EXPLORATIONS

Activity 12

Traveling Shapes— Motion Geometry

Objective

- To describe how to move a shape from one place to another in a plane

Materials

- TI-73
- Student Activity pages (pp. 138 – 143)

In this activity you will

- Slide a shape from one position to another.
- Turn a shape around a point from one position to another.
- Flip a shape across a line from one side to another.

Introduction

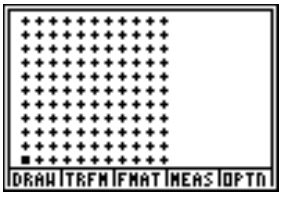
There are three main types of formal movements that will reposition a shape from one part of a flat surface to another. These motions are called *slides*, *turns*, and *flips*. A *slide* moves all points of any shape the same distance and in the same direction. A *turn* rotates all points of any shape about a fixed point through the same angle. A *flip* moves all points of any shape straight across a given line so that each original point and its image on the other side of the line are each the same distance from the original line.

Slides, flips, and turns are rigid motions. Under each of these transformations, the original shape and its image are always the same size and the same shape.

Investigation

This investigation will help you move shapes within a plane.

1. From the main Geoboard menu, select **5:11x11**.

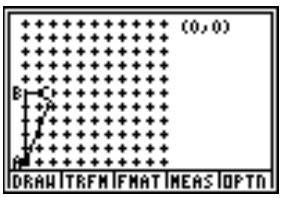


2. To format the geoboard, select **FMAT** and make sure that the following settings are selected:

   LblsOn (Labels are on)
   AxesOff (Axes are off)
   CoordOn (Coordinates are on)
   Decimal (Measurement is in decimal form)

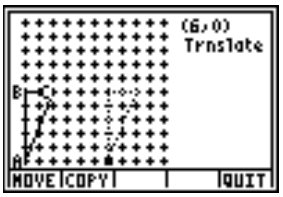
   Select **QUIT** to exit the FORMAT menu.

3. On your board, construct triangle ABC as shown.



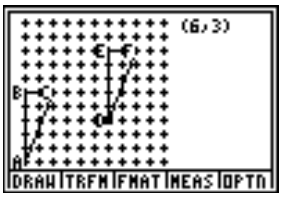
4. Now we will perform a transformation on this shape called a slide or a translation. The original triangle will be moved six units to the right and three units up, which is indicated by using the notation (6, 3). Use the following steps to perform this translation. Start with the flashing cursor on point A, select **TRFM, 3:Translate** ENTER ▶ ▶ ▶ ▶ ▶ ▶.

   Your geoboard should look like the screen at the right.



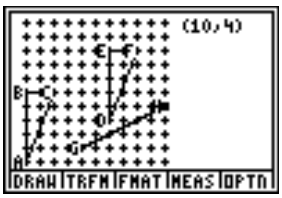
   Press ▲ ▲ ▲ **COPY** to move triangle DEF into its final position and save it.

   Your geoboard should look like the screen at the right.



5. Since we started at the origin, the coordinate (6, 3) indicates that the original object has been moved six units to the right and three units up. Notice that point A has moved to point D and that this movement has been six units to the right and three units up. Similarly, B has moved to E and C has moved to F. The coordinate (6, 3) completely describes this translation from ABC to DEF.

6. Another way of indicating this translation is to move an arrow from an original point to its image point. For example, the directed line segments AD, BE, and CF could indicate this translation. In fact, any directed line segment moving six units to the right and three units up could indicate this translation as shown by segment GH at the right. To move from point G to point H, move 6 units right and 3 units up. GH is called a directed slide arrow and the coordinates are (6, 3).



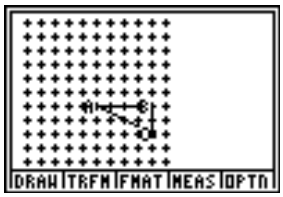
Activity 12.1: Traveling Shapes and *Activity 12.2: Go With The Flow* further explore translations.

7. Now we will consider another transformation called a turn or a rotation. A rotation can be performed about any point through any angle. We will restrict our rotations to those that rotate about any vertex of a figure and have a turn angle of 90 degrees at a time. 6 units right and 3 units up. GH is called a directed slide arrow and the coordinates are (6, 3).

Since coordinates are not needed, go to format and turn the coordinates off.

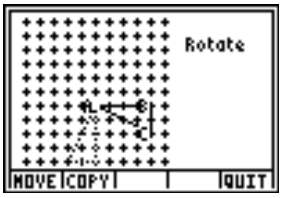
Build triangle ABC on your geoboard.

Your geoboard should look like the screen at the right.

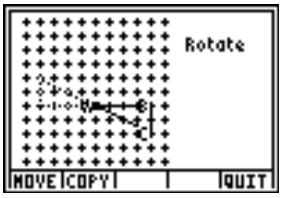


8. Now select **TRFM, 1:Rotate**. Move to point A and press ENTER to select the vertex of the object. The object will become dotted and can now be rotated clockwise using the ▶ key. Press ▶ and notice that the triangle has rotated 90 degrees clockwise about point A. Continue pressing ▶ and notice that the triangle rotates another 90 degrees clockwise each time.

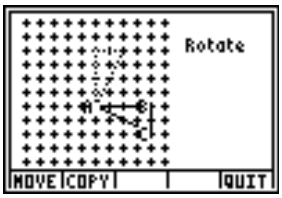
90° rotation



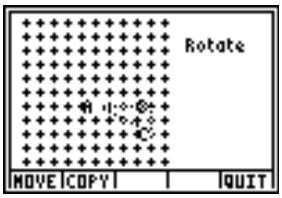
180° rotation



270° rotation

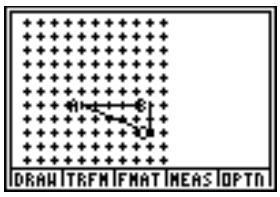


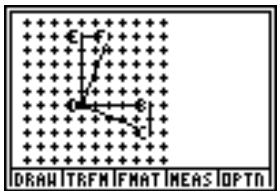
360° rotation



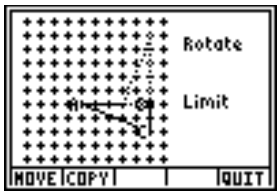
Notice that the fourth rotation brings us back to the original position.

9. From the original position, press ◄ to move the figure counterclockwise 90°. To make a copy of this figure in this position, select **COPY**. Notice that a 90° counterclockwise rotation results in the same figure as a 270° clockwise rotation.





10. If triangle ABC is rotated 180° about vertex B, the TI-73 cannot perform the rotation and will show the error message "Rotate Limit." The rotation will not fit on the geoboard in that direction.

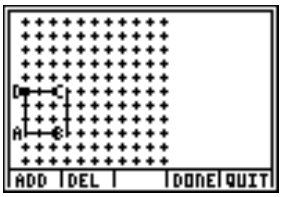


Activity 12.3: Turn Around explores rotations further.

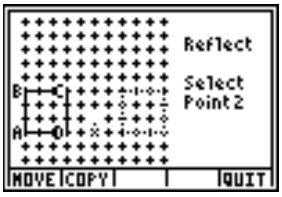
11. Another transformation is called a flip or a line reflection. A reflection can be performed about any line segment. We will restrict line reflections to about points that are next to each other. This means that our reflecting line segments will be vertical or horizontal.

Build square ABCD on your geoboard.

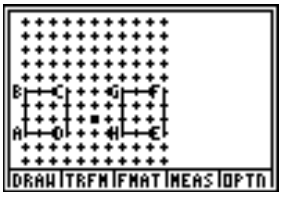
Your geoboard should look like the screen at the right.



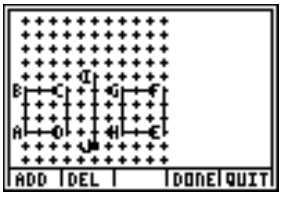
12. Select **TRFM, 2:Reflect**. Move the cursor to D and press ENTER to select the object to be flipped. The object will become dotted and can now be reflected. Next, select point 1 by moving two units to the right of D and pressing ENTER. Select point 2 by moving up one unit and pressing ENTER. The flipped object will appear dotted.



Select **COPY** to complete the reflection.



The flip line or the line of reflection determined by points 1 and 2 above is a vertical line (IJ) located midway between the original square and its image as shown at the right. This flip line will not show up unless you draw it using the **DRAW, ADD** menu.



The flip line can be located outside the shape, inside the shape, or on the boundary of the shape.

Activity 12.4: Let's Reflect On It explores line reflections further.

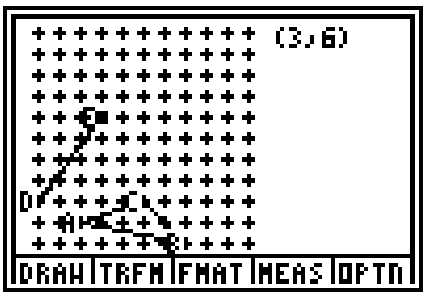
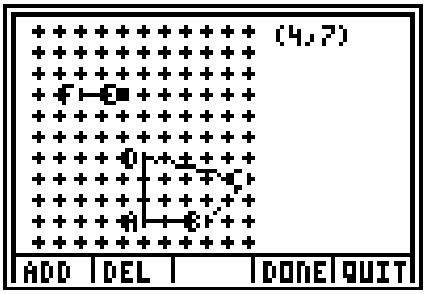
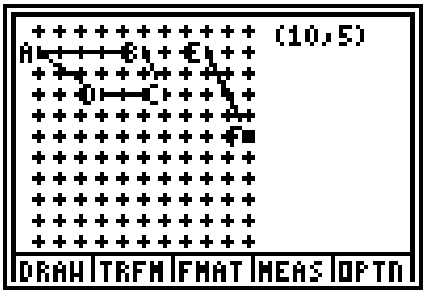
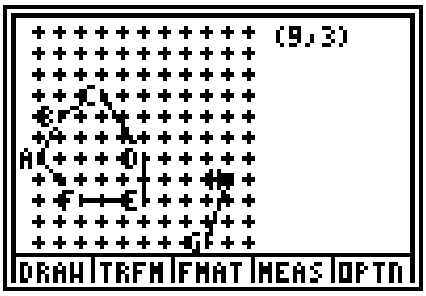
Student Activity

Name _____

Date _____

Activity 12.1: Traveling Shapes

Construct each shape on the TI-73 in the exact position shown, and then move your shape according to the directed slide arrow and draw its final position. Also, give an ordered pair that indicates the amount of horizontal and vertical change between the first and final positions.

1. The coordinates for slide arrow DE are _____.	
2. The coordinates for slide arrow EF are _____.	
3. The coordinates for slide arrow EF are _____.	
4. The coordinates for slide arrow GH are _____.	

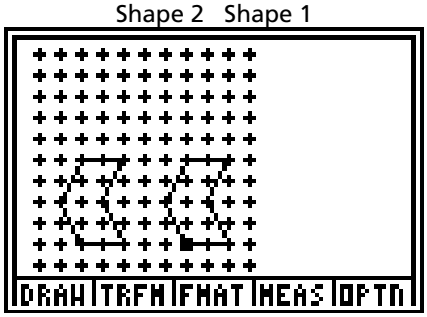
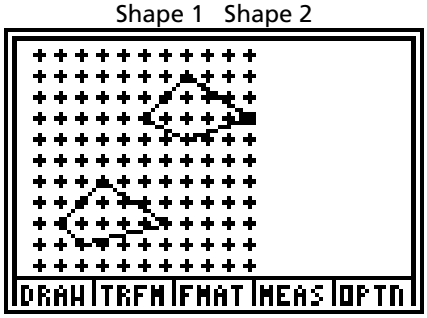
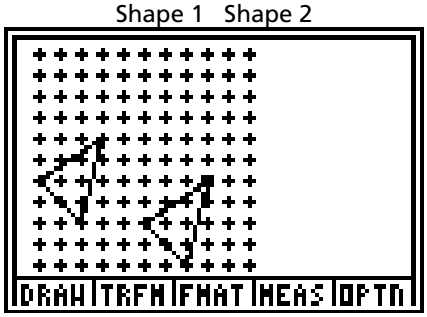
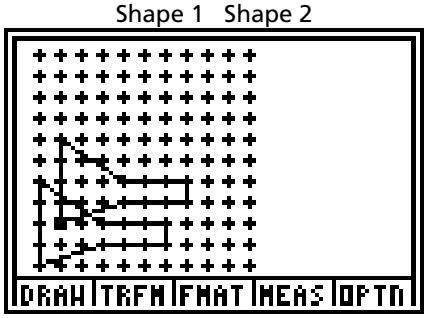
Student Activity

Name _____

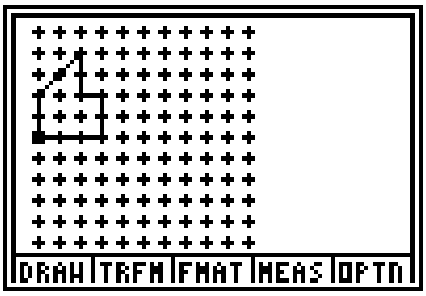
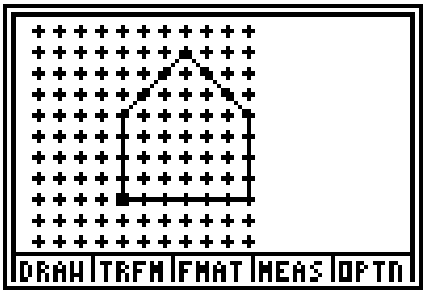
Date _____

Activity 12.2: Go With the Flow

For each diagram, draw a slide arrow from Shape 1 to Shape 2, and then give the coordinates for each translation.

1. Coordinates are _____ and _____.	Shape 2 Shape 1 
2. Coordinates are _____ and _____.	Shape 1 Shape 2 
3. Coordinates are _____ and _____.	Shape 1 Shape 2 
4. Coordinates are _____ and _____.	Shape 1 Shape 2 

Move Shape 1 according to the given coordinates. Then draw a picture of your final Shape 2.

5. Coordinates are 4 and -3.	
6. Coordinates are -3 and -2.	

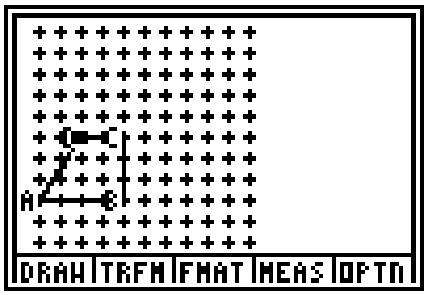
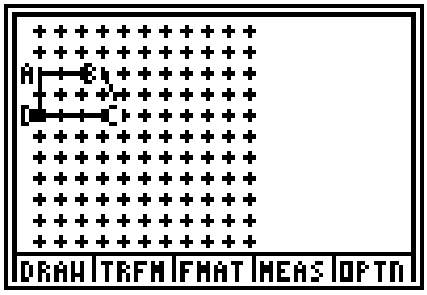
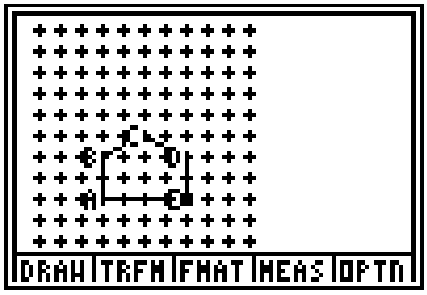
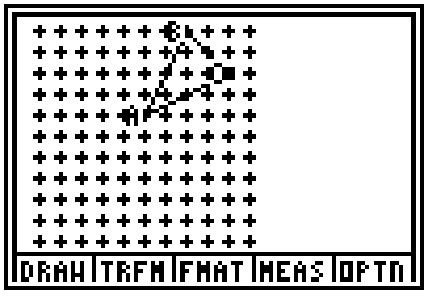
Student Activity

Name _____

Date _____

Activity 12.3: Turn Around

Rotate each shape through the given angle about the given point. Sketch a diagram of the final rotated position.

1. Clockwise 180° about point C.	
2. Counter-clockwise 270° about point C.	
3. Clockwise 90° about point C.	
4. Counter-clockwise 270° about point A.	

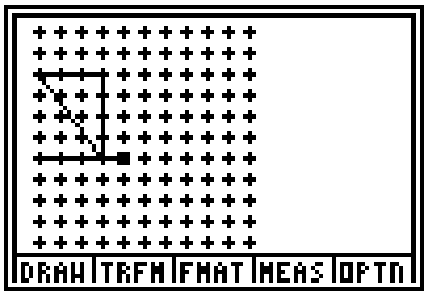
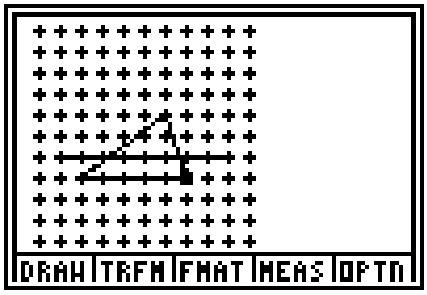
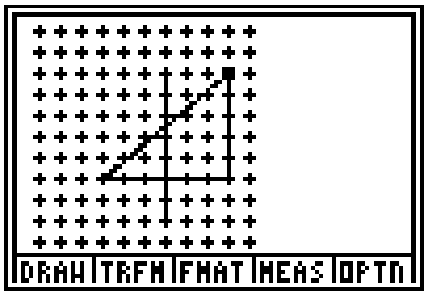
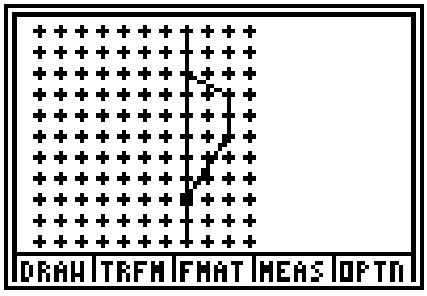
Student Activity

Name _____

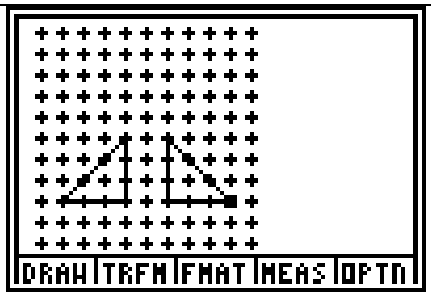
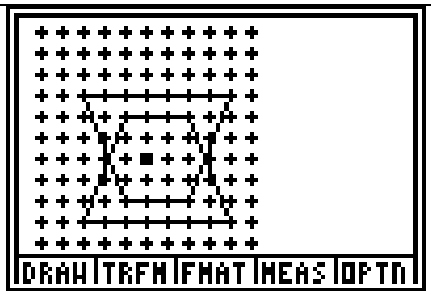
Date _____

Activity 12.4: Reflect On It

Flip each shape about the given line, and then sketch a diagram of the final reflection image.

1.	
2.	
3.	
4.	

Draw the flip line for each shape and its image.

5.	
6.	

⑫ The shape has 4 vertices 	⑫ The shape has at least one 90° angle 
⑫ A line reflection about (4, 5) and (8, 5) gives back the original shape 	⑫ One vertex of the shape is (4, 3) 
⓬ The shape has 2 pairs of congruent sides 	⓬ 1 vertex of the shape is (7, 3) 

Teacher Notes

Activity 12

Traveling Shapes—Motion Geometry

Objective

- To describe how to move a shape from one place to another in a plane

NCTM Standards

- Describe sizes, positions, and orientations of shapes under informal transformation such as flips, turns, slides
- Examine the congruence, similarity, and line or rotational symmetry of objects using transformations

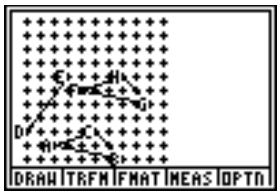
Investigation

Slides, turns, and flips are more formally called translations , rotations and line reflections. All of these transformations change the positions of shapes without changing their sizes or shapes. The line reflection is the basic building block of the other two transformations. Each translation can be represented by successive line reflections in parallel lines. Each rotation can be represented by successive line reflections in intersecting lines. If two shapes in a plane are congruent, one shape can be mapped onto the other by using a maximum of three line reflections.

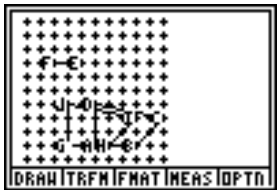
Answers to Student Activity pages

Activity 12.1: Traveling Shapes

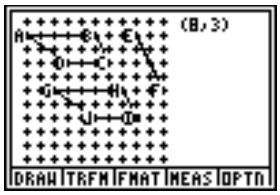
1. (3, 4)



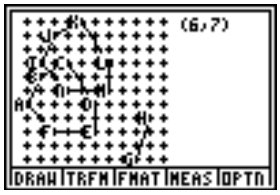
2. (-2, 0)



3. (2, -4)

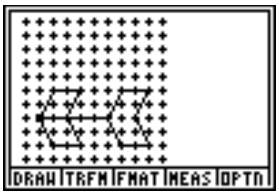


4. (1, 3)

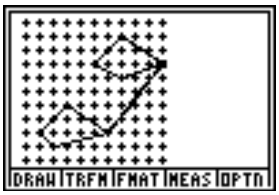


Activity 12.2: Go With The Flow

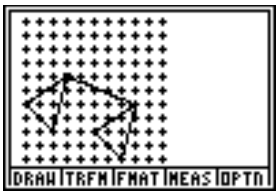
1. (-5, 0)



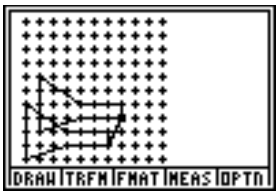
2. (4, 5)



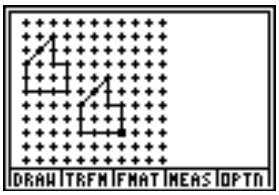
3. (5, -2)



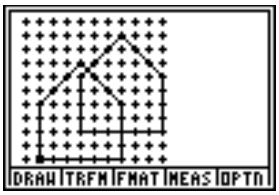
4. (-1, -2)



5.

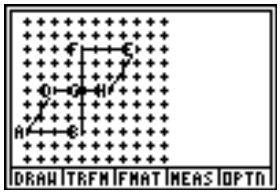


6.



Activity 12.3: Turn Around Motion Geometry

1.



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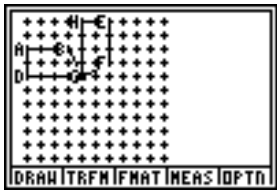
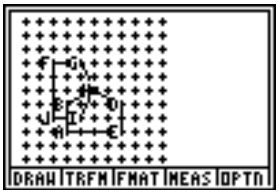
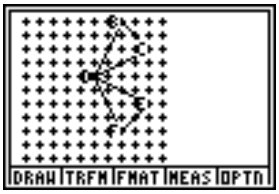


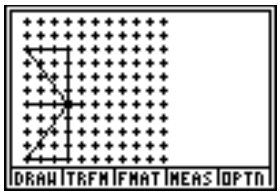
3.

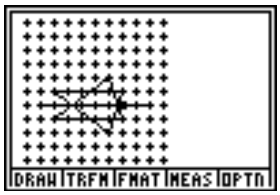


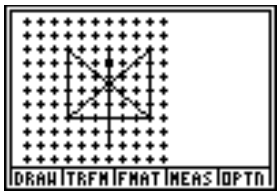
4.

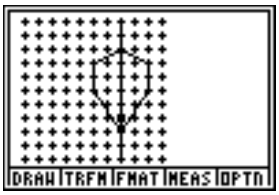


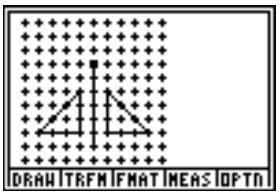
Activity 12.4: Reflect On It

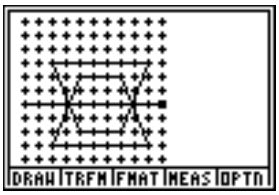
1. 

2. 

3. 

4. 

5. 

6. 

Group Problem Solving: Moving shapes within a plane

The Group Problem Solving cards are challenge problems that can be used alone or with the individual sections of this book. The problems are designed to be used in groups of four (five or six in a group are possibilities using the additional cards) with each person having one of the first four clues. Students can read the information on their cards to others in the group but all should keep their own cards and not let one person take all the cards and do the work.

The numbers at the top of the cards indicate the lesson with which the card set is associated. The fifth and sixth clues (the optional clues) have the lesson number shown in a black circle.

The group problems can be solved using the first four clues. The fifth and sixth clues can be used as checks for the group's solution or they can be used as additional clues if a group gets stuck. Some problems have more than one solution. Any shape that fits all the clues should be accepted as correct.

One solution for this problem solving exercise: