

# CUT & GLUE SORT



## DILATIONS IN THE COORDINATE PLANE

### What Moved the Points?

A dilation about the origin · a dilation about another center · not a dilation

**FREE**

|                                                    |                                                                                   |                                                      |
|----------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------|
| 1<br><br>The rule<br>$(x, y) \rightarrow (3x, 3y)$ | 2<br><br>$A(1, 2)$ goes to<br>$A'(5, 4)$ .<br>$B(0, -1)$ goes to<br>$B'(2, -5)$ . | 3<br><br>The rule<br>$(x, y) \rightarrow (x+3, y+3)$ |
|----------------------------------------------------|-----------------------------------------------------------------------------------|------------------------------------------------------|

## Cut & Glue Sort — how to run it

25 minutes, 5–8 of them cutting

1. **Hand out pages 3 and 4**, one of each per student. Each student needs scissors and glue.
2. **Say this once:** *“Each piece shows some points and where they went. Decide what moved them. A dilation multiplies. A translation adds. Glue each piece into its row.”*
3. **Check a sheet in ten seconds:** every row gets four pieces.

**Student sheets**    pages 3 and 4, one of each per student.

**Answers**            page 5.

**Each row has a rule, two points with their images, and a drawing.** So a student must be able to read all three ways of showing a move.

**The third row, “Not a dilation,” is the hard one.** A translation rule and a dilation rule are written in the same shape. A student who reads quickly often adds when the rule multiplies. This row holds a rule that adds the same amount to  $x$  and to  $y$ , and two points where only the first number is multiplied. It also holds a translation drawn on a grid, and two points where  $A'$  looks like a multiple of  $A$  but  $B'$  is not the same multiple of  $B$ .

**The second row is where the rule  $(x, y) \rightarrow (kx, ky)$  stops working.** Its rule has a “+” and a “–” in it. In its drawing, the center is not on either segment. In one of its pieces a point stays where it is. That point is the center, because a dilation never moves its center.

**Guessing does not sort the sheet.** Every simple rule that ignores the mathematics, such as sorting by the minus signs or by the kind of piece, gets at most six of the twelve pieces right.



**This is the free lesson this activity came from.** The worksheet, the full answers and the lesson plan are on it, at three levels of difficulty.

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# What moved the points?

*Rules, points and drawings*

Name \_\_\_\_\_

Period \_\_\_\_\_

Date \_\_\_\_\_

Cut out the twelve pieces on the next page. **For each piece, decide what moved the points. Then glue it into that row.** Each row gets the same number of pieces.

Compare the step from  $A$  to  $B$  with the step from  $A'$  to  $B'$ . A dilation multiplies that step by the scale factor. A translation keeps it the same. On a drawing, lay a ruler through  $A$  and  $A'$ , and through  $B$  and  $B'$ . The two lines cross at the center. If a point stays where it is, that point is the center.

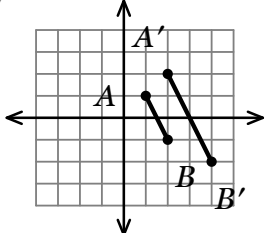
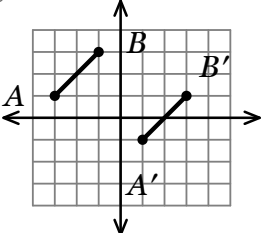
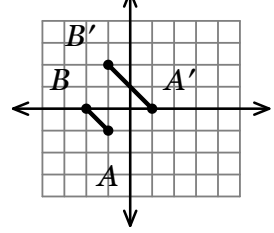
## A dilation with center the origin

## A dilation with a center that is not the origin

## Not a dilation

# The twelve pieces

Cut along the dotted lines

|                                                                                                                                                                 |                                                                                                                                           |                                                                                                                                                                 |                                                                                                                                                                  |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>1</p> <p>The rule<br/> <math>(x, y) \rightarrow (3x, 3y)</math></p>                                                                                          | <p>2</p> <p><math>A(1, 2)</math> goes to<br/> <math>A'(5, 4)</math>.<br/> <math>B(0, -1)</math> goes to<br/> <math>B'(2, -5)</math>.</p>  | <p>3</p> <p>The rule<br/> <math>(x, y) \rightarrow (x+3, y+3)</math></p>                                                                                        | <p>4</p> <p>The rule<br/> <math>(x, y) \rightarrow (2x-3, 2y+1)</math></p>                                                                                       |
| <p>5</p> <p><math>A(4, -2)</math> goes to<br/> <math>A'(2, -1)</math>.<br/> <math>B(-6, 2)</math> goes to<br/> <math>B'(-3, 1)</math>.</p>                      | <p>6</p> <p><math>A(2, 1)</math> goes to<br/> <math>A'(4, 2)</math>.<br/> <math>B(-1, 3)</math> goes to<br/> <math>B'(1, 4)</math>.</p>   | <p>7</p>  <p>Segment <math>AB</math> and its image<br/> <math>A'B'</math></p> | <p>8</p>  <p>Segment <math>AB</math> and its image<br/> <math>A'B'</math></p> |
| <p>9</p>  <p>Segment <math>AB</math> and its image<br/> <math>A'B'</math></p> | <p>10</p> <p><math>A(1, 2)</math> goes to<br/> <math>A'(2, 2)</math>.<br/> <math>B(-3, 1)</math> goes to<br/> <math>B'(-6, 1)</math>.</p> | <p>11</p> <p><math>A(0, 0)</math> goes to<br/> <math>A'(0, 0)</math>.<br/> <math>B(2, -1)</math> goes to<br/> <math>B'(8, -4)</math>.</p>                       | <p>12</p> <p><math>A(-2, 1)</math> goes to<br/> <math>A'(-2, 1)</math>.<br/> <math>B(0, 2)</math> goes to<br/> <math>B'(2, 3)</math>.</p>                        |



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# Cut & Glue Sort — answers

For the teacher

Every row gets four pieces.

|                                                        |                                                                                                                                                                                                       |                                                                                                                                                                  |                                                                                                                                                                                                                                       |                                                                                                                                                                                     |
|--------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>A dilation with center the origin</b>               | <b>1</b> — The rule multiplies both numbers by 3 and adds nothing, so the origin stays where it is. The center is the origin, and the scale factor is 3.                                              | <b>5</b> — $A'$ is $1/2$ times $A$ , and $B'$ is $1/2$ times $B$ . So the center is the origin, and the scale factor is $1/2$ .                                  | <b>7</b> — Read the points from the grid. $A'$ is 2 times $A$ , and $B'$ is 2 times $B$ . So the center is the origin, and the scale factor is 2.                                                                                     | <b>11</b> — $A$ is the origin and it stays where it is, so the origin is the center. $B'$ is 4 times $B$ , so the scale factor is 4.                                                |
| <b>A dilation with a center that is not the origin</b> | <b>2</b> — $A'$ is not 3 times $A$ , so the center is not the origin. The center is $(-1, 1)$ . From there, $A$ is $(2, 1)$ away and $A'$ is $(6, 3)$ away, 3 times as far. So the scale factor is 3. | <b>4</b> — The rule multiplies by 2 and then adds a number, so the origin moves. The point $(3, -1)$ goes to itself, so it is the center. The scale factor is 2. | <b>9</b> — Read the points from the grid. $A'$ is not 2 times $A$ , so the center is not the origin. The center is $(-3, -2)$ . From there, $A$ is $(2, 1)$ away and $A'$ is $(4, 2)$ away, 2 times as far. So the scale factor is 2. | <b>12</b> — $A$ stays where it is, so $A(-2, 1)$ is the center. From $A$ to $B$ is $(2, 1)$ , and from $A$ to $B'$ is $(4, 2)$ . That is 2 times as much, so the scale factor is 2. |
| <b>Not a dilation</b>                                  | <b>3</b> — The rule adds the same amount to every point and multiplies nothing. Every point moves the same way, so it is a translation.                                                               | <b>6</b> — The step from $A$ to $B$ , $(-3, 2)$ , is the same as the step from $A'$ to $B'$ . A dilation would multiply that step, so this is a translation.     | <b>8</b> — Read the points from the grid. The step from $A$ to $B$ , $(2, 2)$ , is the same as the step from $A'$ to $B'$ . A dilation would multiply that step, so this is a translation.                                            | <b>10</b> — The first number is multiplied, but the second number stays the same. A dilation multiplies both numbers by the same scale factor.                                      |

**To check any piece, find the center first.** The center is the one point a dilation leaves where it is. Every other point moves along the line from the center, and its distance from the center is multiplied by the scale factor. A translation moves every point the same way, so it has no center.