2.2 Hats Off to the Wumps: Changing a Figure's Size and Location

Focus Question What types of coordinate rules produce similar figures? Nonsimilar figures? For a pair of similar figures, how can you use a coordinate rule to predict the side lengths of the image?

Launch

In this Problem, students look at hats for the Wump family. The hat is made from a rectangle and a triangle and has 6 vertices. The students can concentrate on what is happening as they manipulate the rule by adding to each coordinate and/or multiplying each coordinate by a number. It is important that students know that the main point is to look at their drawings and make sense of what adding or multiplying in the rule does to the image.

Challenge students to find a way to predict what will happen to the image only by analyzing the rule and not drawing the figure.

Key Vocabulary

- There are no new glossary terms introduced in this Problem.

Materials

Accessibility Labsheets

- 2.2: Mug's Hat
- Labsheet 2ACE: Exercise 3
- Four First-Quadrant Grids
- First-Quadrant Grid

Explore

To help students who have difficulties comparing the hats across the grids, you might have them use different colors to draw two or more hats on the same grid.

Summarize

You can superimpose the images and the original on transparencies to examine what happens to the angles. Ask students what happened with each of the rules.

ACE Assignment Guide for Problem 2.2

Applications: 3–4 | Connections: 16–18
Extensions: 30–31

Answers to Problem 2.2

A. Answers will vary. Hat 1 will move 2 units to the right and 3 units up without changing its size or shape. Hat 2 will move 1 unit left and 4 units up, also without changing its size or shape. Hat 3 will be located 2 units to the right, and it will be 3 times as high (stretched vertically). Hat 4 will shrink vertically and horizontally by the same factor: 0.5. Hat 5 will be stretched both vertically and horizontally, but more in the vertical direction.

B. **1.** (See Figure 1, next page.)

2. (See Figure 2, next page.)

C. **1.** The angles and side measures of Hats 1 and 2 are exactly the same as Mug's Hat. The width of Hat 3 is the same as the width of Mug's Hat, but its height is 3 times as long and the bottom angles have larger measures. Both the width and height of Hat 4 are half as long as Mug's Hat, while its corresponding angles are the same. The width of Hat 5 is 2 times as long as the width of Mug's Hat, while its height is 3 times as long and it has larger angle measures at the bottom.

2. Hat 1, Hat 2, and Hat 4 are similar to Mug's Hat, since they have the same shapes and corresponding angles, and their sides have been multiplied by the same factor (for Hats 1 and 2 the factor is 1 and for Hat 4 it is 0.5). Hat 4 is similar because it is the same shape, only smaller. Its side lengths changed by the same factor, and all its angles have the same measure as Mug's Hat.

D. **1.** $\frac{x}{3}, \frac{y}{3}$ **2.** $(1.5x, 1.5y)$

3. $(x + 1, y + 5)$

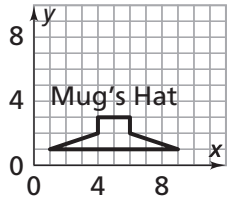
E. Possible answers: $(3x - 2, y - 2)$; $(4x, 3y)$. In fact, if you choose any two positive numbers a and b that are not equal to each other, then the hat made by (ax, by) is not similar to Mug's Hat. Any rule $(ax + r, by + s)$, a and b not equal, where r and s are any two numbers (positive or negative does not matter), gives an image that is not similar to Mug's hat.

Figure 1

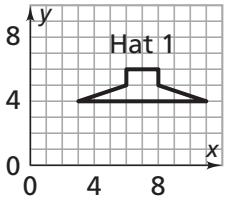
	Mug's Hat	Hat 1	Hat 2	Hat 3	Hat 4	Hat 5
Point	**(x, y)**	**$(x + 2, y + 3)$**	**$(x - 1, y + 4)$**	**$(x + 2, 3y)$**	**$(0.5x, 0.5y)$**	**$(2x, 3y)$**
A	(1, 1)	(3, 4)	(0, 5)	(3, 3)	(0.5, 0.5)	(2, 3)
B	(9, 1)	(11, 4)	(8, 5)	(11, 3)	(4.5, 0.5)	(18, 3)
C	(6, 2)	(8, 5)	(5, 6)	(8, 6)	(3, 1)	(12, 6)
D	(6, 3)	(8, 6)	(5, 7)	(8, 9)	(3, 1.5)	(12, 9)
E	(4, 3)	(6, 6)	(3, 7)	(6, 9)	(2, 1.5)	(8, 9)
F	(4, 2)	(6, 5)	(3, 6)	(6, 6)	(2, 1)	(8, 6)
G	(1, 1)	(3, 4)	(0, 5)	(3, 3)	(0.5, 0.5)	(2, 3)

Figure 2

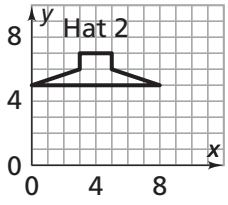
Rule: (*x*, *y*)



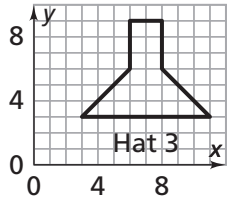
Rule: (*x* + 2, *y* + 3)



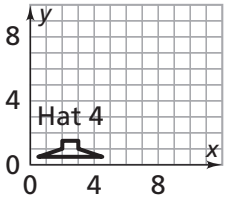
Rule: (*x* – 1, *y* + 4)



Rule: (*x* + 2, 3*y*)



Rule: (0.5*x*, 0.5*y*)



Rule: (2*x*, 3*y*)