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**10/18/19 Bell Ringer 3.5 Equations of Parallel and Perpendicular Lines**

**Name the property of equality the statement illustrates.**

4.  $m\angle A = m\angle A$

5. If  $m\angle D = 38^\circ$  and  $m\angle E = 38^\circ$ , then  $m\angle E = m\angle D$ .

6. If  $FG = JK$ , then  $JK = FG$ .

**Please pass back papers.**

Show me your signed report cards. (until Friday 10/25)

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10/18/19 Bell Ringer 3.5 Equations of Parallel and Perpendicular Lines

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Reflexive Property of Equality

5. If  $m\angle D = 38^\circ$  and  $m\angle E = 38^\circ$ , then  $m\angle E = m\angle D$ .

6. If  $FG = JK$ , then  $JK = FG$ .

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## 3.5 Equations of Parallel and Perpendicular Lines

**Essential Question** How can you write an equation of a line that is parallel or perpendicular to a given line and passes through a given point?

### What You Will Learn

- ★ Use slope to partition directed line segments.
- ▶ Identify parallel and perpendicular lines.
- ▶ Write equations of parallel and perpendicular lines.
- ★ Use slope to find the distance from a point to a line.

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## 3.5 Day 1 Notes

Get out your 3.5 Notes and worksheet from yesterday.  
(3.5 Notetaking with Vocabulary)

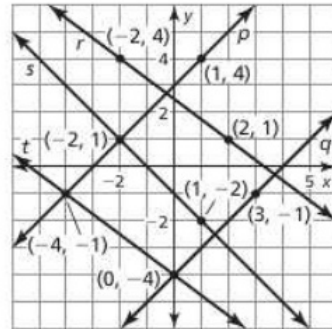
**3.5** Notetaking with Vocabulary (continued)

**Extra Practice**

In Exercises 1 and 2, find the coordinates of point  $P$  along the directed line segment  $AB$  so that  $AP$  to  $PB$  is the given ratio.

1.  $A(-2, 7), B(-4, 1)$ ; 3 to 1                      2.  $A(3, 1), B(8, -2)$ ; 2 to 3

3. Determine which of the lines are parallel and which of the lines are perpendicular.



4. Tell whether the lines through the given points are *parallel*, *perpendicular*, or *neither*. Justify your answer.

Line 1:  $(2, 0), (-2, 2)$

Line 2:  $(1, -2), (4, 4)$

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**Finding the distance from a point to a line.**

*Flip over your note taking paper.*

(See Ex 5 in book for extra help.)

7. Find the distance from point  $A(0, 5)$  to  $y = -3x - 5$ .

**3 Steps**

1.  $\perp$  Line
2. System of Equations  
(to find intersection)
3. Distance Formula

## Finding the distance from a point to a line.

Flip over your note taking paper.

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7. Find the distance from point  $A(0, 5)$  to  $y = -3x - 5$ .

### 3 Steps

- ✓ 1.  $\perp$  Line
- ✓ 2. System of Equations (to find intersection)
- ✓ 3. Distance Formula

$$\begin{aligned} 1.) \perp m &= \frac{1}{3} \\ y &= mx + b \\ 5 &= \frac{1}{3}(0) + b \\ 5 &= b \\ y &= \frac{1}{3}x + 5 \end{aligned}$$

$$\begin{aligned} 2.) \frac{-3x - 5}{+3x} &= \frac{\frac{1}{3}x + 5}{+3x} \\ -5 &= 3 \cdot \frac{1}{3}x + 5 \\ -5 &= x + 5 \\ -10 &= x \\ \left(\frac{-10}{1}\right) &= x \\ -10 &= x \end{aligned}$$

$$\begin{aligned} y &= -3(-3) - 5 \\ y &= 4 \\ (-3, 4) \end{aligned}$$

$$\begin{aligned} 3.) \sqrt{(x-x)^2 + (y-y)^2} \\ \sqrt{(0+3)^2 + (5-4)^2} \\ \sqrt{3^2 + 1^2} \\ \sqrt{9+1} \\ \sqrt{10} \\ 3.2 \end{aligned}$$

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## 3.5 Day 1 Notes

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### Partitioning a Directed Line Segment

A **directed line segment**  $AB$  is a segment that represents moving from point  $A$  to point  $B$ . The following example shows how to use slope to find a point on a directed line segment that partitions the segment in a given ratio.





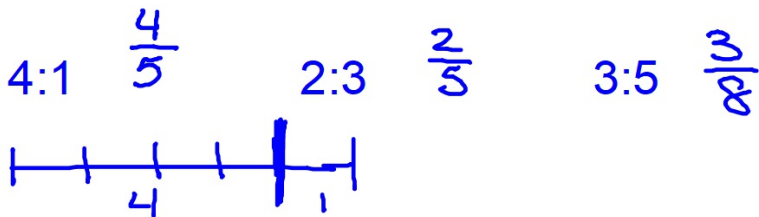
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#### Practice Writing Ratios as Fractions



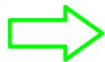
## 3.5 Day 1 Notes

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We are going to use 5 Steps to solve this problem.

1. Graph to check direction (goes with step 5)
2. Ratio
3. Slope
4. Multiply
5. Add or Subtract from  $A$   
(depending on direction)



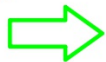
## 3.5 Day 1 Notes

### Partitioning a Directed Line Segment

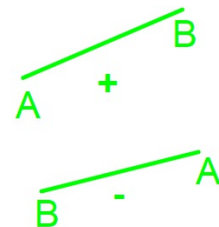
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Check your graph  
If segment is  $A$  to  $B$  add.  
If segment is  $B$  to  $A$  sub.



In Exercises 1 and 2, find the coordinates of point  $P$  along the directed line segment  $AB$  so that  $AP$  to  $PB$  is the given ratio.

1.  $A(-2, 7), B(-4, 1); 3$  to  $1$

5 Steps

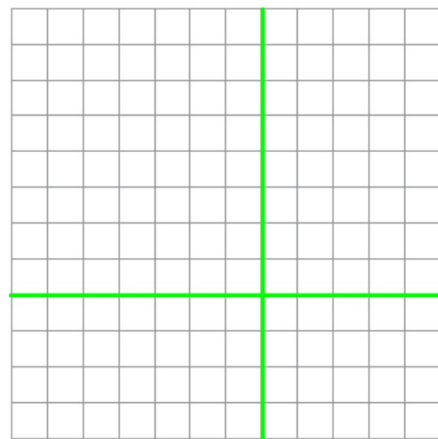
1. Graph:

2. Ratio: We will discuss this next week.

3. Slope:

4. Multiply:

5. Add/Sub from A:  
(depending on direction)



In Exercises 1 and 2, find the coordinates of point  $P$  along the directed line segment  $AB$  so that  $AP$  to  $PB$  is the given ratio.

1.  $A(-2, 7), B(-4, 1); 3$  to  $1$

5 Steps

1. Graph:



2. Ratio:  $\frac{3}{4}$  or  $0.75$

3. Slope:  $\frac{6}{2}$

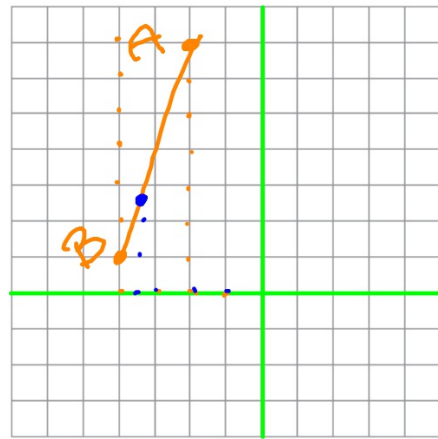
4. Multiply:

rise  $6(.75) = 4.5$   
run  $2(.75) = 1.5$

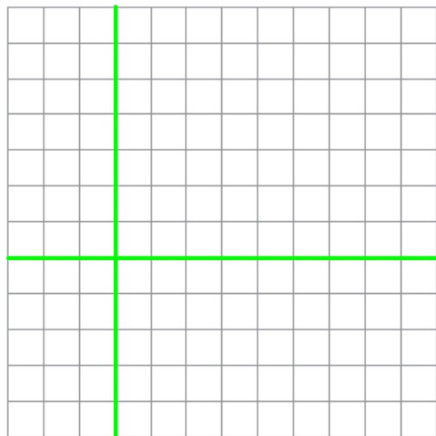
5. Add/Sub from A:  
(depending on direction)

rise  $7 - 4.5 = 2.5$   
run  $-2 - 1.5 = -3.5$   
(point A)

$(-3.5, 2.5)$   
↑  
remember run is  
 $x$  & goes 1<sup>st</sup>  $(x, y)$

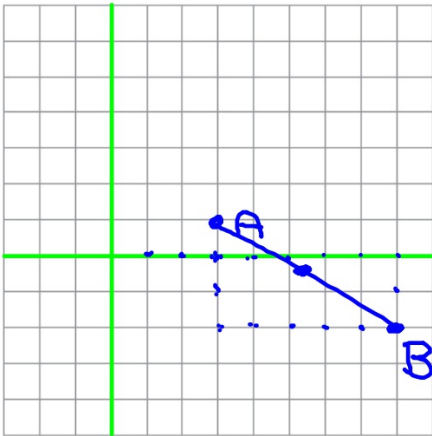


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2.  $A(3, 1), B(8, -2); 2$  to  $3$

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2.  $A(3, 1), B(8, -2); 2$  to  $3$

1. Graph +
2. Ratio  $\frac{2}{5}$  or  $.4$
3. Slope  $-\frac{3}{5}$
4. Mult. rise  $-3 \cdot (.4) = -1.2$   
run  $5 \cdot (.4) = 2$
5. + rise  $1 + -1.2 = -.2$   
run  $3 + 2 = 5$   
 $(5, -.2)$

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**Summary (on notes), Exit Ticket (on HW), and Homework**

**Essential Question** How can you write an equation of a line that is parallel or perpendicular to a given line and passes through a given point?



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## Summary (on notes), Exit Ticket (on HW), and Homework

**Essential Question** How can you write an equation of a line that is parallel or perpendicular to a given line and passes through a given point?

Determine the slope ( $//$  lines have the same slope, and  $\perp$  lines have opposite reciprocal slopes.) Then use point to find new  $b$ . Rewrite as  $y=mx+b$ .

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## Summary (on notes), Exit Ticket (on HW), and Homework

**Essential Question** How can you write an equation of a line that is parallel or perpendicular to a given line and passes through a given point?

**Exit Ticket:** p. 159 # 6

### Monitoring Progress

6. Find the distance from the point  $(6, 4)$  to the line  $y = x + 4$ .

#### 3 Steps

1.  $\perp$  Line
2. System of Equations  
(to find intersection)
3. Distance Formula

## Monitoring Progress

6. Find the distance from the point  $(6, 4)$  to the line  $y = x + 4$ .

6. The slope of  $y = x + 4$  is 1, so the line perpendicular to  $y = x + 4$  will have a slope of  $-1$ .


$$y = -x + b$$

$$4 = -6 + b$$

$$10 = b$$

### 3 Steps

1.  $\perp$  Line
2. System of Equations (to find intersection)
3. Distance Formula



## Monitoring Progress

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$$y = -x + b$$

$$4 = -6 + b$$

$$10 = b$$

The line perpendicular to  $y = x + 4$  is  $y = -x + 10$ .

Find the point of intersection.

$$x + 4 = -x + 10 \quad \text{Equation 1}$$

$$2x + 4 = 10 \quad \text{Equation 2}$$

$$x + 4 = -x + 10$$

$$2x + 4 = 10$$

$$2x = 6$$

$$\frac{2}{2}x = \frac{6}{2}$$

$$x = 3$$

$$y = 3 + 4 = 7$$

So, the perpendicular lines intersect at  $(3, 7)$ .

### 3 Steps

1.  $\perp$  Line
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3. Distance Formula



## Monitoring Progress

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### 3 Steps

1.  $\perp$  Line
2. System of Equations (to find intersection)
3. Distance Formula

Find the distance from  $(6, 4)$  to  $(3, 7)$ .

$$\begin{aligned} \text{distance} &= \sqrt{(3 - 6)^2 + (7 - 4)^2} = \sqrt{(-3)^2 + (3)^2} \\ &= \sqrt{9 + 9} = \sqrt{18} \approx 4.24 \text{ units} \end{aligned}$$

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## Summary (on notes), Exit Ticket (on HW), and Homework

**Essential Question** How can you write an equation of a line that is parallel or perpendicular to a given line and passes through a given point?

**Exit Ticket:** p. 159 # 6

### Monitoring Progress

6. Find the distance from the point  $(6, 4)$  to the line  $y = x + 4$ .

Homework

3.5 p. 160 #8-20 EOE, 22, 28

(8, 12, 16, 20, 22, 28)

6 total

## 3.5 Exercises

Dynamic Solutions available at [BigIdeasMath.com](http://BigIdeasMath.com)

### Vocabulary and Core Concept Check

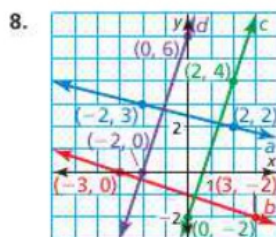
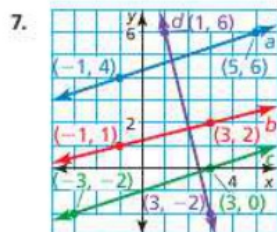
- COMPLETE THE SENTENCE** A \_\_\_\_\_ line segment  $AB$  is a segment that represents moving from point  $A$  to point  $B$ .
- WRITING** How are the slopes of perpendicular lines related?

### Monitoring Progress and Modeling with Mathematics

In Exercises 3–6, find the coordinates of point  $P$  along the directed line segment  $AB$  so that  $AP$  to  $PB$  is the given ratio. (See Example 1.)

- $A(8, 0)$ ,  $B(3, -2)$ ; 1 to 4
- $A(-2, -4)$ ,  $B(6, 1)$ ; 3 to 2
- $A(1, 6)$ ,  $B(-2, -3)$ ; 5 to 1
- $A(-3, 2)$ ,  $B(5, -4)$ ; 2 to 6

In Exercises 7 and 8, determine which of the lines are parallel and which of the lines are perpendicular. (See Example 2.)



In Exercises 9–12, tell whether the lines through the given points are *parallel*, *perpendicular*, or *neither*. Justify your answer.

- Line 1:  $(1, 0)$ ,  $(7, 4)$   
Line 2:  $(7, 0)$ ,  $(3, 6)$
- Line 1:  $(-3, 1)$ ,  $(-7, -2)$   
Line 2:  $(2, -1)$ ,  $(8, 4)$
- Line 1:  $(-9, 3)$ ,  $(-5, 7)$   
Line 2:  $(-11, 6)$ ,  $(-7, 2)$
- Line 1:  $(10, 5)$ ,  $(-8, 9)$   
Line 2:  $(2, -4)$ ,  $(11, -6)$

In Exercises 13–16, write an equation of the line passing through point  $P$  that is parallel to the given line. Graph the equations of the lines to check that they are parallel. (See Example 3.)

- $P(0, -1)$ ,  $y = -2x + 3$
- $P(3, 8)$ ,  $y = \frac{1}{5}(x + 4)$
- $P(-2, 6)$ ,  $x = -5$
- $P(4, 0)$ ,  $-x + 2y = 12$

In Exercises 17–20, write an equation of the line passing through point  $P$  that is perpendicular to the given line. Graph the equations of the lines to check that they are perpendicular. (See Example 4.)

- $P(0, 0)$ ,  $y = -9x - 1$
- $P(4, -6)$ ,  $y = -3$
- $P(2, 3)$ ,  $y - 4 = -2(x + 3)$
- $P(-8, 0)$ ,  $3x - 5y = 6$

In Exercises 21–24, find the distance from point  $A$  to the given line. (See Example 5.)

- $A(-1, 7)$ ,  $y = 3x$
- $A(-9, -3)$ ,  $y = x - 6$
- $A(15, -21)$ ,  $5x + 2y = 4$
- $A(-\frac{1}{4}, 5)$ ,  $-x + 2y = 14$



25. **ERROR ANALYSIS** Describe and correct the error in determining whether the lines are parallel, perpendicular, or neither.

**X** Line 1:  $(3, -5), (2, -1)$   
 Line 2:  $(0, 3), (1, 7)$

$$m_1 = \frac{-1 - (-5)}{2 - 3} = -4 \quad m_2 = \frac{7 - 3}{1 - 0} = 4$$

Lines 1 and 2 are perpendicular.

26. **ERROR ANALYSIS** Describe and correct the error in writing an equation of the line that passes through the point  $(3, 4)$  and is parallel to the line  $y = 2x + 1$ .

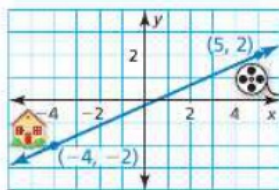
**X**  $y = 2x + 1, (3, 4)$   
 $4 = m(3) + 1$   
 $1 = m$

The line  $y = x + 1$  is parallel to the line  $y = 2x + 1$ .

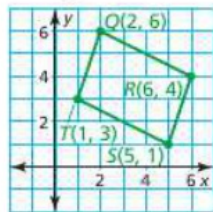
In Exercises 27–30, find the midpoint of  $\overline{PQ}$ . Then write an equation of the line that passes through the midpoint and is perpendicular to  $\overline{PQ}$ . This line is called the *perpendicular bisector*.

27.  $P(-4, 3), Q(4, -1)$     28.  $P(-5, -5), Q(3, 3)$   
 29.  $P(0, 2), Q(6, -2)$     30.  $P(-7, 0), Q(1, 8)$

31. **MODELING WITH MATHEMATICS** Your school lies directly between your house and the movie theater. The distance from your house to the school is one-fourth of the distance from the school to the movie theater. What point on the graph represents your school?

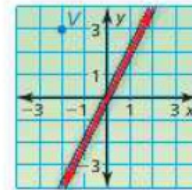


32. **REASONING** Is quadrilateral  $QRST$  a parallelogram? Explain your reasoning.



33. **REASONING** A triangle has vertices  $L(0, 6), M(5, 8)$ , and  $N(4, -1)$ . Is the triangle a right triangle? Explain your reasoning.

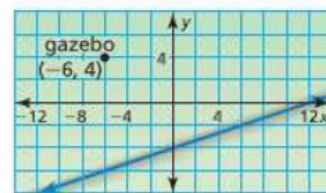
34. **MODELING WITH MATHEMATICS** A new road is being constructed parallel to the train tracks through point  $V$ . An equation of the line representing the train tracks is  $y = 2x$ . Find an equation of the line representing the new road.



35. **MODELING WITH MATHEMATICS** A bike path is being constructed perpendicular to Washington Boulevard through point  $P(2, 2)$ . An equation of the line representing Washington Boulevard is  $y = -\frac{2}{3}x$ . Find an equation of the line representing the bike path.



36. **PROBLEM SOLVING** A gazebo is being built near a nature trail. An equation of the line representing the nature trail is  $y = \frac{1}{3}x - 4$ . Each unit in the coordinate plane corresponds to 10 feet. Approximately how far is the gazebo from the nature trail?



37. **CRITICAL THINKING** The slope of line  $\ell$  is greater than 0 and less than 1. Write an inequality for the slope of a line perpendicular to  $\ell$ . Explain your reasoning.





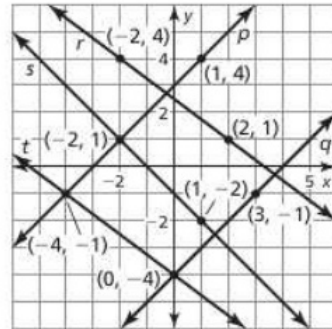
**3.5** Notetaking with Vocabulary (continued)

**Extra Practice**

In Exercises 1 and 2, find the coordinates of point  $P$  along the directed line segment  $AB$  so that  $AP$  to  $PB$  is the given ratio.

1.  $A(-2, 7), B(-4, 1)$ ; 3 to 1                      2.  $A(3, 1), B(8, -2)$ ; 2 to 3

3. Determine which of the lines are parallel and which of the lines are perpendicular.



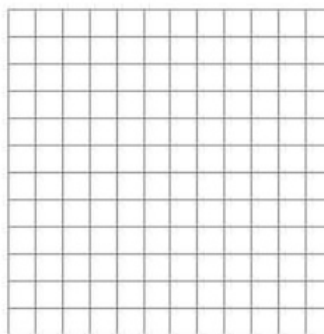
4. Tell whether the lines through the given points are *parallel*, *perpendicular*, or *neither*. Justify your answer.

Line 1:  $(2, 0), (-2, 2)$

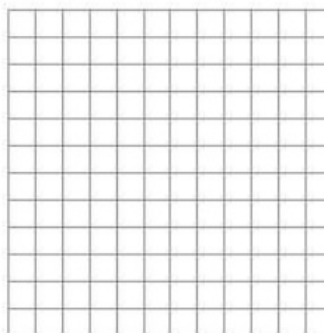
Line 2:  $(1, -2), (4, 4)$

**3.5 Notetaking with Vocabulary (continued)**

5. Write an equation of the line passing through point  $P(3, -2)$  that is parallel to  $y = \frac{2}{3}x - 1$ . Graph the equations of the lines to check that they are parallel.



6. Write an equation of the line passing through point  $P(-2, 2)$  that is perpendicular to  $y = 2x + 3$ . Graph the equations of the lines to check that they are perpendicular.



7. Find the distance from point  $A(0, 5)$  to  $y = -3x - 5$ .