# How a Circle Is Like a Rectangle

## Overview

A video introduction shows how dividing a circle into wedges to make a rectangle demonstrates how to find its area. Students then use physical representations of shapes to explore how other shapes relate to each other.

### Guiding Question

How can we use what we know about two-dimensional shapes to estimate the area of other shapes?

### Objectives

Students will be able to physically represent concepts such as area, perimeter, and circumference.

## Background

The video demonstrates an idea in mathematics known as a dissection argument, in which people infer something about a shape by dividing it into other shapes. In this case, a circle can be divided into wedges of equal size, which can then be rearranged to form an approximate rectangle whose height is the radius of the circle and whose base length is half of the circumference of the circle (pi times radius). Since the area of a rectangle is base times height, it is possible to derive the area of a circle (pi times radius times radius). This approximation becomes more accurate as the circle is divided into smaller wedges; understanding this method of reasoning prepares students for more complex mathematics such as derivatives.

**Time:** 15–20 minutes

**Grade Level:** 7

### Vocabulary

- Area
- Circumference
- Perimeter
- Radius
- Tangram

### Standards

**CCSS.Math. Content.7.G.B.4.**
Know the formulas for the area and circumference of a circle and use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle.

**NGSS Science and Engineering Practice:**
Using Mathematics and Computational Thinking

Tangram puzzles originated in China in the 18th century. This geometric game consists of a square subdivided into seven shapes, which a user can arrange into many new silhouettes. Reasoning as they did in the case of the circle, students can use their knowledge of the dissection argument to intuit that all arrangements of tiles have the same area—the area of the original square. This activity asks students to explore the many ways to arrange simple shapes into more complex figures, from geometric shapes to creative, abstract figures.

## Preparation

For this activity, the educator will need the following:

- Video: *How a Circle Is Like a Rectangle* (1:42) (English | Spanish)
- A way to show the video to students

For this activity, each student will need the following:

- 1 copy of *Tangrams* (English | Spanish)
- Scissors to cut out tangram shapes from template

## EiE® Connections

Continue your classroom activities with *Engineering Everywhere*® units that empower middle schoolers to become more effective problem solvers.

## Museum of Science Connections

Watch *Engineering for Art* to see how engineers and artists work together to make a sculpture of shapes that will fit in the Museum's space.

Visit the *Math Moves* exhibit in person at the Museum of Science, Boston, to bring ratio and proportion to life.

## Family Connections

Continue the learning at home with EiE Families and STEM Events or Family STEM Activities from MOS at Home.

### *Credits*

MOS at School programs are offered at no cost, thanks to the generosity of the Akamai Foundation, Bloomberg Philanthropies, BNY Mellon, Gordon Foundation, Hood, Lincoln and Therese Filene Foundation, Lowell Institute, Mabel Louise Riley Foundation, MathWorks, Richard K. Lubin Family Foundation, Sanofi, and TJX.

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## Activity Instructions

These steps offer support for implementing the How a Circle Is Like a Rectangle video introduction and follow-up activity with students.

1. Before showing the video introduction, discuss these questions:

> **Q: How can we find the area of a circle?**
>
> *A: Responses will vary. Students may know that the formula for the area of a circle is pi times the radius squared. Explain that students will learn a method of remembering this formula by turning a circle into a rectangle.*

> **Q: How would you turn a circle into a rectangle?**
>
> *A: Accept all responses.*

> **Q: What other shapes can you make from a circle by cutting it into pieces using straight lines?**
>
> *A: Accept all responses. Possible responses include half-circles, quarter-circles, and wedges.*

2. Play the video *How a Circle Is Like a Rectangle* (1:42). This video shows an easy way to remember the formula for the area of a circle by transforming that circle into a rectangle.

**watch video**

3. After showing the video, discuss these questions:

> **Q: How is the circumference of a circle related to its area?**
>
> *A: If the circle is transformed into a rectangle, one side is equal to half its circumference. If necessary, remind students that a* ***circumference*** *is the distance around the outside of a circle and* ***area*** *is the amount of space inside a shape.*

**Q: How many triangles do you need to make a square?**

*A: Two triangles are the minimum required to make a square, but squares can be made from larger numbers of triangles as well.*

4. Distribute the *Tangrams* (English | Spanish) handouts to students and have them cut out the shapes. If appropriate, consider whether your students would benefit from using an alternate modality, such as virtual tangrams. Ask:

**Q: What do you already know about tangrams?**

*A: Responses will vary. If necessary, explain that **tangrams** are a geometric puzzle made up of a square cut into seven pieces that can be arranged to make other shapes, and that they originated in China in the 18th century.*

5. For the first five minutes, have students work individually on recreating the shapes from the handout. Emphasize that it is okay to struggle and that students may make valuable discoveries even if they fail to make the shapes shown.

6. For the next five minutes, have students make their own shape combinations.

7. For the final five minutes, have students combine their tangram tiles/paper and work in groups of 2–3 to make new shapes.

8. After completing the activity, discuss these questions:

**Q: What did you observe about the way shapes relate to each other?**

*A: Accept all responses. An important observation is that all puzzles requiring all seven pieces have the same area—the area of the original square.*

**Q: How might this relationship be different with three-dimensional shapes like cubes, spheres, or pyramids?**

*A: Accept all responses. Students may suggest that smaller shapes into which a three-dimensional shape is divided will together have the same volume as the original shape.*

**Q: Why might it sometimes be more helpful to have a rectangular object than a circular one?**

*A: Possible responses include fitting into corners and not rolling away.*

# Glossary

***Area***
the amount of space inside a shape

***Circumference***
the distance around the outside of a circle

***Perimeter***
the distance around the outside of a shape

***Radius***
the distance in a straight line from the center of a circle to its edge

***Tangram***
a geometric puzzle made up of a square cut into seven pieces
that can be arranged to make other shapes