 = 60 degrees. The interior angle is 180 - 60 = 120 degrees.

Questions to ask during the lesson

Question	Expected answer
A teacher shows a class in Luangwa a square, an equilateral triangle, a regular hexagon and the shape of a window frame. (a) Which of these are regular polygons. (b) Which is likely irregular. (c) What is a polygon.	(a) The square, the equilateral triangle and the regular hexagon. (b) The window frame shape, since many shapes on windows are irregular. (c) A closed two-dimensional shape with straight sides.
A learner builds a polygon from sticks and wants to count its parts. (a) What is each stick. (b) What is each joint. (c) How does the number of sides compare with the number of angles.	(a) A side. (b) A corner, or vertex. (c) They are equal.
A learner extends one side of a polygon at a vertex to make an exterior angle. (a) What do the interior and exterior angle at the vertex add up to. (b) Why. (c) What do the exterior angles of any polygon add up to.	(a) 180 degrees. (b) They lie on a straight line. (c) 360 degrees.
A craftsman wants the angles of a regular hexagon for a mat design. (a) How many sides does a hexagon have. (b) Find the exterior angle. (c) Find the interior angle.	(a) 6. (b) 360 divided by 6 = 60 degrees. (c) 180 - 60 = 120 degrees.

Worked examples for the board

Example 1: a regular hexagon

Find the exterior angle and the interior angle of a regular hexagon. A hexagon has 6 sides. Exterior angle = 360 divided by 6 = 60 degrees. Interior angle = 180 - 60 = 120 degrees.

Example 2: a square

A square is a regular polygon with 4 sides. Exterior angle = 360 divided by 4 = 90 degrees. Interior angle = 180 - 90 = 90 degrees.

Example 3: an equilateral triangle

An equilateral triangle is a regular polygon with 3 sides. Exterior angle = 360 divided by 3 = 120 degrees. Interior angle = 180 - 120 = 60 degrees.

Board plan

Write the title and key words. Left: regular and irregular polygons drawn side by side. Centre: a polygon with one interior and one exterior angle marked. Right: the hexagon calculation in three lines.

Feature	Regular polygon	Irregular polygon
Sides	All sides equal	At least two sides of different lengths
Angles	All interior angles equal	Angles not all equal
Examples	Square, equilateral triangle, regular hexagon	Many shapes on walls and windows of buildings

Regular and irregular polygons compared

Mistakes to expect

Learners often think	Put it right
A shape with equal sides is always a regular polygon.	A regular polygon has all sides equal and all angles equal.
The exterior angles add up to different totals for different polygons.	The exterior angles of any polygon always add up to 360 degrees.
The interior and exterior angle at a vertex add up to 90 degrees.	They add up to 180 degrees because they lie on a straight line.
A polygon can have more sides than angles.	The number of sides equals the number of angles, because each joint is a corner.

Differentiation

Learners who struggle

Give learners a card with the two steps: exterior angle is 360 divided by the number of sides, and interior angle is 180 minus the exterior angle. Let them fill a three-line frame for each polygon.

Learners who finish early

Ask learners who finish early to find the exterior and interior angles of a regular pentagon and a regular octagon, and to explain what happens to the interior angles as the number of sides increases.

Hearing or visual impairment

For learners with visual impairment, build the polygons from sticks and string so they can feel each side and corner. For learners with hearing impairment, write each step of the calculation on the board and show the angles on the stick model.

No projector, no printing

Use sticks, grass stems or strips of paper to build polygons, and draw all shapes with chalk on the board or on the ground.

If time is short

Teach regular and irregular polygons and the rule for exterior angles, then work the hexagon example. Leave the extra calculations for the next lesson.

Evaluation

Question or task	A correct answer shows
A craftsman in Luangwa is weaving a mat with a regular hexagon pattern and wants the angles for each corner. (a) How many sides does a hexagon have. (b) Find the exterior angle. (c) Find the interior angle.	(a) 6 sides. (b) 360 divided by 6 = 60 degrees. (c) 180 - 60 = 120 degrees.
A learner at a school looks at a football, a window frame and a square paver and sorts the shapes into regular and irregular polygons. (a) Say what makes a polygon regular. (b) Name one regular polygon from the note. (c) Say what makes a polygon irregular.	(a) All sides equal and all angles equal. (b) A square, an equilateral triangle or a regular hexagon. (c) Unequal sides or unequal angles, with at least two sides of different lengths.
A learner in Lusaka builds a polygon with sticks joined at the ends and extends one side at a vertex. (a) Say how many angles a polygon with 5 sticks has. (b) Say what the interior and exterior angle at one vertex add up to. (c) Say what all the exterior angles add up to.	(a) 5 angles, because the number of sides equals the number of angles. (b) 180 degrees. (c) 360 degrees.

Homework

A builder in Chipata lays square pavers and triangular pavers, all regular, on a path. (a) Find the exterior angle of a square. (b) Find the interior angle of a square. (c) Find the exterior and interior angles of an equilateral triangle.

Extra practice with answers

Question	Answer
1. A trader in Lusaka makes a stand in the shape of a regular octagon, which has 8 sides. (a) Find the exterior angle. (b) Find the interior angle. (c) Say what the exterior angles of all 8 corners add up to.	(a) 360 divided by 8 = 45 degrees. (b) 180 - 45 = 135 degrees. (c) 360 degrees.

2. A learner at a school in Luangwa draws a regular pentagon, which has 5 sides. (a) Find the exterior angle. (b) Find the interior angle. (c) Say what the interior and exterior angle add up to.	(a) 360 divided by 5 = 72 degrees. (b) 180 - 72 = 108 degrees. (c) 180 degrees.
3. A builder in Chipata lays square pavers and notes that each paver is a regular polygon. (a) How many sides does a square have. (b) Find the exterior angle. (c) Find the interior angle.	(a) 4. (b) 360 divided by 4 = 90 degrees. (c) 180 - 90 = 90 degrees.
4. A learner compares a regular hexagon with a regular octagon and notices that the number of sides changes the angles. (a) Which has the bigger interior angle, using 120 degrees and 135 degrees. (b) Which has the bigger exterior angle, using 60 degrees and 45 degrees. (c) Say what happens to interior	(a) The octagon, 135 degrees. (b) The hexagon, 60 degrees. (c) Interior angles get bigger and exterior angles get smaller.

Answers to the learners' check-yourself questions

1. What is a regular polygon?
   A polygon with all sides equal and all angles equal.
2. What is an irregular polygon?
   A polygon with unequal sides or unequal angles.
3. What do the interior angle and exterior angle at one vertex add up to?
   180 degrees.
4. What is the sum of the exterior angles of any polygon?
   360 degrees.
5. Find the exterior angle of a regular pentagon and its interior angle.
   Exterior = 360 divided by 5 = 72 degrees; interior = 180 - 72 = 108 degrees.
6. A road sign near a school in Luangwa is in the shape of a regular octagon. (a) How many sides and angles does it have? (b) Find each exterior angle, showing working. (c) Find each interior angle.
   (a) 8 sides and 8 angles. (b) 360 divided by 8 = 45 degrees. (c) 180 - 45 = 135 degrees.
7. A builder in Lusaka lays regular hexagon pavers. One paver is cut so that two sides are shorter than the rest. (a) Is the cut paver still a regular polygon? (b) Explain your answer using sides and angles. (c) Find the exterior angle of one of the original regular pavers.
   (a) No, it is now irregular. (b) A regular polygon must have all sides equal and all angles equal, and the cut shape does not. (c) 360 divided by 6 = 60 degrees.

Teacher's reflection

What went well:

What I will change next time:

Learners who need follow-up: