Name ____________________________ Period __________ Date ___________

MathLinks

8-13
STUDENT PACKET

MATHLINKS GRADE 8
STUDENT PACKET 13
TRANSLATIONS, ROTATIONS, AND REFLECTIONS

WORD BANK

Phrase	Definition or Explanation	Example or Picture
image		
plane		
reflection		
rotation		
transformation		
translation		

TRANSLATIONS

Summary (Ready)

We will perform a transformation experiment using patty paper. We will define transformations of the plane and observe some properties of transformations. We will learn about a transformation called a translation.

Goals (Set)

- Define transformations of the plane.
- Perform translations using patty paper.
- Explore basic properties of translations.
- Perform translations on coordinate pairs.

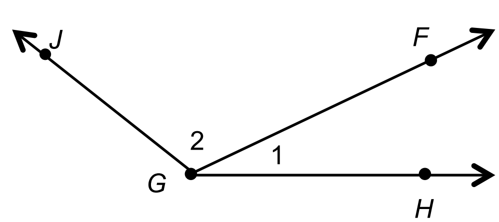
Warmup (Go)

1. Points are named by capital letters. The line segment with endpoints A and B is written $\overline{AB}$. Name and label another point, C, on $\overline{AB}$.

2. Name two other segments on $\overline{AB}$. _____ _____
3. We denote the length of the line segment from A to B by $|AB|$. Use a ruler to find $|AB|$ to the nearest inch. _________
4. Sometimes we use the apostrophe-like symbol to identify points. We read $\overline{A'B'}$ as "segment A prime B prime."

Use a ruler to find $|A'B'|$. _________ Then write $|A'B'|$ in words.

5. The measure of $\angle 1$ may be written as $|\angle 1|$.
6. Use a protractor to find $|\angle 1|$. _____
7. The measure of $\angle 2$ may be written as $|\angle 2|$.
8. Use a protractor to find $|\angle 2|$. _____



TWO-SIDED TRANSFER TECHNIQUE

You will need a sheet of patty paper, a straightedge, and a pencil for this activity.

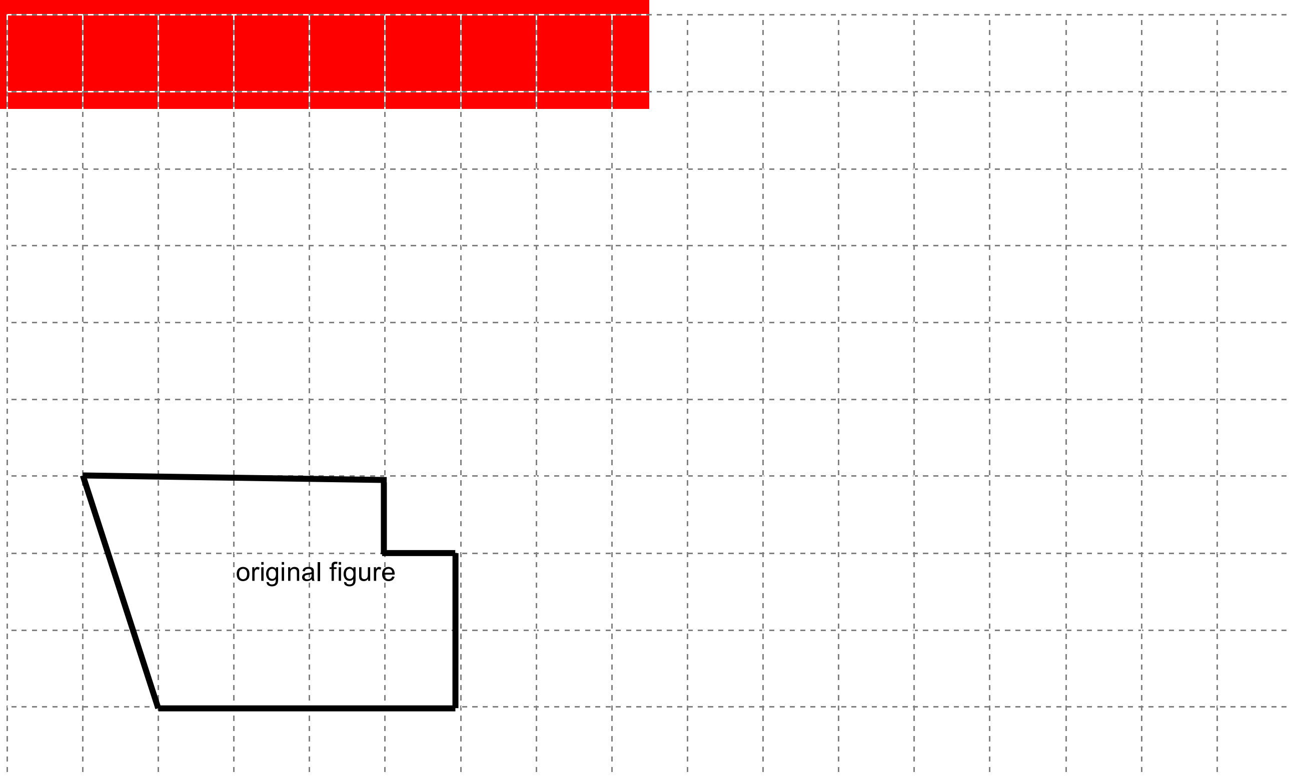
1. Trace the figure below on your patty paper. Make sure the edges of your patty paper line up with the grid lines below.

2. Turn the patty paper over to the backside. Use your pencil to trace over the figure from the front side of the patty paper.

3. Turn the patty paper over to the front side and put it on top of the original figure so that your marks coincide with the original figure. Shift the patty paper to the right, keeping your paper aligned with the horizontal gridlines. Then slide up, keeping your paper aligned with the vertical grid lines.

4. Trace over the patty paper figure. The pencil markings from the backside should transfer to this page. Follow the light pencil markings to draw the resulting figure.

5. Label the new figure as the "image figure."



We will call this drawing technique the "two-sided transfer technique."

TRANSFORMATIONS

On the previous page, you were given a figure. Using patty paper, you performed a "slide" to locate a new figure (called the image figure). The patty paper represents a plane, and the action represents a transformation.

1. Shade the original figure on the previous page and label the figure *ABCDEF*.

2. Do not shade the image figure. Label the figure $A'B'C'D'E'F'$. Be sure to mark corresponding vertices with the same letter.

> A transformation of the plane is a function that maps the plane to the plane.
>
> In other words, a transformation of the plane is a function that takes all points in the plane to points in the plane.

3. Refer to the transformation on the previous page. Complete each sentence. Notice how some of the language of transformations is used here.

Point *A* is taken to Point _____. $\overline{DE}$ is taken to ______.

Point *B* maps to Point _____. $\angle BCD$ maps to ______.

Point C' is the image of Point _____. Figure $A'B'C'D'E'F'$ is the image of __________.

4. Your teacher will give you directions for locating a point *P* and its image P' on your diagram. How is the movement of *P* to P' related to the movement of the original figure to its image?

5. Sometimes a transformation results in an image figure that is exactly the same size and shape as the original figure. Do you think the transformation on the previous page resulted in an image figure that is exactly the same shape and size as the original figure? ______
Why?

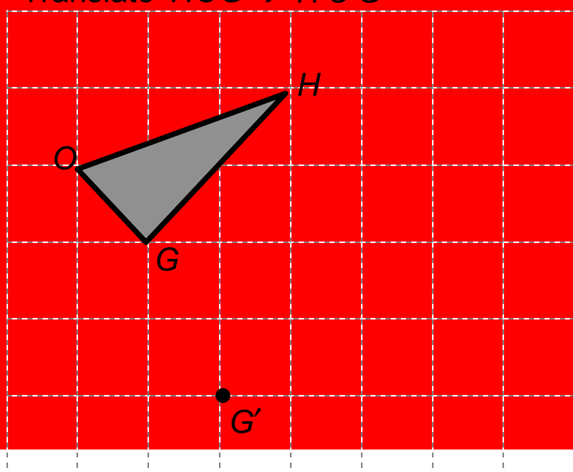
ABOUT TRANSLATIONS

A translation (or "slide") of the plane shifts all points the same distance and in the same direction.

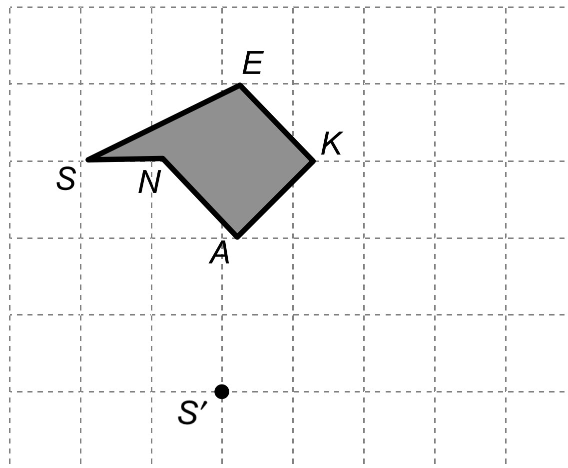
For each problem:

- Draw each shape with pencil markings on both sides of the patty paper.
- Perform the translation (slide) using patty paper, and record using the two-sided transfer technique. Do not shade the image.

1. Translate *HOG* → *H′O′G′*



2. Translate *SNAKE* → *S′N′A′K′E′*



3. Draw "arrows" to show the translation for each vertex of figure *HOG*. These arrows are called translation vectors. Label the translation vectors for *HOG* → *H′O′G′* as $\vec{v}$. What do you notice about the translation vectors?

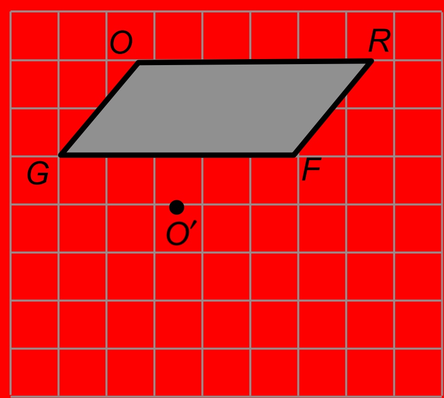
4. In a translation, line segments are taken to line segments of the same length. Use the Pythagorean Theorem to verify that $|HG|$ and $|H'G'|$ have the same length.

5. In a translation, angles are taken to angles of the same measure. For translation *SNAKE* → *S′N′A′K′E′*, use proper geometric notation to indicate which angles have same measure.

   $|\angle SNA|$ = ______

PRACTICE WITH TRANSLATIONS

1a. Translate figure *FROG* → *F′R′O′G′*



b. Identify parallel lines in figure *FROG*.

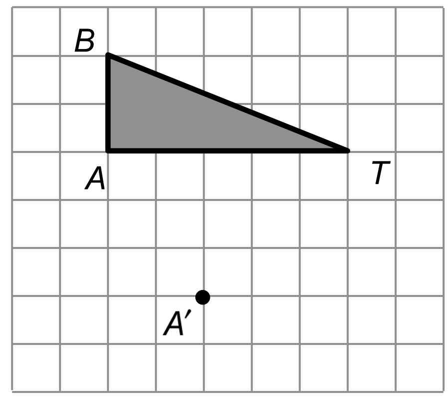
c. Identify parallel lines in figure *F′R′O′G′*.

d. Do parallel line segments in the original figure correspond to parallel line segments in the image? In other words, are parallel lines taken to parallel lines?

e. Draw translation vectors. Label them $\vec{w}$. What is the slope of each of the translation vectors?

f. How do you know that the translation vectors are parallel?

2a. Translate $\Delta BAT \rightarrow \Delta B'A'T'$



b. Find side lengths of ΔBAT and $\Delta B'A'T'$.

c. Use proper geometric notation to indicate which segments have equal length.

d. Find angle measures in ΔBAT and $\Delta B'A'T'$.

e. Use proper geometric notation to indicate which angles have equal measure.

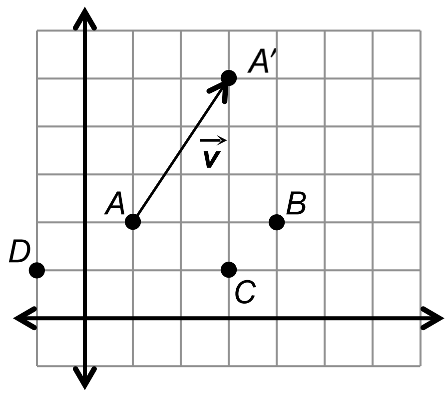
TRANSLATIONS OF THE COORDINATE PLANE

We can use function notation to define a translation.

The function notation $(x, y) \rightarrow (x + 2, y + 3)$ tells us that the image of a point (x, y) in the plane is obtained by adding 2 units to the x-coordinate and 3 units to the y-coordinate. In other words, every point in the plane will shift two units to the right and three units up. The translation vector $\vec{v}$ from A to A' shows visually the effect of the translation on A.

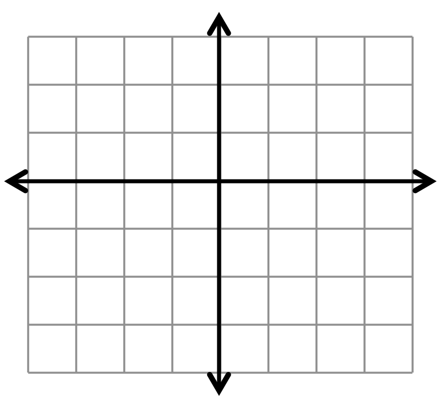
1. Find the images of B, C, and D under the translation $(x, y) \rightarrow (x + 2, y + 3)$. Label the points B', C', and D' respectively.

2. Connect points A, B, C, and D to form quadrilateral $ABCD$. Shade this figure. Connect points A', B', C', D' to form a quadrilateral $A'B'C'D'$.
How are the quadrilaterals related?



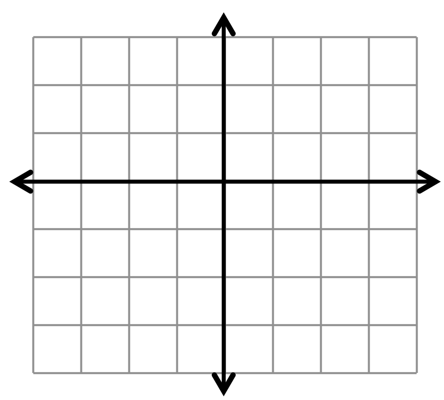
3. Draw the rectangle *GIRL* with coordinates (-2, 2), (3, 2), (3, 0) and (-2, 0). Shade the figure.

Draw the image rectangle $G'I'R'L'$ under the translation $(x, y) \rightarrow (x, y - 4)$.



4. Draw a triangle in quadrant IV. Label it $\triangle BOY$. Shade the figure.

Draw $\triangle B'O'Y'$ under the translation $(x, y) \rightarrow (x - 4, y + 4)$.



5. Are segments taken to segments of the same length under a translation? ______

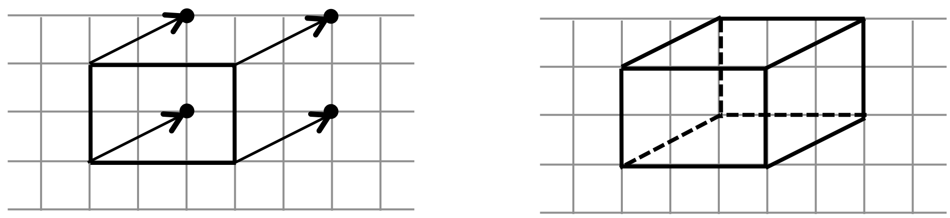
6. Are angles taken to angles of the same measure under a translation? ________

7. Are parallel lines taken to parallel lines under a translation? ________

DRAWING FIGURES IN THREE DIMENSIONS

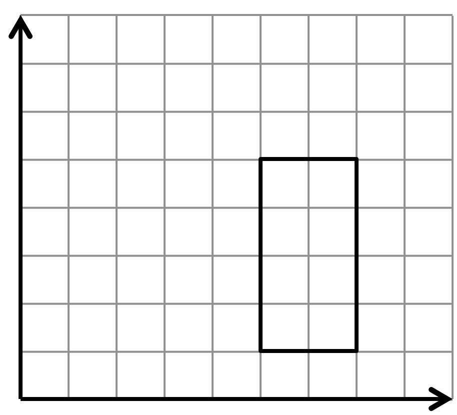
Including a translation vector $\vec{v}$ as part of a translation may help in drawing prisms.

Example: Use a rectangle and the rule (x, y) → (x +2, y + 1) to draw a two-dimensional drawing of a rectangular prism. Shade the original figure, which is the front face of the prism. Use dashed lines for hidden edges of the prism.

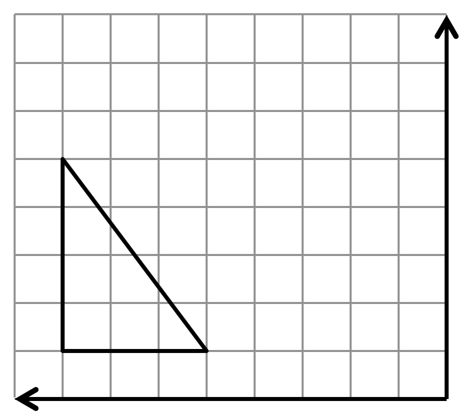


Create two-dimensional drawings of three-dimensional figures by using translation vectors. Begin with the given shape. Use the given translation rule. Shade the front face and fill in edges.

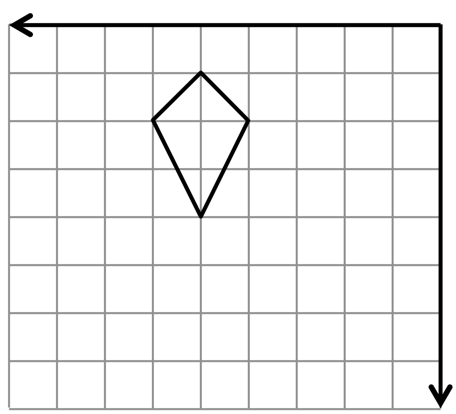
1. Use (x, y) → (x – 1, y + 3)



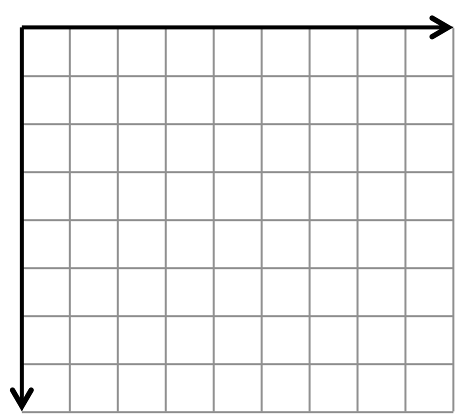
2. Use (x, y) → (x + 5, y + 2)



3. Use (x, y) → (x + 2, y – 3)



4. Draw any polygon so that the original figure and its image fit in the grid.
   Use (x, y) → (x + 2, y + 2)

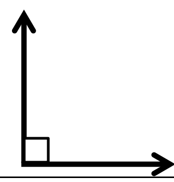
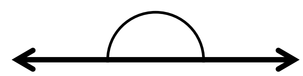
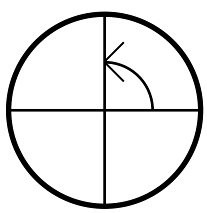
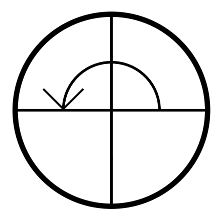
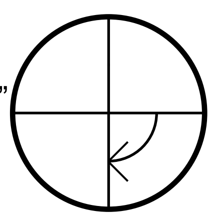
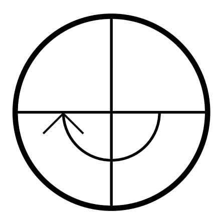


ROTATIONS

Summary (Ready)	Goals (Set)
We will experiment with rotations and explore their properties. We will make conjectures about rotations of coordinate pairs.	• Perform rotations using patty paper. • Explore basic properties of rotations. • Make conjectures about rotations of coordinate pairs.

Warmup (Go)

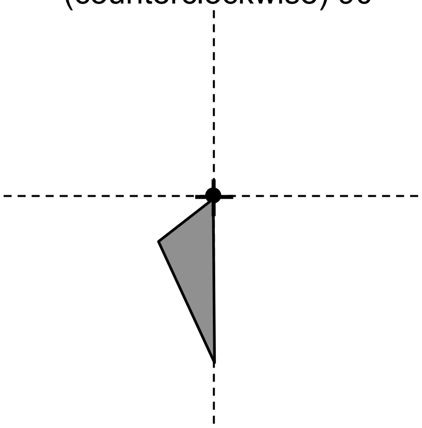
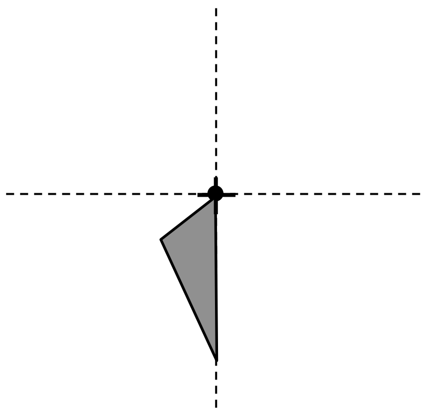
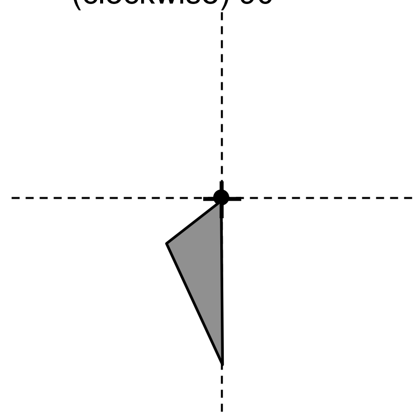
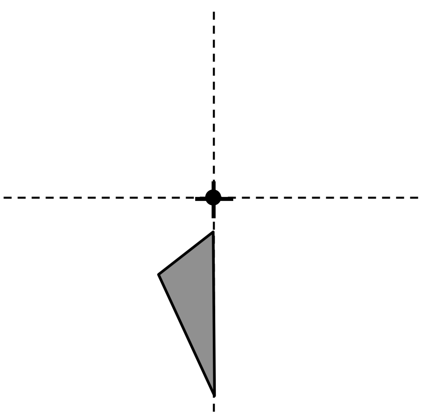
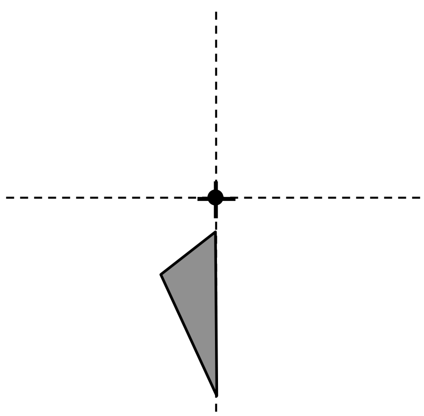
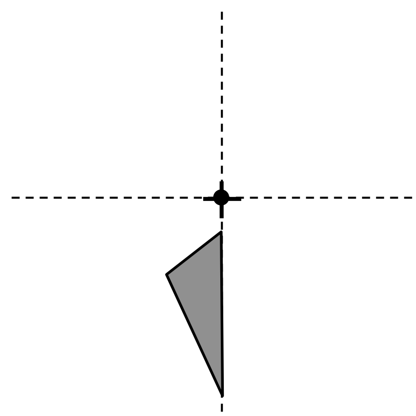
Fill in the blanks.

1. This is a ___________ angle. It measures ___________ degrees. 	2. This is a ___________ angle. It measures ___________ degrees. 
3. There are ___________ degrees in a quarter turn counterclockwise. Another way to say this is “rotate left ______degrees.” 	4. There are ___________ degrees in a half turn counterclockwise. Another way to say this is “rotate left _____ degrees.” 
5. There are ___________ degrees in a quarter turn clockwise. Another way to say this is “rotate right _____ degrees.” 	6. There are ___________ degrees in a half turn clockwise. Another way to say this is “rotate right ____ degrees.” 

ABOUT ROTATIONS

A <u>rotation</u> (or “turn”) of a place is a transformation that turns the plane through a given angle about a given point. The given angle is called the <u>angle of rotation</u>, and the given point is called the <u>center point of rotation</u>. The center point can be on the figure, inside the figure, or outside the figure.

For each row:
- Draw the shape on patty paper with pencil markings on both sides of the paper.
- Make a small + (with arrow pointing up) to indicate location of axes.
- Perform the rotation about the origin using patty paper and record.
- Do not shade the image.

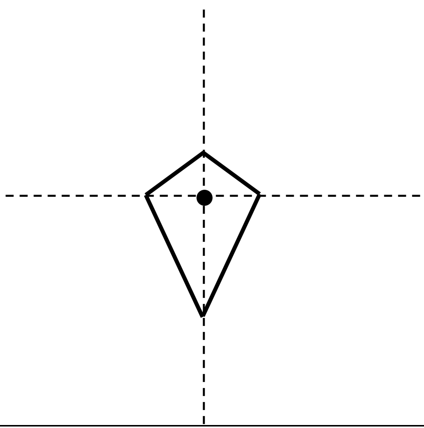
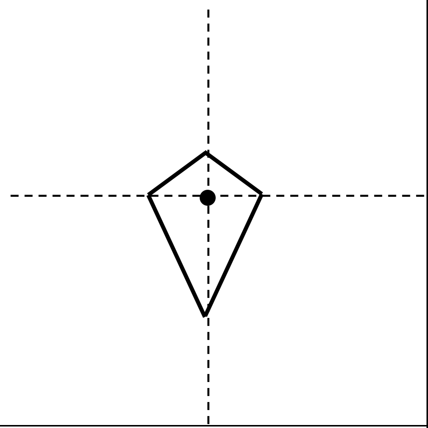
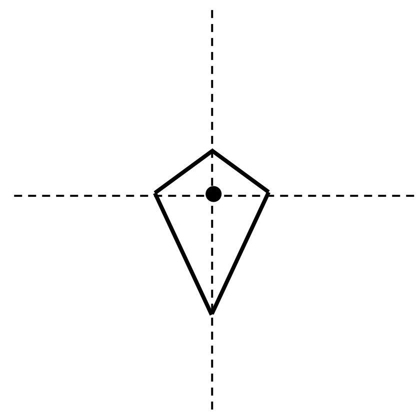
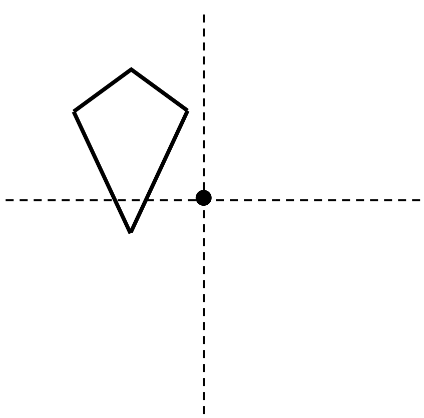
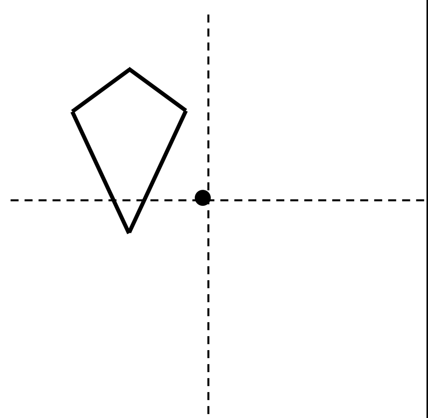
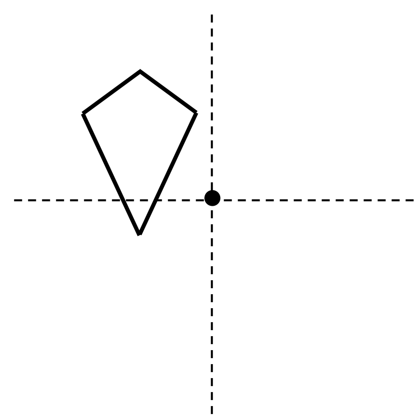
1a. Rotate left (counterclockwise) 90° 	1b. Rotate left 180° 	1c. Rotate right (clockwise) 90° 
2a. Rotate right 90° 	2b. Rotate right 180° 	2c. Rotate left 90° 

3. Make a conjecture about the relationship between the distance from the origin (center) of the rotation to corresponding points on the figure and its image. Explain why you think your conjecture is true.

PRACTICE WITH ROTATIONS

For each row:

- Draw the shape on patty paper with pencil markings on both sides of the paper.
- Make a small $\overset{\uparrow}{+}$ (with arrow pointing up) to indicate location of axes.
- Perform the rotation about the origin using patty paper and record.
- Shade the original figure.

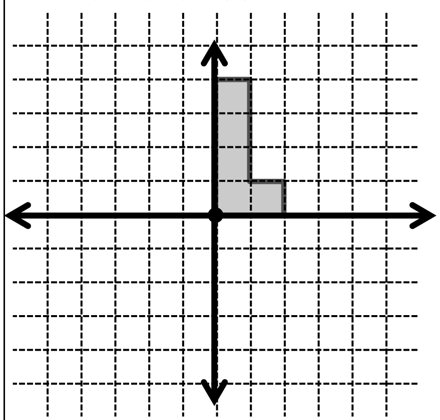
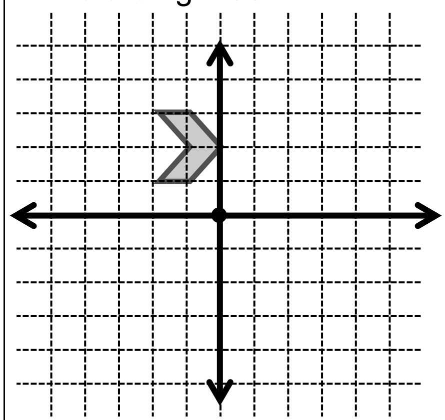
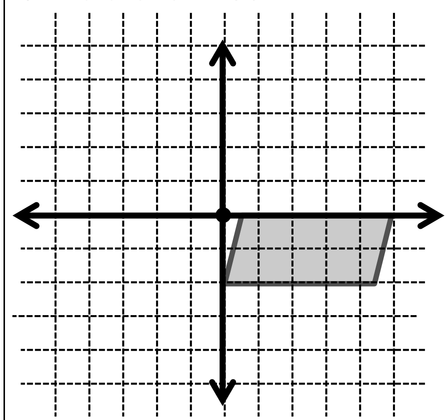
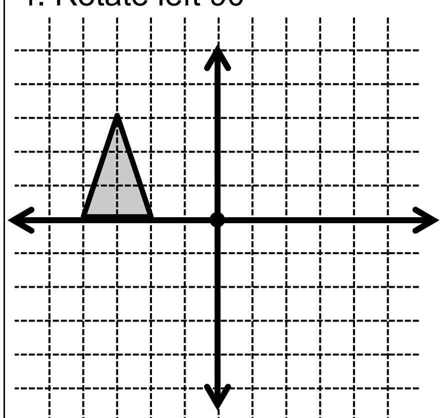
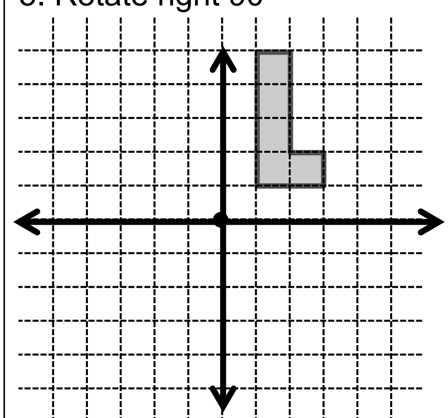
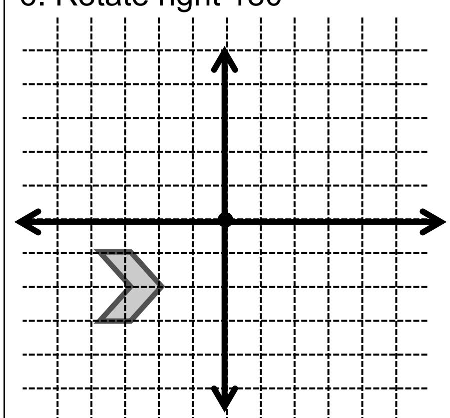
1a. Rotate left (counterclockwise) 90° 	1b. Rotate left 180° 	1c. Rotate right (clockwise) 90° 
2a. Rotate right 90° 	2b. Rotate right 180° 	2c. Rotate left 90° 

3. To show that every point in a plane maps to its image, draw the letter *F* somewhere in 1a. Then rotate left 90° to find its image.

4. Does your conjecture about distances from problem 3 on the previous page hold for these examples? Revise your conjecture as needed.

ROTATIONS OF THE COORDINATE PLANE

Rotate the plane about the origin (0, 0). For each figure given, show its image under the rotation.

1. Rotate left 90° 	2. Rotate right 90° 	3. Rotate left 180° 
4. Rotate left 90° 	5. Rotate right 90° 	6. Rotate right 180° 

7. What happens to the center under a rotation?

8. What happens to every other point in the plane under a rotation?

9. Under a rotation, do you think that:

   a. Segments are taken to segments of the same length.

   b. Angles are taken to angles of the same measure.

   c. Parallel lines are taken to parallel lines.

CONJECTURES ABOUT ROTATIONS

Refer to the rotations on previous page. Label some of the coordinates in the original figures and their images. Make conjectures based on your examples.

How are the coordinates of the figure related to the coordinates of its image under:

1. a rotation left 90° (problems 1 or 4)	2. a rotation right 90° (problems 2 or 5)
Some coordinates in the original figure	Some coordinates in the original figure
(____, ____) (____, ____) (____, ____)	(____, ____) (____, ____) (____, ____)
Corresponding coordinates in its image	Corresponding coordinates in its image
(____, ____) (____, ____) (____, ____)	(____, ____) (____, ____) (____, ____)
Describe the relationship in words.	Describe the relationship in words.
Describe the relationship with symbols.	Describe the relationship with symbols.
(x, y) → (_____, _____)	(x, y) → (_____, _____)

3. a rotation left 180° (problem 3)	4. a rotation right 180° (problem 6)
Some coordinates in the original figure	Some coordinates in the original figure
(____, ____) (____, ____) (____, ____)	(____, ____) (____, ____) (____, ____)
Corresponding coordinates in its image	Corresponding coordinates in its image
(____, ____) (____, ____) (____, ____)	(____, ____) (____, ____) (____, ____)
Describe the relationship in words.	Describe the relationship in words.
Describe the relationship with symbols.	Describe the relationship with symbols.
(x, y) → (_____, _____)	(x, y) → (_____, _____)

5. Denyse says that if you rotate left 180° or rotate right 180°, you will get the same image. Is she correct? ______ Explain.

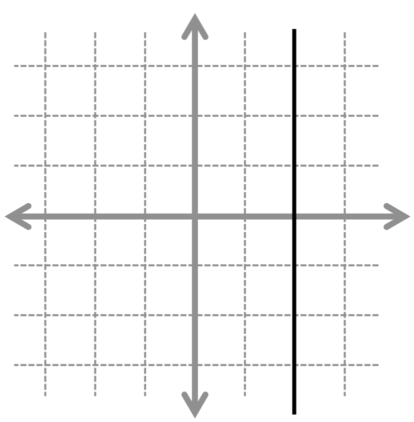
REFLECTIONS

Summary (Ready)	**Goals (Set)**
We will experiment with reflections and explore their properties. We will make conjectures about reflections of coordinate pairs. We will compare properties of translations, rotations, and reflections.	• Perform reflections using patty paper. • Explore basic properties of reflections. • Make conjectures about reflections of coordinate pairs. • Describe and compare properties of translations, rotations, and reflections.

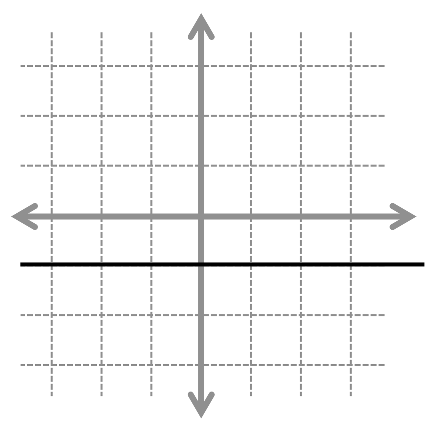
Warmup (Go)

Give the equation of each line below.

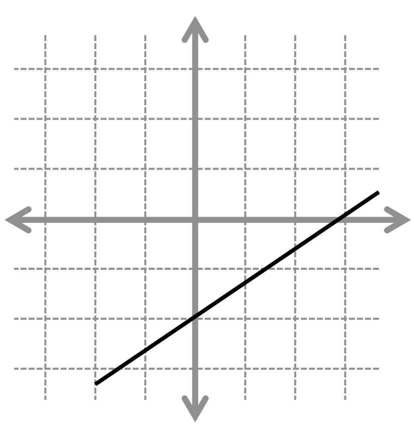
1.



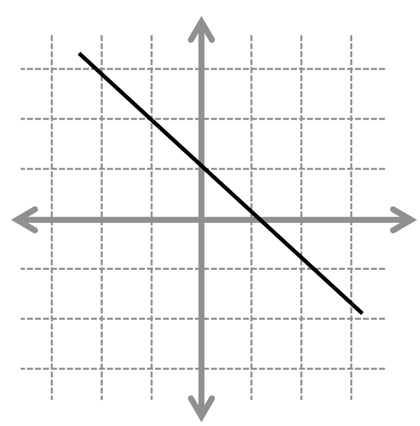
2.



3.



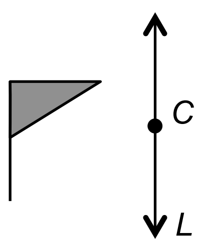
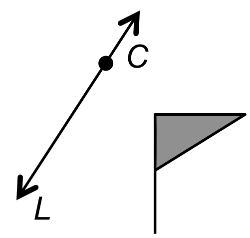
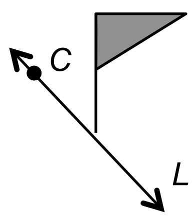
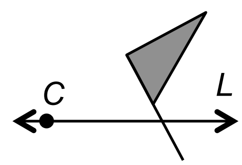
4.



ABOUT REFLECTIONS

> Reflection through a line L maps each point to its mirror image on the other side of L. The line L is the line of reflection. If $A \rightarrow A'$, then L is the perpendicular bisector of the segment AA'.

For each problem:
- Trace the shaded original figure, the line of reflection L, and point C on patty paper.
- Perform the reflection using patty paper and record. Do not shade the image.
- Use the point C to align the patty paper after you have flipped it.

1. 	2. 
3. 	4. 

5. In the reflections above, does it appear that each image figure exactly covers the original figure? ______ Explain.

6. What happens to a point on the line of reflection (such as C) under a reflection?

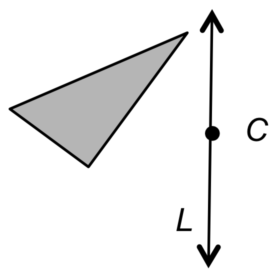
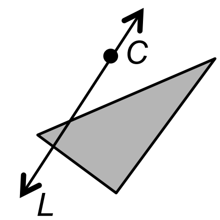
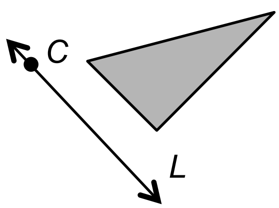
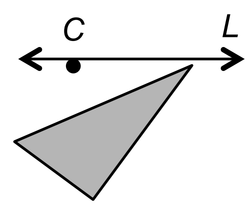
7. For each example, choose any point A in the plane, and find its image A' under the reflection. Draw $\overline{AA'}$. What does line L appear to do to $\overline{AA'}$?

8. What relationships do you see between line L and $\overline{AA'}$?

PRACTICE WITH REFLECTIONS

For each problem:

- Trace the shaded original figure, the line of reflection *L*, <u>and point *C*</u> on patty paper.
- Perform the reflection using patty paper and record. Do not shade the image.
- Use the point *C* to align the patty paper after you have flipped it.

1. 	2. 
3. 	4. 

5. Label vertices on each original figure *X, Y,* and *Z*. Label corresponding vertices on each image X', Y', and Z'.

   Read, and then write, the letters on each figure in a clockwise direction. ______

   Read, and then write, the letters on each image in a clockwise direction. ______

   Do they read the same? ______

> These examples illustrate that a reflection reverses the <u>orientation</u> of a closed figure.

6. Refer to previous examples of translations and rotations. Does orientation change under translations or rotations?

7. Why do you think that orientation reverses for reflection, but not for translation or rotation?

REFLECTIONS OF THE COORDINATE PLANE 1

1. Draw ΔFLP where F = (-1, 3), L =(-3, 1), P = (-3, 4) and shade it. Then reflect the figure through the y-axis to find the coordinates of the vertices of its image. Use patty paper if needed.

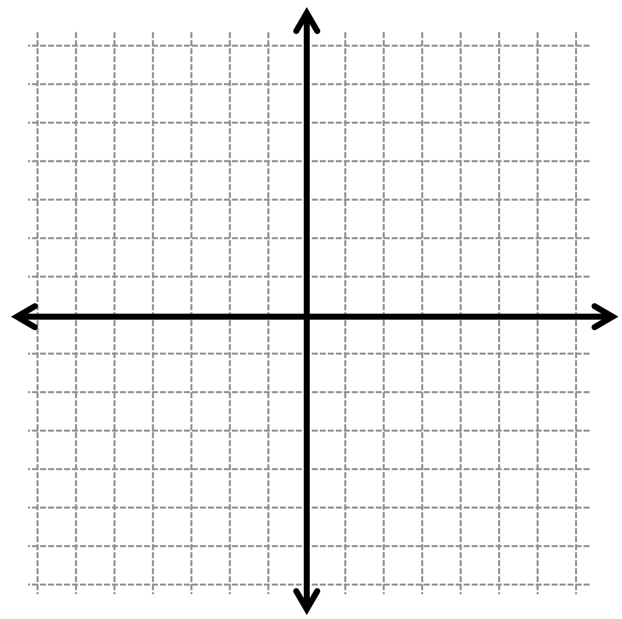
Vertices of triangles:

F = (-1, 3), L = (-3, 1), P = (-3, 4)

Coordinates of images of vertices:

F' = (__, __) L' = (__, __) P' = (__, __)

How do you think the coordinates of the vertices of the triangle are related to the coordinates of their image points under the reflection through the *y*-axis?



2. Make up another example to test your conjecture.

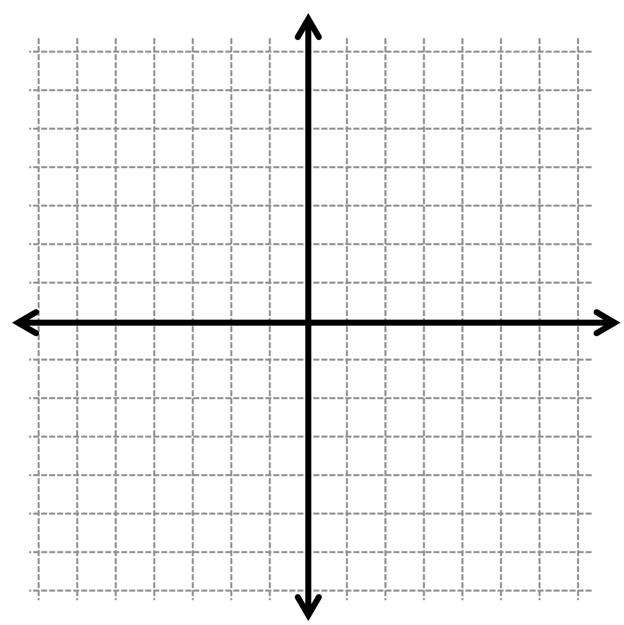
Some points belonging to your figure:

Corresponding image points:

Is your conjecture still true?_____ Revise your conjecture above if needed.

Generalize your conjecture using arrow notation. Describe how the coordinates of a point are related to the coordinates of its image under the reflection through the *y*-axis?

(x , y) → (______ , ______)



REFLECTIONS OF THE COORDINATE PLANE 2

1. Draw $\Delta\, FLP$ where $F = (-1, 3)$, $L = (-3, 1)$, $P = (-3, 4)$ and shade it. Then reflect the figure through the x-axis to find its image. Use patty paper if needed.

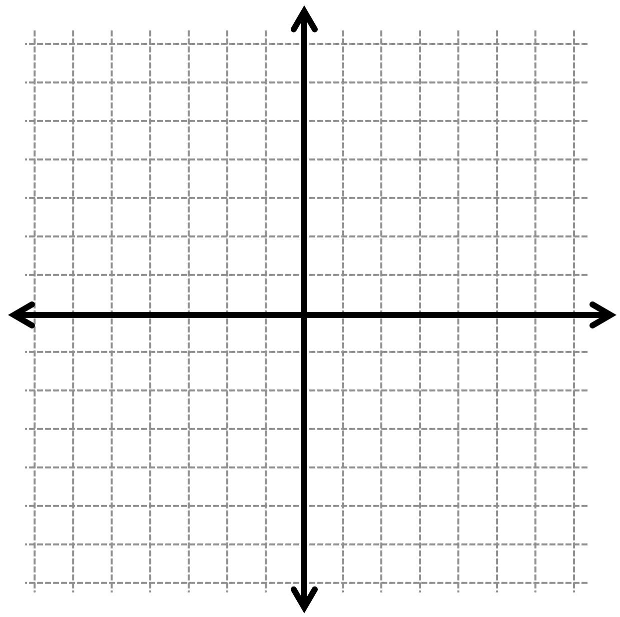
Vertices of triangles:

$F =$ (-1, 3), $L =$ (-3, 1), $P =$ (-3, 4)

Images of vertices:

$F' =$ (__, __) $L' =$ (__, __) $P' =$ (__, __)

How do you think the coordinates of points of this figure are related to their images under the reflection through the *x*-axis?



2. Make up another example to test your conjecture.

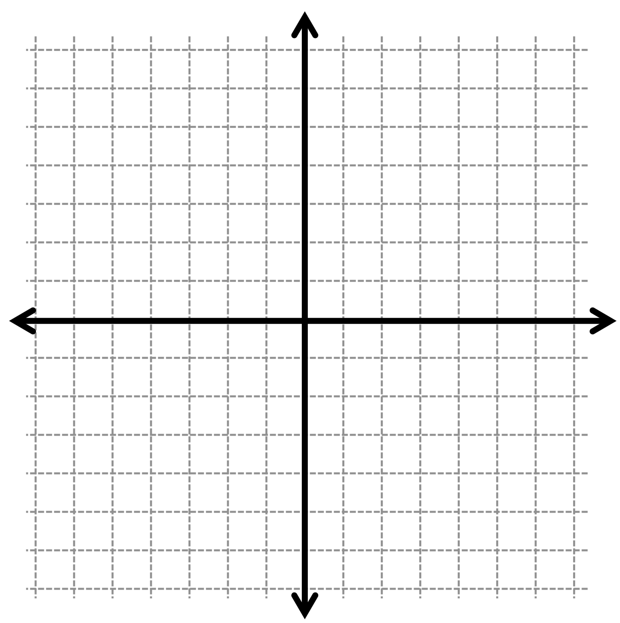
Some points belonging to your figure:

Corresponding image points:

Is your conjecture still true?_____ Revise your conjecture above if needed.

Generalize your conjecture using arrow notation. Describe how the coordinates of a point are related to the coordinates of its image under the reflection through the *x*-axis?

(*x* , *y*) → (______ , ______)



Describe how the coordinates of a point are related to the coordinates of its image under the reflection through the *x*-axis.

FINDING THE LINE OF REFLECTION

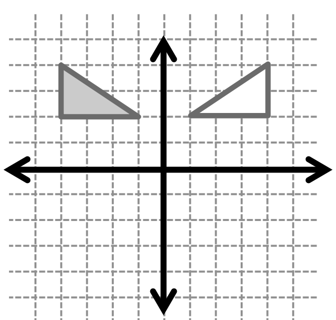
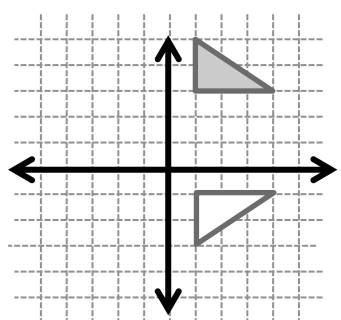
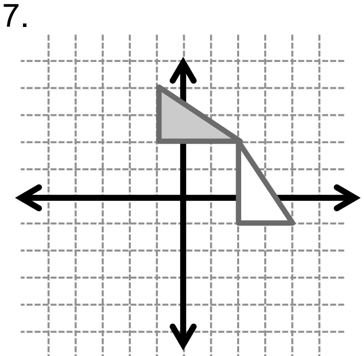
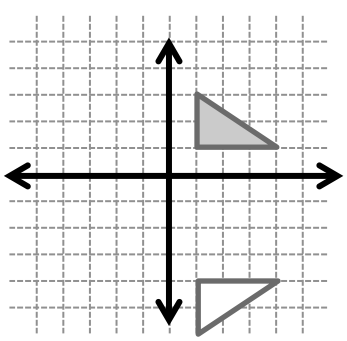
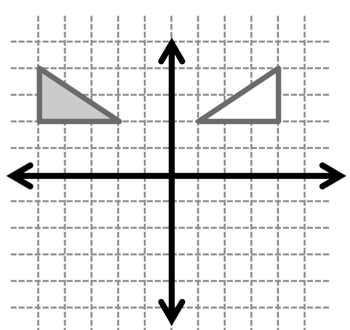
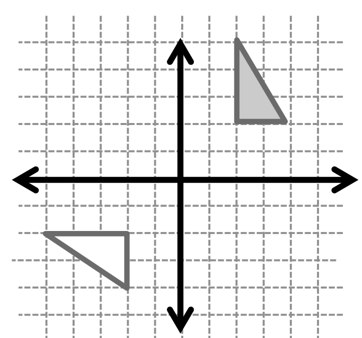
1. What is the equation of the *y*-axis?

2. What is the equation of the *x*-axis?

3. What is the equation of a horizontal line that goes through the point (3, 5)?

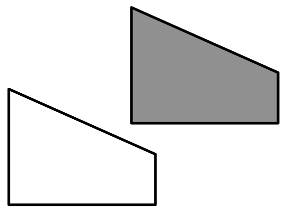
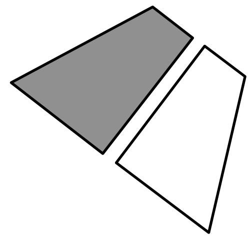
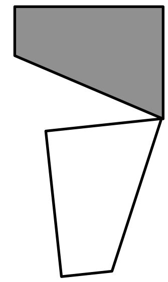
4. What is the equation of a vertical line that goes through the point (3, 5)?

A figure and its image under a reflection are shown. Draw the line of reflection. Give the equation for the line of reflection. Use patty paper if needed.

5.  Line of reflection:	6.  Line of reflection:	7.  Line of reflection:
8.  Line of reflection:	9.  Line of reflection:	10.  Line of reflection:

PROPERTIES OF TRANSFORMATIONS

For each transformation, describe steps that map the shaded figure to its unshaded image. Use patty paper if needed.

		A	B	C
1.	Label the vertices of the original figure *BANK* and its image *B'A'N'K'* .			
2.	Describe steps that map the figure to its image.			
4.	Write whether a rotation, translation, or reflection is illustrated.			

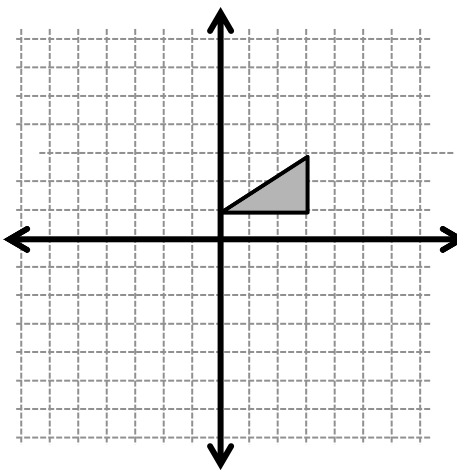
Examine other properties of the figure and its image. Verify experimentally if needed.

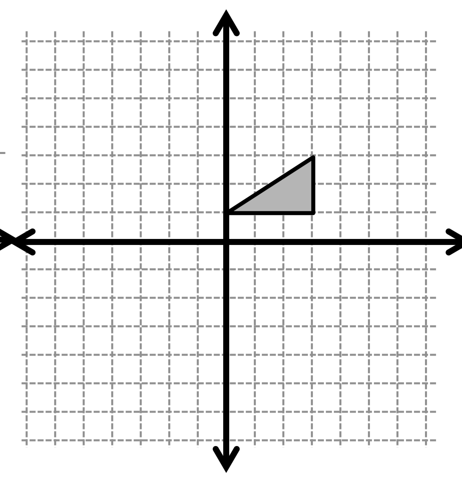
5.	Are parallel segments taken to parallel segments?			
6.	Are angles taken to angles of the same measure?			
7.	Are segments taken to segments of the same length?			
8.	Is orientation preserved?			
9.	Does the original figure have the same size and shape as the image?			

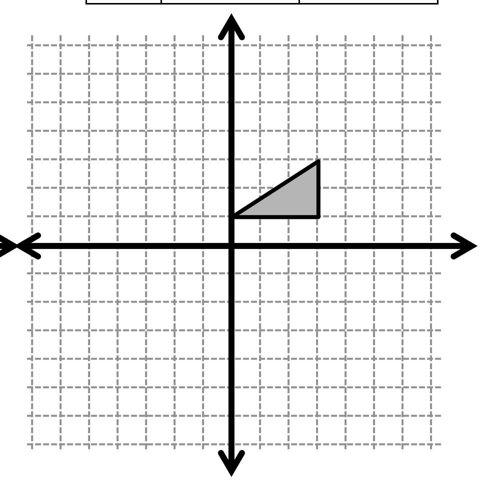
WHAT'S HAPPENING HERE?

- Triangle *ABC* has vertices at *A*(3, 1), *B*(3, 3), *C*(0, 1).
- Transfer these coordinates to the table at right prior to beginning the problems.
- Find the coordinates of the images *A*, *B*, and *C* and sketch the image of ΔABC, for each of the three transformations below.
- Explore the effects of transformations (which are not necessarily translations, rotations, or reflections) by examining the images of the triangle.

Original Figure		
	x	*y*
A		
B		
C		







1. $(x, y) \rightarrow (-x, y - 2)$		
	$-x$	$y - 2$
A′		
B′		
C′		

2. $(x, y) \rightarrow (2x, 2y)$		
A′		
B′		
C′		

3. $(x, y) \rightarrow (x, x - y)$		
A′		
B′		
C′		

Refer to each of the three problems above (tables and diagrams).

	Is the transformation a translation, rotation, or reflection?	Are lines taken to lines?	Are segments taken to segments of the same length?	Are angles taken to angles of the same measure?
1.				
2.				
3.				

SKILL BUILDERS, VOCABULARY, AND REVIEW

SKILL BUILDER 1

Recall that a function is a rule that assigns to each input value exactly one output value.

1. Consider the rule that assigns to each input value x a unique output value $x + 3$. This rule can be written using arrow notation as $x \rightarrow x + 3$. We can read this as "the input value x corresponds to the output value $x + 3$" or "x maps to $x + 3$."

Complete a table of values for this rule.

input	x	-4		2.5	$-\frac{3}{2}$	0	14	
output	$x + 3$		5					-32

Write an equation for the rule $x \rightarrow x + 3$ using the variable y to represent the output.

$y =$ __________

Is the rule defined by the equation a function? __________________

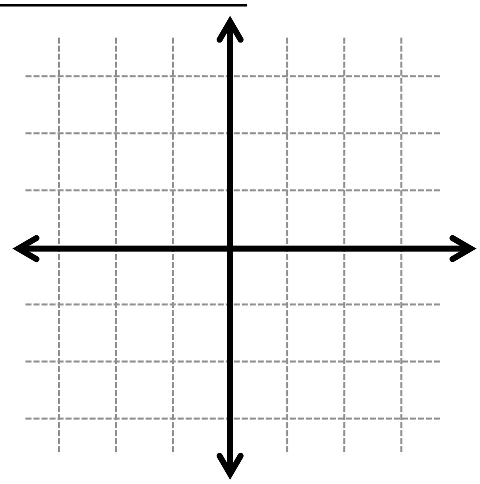
2. Consider the rule $y = -x$.

Complete a table of values for this rule.

input	x	4		0		-0.03	12.2	
output			6		$-2\frac{2}{5}$			-3

Write an equation for $y = -x$ using arrow notation. ____________________

Use words to describe what this function does to each input.



3. Using the axes to the right, graph and label the following equations:

$y = 2$ $\qquad$ $x = -1$ $\qquad$ $y = x$

Circle the equations that represent functions.

How do you know?

SKILL BUILDER 2

1. The <u>fraction inverse property</u> states that for any proportion, if $\frac{a}{b} = \frac{c}{d}$ then $\frac{b}{a} = \frac{d}{c}$.

   State what this means in your own words.

Rewrite each proportion using the fraction inverse property.

2. $\frac{1}{2} = \frac{5}{10} \rightarrow$	3. $\frac{12}{21} = \frac{4}{7} \rightarrow$

Change each fraction to a decimal and a percent.

4. $\frac{17}{100}$	5. $\frac{11}{25}$	6. $\frac{7}{10}$	7. $\frac{4}{5}$

8. What is 30% of 52?	9. What percent of 56 is 7?

Solve each system of equations using any method.

10. $\begin{cases} 4x + y = 2 \\ 4x - 6 = y \end{cases}$

11. $\begin{cases} \frac{1}{2}x + 4y = 3 \\ x + 3y = -4 \end{cases}$

SKILL BUILDER 3

Paulo wanted to investigate the effect that playing video games had on homework completion. He asked 50 students the following questions:

- Do you play video games?
- Did you complete all your homework last week?

Unfortunately he lost some of his data. Can you help him out?

1. Complete the missing fields in the table.

	Plays Video Games	No Video Games	Total
Homework Completed	27		36
Homework Not Completed		2	
Total	39		50

2. Complete the relative frequency table.

	Plays Video Games ($n =$)	No Video Games ($n =$)
Homework Completed		
Homework Not Completed		
Total		

Use the tables above to help you answer the following questions.

3. What percent of all students completed their homework?

4. What percent of all students played video games?

5. Paulo thinks that students who play video games will not complete their homework. Does this data support his conjecture? _____ Explain.

SKILL BUILDER 4

1. For the linear function $y = \frac{3}{2}x - 4$, the slope is _____ and the y-intercept is _____.

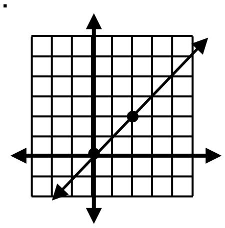
2. What is the equation of the line that goes through the point $(0, \frac{1}{2})$ and has slope is -5?

Use the information given in each problem to write an equation of a line.

3. Table:

x	y
0	-1
1	1
2	3
3	5
4	7

4. Graph:



5. (2, -2) and (0, 2) are on the line.

6. Explain why 0.055×10^6 is NOT written in scientific notation. Then rewrite it in scientific notation.

7. Multiply the numbers and write the result in scientific notation: $(45 \times 10^{-8})(15 \times 10^{-5})$

8. Simon multiplied two numbers on his calculator and saw the following. Explain to him what number this represents, and why it is displayed this way.

3.2651 E+10

SKILL BUILDER 5

Each student in the community service club tries to sell 20 t-shirts to raise money for charity. Yolanda tracked her sales by noting how many shirts were left after each day of selling over an 8-day period.

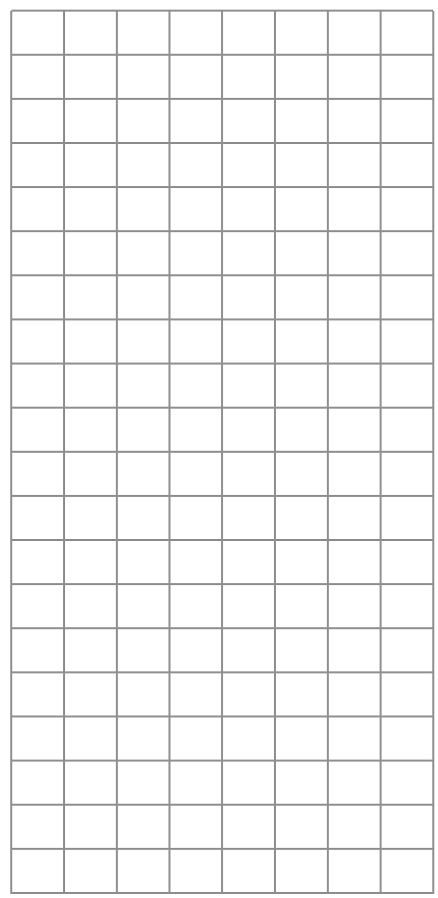
day # (x)	# of shirts left (y)
1	18
2	17
3	16
4	14
5	10
6	8
7	7
8	6

1. Plot the data on the graph. Make sure you label each axis appropriately and give your graph a title.

2. Describe any patterns you see and make a conjecture about what is happening to the number of shirts that remain.

3. Draw a line of best fit on your graph.

4. Choose two points **on your line** and find the slope of your line of best fit.



5. What does this slope mean in the context of the problem?

6. What is the y-intercept of your line of best fit?

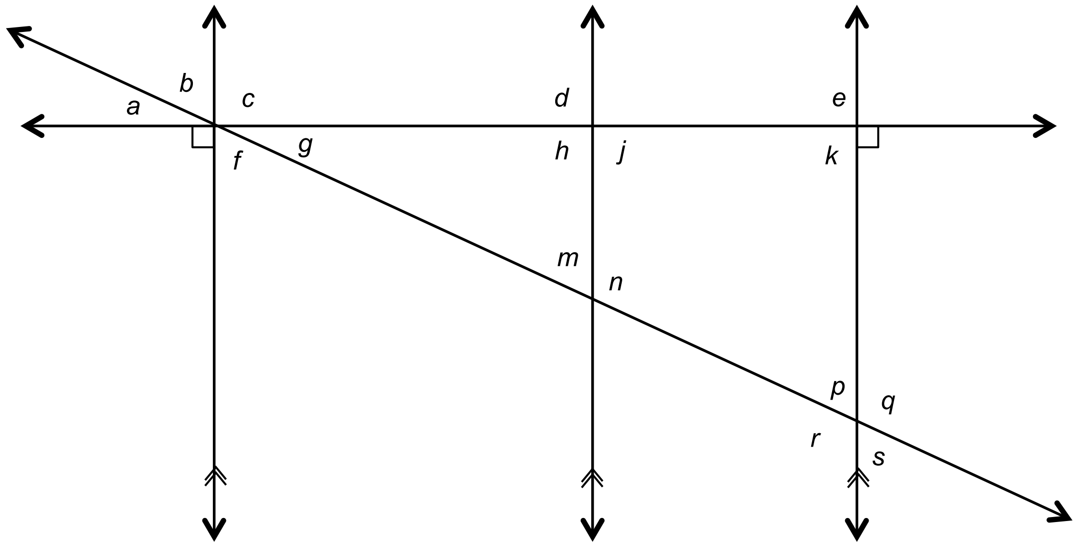
7. What does the y-intercept mean in the context of the problem?

8. Use the graph to estimate on which day Yolanda would have no shirts left.

9. Use your model (your equation) to estimate on which day Yolanda would have no shirts left.

10. Do these estimates agree?

SKILL BUILDER 6



Find the measures of all the angles in the figure above. One is given to you.

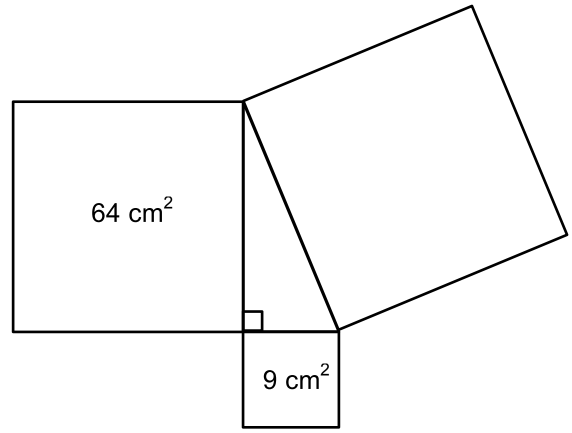
1. $|\angle a| = 35^{o}$	2. $|\angle b|$ = ___	3. $|\angle c|$ = ___	4. $|\angle d|$ = ___
5. $|\angle e|$ = ___	6. $|\angle f|$ = ___	7. $|\angle g|$ = ___	8. $|\angle h|$ = ___
9. $|\angle j|$ = ___	10. $|\angle k|$ = ___	11. $|\angle m|$ = ___	12. $|\angle n|$ = ___
13. $|\angle p|$ = ___	14. $|\angle q|$ = ___	15. $|\angle r|$ = ___	16. $|\angle s|$ = ___

17. Explain how you found $|\angle g|$.

18. Explain how you found $|\angle m|$.

SKILL BUILDER 7

For the diagram at the right that depicts the Pythagorean relationship, the areas of two squares are given. (Leave non-integer values in square root form.)



1. What is the length of the shorter leg? ________
2. What is the length of the longer leg? ________
3. What is the area of the third square? ________
4. What is the length of the hypotenuse? ________

5. A square has a diagonal that is 6 inches long. Find the length of its side.

a. Draw a sketch and label the side length x and the diagonal.	b. Calculate the side length. Write it in square root form and also as a decimal rounded to one place.

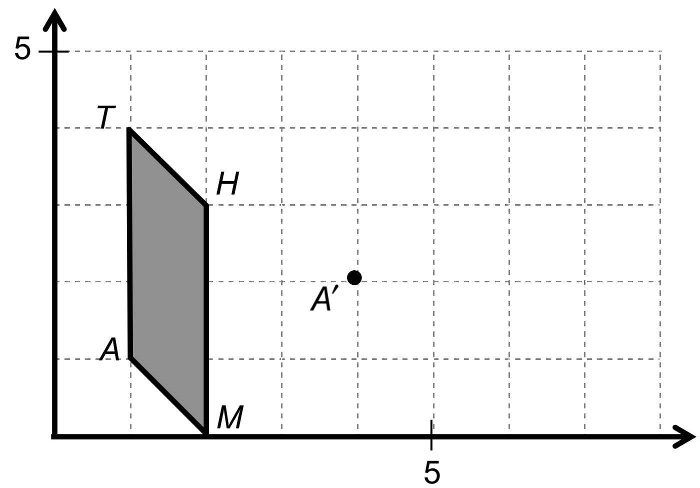
6. Elena sees a triangle with sides of lengths 21, 28, and 35 inches, and without directly applying the converse of the Pythagorean Theorem knows very quickly that it must be right. How do you think she knows this?

7. Evaluate the expression $\dfrac{\sqrt{b^2 - 4ac}}{2a}$ for $a = 1$, $b = 6$, and $c = 4$.

SKILL BUILDER 8

1. Translate $MATH \rightarrow M'A'T'H'$. Then answer problems 2-4.

2. Do parallel line segments in the original figure remain parallel within the image? In other words, are parallel lines taken to parallel lines?

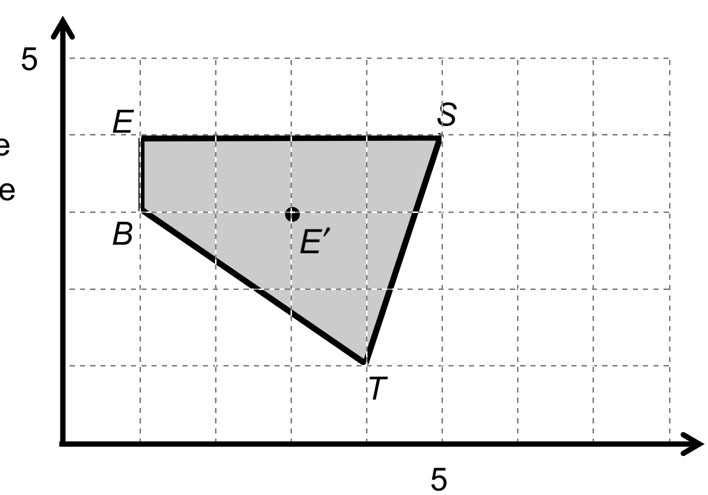


3. Draw translation vectors. Label them $\vec{w}$. What is the slope of each of the translation vectors?

4. How do you know that the translation vectors are parallel?

5. Translate *BEST* → *B'E'S'T'* . Then answer problem 6.

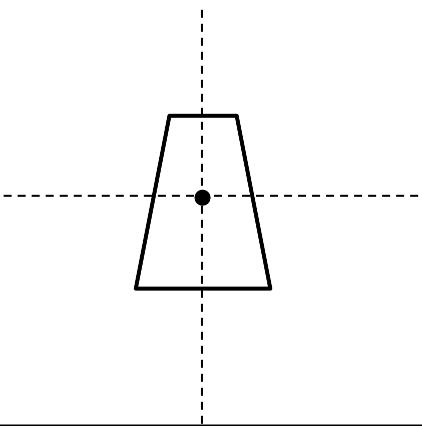
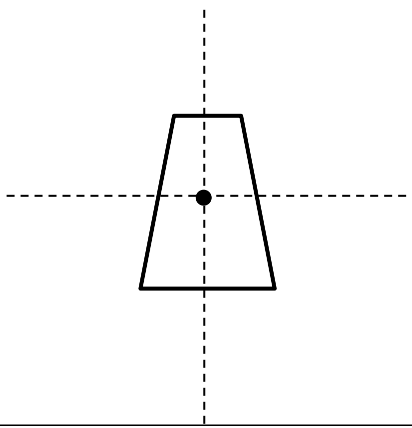
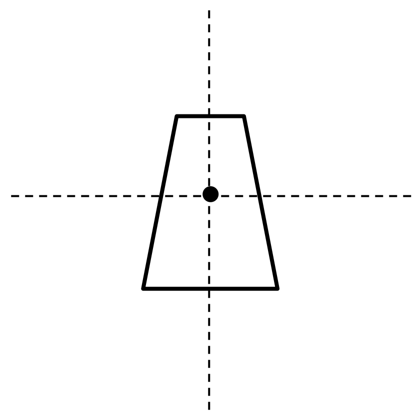
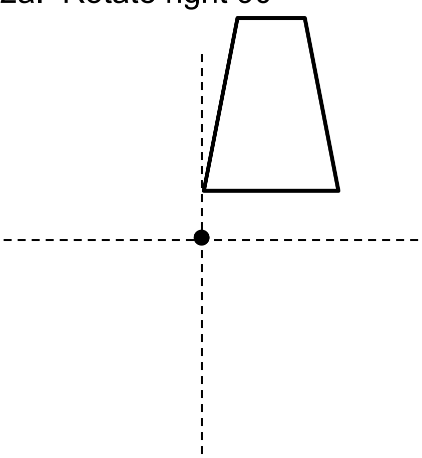
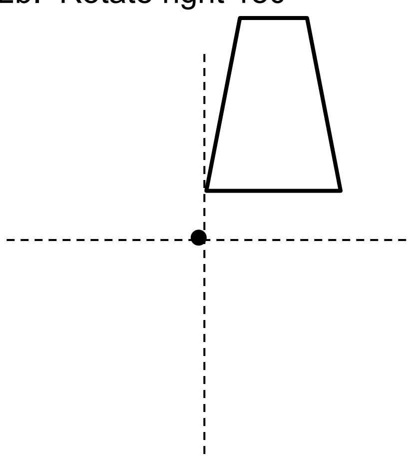
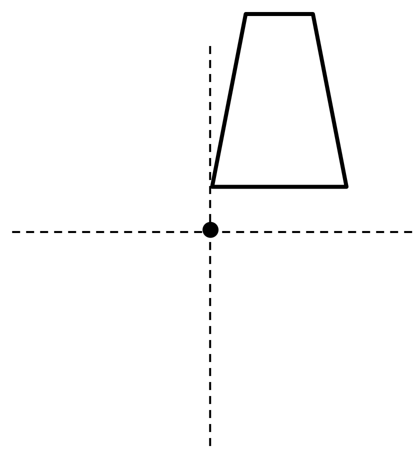
6. Write coordinates for *B*, *T*, *B'*, and *T'* on the graph. Then verify that $|BT| = |B'T'|$ using the Pythagorean Theorem.



SKILL BUILDER 9

For each row:

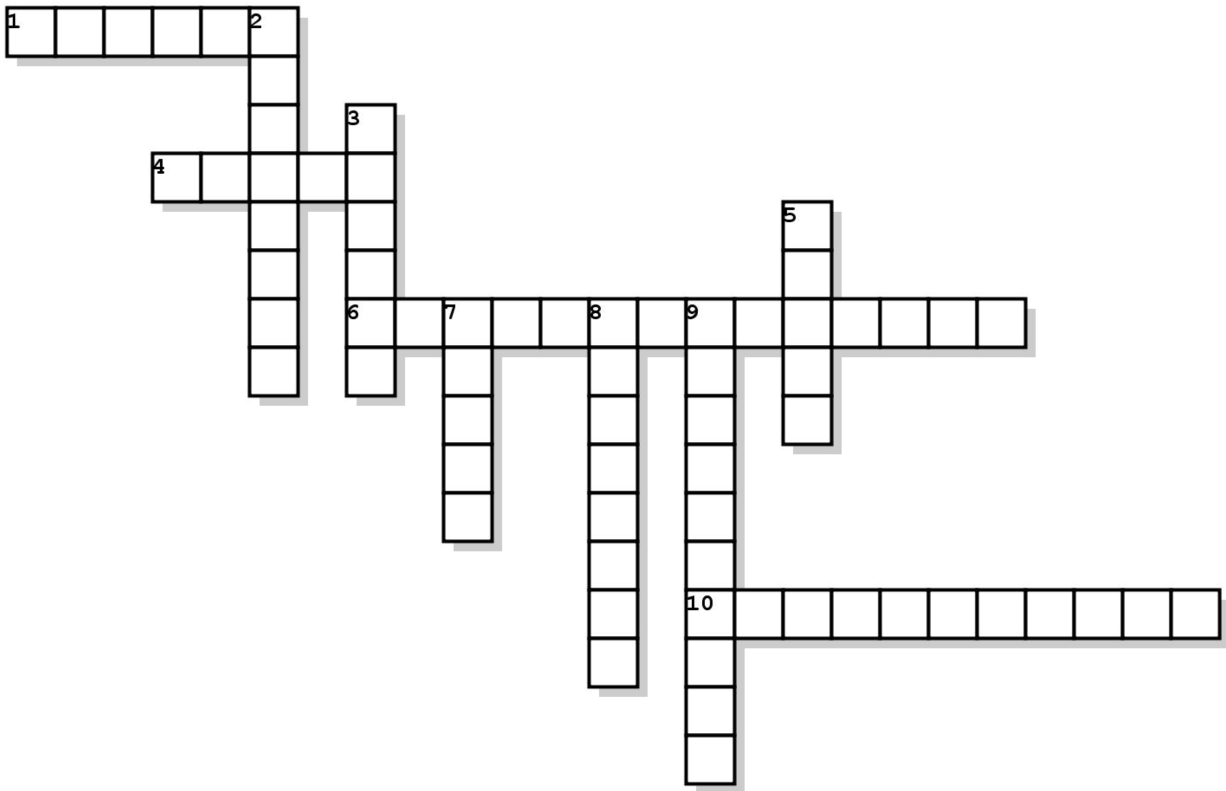
- Draw the shape on patty paper with pencil markings on both sides of the paper.
- Make a small (with arrow pointing up) to indicate location of axes.
- Perform the rotation about the origin using patty paper and record.
- Shade the original figure.

1a. Rotate left (counterclockwise) 90° 	1b. Rotate left 180° 	1c. Rotate right (clockwise) 90° 
2a. Rotate right 90° 	2b. Rotate right 180° 	2c. Rotate left 90° 

3. To show that every point in a plane maps to an image, draw the letter F somewhere in 1a. Then rotate left 90° to find its image.

FOCUS ON VOCABULARY

Use vocabulary from this packet to complete the crossword below.



<u>Across</u>

1 A point taken to itself by a rotation

4 The result of transformation

6 A function that takes the plane to itself

10 slide

<u>Down</u>

2 turn

3 A measure of distance

5 A flat surface with no thickness

7 A figure formed by two rays that share a common endpoint

8 A rule that assigns to a unique output to each input

9 flip

SELECTED RESPONSE

Show your work on a separate sheet of paper and choose the best answer(s).

1. Which of the following statements are NOT true?

   A. A transformation of the plane is a function that maps the plane to the plane.

   B. A transformation moves a figure from one place to another.

   C. A transformation takes all points in the plane to other points in the plane.

   D. Translations, rotations, and reflections are three examples of transformations.

---

2. Choose ALL true statements about translations, rotations, and reflections.

   A. Lines are taken to lines.

   B. Line segments are taken to line segments of the same length.

   C. Angles are taken to angles of the same measure.

   D. Parallel lines are taken to parallel lines.

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3. A reflection through the *x*-axis transforms a segment with endpoints at (5, 2) and (-3, 4) to an image with endpoints:

   A. (5, -2) and (-3, -4) B. (5, -2) and (3, -4)

   C. (2, 5) and (4, -3) D. (-2, 5) and (-4, 3)

---

4. A segment with endpoints (0, 0) and (4, 0) is rotated 90° right with the center of rotation at the origin. The endpoints of the image are:

   A. (0, 0) and (4, 0) B. (0, 0) and (-4, 0)

   C. (0, 0) and (0, -4) D. (0, 0) and (0, 4)

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5. A segment with endpoints (-3, -1) and (2, -3) under a transformation $(x, y) \rightarrow (-x, y + 4)$, has an image with endpoints:

   A. (3, -3) and (-2, -1) B. (3, 3) and (-2, 1)

   C. (-1, -3) and (6, 1) D. (1, 1) and (6, 3)

KNOWLEDGE CHECK

Show your work on a separate sheet of paper and write your answers on this page.

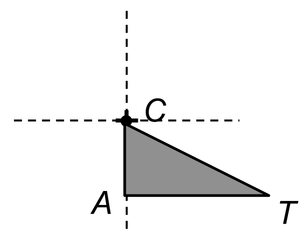
13.1 Translations

1. Draw and label ΔCOW with coordinates (3, 2), (2, 1), (1, 4). Then find its image, $\Delta C'O'W'$ under the transformation $(x, y) \rightarrow (x - 3, y - 4)$.

2. Use problem 1. Give an example to illustrate that "angles are taken to angles of the same measure" under a translation.

13.2 Rotations

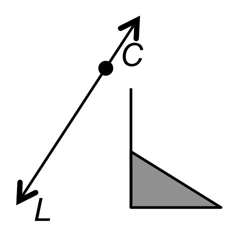
3. Rotate $\Delta\ CAT$ 180° counter-clockwise about point C and record. Do not shade the image.



4. Use problem 6. Give an example to illusrate that "line segments are taken to line segments of the same measure" under a rotation.

13.3 Reflections

5. In the problem at right, trace the shaded original figure, the line of reflection L, and point C on patty paper. Perform the reflection using patty paper and record. Do not shade the image.



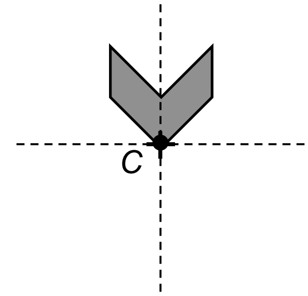
6. Draw and label ▱ $MARS$ with vertices at (-3, 4), (-1, 3), (-1, 1), and (-3, 1), respectively. Then draw $M'A'R'S'$ under the transformation $(x, y) \rightarrow (-x, y)$.

7. Use problem 4. Give an example to illustrate that "parallel lines are taken to parallel lines" under a reflection.

HOME-SCHOOL CONNECTION

Here are some questions to review with your young mathematician.

1. Draw the shape on patty paper with pencil markings on both sides of the paper. Mark point C on the paper. Make a small + to indicate location of axes. Rotate 90° counter-clockwise around point C. Do not shade the image.



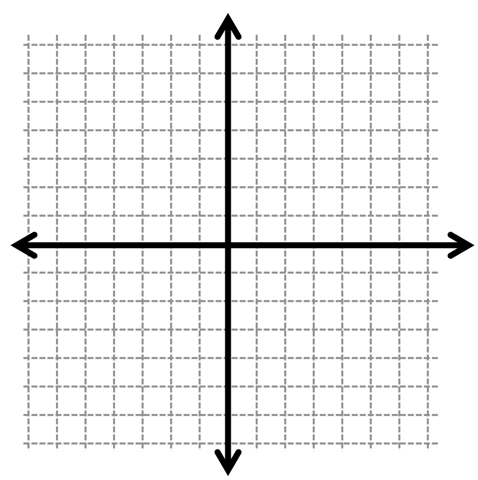
2. Describe three properties of a rotation.

Triangle *HEN* has vertices at H (2, 2), E (2, 5), N (6, 2).

3. Describe effects of the given transformation by observing the effect on the image of the figure.

Original Figure		
	x	*y*
H		
E		
N		

$(x, y) \rightarrow (-x, -y)$		
H'		
E'		
N'		
Description:		



Parent (or Guardian) Signature ___________________________

COMMON CORE STATE STANDARDS – MATHEMATICS

STANDARDS FOR MATHEMATICAL CONTENT	
8.F.1	Understand that a function is a rule that assigns to each input exactly one output. The graph of a function is the set of ordered pairs consisting of an input and the corresponding output.
8.G.1a	Verify experimentally the properties of rotations, reflections, and translations: Lines are taken to lines, and line segments to line segments of the same length.
8.G.1b	Verify experimentally the properties of rotations, reflections, and translations: Angles are taken to angles of the same measure.
8.G.1c	Verify experimentally the properties of rotations, reflections, and translations: Parallel lines are taken to parallel lines.
8.G.3	Describe the effect of ~~dilations~~, translations, rotations, and reflections on two-dimensional figures using coordinates.

STANDARDS FOR MATHEMATICAL PRACTICE	
MP1	Make sense of problems and persevere in solving them.
MP2	Reason abstractly and quantitatively.
MP3	Construct viable arguments and critique the reasoning of others.
MP5	Use appropriate tools strategically.
MP7	Look for and make use of structure.

9 7 8 1 6 1 4 4 5 2 2 1 8