Beating the U-Boats

Key Learning Content

This film tells the story of how supply ships in the Second World War were protected from attack by travelling in large convoys. The film illustrates how the most efficient configuration of the convoy was circular; the larger the circle, the better. A graph of area and circumference plotted against radius is used to demonstrate that area grows more quickly than circumference as radius increases.

Core Outcomes

Learning Points

- Be able to find the perimeters of shapes made from triangles and rectangles.
- Be able to recognise the terms ‘centre’, ‘radius’, ‘diameter’, ‘circumference’, ‘arc’ and ‘sector’ of a circle.
- Be able to find circumferences and areas of circles using relevant formulae.

Suggested Activities

- Learn the formulae for area and circumference of a circle and apply them to simple problems.
- Calculate the area and arc lengths of sectors of circles.

Churchill’s advisers used the principles of geometry to outsmart the U-Boat commanders and defend supply routes.

Extension Outcomes

Learning Points

- Be able to set up problems involving direct proportion, and relate algebraic solutions to graphical representation of the equations.
- Be able to understand and use the formula ½bc sin A for the area of a triangle.
- Be able to manipulate algebraic fractions where the numerator and/or the denominator can be quadratic.
- Be able to understand the process of manipulating formulae to change the subject where the subject may appear twice or a power of the subject occurs.
- Be able to interpret information presented in a range of linear and non-linear graphs.

Suggested Activities

- Calculate the ratio between the perimeter and area of an equilateral triangle, and of a square, as the side length increases.
- Calculate the ratio between perimeter and area of a circle as the radius increases.
- Plot results on a graph to illustrate the greater ‘efficiency’ of large circles.

Related Films

To use before the lesson plan:

Perspective: Dazzle Camouflage	This film gives an example of how geometry and perspective tricks were used by the military to protect ships at sea.
Tank Wars	This film shows how statistics were used to estimate the number and size of enemy forces in the Second World War.

To use after the lesson plan:

Designing Chartres	This film explores how complex properties of circles were used in the design of this famous French cathedral.
Calculating Pi: Archimedes	This film asks how Pi was calculated thousands of years ago.
Bees and their Hives	This film shows how bees use the geometrical properties of hexagons to build hives.

Guide Lesson Plan

Introduction

Blow some soap bubbles across the room and ask students why the bubbles have this particular shape. Ask if anyone has ever seen a bubble in the shape of a cube, or a tetrahedron. Why don't these shapes commonly occur?

Show Film

Beating the U-Boats

Main Activity

Foundation

Hand out a worksheet showing shapes made from straight edges and semicircles. Get students to calculate areas and perimeters and check results.

Next, get students to calculate the perimeter and area of a square and circle of side or radius 1cm, 2cm, 3cm, 4cm and 5cm. Tabulate results and calculate the ratio of area to perimeter in each case. Comment on results.

Main Activity cont ...

Advanced

Get students to write down formulae for the area and perimeters of an equilateral triangle, a square and a circle. Then form algebraic fractions with the perimeter formulae as numerator and the area formulae as denominator. Simplify and interpret these expressions.

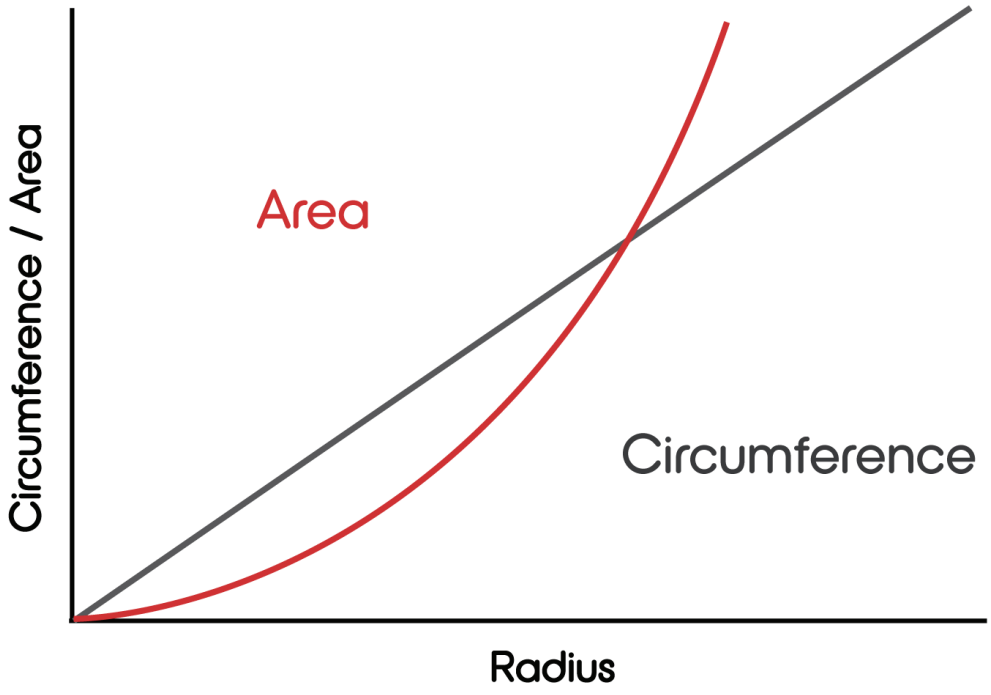
Plot these expressions on a graph with length of side or radius on the x-axis and interpret results.

Extension Activity

By changing the subject of a formula and by algebraic substitution, construct formulas for the perimeter of a square in terms of its area, and the circumference of a circle in terms of its area. Plot these on a graph and interpret results.

Optional Extra

Similar efficiency arguments apply to volumes. Calculate surface area and volume for a range of 3D shapes and explore what happens as volume increases. Plot ratios on a graph and interpret results (refer back to the soap bubbles at the beginning of the lesson).



The number of supply ships in a convoy was proportional to the area of the circle, but the number of guard ships needed was proportional to the circumference of the circle.