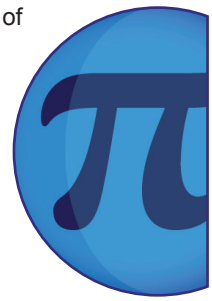
Designing Chartres

Key Learning Content

This film introduces some of the more specialised properties of circles using as an example the design of Chartres cathedral in France and, in particular, its famous circular Rose Window. The film shows how triangles, squares and circles can be found throughout the cathedral's design. The use of circles to draw accurate n-sided polygons is illustrated on screen. Circle Theorems for the angle in a semicircle, and for angles in the same segment, are stated and shown. The symmetry of the Rose Window is demonstrated. Finally, the optimum viewing angle for the window is constructed, making use of one of the Circle Theorems given previously.



Core Outcomes

Learning Points

- Be able to recognise the terms 'centre', 'radius', 'chord', 'diameter', 'circumference', 'tangent', 'arc', 'sector' and 'segment' of a circle.
- Be able to construct regular n-sided polygons using only a ruler and compass.
- Be able to recognise line and rotational symmetry.
- Be able to provide reasons, using standard geometrical statements, to support numerical values for angles obtained in any geometrical context involving lines and circles.

Suggested Activities

- Using only a ruler and compass, construct within a circle an equilateral triangle, square, regular pentagon, hexagon, octagon and other shapes of choice.
- Draw all lines of symmetry and identify the order of rotational symmetry of the Rose Window at Chartres.

Extension Outcomes

Learning Points

- Be able to understand that the angle subtended by an arc at the centre of a circle is twice the angle subtended at any point on the remaining part of the circumference.
- Be able to understand that the angle subtended at the circumference of a circle by a diameter is a right angle.
- Be able to understand that angles in the same segment within a circle are equal.

Suggested Activities

- Solve problems involving angles in circles using the Circle Theorems.
- Prove that there is an optimum viewing point to see the Rose Window at Chartres and describe the construction necessary to find that point.
- Work out how crop circles are constructed using only a straight edge and rope.

Related Films

To use before the lesson plan:

Beating the U-Boats	This film explains how the special properties of circles helped to protect merchant vessels during the war.

To use after the lesson plan:

Calculating Pi: Archimedes	This film describes an ingenious method for estimating Pi using polygons within circles.
Arches	This film provides more descriptions of the use of geometry and curves in architecture.
The Greeks and Proof	This film features the principles of mathematical proof as laid down by the discoverers of the Circle Theorems.
Geometry: Euclid	This film gives examples of the mathematical theorems documented by Euclid in one of the most widely read textbooks of all time.

Guide Lesson Plan

Introduction

Ask students what they think is the most spectacular or beautiful building they know that was built in their lifetime. Then show images of Chartres cathedral and ask students when they think it was built. Discuss whether a building like this could be built today.

Show Film

Designing Chartres

Main Activity

Foundation

Show students how to construct an equilateral triangle, square and hexagon inside a circle, working only with a straight-edge and compass, the method used by ancient Greek mathematicians. Then set students the challenge of constructing other regular polygons inside circles (warn students that some regular polygons cannot be constructed in this way.)

Advanced

Go through the proofs of the two Circle Theorems shown in the film, then set simple problems that can be solved using them. State the other Circle Theorems and challenge students to prove these in a similar way.

Extension Activity

Foundation

Challenge students to construct, using only ruler and compass, regular polygons of sides 15, 16 and 17. Then ask how they could then simply construct polygons of sides 30, 32 and 34. Is there any limit to the size of polygons that can be constructed?

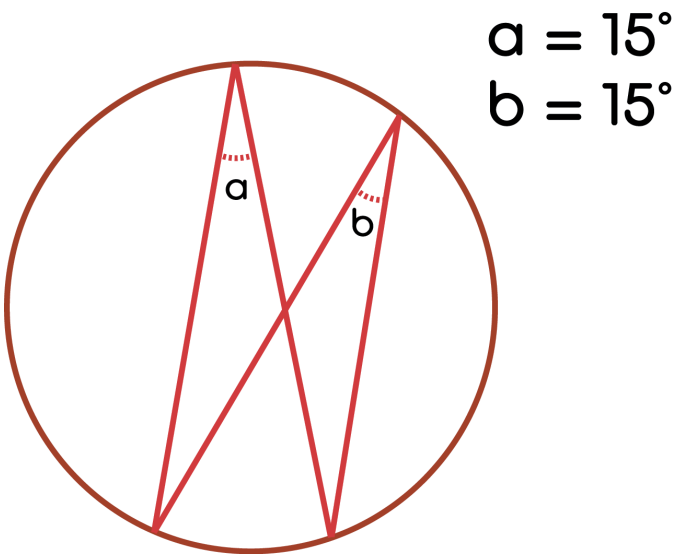
Advanced

Get students to demonstrate and prove the viewing angle result shown at the end of the film, using only the Circle Theorems used previously. This result has a special name; get students to research the name and explain its origins.

Optional Extra

Crop circles could be made by alien spacecraft – or by people with basic implements such as a plank and length of rope. Get crop circle images from the internet and work out how they could have been made by humans.

Medieval architects mapped out precise proportions for their immense churches using the mathematics of triangles and squares.



The angle formed from two points on a circle's circumference are equal to other angles in the same segment, formed from those two points.