

From Algebra, what is the slope formula?

3.4

Find and Use Slopes of Lines

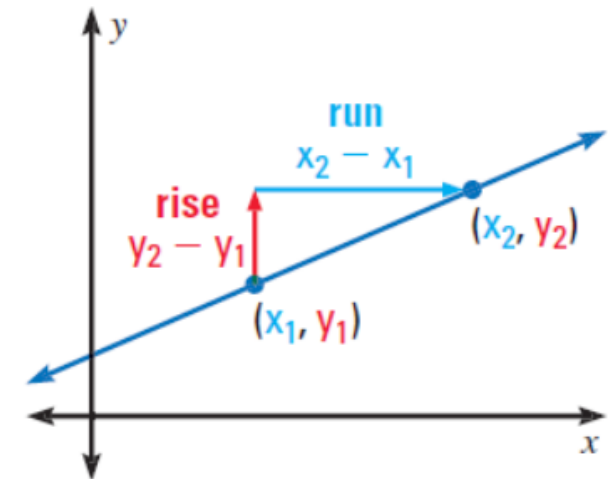
Goal • Find and compare slopes of lines.

Slope -

the ratio of vertical change (*rise*)
to horizontal change (*run*)
between any two points on the line

If a line in the coordinate plane passes through points (x_1, y_1) and (x_2, y_2) then the slope m is

$$m = \frac{\text{rise}}{\text{run}} = \frac{\text{change in } y}{\text{change in } x} = \frac{y_2 - y_1}{x_2 - x_1}$$



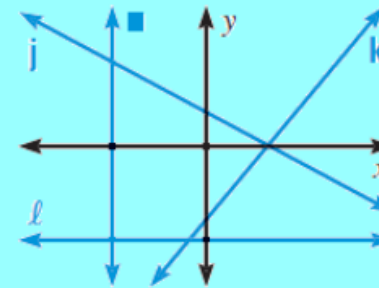
KEY CONCEPT*For Your Notebook***Slope of Lines in the Coordinate Plane**

Negative slope: falls from left to right, as in line j

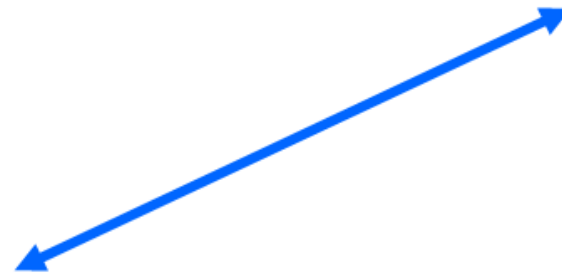
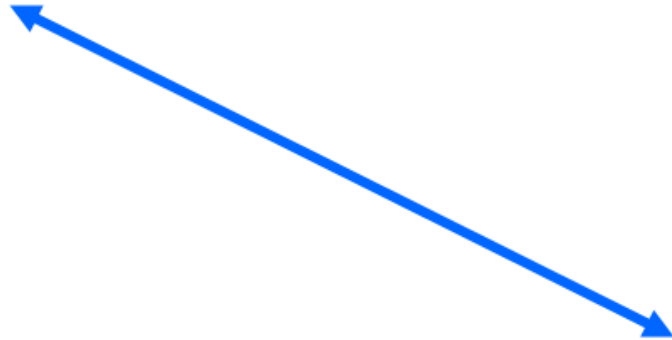
Positive slope: rises from left to right, as in line k

Zero slope (slope of 0): horizontal, as in line ℓ

Undefined slope: vertical, as in line n



What kind of slope does each have?



Find the slope of each.

\overleftrightarrow{AB}

A (-3, 2) B (12, -3)

\overleftrightarrow{CD}

C (2, -4) D (-7, -3)

EXAMPLE 1 Find slopes of lines in a coordinate plane

REVIEW SLOPE

For more help with slope, see p. 879.

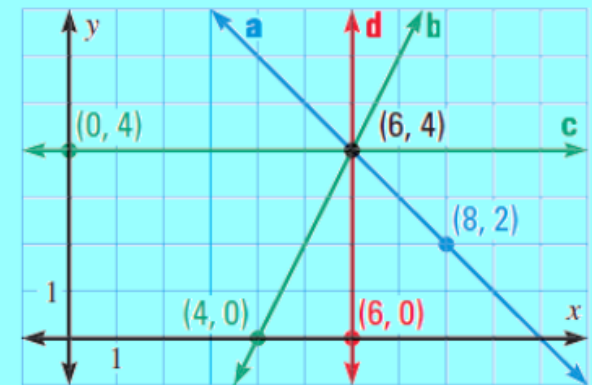
Find the slope of line a and line d .

Solution

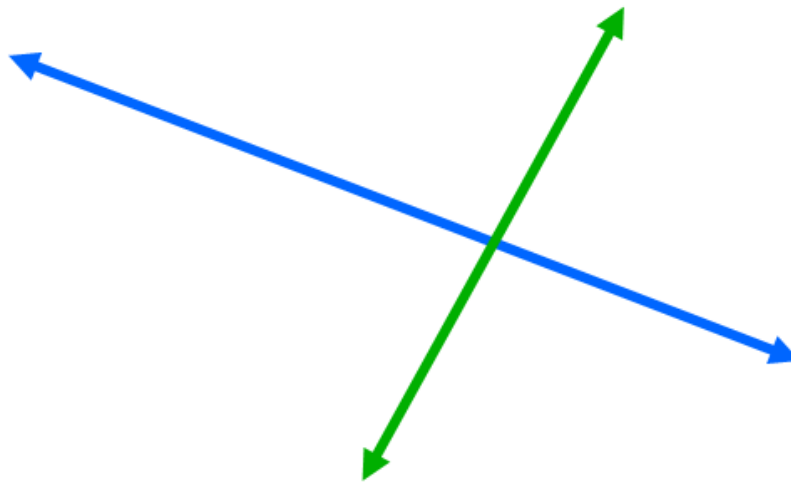
$$\text{Slope of line } a: m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{4 - 2}{6 - 8} = \frac{2}{-2} = -1$$

$$\text{Slope of line } d: m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{4 - 0}{6 - 6} = \frac{4}{0},$$

which is undefined.



When Two lines intersect in a coordinate plane, the steeper line has the slope with the greater absolute value. You can also use the slope of lines to determine if they are parallel, or perpendicular.





READ VOCABULARY

If the product of two numbers is -1 , then the numbers are called *negative reciprocals*.

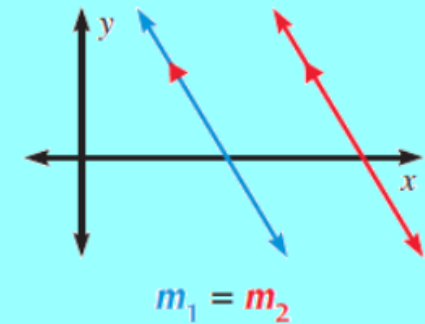
POSTULATES

POSTULATE 17 Slopes of Parallel Lines

In a coordinate plane, two nonvertical lines are parallel if and only if they have the same slope.

Any two vertical lines are parallel.

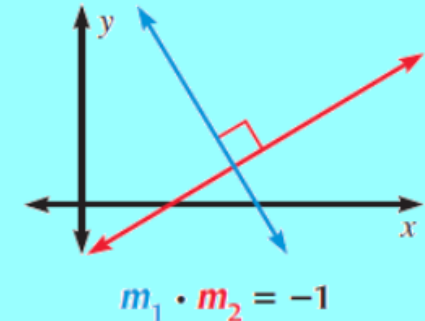
For Your Notebook



POSTULATE 18 Slopes of Perpendicular Lines

In a coordinate plane, two nonvertical lines are perpendicular if and only if the product of their slopes is -1 .

Horizontal lines are perpendicular to vertical lines.



EXAMPLE 2 Identify parallel lines

Find the slope of each line. Which lines are parallel?

Solution

Find the slope of k_1 through $(-2, 4)$ and $(-3, 0)$.

$$m_1 = \frac{0 - 4}{-3 - (-2)} = \frac{-4}{-1} = 4$$

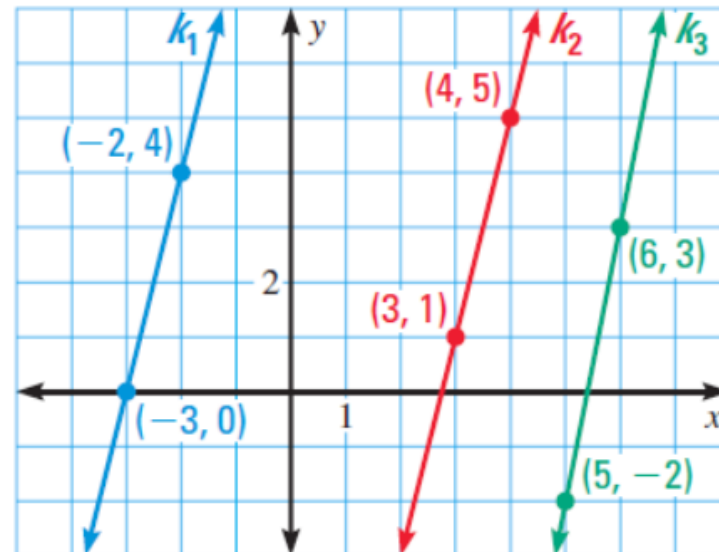
Find the slope of k_2 through $(4, 5)$ and $(3, 1)$.

$$m_2 = \frac{1 - 5}{3 - 4} = \frac{-4}{-1} = 4$$

Find the slope of k_3 through $(6, 3)$ and $(5, -2)$.

$$m_3 = \frac{-2 - 3}{5 - 6} = \frac{-5}{-1} = 5$$

► Compare the slopes. Because k_1 and k_2 have the same slope, they are parallel. The slope of k_3 is different, so k_3 is not parallel to the other lines.



EXAMPLE 3 Draw a perpendicular line

Line h passes through $(3, 0)$ and $(7, 6)$. Graph the line perpendicular to h that passes through the point $(2, 5)$.

Solution

STEP 1 Find the slope m_1 of line h through $(3, 0)$ and $(7, 6)$.

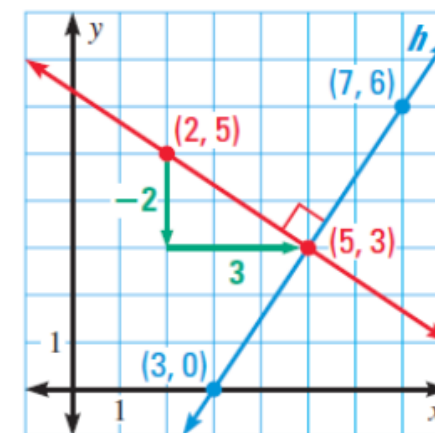
$$m_1 = \frac{6 - 0}{7 - 3} = \frac{6}{4} = \frac{3}{2}$$

STEP 2 Find the slope m_2 of a line perpendicular to h . Use the fact that the product of the slopes of two perpendicular lines is -1 .

$$\frac{3}{2} \cdot m_2 = -1 \quad \text{Slopes of perpendicular lines}$$

$$m_2 = \frac{-2}{3} \quad \text{Multiply each side by } \frac{2}{3}.$$

STEP 3 Use the rise and run to graph the line.



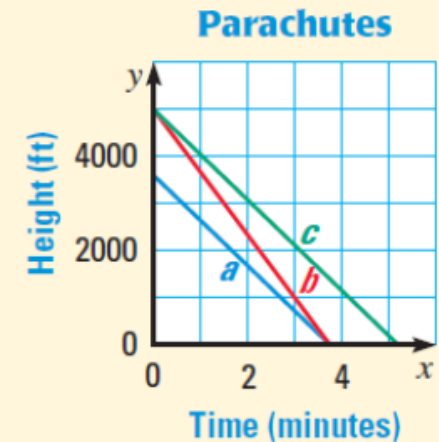
REVIEW GRAPHING

Given a point on a line and the line's slope, you can use the rise and run to find a second point and draw the line.



EXAMPLE 4 Standardized Test Practice

A skydiver made jumps with three parachutes. The graph shows the height of the skydiver from the time the parachute opened to the time of the landing for each jump. Which statement is true?



ELIMINATE CHOICES

The y-intercept represents the height when the parachute opened, so the heights in jumps *a* and *b* were not the same. So you can eliminate choice A.

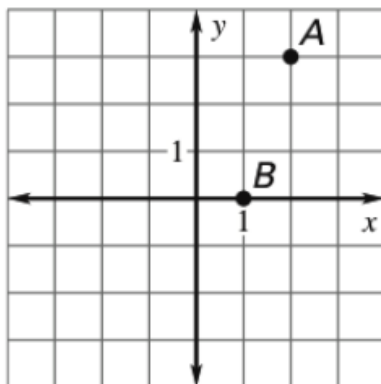
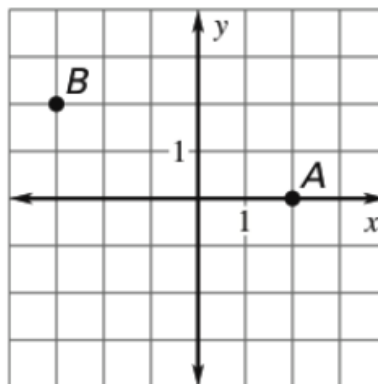
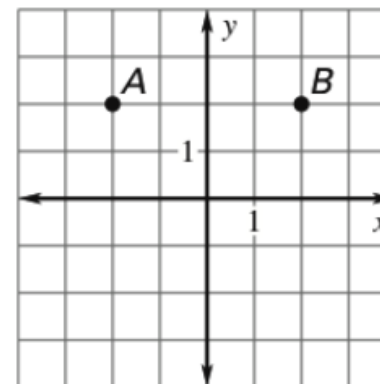
- Ⓐ The parachute opened at the same height in jumps *a* and *b*.
- Ⓑ The parachute was open for the same amount of time in jumps *b* and *c*.
- Ⓒ The skydiver descended at the same rate in jumps *a* and *b*.
- Ⓓ The skydiver descended at the same rate in jumps *a* and *c*.

Solution

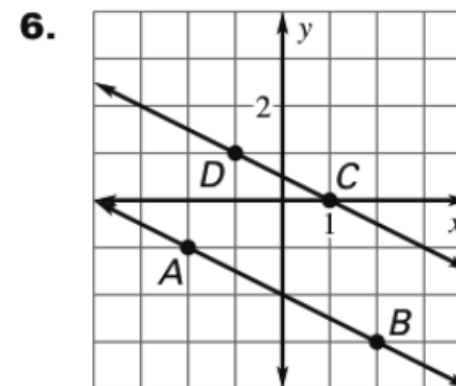
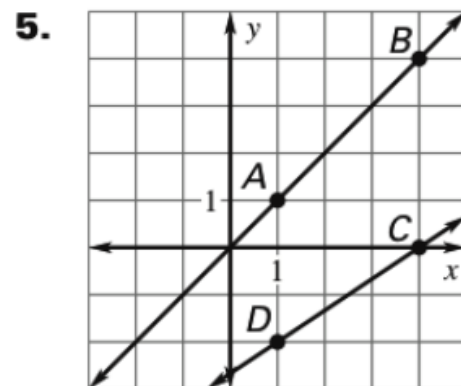
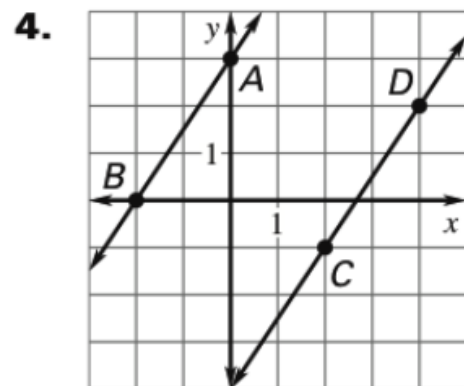
Day 1 Assignment:

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3.4 Worksheet

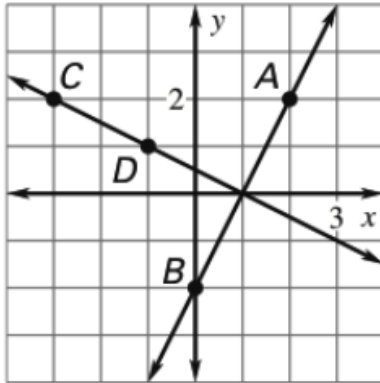
LESSON
3.4**Practice***For use with pages 171–179***Find the slope of the line that passes through the points.****1.****2.****3.**

Find the slope of each line. Are the lines parallel?

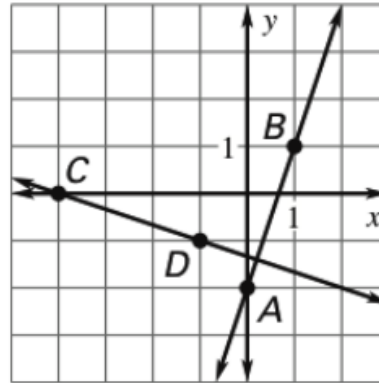


Find the slope of each line. Are the lines perpendicular?

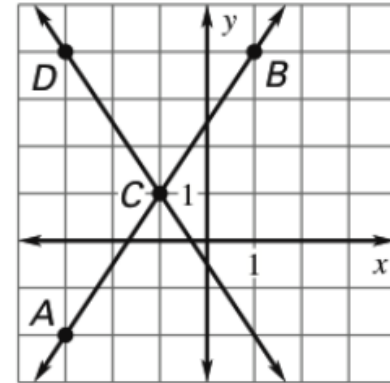
7.



8.



9.



LESSON
3.4**Practice** *continued*
For use with pages 171–179

Tell whether the lines through the given points are *parallel*, *perpendicular*, or *neither*.

10. Line 1: $(-1, 2), (2, 3)$
Line 2: $(0, 0), (3, 1)$

11. Line 1: $(0, 1), (1, 3)$
Line 2: $(4, -1), (5, 2)$

12. Line 1: $(-5, 0), (-3, -2)$
Line 2: $(-2, 2), (0, 4)$

13. Line 1: $(-3, 4), (-3, 1)$
Line 2: $(2, 1), (5, 5)$

14. Line 1: $(-5, 2), (-2, 2)$
Line 2: $(2, 1), (4, 1)$

15. Line 1: $(-2, 5), (1, 4)$
Line 2: $(4, 0), (5, 3)$

Tell whether the intersection of \overleftrightarrow{AB} and \overleftrightarrow{CD} forms a right angle.

16. $A(-8, 3), B(1, 2), C(0, 9), D(-1, 0)$

17. $A(3, 2), B(5, 10), C(7, -4), D(3, -3)$

18. $A(5, 4), B(-3, 20), C(9, -2), D(6, 4)$

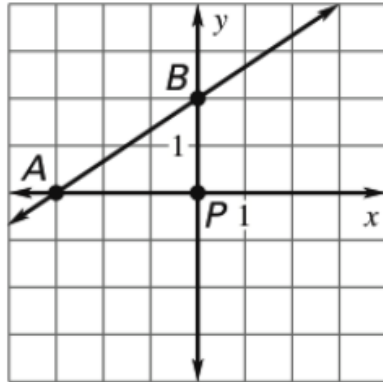
19. $A(7, 12), B(1, 5), C(10, -7), D(3, -1)$

20. $A(-8, 17), B(-5, 18), C(6, 11), D(5, 8)$

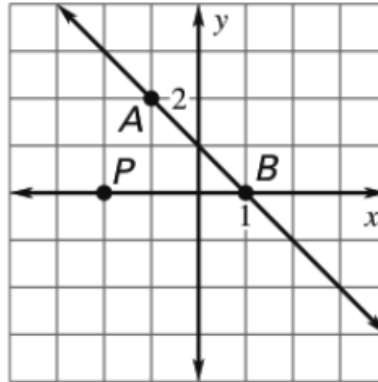
21. $A(-7, 3), B(-10, 15), C(-1, 5), D(4, 35)$

Graph the line parallel to line AB that passes through point P .

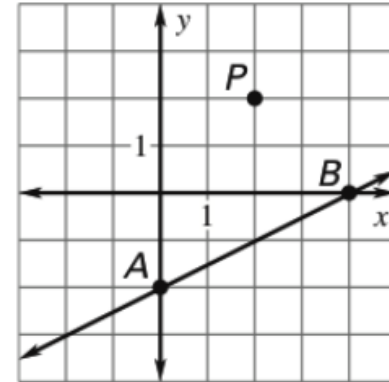
22.



23.

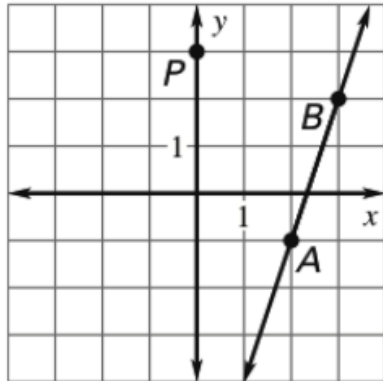


24.

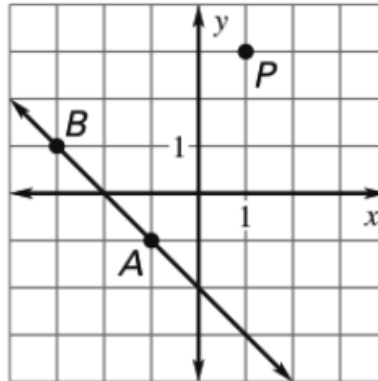


Graph the line perpendicular to line AB that passes through point P .

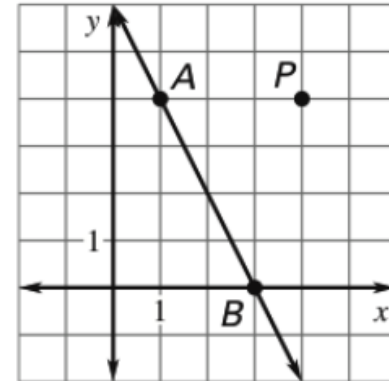
25.



26.



27.



In Exercises 28 and 29, consider the three given lines.

Line a : through the point $(2, 0)$ with a y -intercept of $(0, 1)$

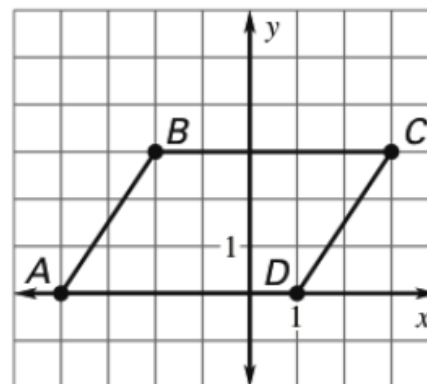
Line b : through the point $(2, 0)$ with a y -intercept of $(0, 5)$

Line c : through the point $(2, 0)$ with a y -intercept of $(0, 3)$

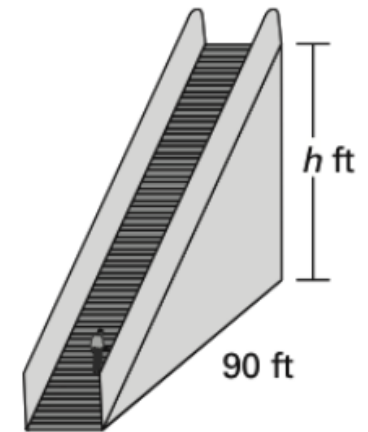
28. Which line is most steep?

29. Which line is least steep?

- 30. Parallelograms** A parallelogram is a four-sided figure whose opposite sides are parallel. *Explain* why the figure shown is a parallelogram.



- 31. Escalators** On an escalator, you move 2 feet vertically for every 3 feet you move horizontally. When you reach the top of the escalator, you have moved a horizontal distance of 90 feet. Find the height h of the escalator.



Answer Key

Lesson 3.4

Practice Level B

1. 3 2. $-\frac{2}{5}$ 3. 1 4. $m_{\overline{AB}} = \frac{3}{2}$, $m_{\overline{CD}} = \frac{3}{2}$; yes

5. $m_{\overline{AB}} = 1$, $m_{\overline{CD}} = \frac{2}{3}$; no

6. $m_{\overline{AB}} = -\frac{1}{2}$, $m_{\overline{CD}} = -\frac{1}{2}$; yes

7. $m_{\overline{AB}} = 2$, $m_{\overline{CD}} = -\frac{1}{2}$; yes

8. $m_{\overline{AB}} = 3$, $m_{\overline{CD}} = -\frac{1}{3}$; yes

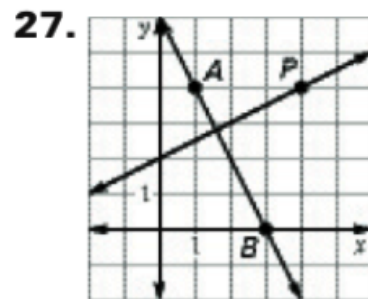
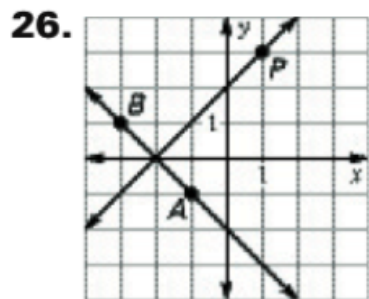
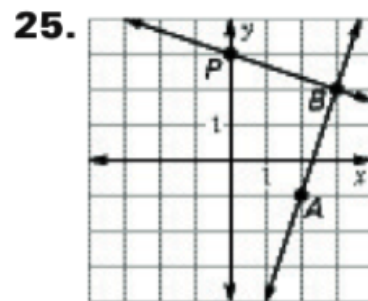
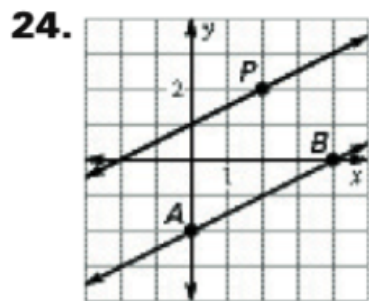
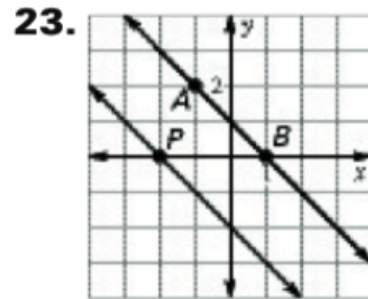
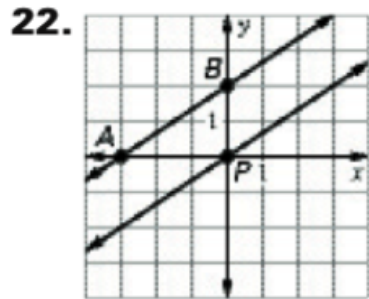
9. $m_{\overline{AB}} = \frac{3}{2}$, $m_{\overline{CD}} = -\frac{3}{2}$; no

10. parallel 11. neither 12. perpendicular

13. neither 14. parallel 15. perpendicular

16. yes 17. yes 18. no 19. yes

20. no 21. no



28. line b 29. line a

30. $m_{\overline{AB}} = \frac{3}{2}$, $m_{\overline{CD}} = \frac{3}{2}$, $m_{\overline{BC}} = 0$, $m_{\overline{AD}} = 0$;

The opposite sides of the figure are parallel because they have the same slope. 31. 60 feet

Assignment Day 2:

p. 175 (3-21, 23, 24, 27, 28, 33, 34, 43-49)