



Name: \_\_\_\_\_

Date: \_\_\_\_\_

## Student Exploration: Biconditional Statements

**Vocabulary:** biconditional statement, conclusion, conditional statement, converse, hypothesis

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

1. Kara said, "A cheeseburger is a type of food."

A. Is this true? \_\_\_\_\_

B. Is this a good definition of a cheeseburger? \_\_\_\_\_ Why or why not? \_\_\_\_\_

\_\_\_\_\_

2. What is a better definition of "cheeseburger"? \_\_\_\_\_

\_\_\_\_\_

### Gizmo Overview

In the *Biconditional Statements* Gizmo, you'll work with a **conditional statement** (an if-then statement) and its **converse** (formed by switching the **hypothesis**, the "if" part of a conditional, and the **conclusion**, the "then" part). You'll use the conditional and converse to write two-way **biconditional statements** (if-and-only-if statements).

Here's how the Gizmo looks at first:

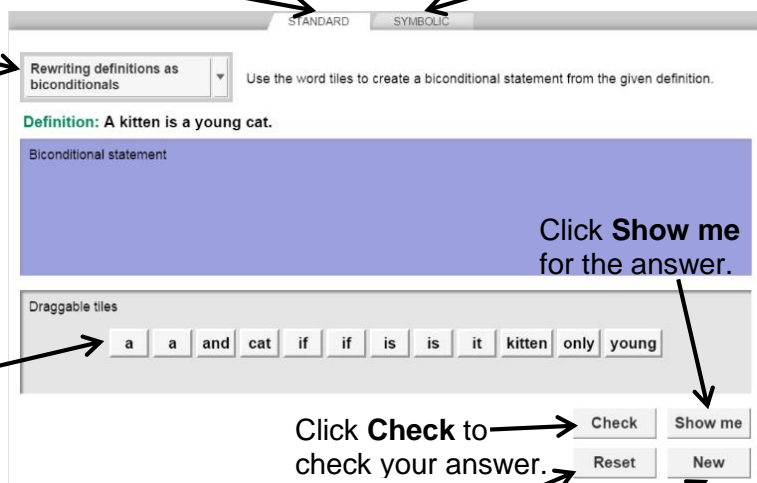
At the top, click the tabs to select a "mode": **STANDARD** (words) or **SYMBOLIC** (with symbols).

You can choose three different problem types from this menu:

- **Rewriting definitions as biconditionals**
- **Writing biconditionals**
- **Rewriting biconditionals as two conditionals**

Your job is to put these word tiles in the correct order in the bin above.

(Note that the bin(s) may be different depending on which problem type you've selected.)



Click **Check** to check your answer.

Click **Reset** to start over. Click **New** to try a new problem.



<b>Activity A:</b> <b>Rewriting definitions</b>	<u>Get the Gizmo ready:</u> <ul style="list-style-type: none"> <li>• Be sure the <b>STANDARD</b> tab is selected.</li> <li>• Select <b>Rewriting definitions as biconditionals</b>.</li> </ul>	<div style="border: 1px solid black; padding: 5px; background-color: #d9e1f2;">       Biconditional statement  <div style="border: 1px solid black; display: inline-block; padding: 2px;">if</div> <div style="border: 1px solid black; display: inline-block; padding: 2px;">and</div> </div>
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1. You should see the definition to the right at the top. **Definition: A kitten is a young cat.**

A. Are there any kittens that are not young cats? \_\_\_\_\_ How can you express that as a true conditional statement? Fill in the blanks below to do so.

If a cat \_\_\_\_\_, then it \_\_\_\_\_

B. Are there any young cats that are not kittens? \_\_\_\_\_ Express this as a conditional statement below. (This should be the converse of the above conditional.)

If a cat \_\_\_\_\_, then it \_\_\_\_\_

C. When a conditional statement and its converse are both true, you can combine them into one true biconditional (“if and only if”) statement. Fill in the blanks below with the hypothesis and conclusion to form this statement.

\_\_\_\_\_ if and only if \_\_\_\_\_

In the Gizmo, drag these tiles into the **Biconditional statement** bin. Click **Check**. Adjust your tiles if needed.

D. Switch the hypothesis and conclusion. Click **Check**. What do you find? \_\_\_\_\_

\_\_\_\_\_

2. With **Rewriting definitions as biconditionals** still chosen, click the **SYMBOLIC** tab. You should still see the definition, “A kitten is a young cat.”

A. The symbolic statement  $p \leftrightarrow q$  is read, “ $p$  if and only if  $q$ .” Drag the word tiles into the bins to form  $p$  and  $q$ . Then click **Check** to check your answers. What are  $p$  and  $q$ ?

$p$ : \_\_\_\_\_

$q$ : \_\_\_\_\_

B. How does your answer for this statement on the **SYMBOLIC** tab compare to your answer on the **STANDARD** tab? \_\_\_\_\_

3. Click **New**. Work through more **Rewriting definitions as biconditionals** problems.

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



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

4. A good definition can be written as a biconditional statement. Write two biconditionals that mean the same thing as each definition below. For the first statement, use only words. For the second one, use words and the  $\leftrightarrow$  symbol, and reverse the hypothesis and conclusion.

A. A hurricane is a tropical storm with winds of at least 74 mph.

\_\_\_\_\_ if and only if \_\_\_\_\_

\_\_\_\_\_  $\leftrightarrow$  \_\_\_\_\_

B. Independence Day in the United States is the fourth of July.

\_\_\_\_\_

\_\_\_\_\_

C. Noon is 12:00 P.M.

\_\_\_\_\_

\_\_\_\_\_

D. A right triangle has one right angle.

\_\_\_\_\_

\_\_\_\_\_

E. A quadrilateral is a polygon with four sides.

\_\_\_\_\_

\_\_\_\_\_

F. Two perpendicular lines intersect at a 90-degree angle.

\_\_\_\_\_

\_\_\_\_\_

G. An obtuse angle measures greater than 90 degrees.

\_\_\_\_\_

\_\_\_\_\_



<b>Activity B:</b> <b>Conditionals and biconditionals</b>	<u>Get the Gizmo ready:</u>	Converse
	<ul style="list-style-type: none"> <li>Click on the <b>STANDARD</b> tab.</li> <li>Choose <b>Writing biconditionals</b>.</li> </ul>	<div style="border: 1px solid black; padding: 5px; width: fit-content;"> <div style="border: 1px solid black; padding: 2px; display: inline-block; margin-right: 5px;">if</div> <div style="border: 1px solid black; padding: 2px; display: inline-block; margin-right: 5px;">a</div> <div style="border: 1px solid black; padding: 2px; display: inline-block; margin-right: 5px;">then</div> </div>

1. You should see the statements at the right. **Statement 1:** If a rock is a boulder, then it is large.  
**Statement 2:** If a rock is large, then it is a boulder.

- A. Are both statements true? \_\_\_\_\_
- B. Fill in the blank below to describe how **Statement 2** relates to **Statement 1**.

**Statement 2** is the \_\_\_\_\_ of **Statement 1**.

- C. Write a true biconditional that combines **Statement 1** and **Statement 2**.

\_\_\_\_\_

Form the biconditional by dragging word tiles into the **Biconditional statement** bin. Click **Check** to see if your answer is correct. If not, make some changes and click **Check** again.

- D. Write a different (reversed) biconditional that combines the two given statements.

\_\_\_\_\_

Rearrange the tiles to form this statement. Click **Check** to check your answer.

2. With **Writing biconditionals** chosen, click the **SYMBOLIC** tab. You should see the statements below in the Gizmo.

**Given statements:**  $p \leftrightarrow q$ ,  $p$ : a rock is a boulder,  $q$ : a rock is large.

- A. Write two true biconditionals for these statements in symbolic form.

\_\_\_\_\_  $\leftrightarrow$  \_\_\_\_\_

\_\_\_\_\_  $\leftrightarrow$  \_\_\_\_\_

- B. Drag the tiles into the bin to form one of the biconditionals from above. How does this biconditional compare with the ones you formed on the **STANDARD** tab?

\_\_\_\_\_

3. Click **New**. Work through more **Writing biconditionals** problems in the Gizmo, in both **STANDARD** and **SYMBOLIC** form.

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



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

4. Choose **Rewriting biconditionals as two conditionals** from the dropdown menu. Click on the **STANDARD** tab. You should see the biconditional below at the top of the Gizmo.

**Given biconditional:** A polygon is a triangle if and only if it has three sides.

- A. What conditional and converse were combined to make the given biconditional?

Conditional: \_\_\_\_\_

Converse: \_\_\_\_\_

Drag the tiles into the bins to form the conditional and converse. Click **Check**.

- B. If you switch the answers in the bins, are the statements still true? \_\_\_\_\_

Explain: \_\_\_\_\_

Rearrange the tiles to check your answer.

5. With **Rewriting biconditionals as two conditionals** still chosen, click the **SYMBOLIC** tab. You should see the biconditional below at the top of the Gizmo.

**Given biconditional:**  $p \leftrightarrow q$ ,  $p$ : a polygon is a triangle,  $q$ : a polygon has three sides.

Write the conditional and converse in symbolic form below. Then, form them in the Gizmo.

\_\_\_\_\_  $\rightarrow$  \_\_\_\_\_

\_\_\_\_\_  $\rightarrow$  \_\_\_\_\_

6. Click **New**. Work through more **Rewriting biconditionals as two conditionals** problems in the Gizmo, in both **STANDARD** and **SYMBOLIC** form.

7. Rewrite each biconditional statement as a conditional and a converse.

- A. A quadrilateral is a rhombus if and only if it has four congruent sides.

Conditional: \_\_\_\_\_

Converse: \_\_\_\_\_

- B. The time is midnight if and only if it is 12:00 A.M.

Conditional: \_\_\_\_\_

Converse: \_\_\_\_\_

