Set the Sails!

The sails on a sailboat are set according to the direction of the wind and the bearing. When one jibes or tacks, the main sail is moved from one side of the boat to the opposite about the mast. As the captain tacks, the sailboat is translated in a direction called its bearing. When the captain yells, "ready jibe or ready tack", the sailboat is then rotated about its bow to a new position and the sails are set for this new course.

You will be modeling "setting the sails" in a coordinate plane using graphing technology and make generalizations about transformations of a sail as a mapping of points in this plane.

1. Use a TI-83+ with Cabri Junior™ software to investigate reflections, translations, sequences of reflections and translations, and rotations in a coordinate plane.

2. Follow the instructions on the activity sheet and ask your instructor for assistance in using the Cabri Junior™ software on your graphing calculator when needed.

3. You will study patterns on the graphs and tables and make generalizations about the transformations presented.

4. Good luck and smooth sailing !

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Reflections Investigation:
Use a TI-83+ with Cabri Junior^{TM} software to conduct each investigation.
Ask your instructor for assistance when needed.
1. Reflect the sail about the y-axis:

Pre-image Coordinates		Image Coordinates	
x	**y**	**x'**	**y'**

    a. How do the coordinates of the image compare with the coordinates of the preimage? What stayed the same? What changed?

    b. What is the relationship between the y-axis and any segment joining corresponding vertices of the image and preimage? Explain.

    c. Write a description of a reflection of a geometric figure in the coordinate plane.

    d. Write this transformation with a mapping rule: **(x, y) → (_____, _____)**

2. Reflect the sail about the x-axis:

Pre-image Coordinates		Image Coordinates	
x	**y**	**x'**	**y'**

    a. What stayed the same? What changed?

    b. Describe the relationship between the coordinates of the preimage and image as a mapping rule: **(x,y)) →(_____, _____)**

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3. **Reflect the sail about the line y=x.**

Pre-image Coordinates		Image Coordinates	
x	**y**	**x'**	**y'**

   a. How do the coordinates of the vertices of the image compare with those of the pre- image?

   b. Write a rule that describes the relationship between the coordinates of the vertices of the image and the coordinates of the corresponding vertices of the preimage.

4. **Sequence of Reflections:**
   Reflect the sail about the x-axis and then the y-axis.

Pre-image Coordinates		Coordinates for reflection about x-axis		Coordinates for reflection about the y-axis	
x	**y**	**x'**	**y'**	**x"**	**y"**

   a. How do the coordinates of the final image compare with the original coordinates?

   b. Describe this relationship with a written description and a mapping rule.
      (x, y) ʊ (_____, _____)

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5. **Sequence of Reflections:**
   Reflect the sail about the y-axis and then about the x-axis.

Pre-image Coordinates		Coordinates for reflection about the y-axis		Coordinates for reflection about the x-axis	
x	y	x'	y'	x"	y"

   a. Compare the coordinates of the final image and the original coordinates.

   b. How would you describe this relationship with a mapping rule?
       (x, y) → (_____, _____)

   c. Does order matter in a sequence of reflections? Explain.

Translation Investigations:
6. **Translation in one direction:**
   Translate the sail to the right 4 units.

Pre-image Coordinates		Image Coordinates	
x	y	x'	y'

   a. How did this translation affect the coordinates of the preimage?

   b. What stayed the same? What changed?

   c. Write a mapping rule for this transformation?

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7. Translate the sail to the left 5 units.

Pre-image Coordinates		Image Coordinates	
x	**y**	**x'**	**y'**

a. What stayed the same? What changed?

b. Write a rule for translating the sail 5 units to the left.

8. Translate the sail by a distance OT up in a vertical direction.

Pre-image Coordinates		Image Coordinates	
x	**y**	**x'**	**y'**

a. What effect did this translation have on the coordinates of the preimage?

b. Write a rule that represents this transformation.

9. Translate the sail a distance of OT down.

Pre-image Coordinates		Image Coordinates	
x	**y**	**x'**	**y'**

a. How did this translation affect the coordinates of the preimage?

b. Write a rule for translating the sail a distance of OT down in the coordinate plane.

c. Write a rule for translating the sail "b" units vertically in the coordinate plane.

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Sequence of translations:
10. Translate the sail a distance of OM to the left and OP down.

Pre-image Coordinates		Image Coordinates	
x	**y**	**x'**	**y'**

      a. What effect did this sequence of translations have on the coordinates of the preimage?

      b. Write a rule to describe this sequence of translations.

11. Translate the sail by a distance OP down and then OM left.

Pre-image Coordinates		Image Coordinates	
x	**y**	**x'**	**y'**

      a. How do the coordinates for the sequence of transformations in #10 and #11 compare?

      b. Does order matter for this sequence of transformations? Explain.

12. Sequence of Reflections and Translations:
Use a TI-83+ with Cabri Junior™ software to do the following investigations.
Start with a sail (triangle) in a coordinate plane on your calculator screen.

  a. Reflect the sail about the y-axis and then translate the image down a distance of OP.

  b. Translate the sail down by a distance of OP and then reflect it about the y-axis.

  c. Compare the results and determine if this sequence of transformations produces the same result. Does order matter in this sequence of transformations? Why or why not?

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13. **Rotations in the coordinate plane:**
Draw a triangle (sail) in the second quadrant and rotate it 90 degrees about the origin as the center of rotation in a clockwise direction. Then rotate the image 90 degrees in a clockwise direction about the origin. Record the coordinates of the preimage and its image for each rotation in the table provided. Use the data collected to answer the questions that follow.

Coordinates of Original Sail (Triangle)		Coordinates of sail rotated 90 degrees clockwise		Coordinates of sail rotated 180 degrees clockwise	
x	**y**	**X'**	**Y'**	**X''**	**Y''**

a. What effect did rotating the sail 180 degrees clockwise about the origin have on the coordinates of the preimage?

b. Write a rule that describes the transformation in "a".