Name: Date:

**Student Exploration:** **Parallelogram Conditions**

**Vocabulary:** parallelogram, trapezoid

**Main Street**

**Elm Avenue**

**Pine Street**

**East**

**West**

**Prior Knowledge Questions** (Do these BEFORE using the Gizmo.)

Tricia is programming a “robot” car to travel from Main Street to Pine Street. Main Street and Pine Street run exactly east-west.

1. Suppose the car is travelling due east on Main Street.
2. Tricia gives it the command to “turn right by 110 degrees” to turn onto Elm Avenue. What command

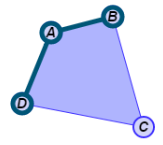
will she need to give the car for it to turn on to Pine Street, heading due east again?

1. What command will she need to give the car if she wants it to drive west (instead of east) when it reaches Pine Street?
2. On the map, Main Street and Pine Street are parallel, and Elm Avenue is a transversal that intersects both. What is the pair of angles marked on the map called?

**Gizmo Warm-up**

In the *Parallelogram Conditions* Gizmo, you can manipulate a dynamic quadrilateral with various constraints. You can explore which constraints guarantee that the quadrilateral is a **parallelogram** (a quadrilateral with two pairs of parallel sides).

1. Be sure **None** is chosen under **Condition**. Drag the vertices to create a quadrilateral that is *not* a parallelogram. Sketch your quadrilateral in the space to the right.



1. To open a Gizmo protractor, select **Show angle measure tool**. Measure an angle by attaching the “donuts” to three points, as shown to the right.

Drag the vertices of *ABCD* around. Use the Gizmo protractor to measure all four angles of one of the quadrilaterals. What do the angles measure?

*m*∠*A* = *m*∠*B* = *m*∠*C* = *m*∠*D* =

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| **Activity A:**  **Conditions that guarantee parallelograms** | Get the Gizmo ready:   * Under **Condition**, select **One diagonal bisects the other**. | 187SE2 |

1. With **One diagonal bisects the other** selected, drag the vertices of quadrilateral *ABCD*.
2. Which diagonal bisects which? (Fill in the blanks.) bisects
3. Continue dragging vertices of *ABCD*. Do you think that a quadrilateral with one diagonal bisected by the other is guaranteed to be a parallelogram? Explain.
4. Select **Diagonals bisect each other**. Study the figure while you drag the vertices.
5. Sketch one of the quadrilaterals in the space to the right.
6. Use the Gizmo protractor to measure ∠*ACB* and ∠*CAD*. What is true about these two angles? In your sketch above, mark these angles with arcs.
7. If ∠*ACB* ≅ ∠*CAD*, what must be true about  and ?

Explain why.

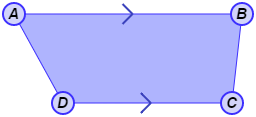
1. Which angles need to be congruent to prove that  || ?

Use the Gizmo protractors to measure the angles. Mark these angles in your sketch.

1. Does having the diagonals bisect each other guarantee that a quadrilateral is a parallelogram? Explain.

**(Activity A continued on next page)**

**Activity A (continued from previous page)**

1. Under **Condition**, select **One pair of opposite sides is ≅**. Drag the vertices of *ABCD* around. Does having one pair of opposite sides congruent guarantee that a quadrilateral is a parallelogram? Explain.
2. Select **One pair of opposite sides is ||**. Experiment with the quadrilateral. Does having one pair of opposite sides parallel guarantee that a quadrilateral is a parallelogram?

Explain.

A quadrilateral with exactly one pair of parallel sides is called a **trapezoid**.

1. Select **One pair of opposite sides is ≅ and ||** and **Show transversals**. Experiment by dragging the vertices around. Use the Gizmo protractor to measure the angles formed by the transversals and sides.
2. Are *both* pairs of opposite sides parallel? Explain.
3. Drag the vertices of *ABCD* a bit more. Is a quadrilateral with one pair of opposite sides that are congruent and parallel guaranteed to be a parallelogram?
4. Experiment with the Gizmo to help answer the questions below.
5. If both pairs of opposite sides are congruent, does that guarantee that a quadrilateral is a parallelogram? Explain.
6. If both pairs of opposite angles are congruent, does that guarantee that a quadrilateral is a parallelogram? Explain.

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| **Activity B:**  **Using parallelograms** | Get the Gizmo ready:   * Under **Condition**, select **None**. | 187SE4 |

1. State whether each statement is always, sometimes, or never true. Then, explain your answer, and check it in the Gizmo.
2. If one diagonal of a quadrilateral bisects the other, it is a parallelogram.

1. If one pair of opposite sides of a quadrilateral is congruent, it is a parallelogram.

1. Adjacent sides of a parallelogram are congruent.

1. Find the values of *x* and *y* that make each quadrilateral a parallelogram. Show your work.

**63°**

**(8*y* – 1)°**

**4*x* + 5**

**17**

**112°**

**(8*y* – 4)°**

**(10*x* – 8)°**

**(7*y* + 5)°**