| | |
|---|---|
| **Lesson Title** | Properties of a Rhombus |
| **Length of Lesson** | 50 minutes |
| **Created By** | Emily Burtnett |
| **Subject** | High School Geometry |
| **Grade Level** | 9-12th grades |
| **State Standards** | 3a |
| **DOK Level** | 2 |
| **DOK Application** | Develop mathematical arguments about geometric relationships and describe spatial relationships using coordinate geometry. Analyze and describe the characteristics of symmetry relative to classes of polygons (parallelograms, triangles, etc.). |
| **National Standards** | Use visualization, spatial reasoning, and geometric modeling to solve problems. Draw and construct representations of two- and three-dimensional geometric objects using a variety of tools; use geometric ideas to solve problems in, and gain insights into, other disciplines and other areas of interest such as art and architecture. |
| **Graduate Research Element** | Control volumes used in many computational fluid dynamic applications are often in the shape of a parallelogram. Parallelograms are used in unstructured grids for simulations that require a unique grid spacing around an irregular object such as an aircraft wing where flow around the leading edge is unique and require more grid points. |

**Student Learning Goal:**
Students will learn the properties of a rhombus by changing the measures of the interior angles with a hands-on activity.

**Materials Needed (supplies, hand-outs, resources):**
4 1/2" by 9" strips cut from a manila folder, four brads, hole punch, ruler, protractor, handout (see attached)
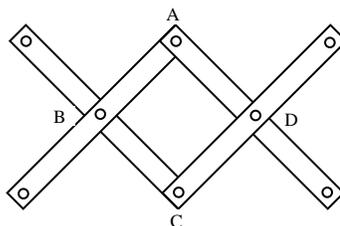
**Lesson Performance Task/Assessment:**
- Make a mug rack.
  - Cut out four strips from a manila folder measuring ½" by 9"
  - Punch three holes in each manila folder strip, one centered at the midpoint of the strip and two centered ½ inch from each end.
  - Arrange the four strips as shown in the illustration below

- Fasten the overlapping strips with a brad through each hole at A, B, C, and D.

- On a sheet of paper, draw a horizontal line segment approximately 8 inches long. Lay the mug rack on the paper with points B and D on the horizontal line. Mark points on the paper for A, B, C, and D at the inside edges of the mug rack. Make sure B and D are on the horizontal line.
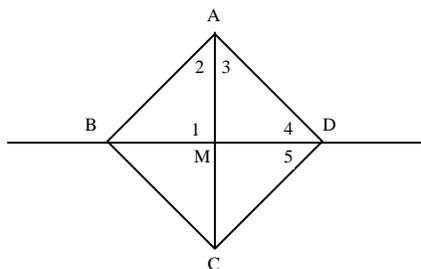
- Remove the mug rack, and use a straight edge to draw rhombus ABCD.

- Measure the lengths of the sides of the rhombus and enter the values in the column for "Rhombus 1" in the table below.

| Properties | | Rhombus 1 | Rhombus 2 | Rhombus 3 |
|---|---|---|---|---|
| Sides | AB | | | |
| | BC | | | |
| | CD | | | |
| | DA | | | |
| Diagonals | AC | | | |
| | BD | | | |
| Diagonal Segments | MA | | | |
| | MC | | | |
| | MB | | | |
| | MD | | | |
| Diagonals' Angle | m<1 | | | |
| Adjacent Angles at Vertices | m<2 | | | |
| | m<3 | | | |
| | m<4 | | | |

| | m<5 | | | |
|---|---|---|---|---|

- Draw diagonals AC and BD. Measure the lengths of the diagonals and enter the values in the table.

- Label the point of intersection of the diagonals point M. Measure the lengths of MA, MC, MB, and MD. Enter these values in the table.

- Is M the midpoint of both diagonals?

- Measure <1 formed by the intersecting diagonals. What is the measure of the other three angles with vertices at M? Record this value in the table.

- Measure the adjacent angles, <2 and <3, formed by the diagonal. Measure the adjacent angles formed at the opposite vertex, C. Compare these two pairs of adjacent angles. Record m<2 and m<3 in the table.

- Repeat step #9 for the adjacent angles at vertex D and at vertex B. Record m<4 and m<5 in the table.

- Stretch or shrink the mug rack, and repeat steps #2 - #10 for two additional rhombuses with different interior angles. Complete the last two columns of the table.

- This activity demonstrates the basic properties of a rhombus. Review the data in your table. Complete the following statements that summarize your findings using choices a-f.
    - The sides of a rhombus are _____.
    - The diagonals of a rhombus _____ each other.
    - The diagonals of a rhombus are _____ to each other.
    - The diagonals of a rhombus _____ pairs of opposite angles.

    a. Collinear
    b. Perpendicular
    c. Bisect
    d. Parallel
    e. Congruent
    f. Correspond to

**Lesson Relevance to Performance Task and Students:**
Building and manipulating a non-static rhombus allows students to investigate properties of rhombi. Students will learn the properties of a rhombus and how they can be applied to real-world applications such as construction, art or architecture.

**Anticipatory Set/Capture Interest:**
There is no anticipatory set for this lesson. When students are informed that they will be building something, that alone is usually enough to motivate them to begin the activity. Students will be told they will be building a non-static rhombus and given materials and instructions and begin immediately. After the activity is finished, the instructor will close the lesson with a discussion.

**Guided Practice:**
After the students have completed the activity, the instructor will review the properties of rhombi and ask students to discuss their findings.

Theorem: If one diagonal of a parallelogram bisects two angles of the parallelogram, then the parallelogram is a rhombus.

Theorem: If the diagonals of a parallelogram are perpendicular, then the parallelogram is a rhombus.

**Independent Practice:**
Students will construct a non-static rhombus that they can manipulate and measure to discover the various properties of the parallelogram. Working independently, they will take measurements of three different rhombi and record their findings in a table for comparison.

**Remediation and/or Enrichment:**
For enrichment, the instructor could ask the students to describe the properties of various special parallelograms such as rectangles, and compare them to rhombi. Instructor may briefly introduce students to how parallelograms are used in unstructured grid generation for computational fluid dynamics applications in the engineering field.

For remediation, the instructor may guide the students through the construction of the mug rack or even have them prepared. The instructor can provide more information about properties of a rhombus prior to the activity to refresh students' minds or to introduce them to the special parallelogram. Students may be asked to measure and record data for one rhombus to save time. Individual IEPs will be supported.

**Check(s) for Understanding:**
This activity demonstrates the basic properties of a rhombus. Review the data in your table. Complete the following statements that summarize your findings using choices a-f.
- The sides of a rhombus are _____.
- The diagonals of a rhombus _____ each other.
- The diagonals of a rhombus are _____ to each other.
- The diagonals of a rhombus _____ pairs of opposite angles.

    g. Collinear
    h. Perpendicular
    i. Bisect
    j. Parallel
    k. Congruent
    l. Correspond to

**Closure:**
The instructor will review the basic properties of a rhombus and explain the difference between a rectangle and rhombus. The class will be asked to share/discuss their findings from the activity.

**Possible Alternate Subject Integrations:**
None

**Teacher Notes:**
Use attached worksheet.