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Master 1 Geoboard Recording Paper

Master 2 12-Point Recording Paper

Master 3 12-Point Design Paper

Introduction

The **Exploring Geometry Through Designs MathBox** is a set of thirty-two activities that engage students in creating geometric figures and designs using a compass, straightedge, protractor, and ruler. Students learn how to create a variety of designs based on circles, triangles, squares, hexagons, octagons, and dodecagons. They begin by copying designs, and then use their own imaginations to construct and color original designs.

Creating geometric designs is a motivating activity that appeals to students with a wide range of abilities. Students who have difficulty with computation often experience success with geometry and gain recognition from their peers. Advanced students can create complex designs and write directions for other students to follow. Through the active process of creating designs, students can discover many geometric relationships and develop an appreciation for the beauty of geometry.

In Standards 2000, the National Council of Teachers of Mathematics calls for an emphasis on patterns, geometry, and spatial sense at the middle school level.

Specific focus is placed on:

- understanding various types of patterns and functional relationships
- analyzing properties of geometric objects

This math box was written to help teachers implement these standards. The activities are appropriate for individual work, partners or groups, activity centers, or for whole class lessons.

Materials

Tools

compass, straightedge, ruler, and protractor

Drawing materials

standard 8 1/2" by 11" paper, colored construction paper, crayons, colored pencils, markers, scissors, and glue

Students do not write on the reproducible activity pages. Pages can be laminated for use in an activity center. Transparencies can also be made for presenting a lesson to an entire class or group of students.

Manipulatives (optional):

geoboards, circular geoboards, pattern blocks, and mirrors

Sequence

In general, the activities are intended to be followed in sequence. However, a teacher may adapt this sequence and pick and choose activities to meet instructional goals for a particular group of students.

Bulletin Board

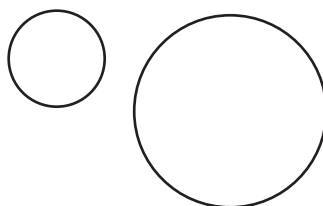
Students take pride in sharing their completed work on a bulletin board or other display area. Many of the designs will be unique, and students can learn a lot by viewing and discussing each other's work.

Drawing Circles and Arcs

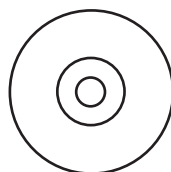
A **compass** is a tool for drawing circles and parts of circles called arcs.

Practice using a compass.
Experiment and have fun!

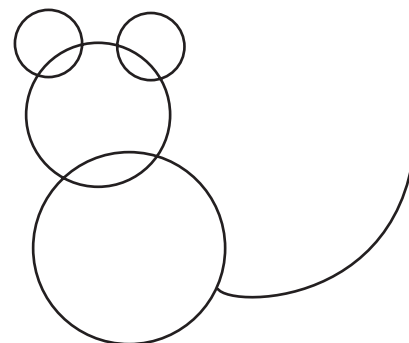
Draw circles of different sizes.



Draw several circles that have the same center.



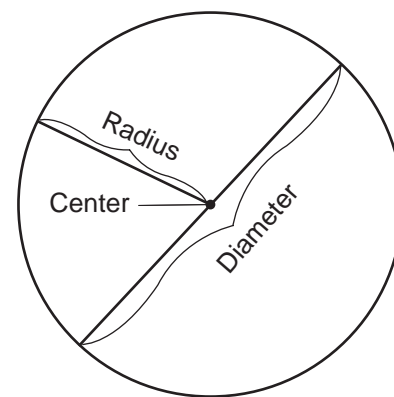
Draw overlapping circles.



Draw a part of a circle, called an arc.

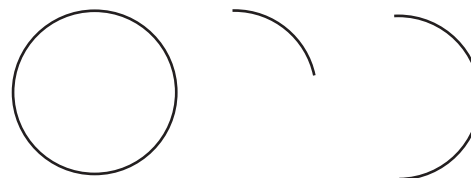
A **circle** is a plane figure in which all the points are the same distance from a point called the center.

The **radius** is a line segment from the center of a circle to a point on the circle. The term radius is also used for the length of such a segment.



The **diameter** is a line segment that passes through the center of a circle and has its endpoints on the circle. The term diameter is also used for the length of such a segment.

An **arc** is a part of a circle. The circle and the arcs shown in the picture all have the same radius.

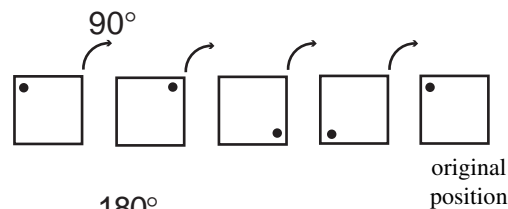


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1. Draw a circle with a radius of 3 centimeters.
Draw another circle with the same center and a radius of 5 centimeters.
 2. Draw an arc with a radius of 4 centimeters.

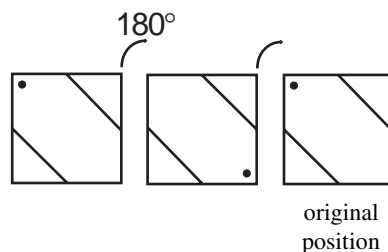
Rotational Symmetry in Designs

A plain square has rotational symmetry of order 4.

In the picture, a dot is marked in one corner of the square to keep track of the original position. Each time the square is rotated a quarter turn (90°), it looks the same.

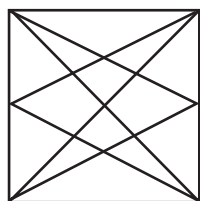


When a design is added to the square, the order of rotational symmetry is sometimes changed. This design looks the same when it is rotated a half turn (180°). The rotational symmetry of the design is order 2.

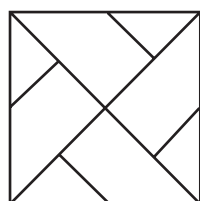


Write the order of rotational symmetry for each of these shapes.

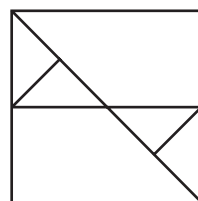
1.



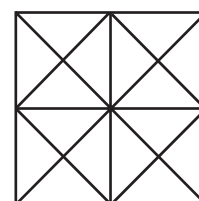
2.



3.



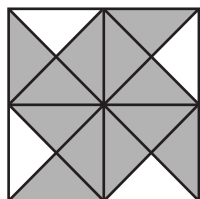
4.



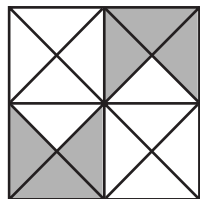
The way that a design is colored can sometimes change the rotational symmetry.

Write the order of rotational symmetry for each of these shaded designs.

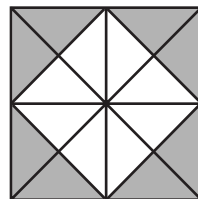
5.



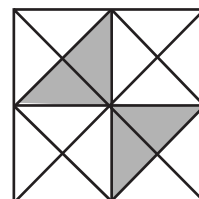
6.



7.



8.

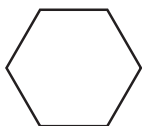


9. Create a square design that has rotational symmetry. Does your design have line symmetry as well?

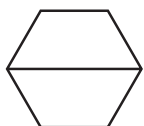
Tessellations

You can divide a regular hexagon in half, thirds, or sixths to make other shapes.

1 hexagon



2 trapezoids



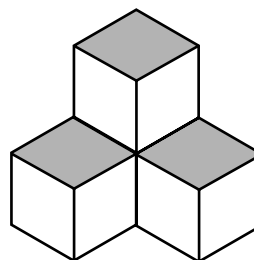
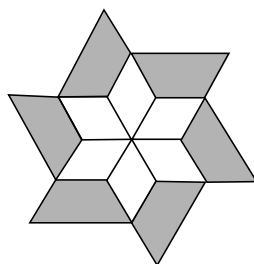
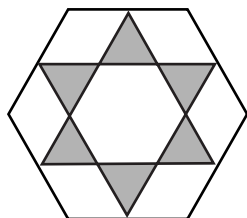
3 rhombuses



6 equilateral triangles



By fitting these shapes together, you can create many designs and patterns.



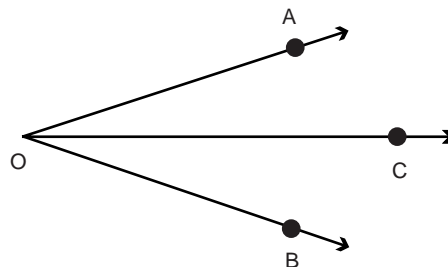
A **tessellation** is an arrangement of shapes that covers a surface completely without overlaps. Tessellating shapes are often used as tiles for surfaces such as floors and walls.

1. Make a set of shapes from colored construction paper.
 - Step 1. Make a hexagon template by drawing a hexagon on a piece of cardboard and cutting it out.
 - Step 2. Trace around the template on several pieces of construction paper of different colors. Cut some of the hexagons in half, thirds, or sixths to make other shapes.
2. Fit the shapes together to create a variety of designs and patterns. Glue your favorite design to a piece of construction paper.

Bisecting an Angle

To **bisect** an angle means to divide the angle into two angles of equal measure.

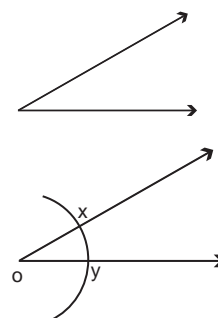
The ray \overrightarrow{OC} bisects $\angle AOB$.
 $\angle AOC$ and $\angle COB$ have the same measure.



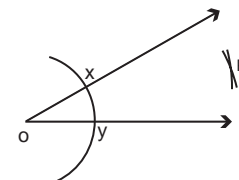
One way to bisect an angle is to measure with a protractor.

You can also bisect an angle using a compass and straightedge.

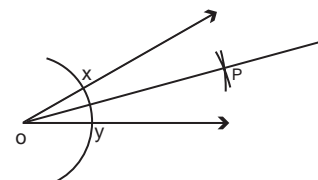
Step 1: Draw an arc with center O. Label points X and Y.



Step 2: Draw arcs with centers at X and Y. Label the intersection of the arcs P.



Step 3: Draw \overrightarrow{OP} . \overrightarrow{OP} bisects $\angle XOY$.



1. Use your straightedge to draw two angles:

- an acute angle (measuring between 0° and 90°) and
- an obtuse angle (measuring between 90° and 180°).

Then use your compass and straightedge to bisect each angle.

2. Draw a straight angle. The measure of a straight angle is 180° . Use your compass and straightedge to bisect the angle.

