## Lesson 14: Alternate Interior Angles

Let’s explore why some angles are always equal.

### 14.1: Angle Pairs

1. Find the measure of angle $JGH$.  Explain or show your reasoning.
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1. Find and label a second $30^{∘}$ degree angle in the diagram. Find and label an angle congruent to angle $JGH$.

### 14.2: Cutting Parallel Lines with a Transversal

Lines $AC$ and $DF$ are parallel. They are cut by **transversal** $HJ$.



1. With your partner, find the seven unknown angle measures in the diagram. Explain your reasoning.
2. What do you notice about the angles with vertex $B$ and the angles with vertex $E$?
3. Using what you noticed, find the measures of the four angles at point $B$ in the second diagram. Lines $AC$ and $DF$ are parallel.
* 
1. The next diagram resembles the first one, but the lines form slightly different angles. Work with your partner to find the six unknown angles with vertices at points $B$ and $E$.
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1. What do you notice about the angles in this diagram as compared to the earlier diagram? How are the two diagrams different? How are they the same?

#### Are you ready for more?



Parallel lines $ℓ$ and $m$ are cut by two transversals which intersect $ℓ$ in the same point. Two angles are marked in the figure. Find the measure $x$ of the third angle.

### 14.3: Alternate Interior Angles Are Congruent

1. Lines $ℓ$ and $k$ are parallel and $t$ is a transversal. Point $M$ is the midpoint of segment $PQ$.
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* Find a rigid transformation showing that angles $MPA$ and $MQB$ are congruent.
1. In this picture, lines $ℓ$ and $k$ are no longer parallel. $M$ is still the midpoint of segment $PQ$.
* 
* Does your argument in the earlier problem apply in this situation? Explain.

### Lesson 14 Summary

When two lines intersect, vertical angles are equal and adjacent angles are supplementary, that is, their measures sum to 180$​^{∘}$. For example, in this figure angles 1 and 3 are equal, angles 2 and 4 are equal, angles 1 and 4 are supplementary, and angles 2 and 3 are supplementary.



When two parallel lines are cut by another line, called a **transversal**, two pairs of **alternate interior angles** are created. (“Interior” means on the inside, or between, the two parallel lines.) For example, in this figure angles 3 and 5 are alternate interior angles and angles 4 and 6 are also alternate interior angles.



Alternate interior angles are equal because a $180^{∘}$ rotation around the midpoint of the segment that joins their vertices takes each angle to the other. Imagine a point $M$ halfway between the two intersections—can you see how rotating $180^{∘}$ about $M$ takes angle 3 to angle 5?

Using what we know about vertical angles, adjacent angles, and alternate interior angles, we can find the measures of any of the eight angles created by a transversal if we know just one of them. For example, starting with the fact that angle 1 is $70^{∘}$ we use vertical angles to see that angle 3 is $70^{∘}$, then we use alternate interior angles to see that angle 5 is $70^{∘}$, then we use the fact that angle 5 is supplementary to angle 8 to see that angle 8 is  $110^{∘}$ since $180−70=110$. It turns out that there are only two different measures. In this example, angles 1, 3, 5, and 7 measure $70^{∘}$, and angles 2, 4, 6, and 8 measure $110^{∘}$.



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