Problem 1.1

A Sort the polygons in the Shapes Set into groups that have one or more properties in common.

1. Describe the properties shared by the members of each group.
2. Sketch another shape that belongs in each group.

B Polygons with three sides (and three angles) are called *triangles*. How are the triangles in the Shapes Set different from each other?

C Polygons with four sides are called *quadrilaterals*. Sort the quadrilaterals in the Shapes Set into two or more subgroups. What properties do the subgroup members share?

D A group of students put shapes R, O, and S into the same group.

1. What properties do R, O, and S share?
2. Would shape Q belong in this group? Why or why not?
3. Would shape L belong in this group? Why or why not?

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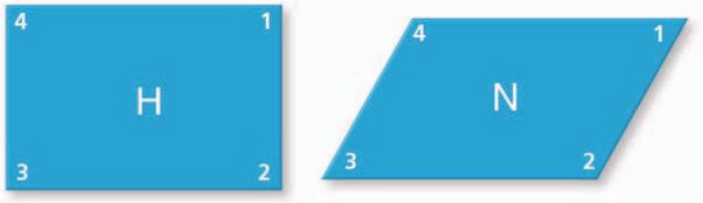
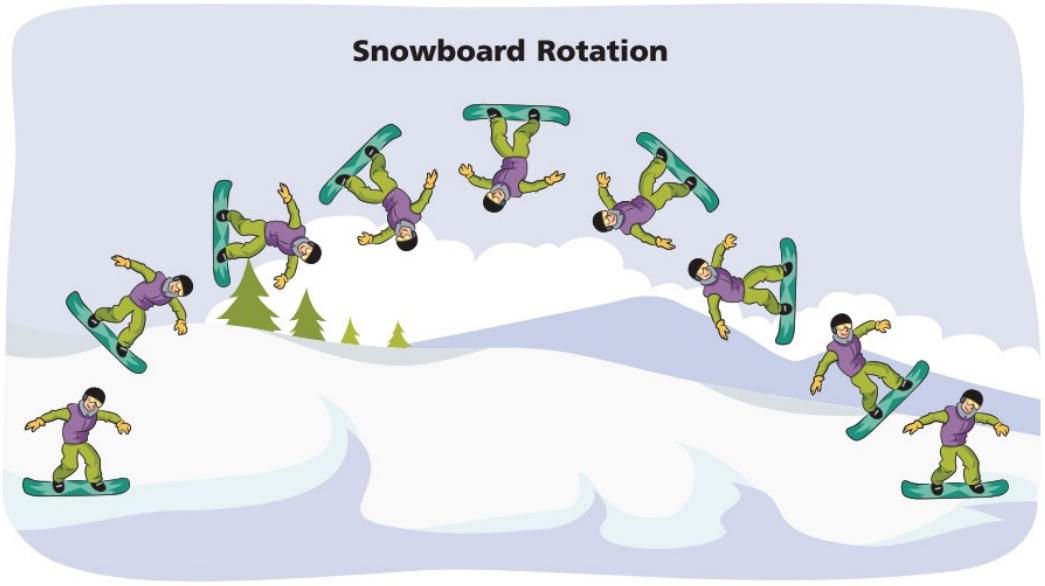
1.2 In a Spin
Angles and Rotations

The shape of any polygon depends on the number and length of its sides. The shape also depends on the angles at which those sides meet. Here are two quadrilaterals with identical side lengths, but different shapes.



The term *polygon* is a Greek word that means "many angles." You will look at how the side lengths and angles affect the shape of a polygon. To begin, you will explore angles.

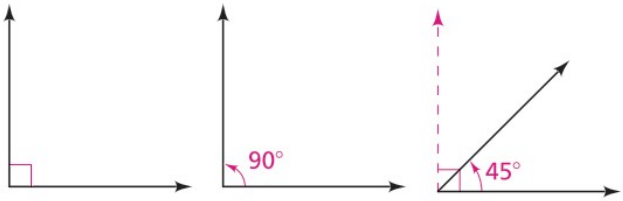
The *X-Games* are popular summer and winter sports events. Contestants perform spectacular jumps, flips, and spins on skateboards, snowboards, motorcycles, bicycles, and even snowmobiles. Judges, competitors, and fans describe the challenge of a flip or spin with numbers like 180, 360, 540, 720, 900, or 1080.



Measuring flips and spins involves thinking about an angle as a change in direction called a *rotation*. In mathematics, you measure an angle or a rotation with a unit called the **degree.** Rotation angles are measured from 0 degrees to 360 degrees or more to indicate turns from a small amount to one full turn (and more).

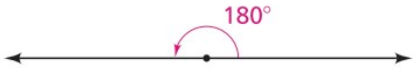
You measure rotation angles in a counterclockwise direction. A rotation angle has an *initial* and a *terminal side*. The initial side is the ray showing the starting direction while the terminal side is the ray showing the ending direction after the rotation.

A one-quarter rotation is 90°. A **right angle** measures 90°. Right angles are commonly marked with a small square. Suppose you draw a ray to divide a right angle into two angles of equal measure. Each angle would be a 45° acute angle.



Suppose you draw 89 rays to divide a right angle into 90 angles of equal measure. Each angle would have a measure of 1°.

A rotation of one-half turn defines a *straight angle*. It measures 180°.



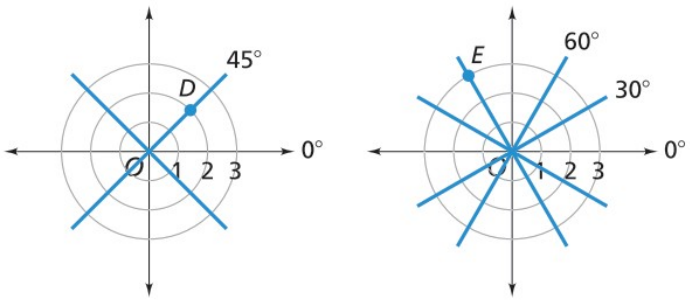
Recall that angles whose measures are less than 90° are called *acute angles*. Angles whose measures are between 90° and 180° are called *obtuse angles*.

- Can you jump and turn through angles of 90°, 180°, 270°, or even 360°?

Did You Know?

The ancient Babylonians measured angles in degrees. They set the measure of an angle that goes all the way around a point to 360°. They may have chosen 360° because their number system was based on the number 60. They may have also considered the fact that the number 360 has many factors. This makes it easy to measure many fractions of full turns.

Estimating and measuring rotation angles is easier if you know some *benchmark angles*. Playing the Four in a Row game will help you build your angle sense. The Four in a Row game is played on the circular grids shown below.



The grid on the left has lines at 45° intervals. The grid on the right has lines at 30° intervals. The circles are numbered 1, 2, and 3 as you move out from the center at 0. Point *D* has coordinates (2, 45°).

- What are the coordinates for the location of point *E*?

Four in a Row

Directions

Choose one of the circular grids. The grids have either 30° or 45° intervals.

- Player A chooses a point where a circle and grid line meet. Then Player A says the coordinates of the point.
- Player B checks that the coordinates Player A gave are correct. If they are, Player A marks the point with an X. If they are not, Player A does not mark the point.
- Player B chooses a point and says its coordinates. If the coordinates are correct, Player B marks the point with an O.
- Players continue to take turns, saying the coordinates of points and marking the points.
- The first player to get four marks in a row, either along a grid line or around a circle, wins the game.

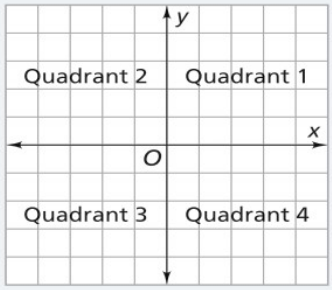
Problem 1.2

A Play Four in a Row several times. Play games with the 30° grid and the 45° grid. Write down any winning strategies you discover.

On one of the circular grids, label points A, B, and C that fit the descriptions in parts (1)–(3) below. Explain your reasoning.

1. The angle measure for point A is greater than 120°.
2. The angle measure for point B is equal to 0°.
3. The angle measure for point C is less than 90°.
4. Will everyone in class have the same points marked? Why or why not?

B In the Four in a Row game, the circular grids have horizontal and vertical axes. They divide the playing area into four sectors called *quadrants*.



What can you say about measures of rotation angles with the first side on the positive x-axis (to the right) and second side in each quadrant below?

1. Quadrant 1
2. Quadrant 2
3. Quadrant 3
4. Quadrant 4

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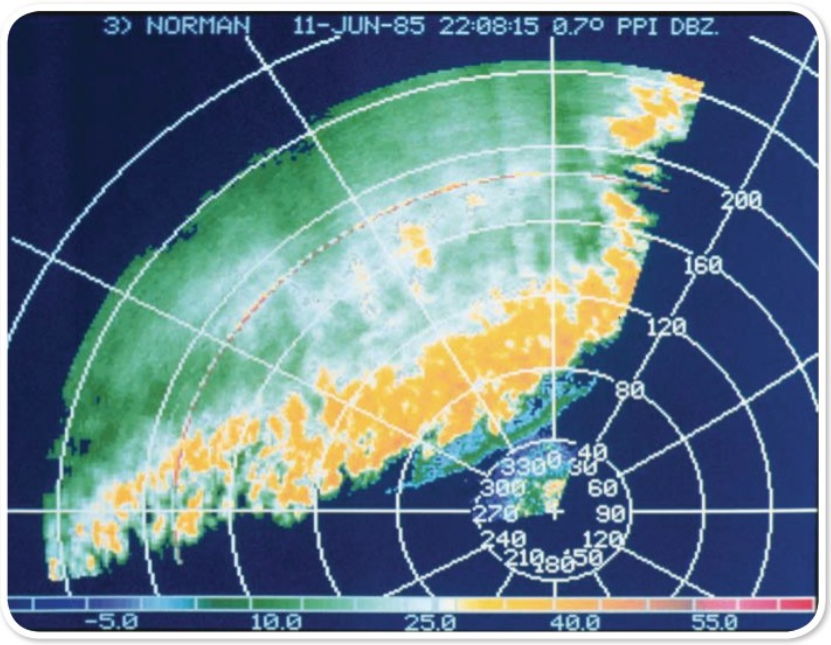
Did You Know?

The circular grids used to play Four in a Row are examples of polar coordinate systems. Sir Isaac Newton used polar coordinates in his contributions to mathematics and science.



Polar coordinates are commonly used to locate ships at sea, planes in the air, or rain and snowstorms. An object appearing on a radar screen is a moving point or region. It has direction (in degrees) and distance from the radar site.