Unit 1, Lesson 9

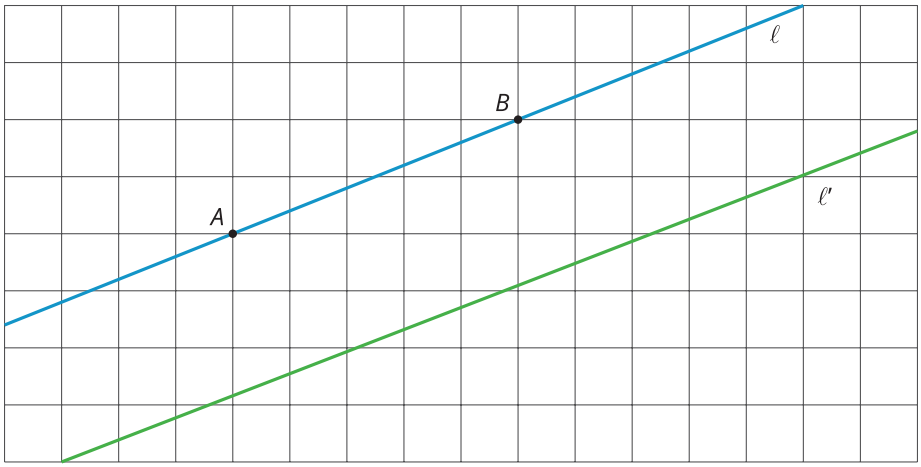
# Moves in Parallel

Let's transform some lines.

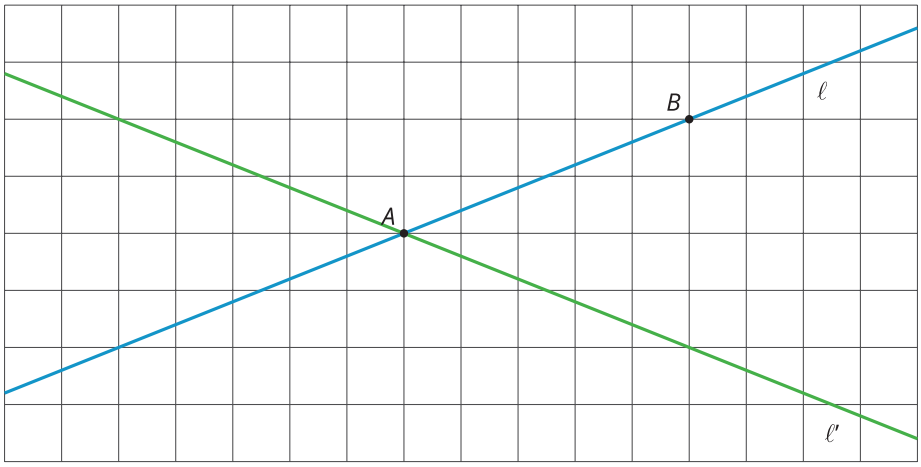
## 9.1 Line Moves

For each diagram, describe a translation, rotation, or reflection that takes line $\ell$ to line $\ell'$. Then plot and label $A'$ and $B'$, the images of $A$ and $B$.

1.



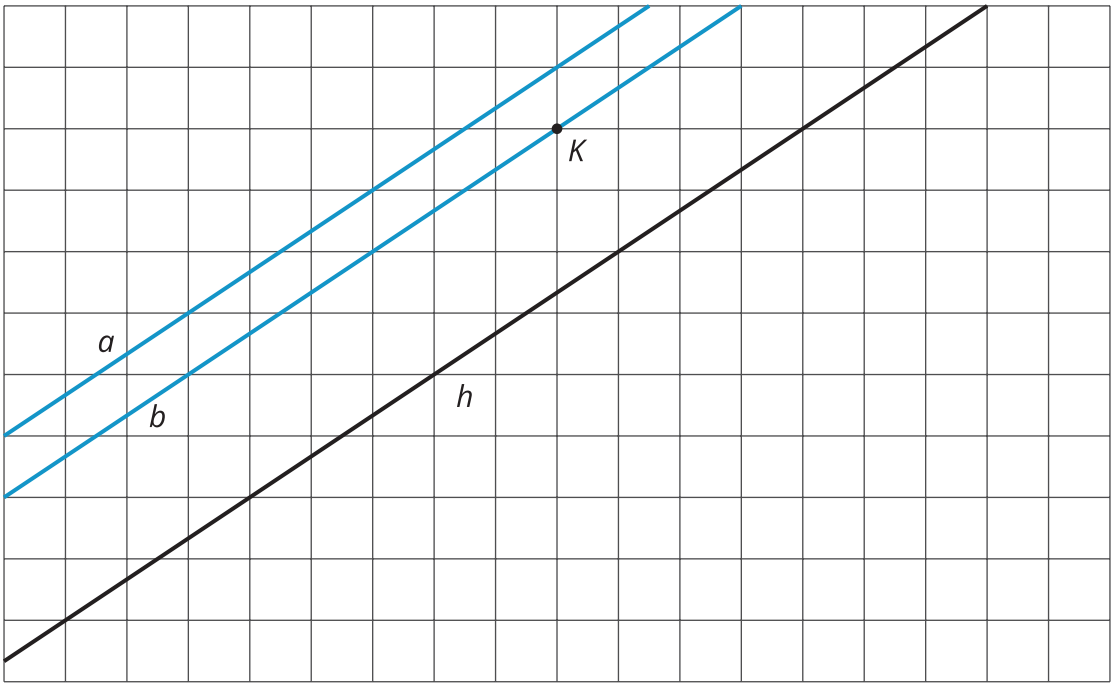

2.





CC BY NC Illustrative Mathematics, based on IM 6–8 Math, CC BY Open Up Resources.

# 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.

   a. What do you notice about the changes that occur to lines $a$ and $b$ after the translation?

   b. What is the same in the original and the image?

2. Rotate lines $a$ and $b$ counterclockwise $180^\circ$ using $K$ as the center of rotation.

   a. What do you notice about the changes that occur to lines $a$ and $b$ after the rotation?

   b. What is the same in the original and the image?

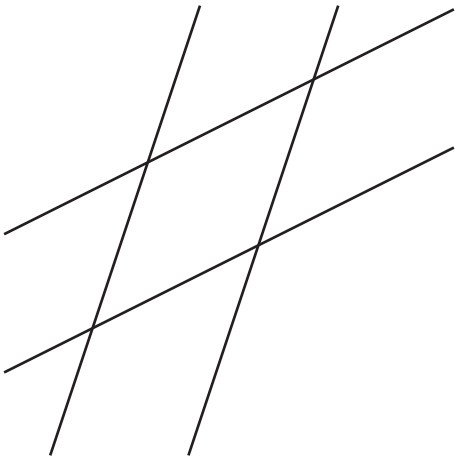
3. Reflect lines $a$ and $b$ across line $h$.

   a. What do you notice about the changes that occur to lines $a$ and $b$ after the reflection?

   b. 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.

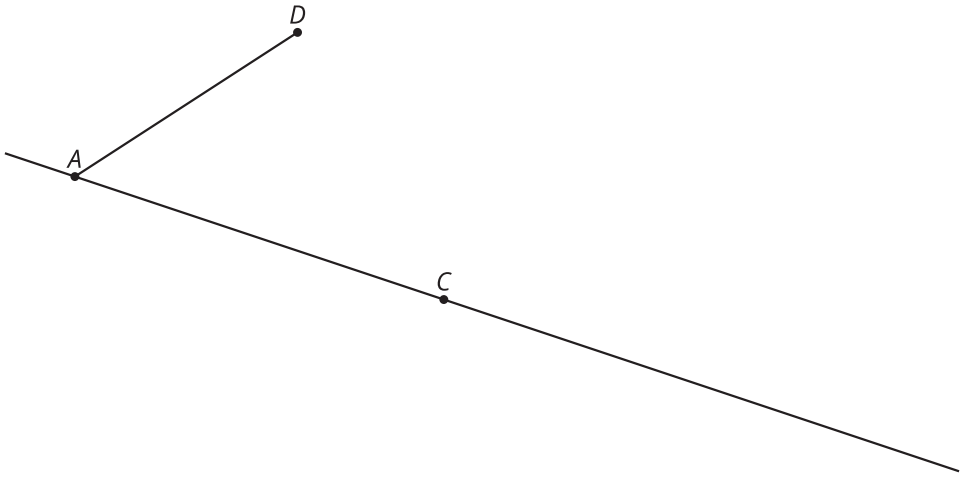



CC BY NC Illustrative Mathematics, based on IM 6–8 Math, CC BY Open Up Resources.

# 9.3 Let's Do Some 180s

1. The diagram shows a line with points labeled $A$, $C$, $D$, and $B$.
   a. On the diagram, draw the image of the line and points $A$, $C$, and $B$ after the line has been rotated $180^\circ$ around point $D$.
   b. Label the images of the points $A'$, $B'$, and $C'$.
   c. What is the order of all seven points? Explain or show your reasoning.

2. The diagram shows a line with points $A$ and $C$ on the line and a segment $AD$ where $D$ is not on the line.
   a. Rotate the figure $180^\circ$ about point $C$. Label the image of $A$ as $A'$ and the image of $D$ as $D'$.
   b. What do you know about the relationship between angle $CAD$ and angle $CA'D'$? Explain or show your reasoning.



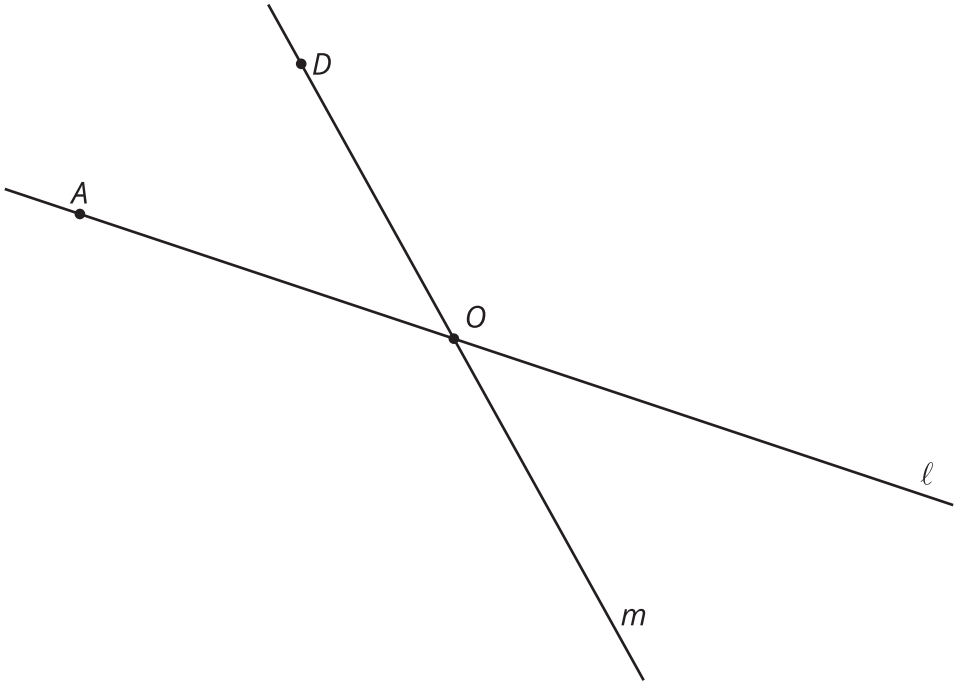


CC BY NC Illustrative Mathematics, based on IM 6–8 Math, CC BY Open Up Resources.

3. The diagram shows two lines $\ell$ and $m$ that intersect at a point $O$ with point $A$ on $\ell$ and point $D$ on $m$.

   a. Rotate the figure $180^\circ$ around $O$. Label the image of $A$ as $A'$ and the image of $D$ as $D'$.

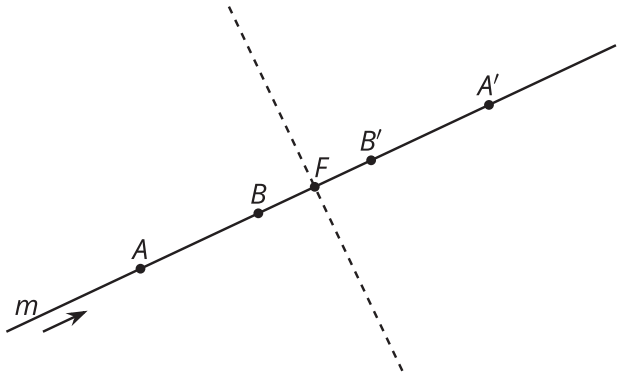
   b. What do you know about the relationship between the angles in the figure? Explain or show your reasoning.



## Lesson 9 Summary

Rigid transformations have the following properties:

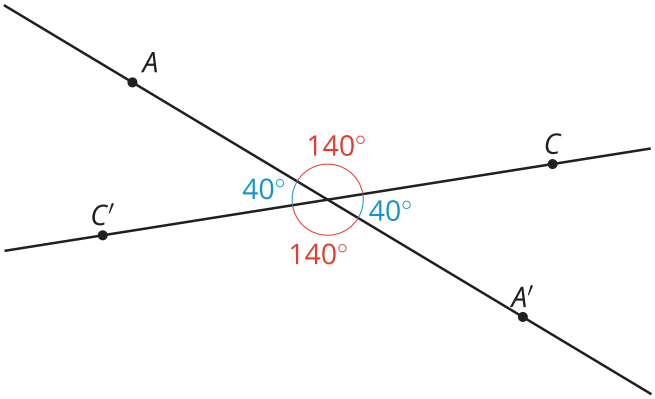
- A rigid transformation of a line is a line.
- A rigid transformation of two parallel lines results in two parallel lines that are the same distance apart as the original two lines.
- Sometimes, a rigid transformation takes a line to itself. For example:




  - A translation parallel to the line. The arrow shows a translation of line $m$ that will take $m$ to itself.
  - A rotation by $180^\circ$ around any point on the line. A $180^\circ$ 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 $180^\circ$ rotation of the lines with center $O$ shows that **vertical angles** are congruent. Here is an example:




Rotating both lines by $180^\circ$ around $O$ sends angle $AOC$ to angle $A'OC'$, therefore proving that they have the same measure. The rotation also sends angle $AOC'$ to angle $A'OC$.