## Lesson 9: Moves in Parallel

Let’s transform some lines.

### 9.1: Line Moves

For each diagram, describe a translation, rotation, or reflection that takes line $ℓ$ to line $ℓ^{′}$. Then plot and label $A^{′}$ and $B^{′}$, the images of $A$ and $B$.

1. 
2. 

### 9.2: Parallel Lines



Use a piece of tracing paper to trace lines $a$ and $b$ and point $K$. Then use that tracing paper to draw the images of the lines under the three different transformations listed.

As you perform each transformation, think about the question:

What is the image of two parallel lines under a rigid transformation?

1. Translate lines $a$ and $b$ 3 units up and 2 units to the right.
	1. What do you notice about the changes that occur to lines $a$ and $b$ after the translation?
	2. What is the same in the original and the image?
2. Rotate lines $a$ and $b$ counterclockwise 180 degrees using $K$ as the center of rotation.
	1. What do you notice about the changes that occur to lines $a$ and $b$ after the rotation?
	2. What is the same in the original and the image?
3. Reflect lines $a$ and $b$ across line $h$.
	1. What do you notice about the changes that occur to lines $a$ and $b$ after the reflection?
	2. What is the same in the original and the image?

#### Are you ready for more?

When you rotate two parallel lines, sometimes the two original lines intersect their images and form a quadrilateral. What is the most specific thing you can say about this quadrilateral? Can it be a square? A rhombus? A rectangle that isn’t a square? Explain your reasoning.



### 9.3: Let’s Do Some 180’s

1. The diagram shows a line with points labeled $A$, $C$, $D$, and $B$.
	1. On the diagram, draw the image of the line and points $A$, $C$, and $B$ after the line has been rotated 180 degrees around point $D$.
	2. Label the images of the points $A^{′}$, $B^{′}$, and $C^{′}$.
	3. What is the order of all seven points? Explain or show your reasoning.
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1. The diagram shows a line with points $A$ and $C$ on the line and a segment $AD$ where $D$ is not on the line.
	1. Rotate the figure 180 degrees about point $C$. Label the image of $A$ as $A^{′}$ and the image of $D$ as $D^{′}$.
	2. What do you know about the relationship between angle $CAD$ and angle $CA^{′}D^{′}$? Explain or show your reasoning.
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1. The diagram shows two lines $ℓ$ and $m$ that intersect at a point $O$ with point $A$ on $ℓ$ and point $D$ on $m$.
	1. Rotate the figure 180 degrees around $O$. Label the image of $A$ as $A^{′}$ and the image of $D$ as $D^{′}$.
	2. What do you know about the relationship between the angles in the figure? Explain or show your reasoning.
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### Lesson 9 Summary

Rigid transformations have the following properties:

* A rigid transformation of a line is a line.
* A rigid transformation of two parallel lines results in two parallel lines that are the same distance apart as the original two lines.
* Sometimes, a rigid transformation takes a line to itself. For example:
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	+ A translation parallel to the line. The arrow shows a translation of line $m$ that will take $m$ to itself.
	+ A rotation by $180^{∘}$ around any point on the line. A $180^{∘}$ rotation of line $m$ around point $F$ will take $m$ to itself.
	+ A reflection across any line perpendicular to the line. A reflection of line $m$ across the dashed line will take $m$ to itself.

These facts let us make an important conclusion. If two lines intersect at a point, which we’ll call $O$, then a $180^{∘}$ rotation of the lines with center $O$ shows that **vertical angles** are congruent. Here is an example:



Rotating both lines by $180^{∘}$ around $O$ sends angle $AOC$ to angle $A^{′}OC^{′}$, proving that they have the same measure. The rotation also sends angle $AOC^{′}$ to angle $A^{′}OC$.



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