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Chapter 3: Representations of a Line (4 weeks)

Utah Core Standard(s):

- Use similar triangles to explain why the slope m is the same between any two distinct points on a non-vertical line in the coordinate plane; derive the equation $y = mx$ for a line through the origin and the equation $y = mx + b$ for a line intercepting the vertical axis at b . (8.EE.6)
- Interpret the equation $y = mx + b$ as defining a linear function, whose graph is a straight line; give examples of functions that are not linear. For example, the function $A = s^2$ giving the area of a square as a function of its side length is not linear because its graph contains the points (1,1), (2,4) and (3,9), which are not on a straight line. (8.F.3)
- Construct a function to model a linear relationship between two quantities. Determine the rate of change and initial value of the function from a description of a relationship or from two (x, y) values, including reading these from a table or from a graph. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values. (8.F.4)
- Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). For example, given a linear function represented by a table of values and a linear function represented by an algebraic expression, determine which function has the greater rate of change. (8.F.2)

Academic Vocabulary: graph, table, equation, context, geometric model, constant difference, difference table, slope, unit rate, rate of change, y-intercept, initial value, linear, slope-intercept form, vertical, horizontal, transformation, translation, rotation, reflection, parallel, perpendicular

Chapter Overview:


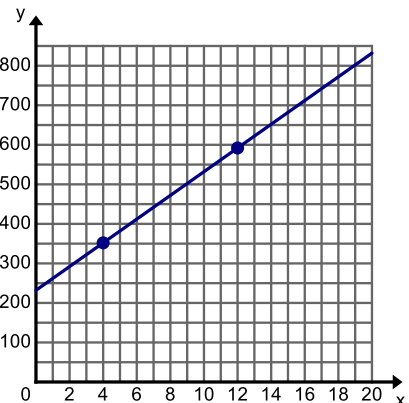

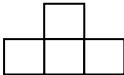
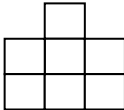
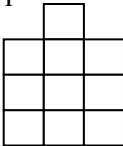

In the previous chapter, students began to surface ideas about the slope-intercept form of the equation of a line. In this chapter, students solidify their understanding of the slope-intercept form of a linear equation and identify the slope and y-intercept of a line in each of the representations (context, table, equation, graph, and geometric model). Students will move fluently between the representations of a linear relationship, making connections between the representations. Students explore the growth rate of a linear pattern, realizing that a linear function grows by equal differences over equal intervals. This work will set the stage for students to be able to write the equation of a line given any set of conditions. The transition from equation to relation to function is an important and difficult one, so we shall be devoting Chapter 4 specifically to helping students make the change in thinking.



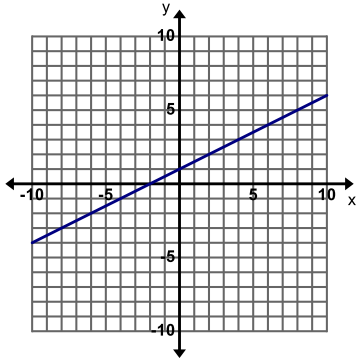


Connections to Content:

Prior Knowledge: Up to this point, students have been studying a special case of linear relationships, those that are proportional ($y = mx$). They know how to find the slope of a line and understand the slope as the rate of change (unit rate) in a proportional relationship. Students have worked with the different representations of a line that passes through the origin. In this chapter, they move to the general form of a linear equation $y = mx + b$ for a line intercepting the y-axis at b .

Future Knowledge: This chapter is the building block for a student's understanding of the idea of function. In the next chapter, students will solidify the concept of function, construct functions to model linear relationships between two quantities, and interpret key features of a linear function. This work will provide students with the foundational understanding and skills needed to work with other types of functions in future courses.

MATHEMATICAL PRACTICE STANDARDS (emphasized):

	<p>Make sense of problems and persevere in solving them</p>	<p>The graph below shows the weight of a baby elephant where x is the time (in weeks) since the elephant's birth and y is the weight (in pounds). At 4 weeks, the elephant weighed 352 lbs. and at 12 weeks, the elephant weighed 592 lbs. Label the axes of the graph.</p>  <p>Use your graph and equation to tell the story of this elephant. <i>Students are using the skills they learned for writing equations of lines to solve a real world problem. They are translating between the different representations of a line and recognizing important features of the representations. Following this work, the teacher is prompted to ask the students if it really makes sense that this elephant gains exactly 30 pounds each week, leading to a conversation about real world data and statistics.</i></p>
	<p>Reason abstractly and quantitatively</p>	<p>Use the pattern below to answer the questions that follow.</p> <div style="display: flex; justify-content: space-around; align-items: flex-end;"> <div style="text-align: center;">  <p>Stage 1</p> </div> <div style="text-align: center;">  <p>Stage 2</p> </div> <div style="text-align: center;">  <p>Stage 3</p> </div> </div> <p>Write a rule that gives the number of blocks b for any stage, s. Show how your rule relates to the pattern (geometric model). <i>Students can see these patterns in many different ways. One way a student might see this pattern growing is one block on the top + n groups of 3. One way to help them arrive at the rule (abstract representation) is to have them write out what they are seeing numerically as shown below:</i></p> <p> $1+1(3)$ for stage 1 $1+2(3)$ for stage 2 $1+3(3)$ for stage 3 $1+100(3)$ for stage 100 $1+s(3)$ for stage s </p>
	<p>Construct viable arguments and critique the reasoning of others</p>	<p>Create your own geometric model of a linear pattern in the space below. Then complete the table, graph, and equation for your pattern. Use these representations to prove that your pattern is linear. <i>Students are asked to create their own geometric model of a linear pattern and use the representations to justify why their pattern is linear. By selecting students to share their patterns with the class, the class will have the opportunity to critique the patterns to determine if they are in fact linear.</i></p>

	Model with mathematics	<p>You are taking a road trip. You start the day with a full tank of gas. Your tank holds 16 gallons of gas. On your trip, you use 2 gallons per hour. Consider the relationship between time in hours and amount of gas remaining in the tank. Complete the table, graph, and equation for this situation. Identify the slope and y-intercept in each representation. How would your graph, equation, and context change if the equation was changed to $y = 18 - 2.5x$?</p> <p><i>This question is asking students to show that they understand the parameters of a linear relationship and to identify these parameters in each of the representations of a linear relationship. These representations serve as models relating two quantities of interest in the real world.</i></p>
	Attend to precision	<p>Error Analysis: Kevin was asked to graph the line $y = -\frac{1}{2}x + 1$. Kevin graphed the line below and made a common error. Describe Kevin's error and then graph the line correctly on the grid.</p>  <p><i>By the end of this chapter, students should be proficient with graphing and writing the equation of a line given any set of conditions. This skills requires students to calculate accurately and efficiently. Asking students to identify common errors as seen in the problem above requires them to be precise in their execution of the skills learned in this section.</i></p> <p><i>While graphing, students are expected to label axes (including units of measure) and determine how to scale a graph appropriately.</i></p>
	Look for and make use of structure	<p><i>As seen in the pattern problem above, students investigate geometric models in order to discern a pattern. They communicate the structure they are seeing in the pattern. For example, "I see one center block plus 3 groups of $(n - 1)$." Finding structure in these geometric models allows students to determine a rule (equation) for the pattern.</i></p>
	Look for and express regularity in repeated reasoning	<p>Hillary is saving money for college expenses. She is saving \$200 per week from her summer job. Currently, she does not have any money saved. Create a table, graph, and equation to show the amount of money m Hillary will have saved after w weeks. Is this context linear? Use evidence from the context, graph, table, and equation to support your answer.</p> <p><i>In this problem, students are demonstrating the growth rate of a linear relationship (linear relationships grow by equal differences over equal intervals). They show this constant rate of change on each of the representations of a linear relationship: on the graph showing the slope between points, on the table showing the first difference, in the context identifying the key words, and in the equation recognizing the piece that is changing by a fixed amount for each increase in the independent variable.</i></p>

Section 3.1: Represent Linear Patterns and Contexts

Section Overview:

In this section, students start by writing rules for linear patterns. Students connect their rules to the geometric model and begin to surface ideas about the rate of change and initial value (starting point) in a linear relationship. Students continue to use linear patterns and identify the rate of change and initial value in the different representations of a linear pattern (table, graph, equation, and geometric model). They also begin to understand how linear functions grow. The section then transitions students to contexts (situations) that are linear, interpreting the parameters m and b in the context and advancing their understanding of a linear relationship. Students move fluently between the representations of a linear relationship and make connections between the representations. This conceptual foundation will set the stage for students to be able to write the equation of a line from any set of conditions in section 3.2.

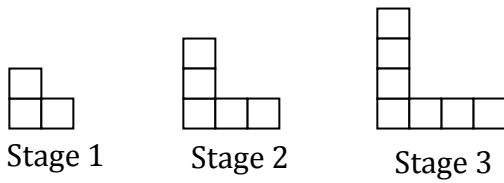
Concepts and Skills to Master:

By the end of this section, students should be able to:

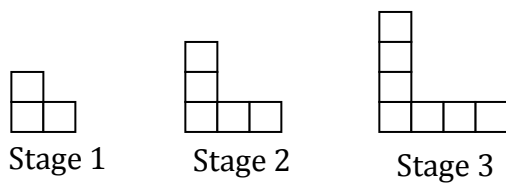
- Write rules for linear patterns and connect the rule to the pattern (geometric model).
- Create the additional representations (table, graph, equation, context, geometric model) of a linear relationship when given one representation.
- Understand the meaning of slope and y-intercept.
- Identify the rate of change and initial value of a linear relationship in the table, graph, equation, context, and geometric model of a linear pattern and context.
- Make connections between the table, graph, equation, context, and geometric model of a linear relationship.
- Understand how a linear relationship grows and show how that growth can be seen in each of the representations.

3.1a Class Activity: Connect the Rule to the Pattern

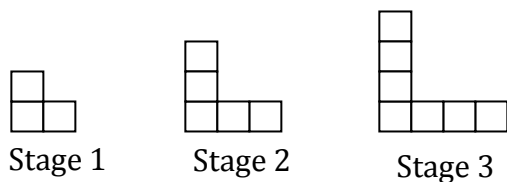
1. Use the pattern below to answer the questions that follow.



- a. Draw the figure at stage 4 in the space above. How did you draw your figure for stage 4 (explain or show on the picture how you see the pattern growing from one step to the next)?
- b. How many blocks are in stage 4? Stage 10? Stage 100?
- c. Write a rule that gives the number of blocks b for any stage, s . Show how your rule relates to the pattern (geometric model).

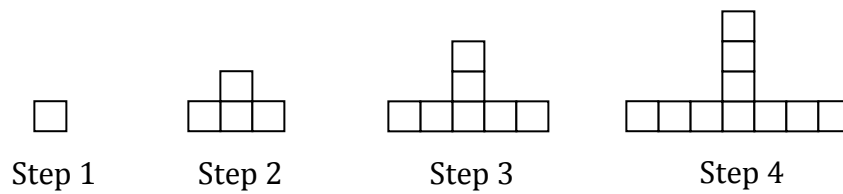


- d. Try to think of a different rule that gives the number of blocks b for any stage, s . Show how your rule relates to the pattern (geometric model).



- e. Use your rule to determine the number of blocks in stage 100.
- f. Use your rule to determine which stage has 25 blocks.
- g. Draw or describe stage 0 of the pattern. How does the number of blocks b in stage 0 relate to the simplified form of your rule?

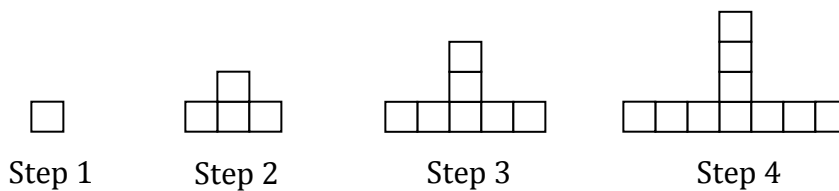
2. Use the pattern below to answer the questions that follow.



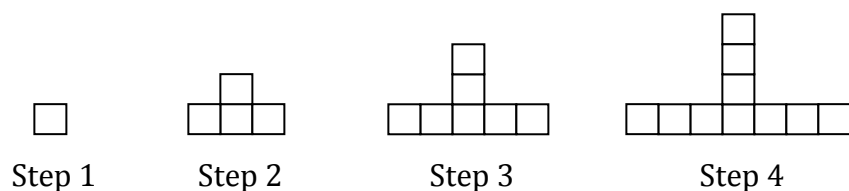
a. Draw the figure at step 5 in the space above. How did you draw your figure in step 5 (explain or show on the picture how you see the pattern growing from one step to the next)?

b. How many blocks are in step 5? Step 10? Step 100?

c. Write a rule that gives the number of blocks b for any step, s . Show how your rule relates to the pattern (geometric model).



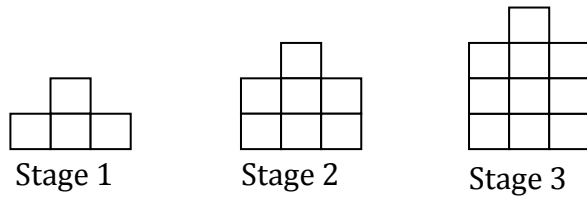
- d. Try to think of a different rule that gives the number of blocks b for any step, s . Show how your rule relates to the pattern (geometric model).



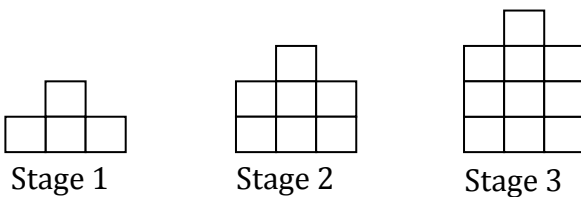
- e. Use your rule to determine the number of blocks in Step 100.
- f. Use your rule to determine which step has 58 blocks.
- g. Draw or describe step 0 of the pattern. How does the number of blocks in stage 0 relate to the simplified form of your rule?

3.1a Homework: Connect the Rule to the Pattern

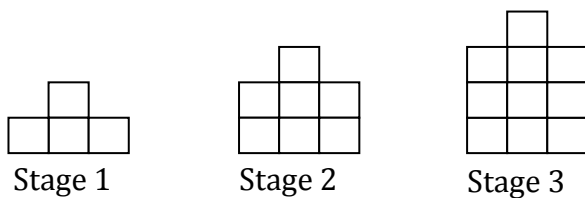
1. Use the pattern below to answer the questions that follow.



- Draw the figure at stage 4 in the space above. How did you draw your figure in stage 4 (explain or show on the picture how you see the pattern growing from one step to the next)?
- How many blocks are in stage 4? Stage 10? Stage 100?
- Write a rule that gives the number of blocks b for any stage, s . Show how your rule relates to the pattern (geometric model).

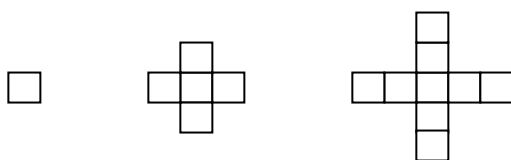


- Try to think of a different rule that gives the total number of blocks b for any stage, s . Show how your rule relates to the pattern (geometric model).



- Use your rule to determine the number of blocks in stage 100.
- Use your rule to determine which stage has 28 blocks.
- Draw or describe stage 0 of the pattern. How does the number of blocks in stage 0 relate to the simplified form of your rule?

2. Use the pattern below to answer the questions that follow.

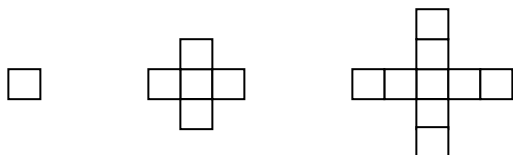


Stage 1

Stage 2

Stage 3

- Draw the figure at stage 4 in the space above. How did you draw your figure in stage 4 (explain or show on the picture how you see the pattern growing from one step to the next)?
- How many blocks are in stage 4? Stage 10? Stage 100?
- Write a rule that gives the total number of blocks b for any stage, s . Show how your rule relates to the pattern (geometric model).

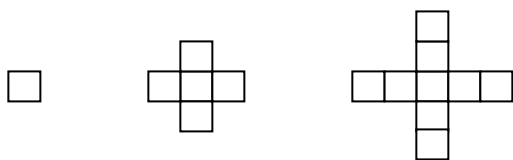


Stage 1

Stage 2

Stage 3

- Try to think of a different rule that gives the total number of blocks b for any stage, s . Show how your rule relates to the pattern (geometric model).



Stage 1

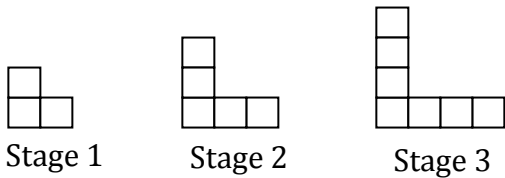
Stage 2

Stage 3

- Use your rule to determine the number of blocks in stage 100.
- Use your rule to determine which stage has 37 blocks.
- Draw or describe Stage 0 of the pattern. How does the number of blocks in stage 0 relate to the simplified form of your rule?

3.1b Classwork: Representations of a Linear Pattern

1. You studied this pattern in the previous lesson. Use your work from the previous lesson to answer the questions that follow.

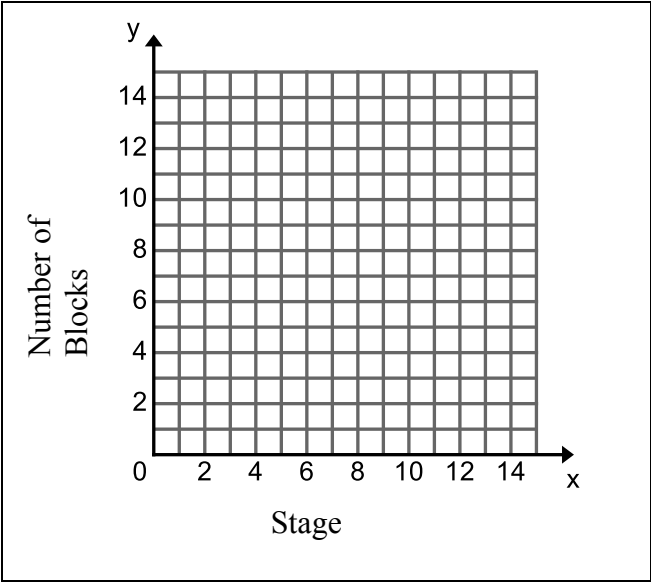


- a. How many new blocks are added to the pattern from one stage to the next?
- b. Complete the table.

<i>Stage (s)</i>	<i># of Blocks (b)</i>
1	
2	
3	
4	
5	

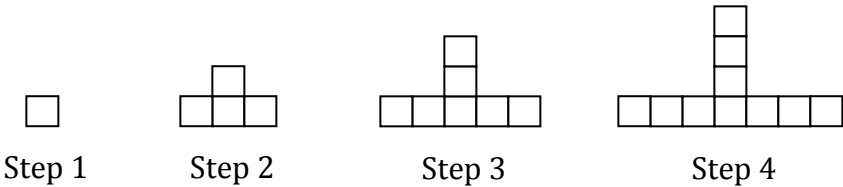
c. Show where you see the rate of change in your table.

d. Create a graph of this data. Where do you see the rate of change on your graph?



- e. What is the simplified form of the equation that gives the number of blocks b for any stage s (see previous lesson)? Where do you see the different pieces of the equation in the geometric model, table, and graph?
- f. The pattern above is a **linear** pattern. Describe how a linear pattern grows. Describe what the graph of a linear pattern looks like.

2. You studied this pattern in the previous lesson. Use your work from the previous lesson to answer the questions that follow.



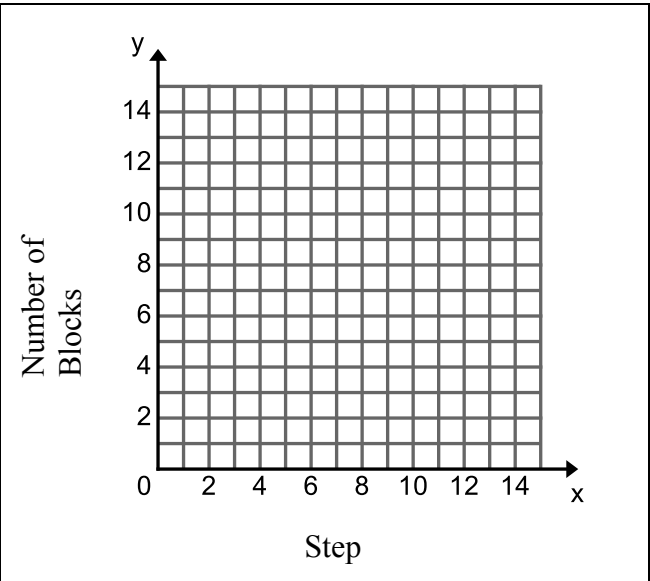
a. How many new blocks are added to the pattern from one stage to the next?

b. Complete the table.

c. Show where you see the rate of change in your table.

<i>Step (s)</i>	<i># of Blocks (b)</i>
1	
2	
3	
4	
5	

d. Create a graph of this data. Where do you see the rate of change on your graph?



e. What is the equation that gives the number of blocks b for any step s (see previous lesson)?
Where do you see the different pieces of the equation in the geometric model, table, and graph?

f. Is this pattern a linear pattern? Use supporting evidence from each of the representations to justify your answer.

3. Describe what you see in each of the representations (geometric model, table, graph, and equation) of a linear pattern. Make connections between the different representations.

Geometric Model:

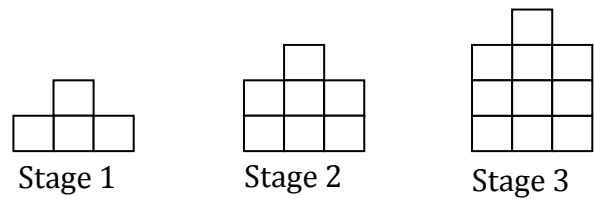
Table:

Graph:

Equation:

3.1b Homework: Representations of a Linear Pattern

1. You studied this pattern in the previous lesson. Use your work from the previous lesson to answer the questions that follow.

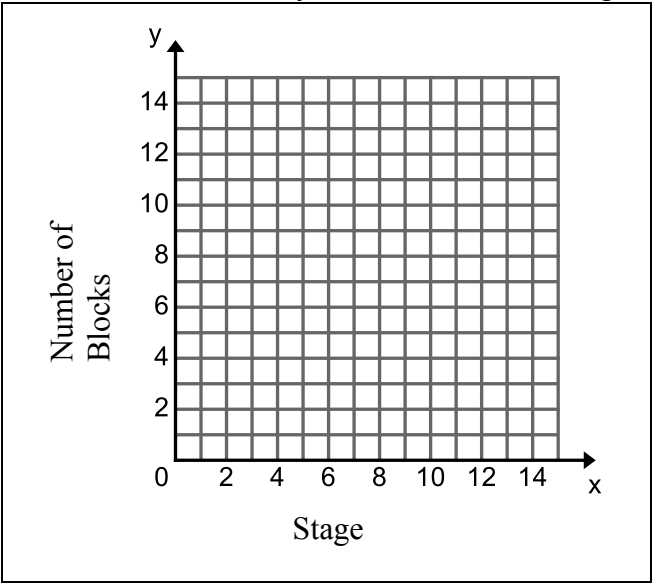


- a. How many new blocks are added to the pattern from one stage to the next?
- b. Complete the table.

<i>Stage (s)</i>	<i># of Blocks (b)</i>
1	
2	
3	
4	
5	

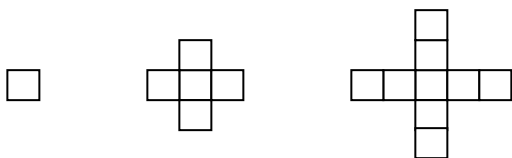
- c. Show where you see the rate of change in your table.

- d. Create a graph of this data. Where do you see the rate of change on your graph?



- e. What is the equation that gives the total number of blocks b for any stage s (see previous lesson)? Where do you see the different pieces of the equation in the geometric model, table, and graph?
- f. Is this pattern a linear pattern? Use supporting evidence from each of the representations to justify your answer.

2. You studied this pattern in the previous lesson. Use your work from the previous lesson to answer the questions that follow.



Stage 1

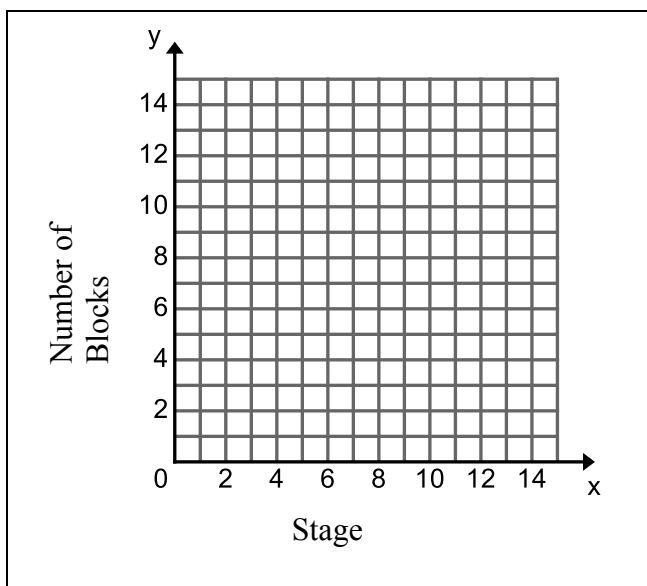
Stage 2

Stage 3

- How many new blocks are added to the pattern from one stage to the next?
- Complete the table.
- Show where you see the rate of change in your table.

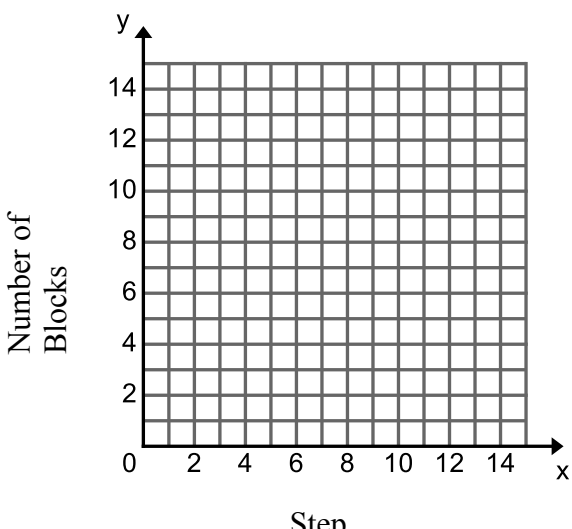
<i>Stage (s)</i>	<i># of Blocks (b)</i>
1	
2	
3	
4	
5	

- Create a graph of this data. Where do you see the rate of change on your graph?



- What is the equation that gives the total number of blocks b for any stage s (see previous lesson)? Where do you see the different pieces of the equation in the geometric model, table, and graph?
- Is this pattern a linear pattern? Use supporting evidence from each of the representations to justify your answer.

3. Create your own geometric model of a linear pattern in the space below. Then complete the table, graph, and equation for your pattern. Use these representations to prove that your pattern is linear.

<table border="1" style="margin: auto; border-collapse: collapse; text-align: center;"> <thead> <tr> <th style="padding: 5px;"><i>Step (s)</i></th> <th style="padding: 5px;"><i># of Blocks (b)</i></th> </tr> </thead> <tbody> <tr><td style="padding: 5px;">1</td><td style="padding: 5px;"></td></tr> <tr><td style="padding: 5px;">2</td><td style="padding: 5px;"></td></tr> <tr><td style="padding: 5px;">3</td><td style="padding: 5px;"></td></tr> <tr><td style="padding: 5px;">4</td><td style="padding: 5px;"></td></tr> <tr><td style="padding: 5px;">5</td><td style="padding: 5px;"></td></tr> </tbody> </table>	<i>Step (s)</i>	<i># of Blocks (b)</i>	1		2		3		4		5		<div style="text-align: center;">  </div>
<i>Step (s)</i>	<i># of Blocks (b)</i>												
1													
2													
3													
4													
5													
Equation:													

Prove that your pattern is linear using the representations (geometric model, table, graph, and equation) as evidence.

4. Draw or describe a pattern that can be represented by the equation $b = 1 + 6s$ where b is the number of blocks and s is the stage

3.1c Class Activity: Match the Graphs with CBRs, Write Stories

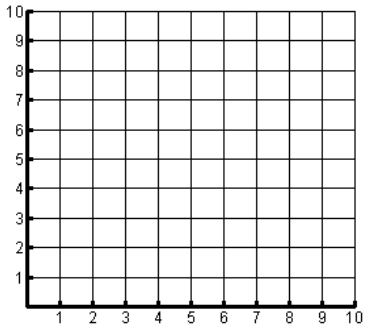
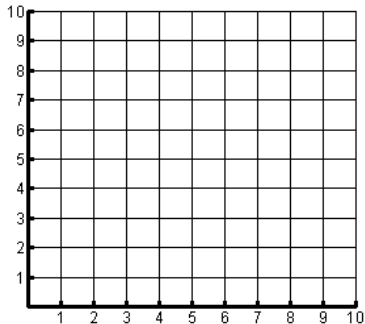
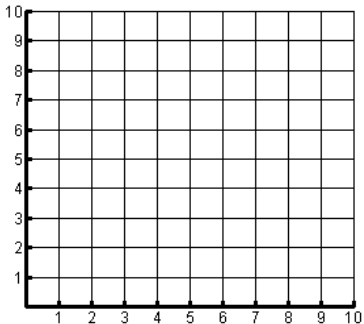
You will be using the *DIST MATCH* application in the *CBRTM Ranger* program on the TI 73 (or other) graphing calculators. Instructions for CBR/calculator use:

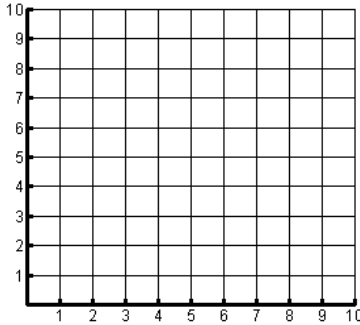
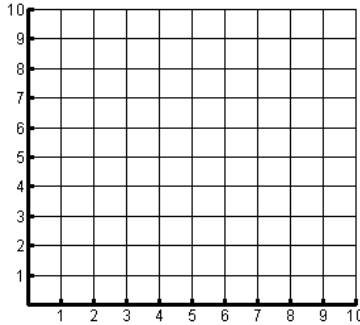
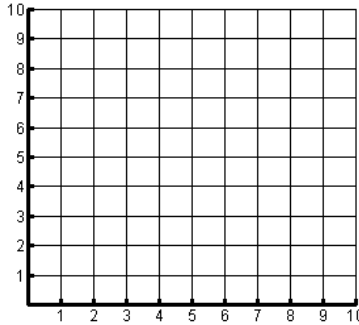
- Firmly attach the TI 73 to the CBR Ranger.
- Choose the APPS button on the TI 73.
- Choose 2: CBL/CBR.
- Choose 3: RANGER.
- Choose 3: APPLICATIONS.
- Choose 2: FEET.
- Choose 1: DIST MATCH. Get your first graph onto the calculator screen.

1. Try to match the graph given to you in the program. You will reproduce the graph by walking. Then trace the graph onto the graph forms below.

Be sure to model a few examples with your class before you begin in teams!

- a. Get a graph to match ready in the calculator.
- b. Decide how far away from the wall you should stand to begin.
- c. Talk through the walk that will make a graph match. (how far away to begin, walk forward or backward, how fast to move forward or backward, how long to walk forward or backward, when to change directions or speed, etc.)
- d. You may wish to write the story of the graph first (before you walk it)—see below.
- e. Hold the CBR so that the CBR sensor is up and directed toward the wall.
- f. Press start. Then walk toward or away from the wall trying to make your walk matches the graph on the calculator screen.
- g. Each member of your group should walk to match at least one graph on the calculator.
- h. Sketch each graph below. Write the story for the graph.

Graph 1:	Graph 2:	Graph 3:
		
Story:	Story:	Story:

<p>Graph 4:</p> 	<p>Graph 5:</p> 	<p>Graph 6:</p> 
<p>Story:</p>	<p>Story:</p>	<p>Story:</p>

Extra for Experts

If you finish early try to create the following graphs, write a description/story that matches the graph.

1. A line that rises at a steady rate.

Story:

2. A line that falls at a steady rate.

Story:

3. A horizontal line

Story:

4. A “V”

Story:

5. A “U

Story:

6. An “M”

Story:

7. Try creating an O. Are you successful? Why or why not?

8. Name a letter you could graph using the CBR.
Name a letter you cannot graph using the CBR.
Explain your choices.

3.1c Homework: Stories and Graphs

Directions: Sketch graphs to match the stories.

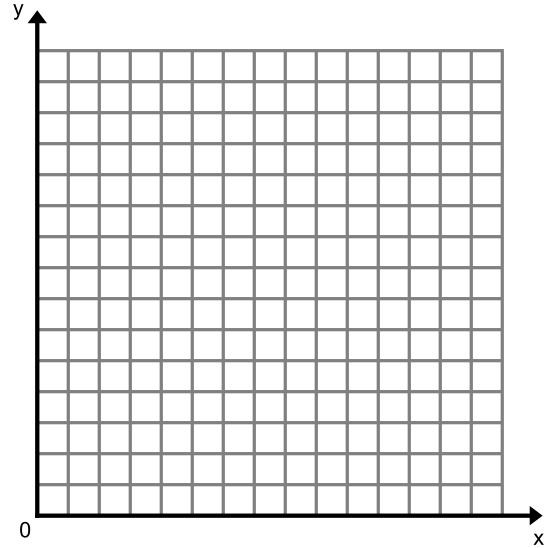
1. Before School.

Create a graph to match the story below (distance in feet, time in minutes). (Note: This graph will show distance traveled related to time passing—consider the student to be continually moving forward.)

Story:

A student walks through the halls before school. He/she begins at the front door, stops to talk to at least three different friends, stops at his/her locker, stops in the office.

Graph

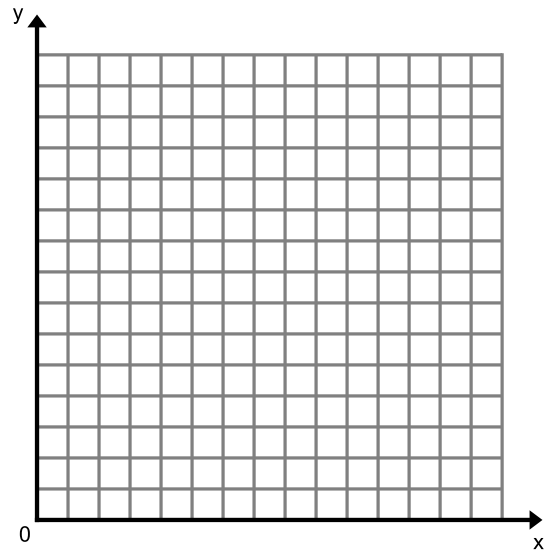


2. Birthday Cake

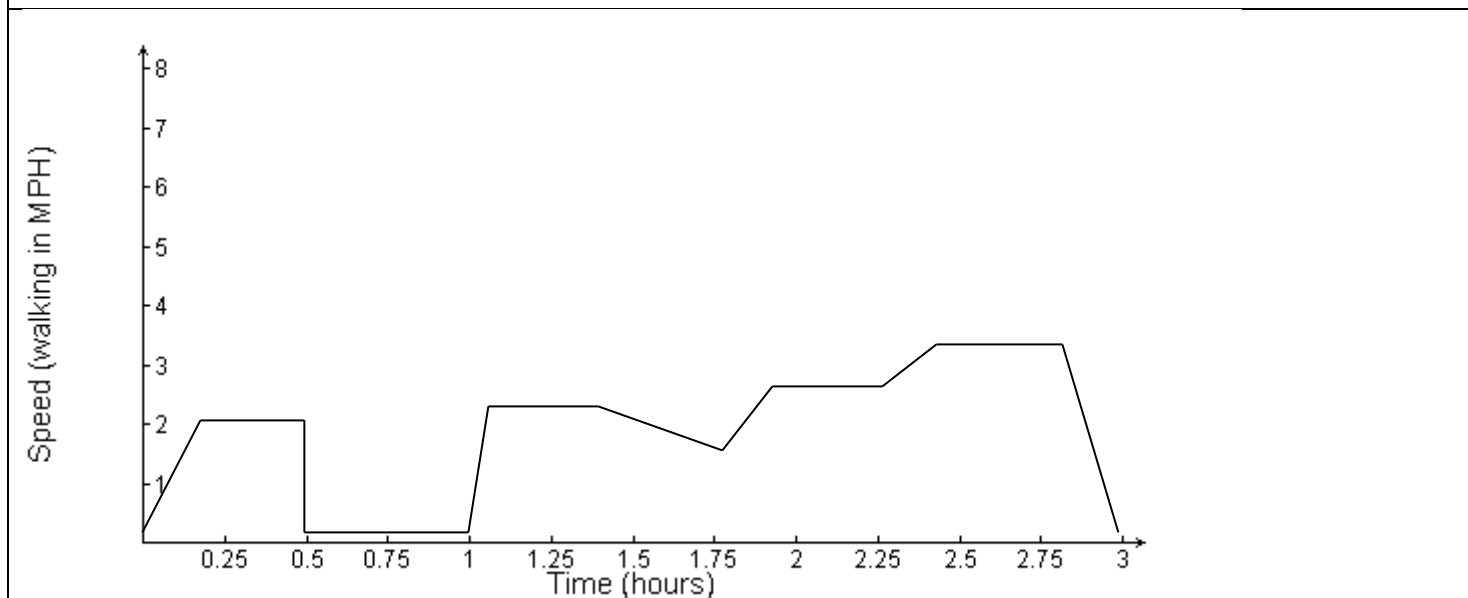
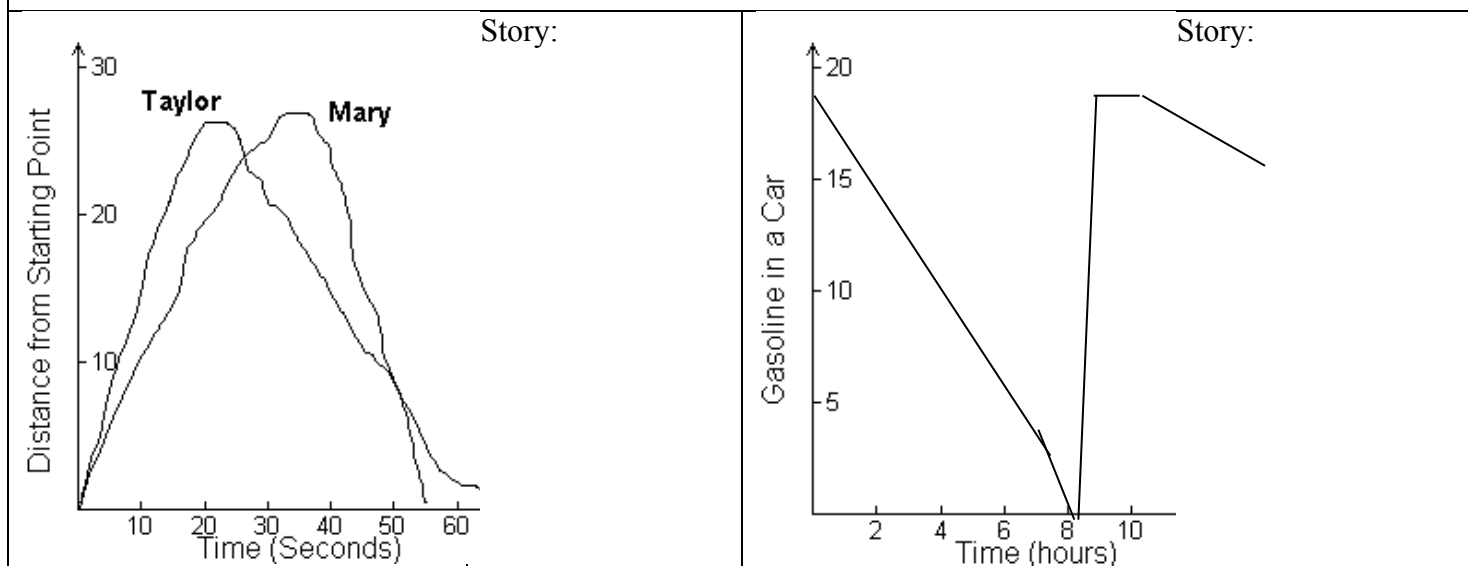
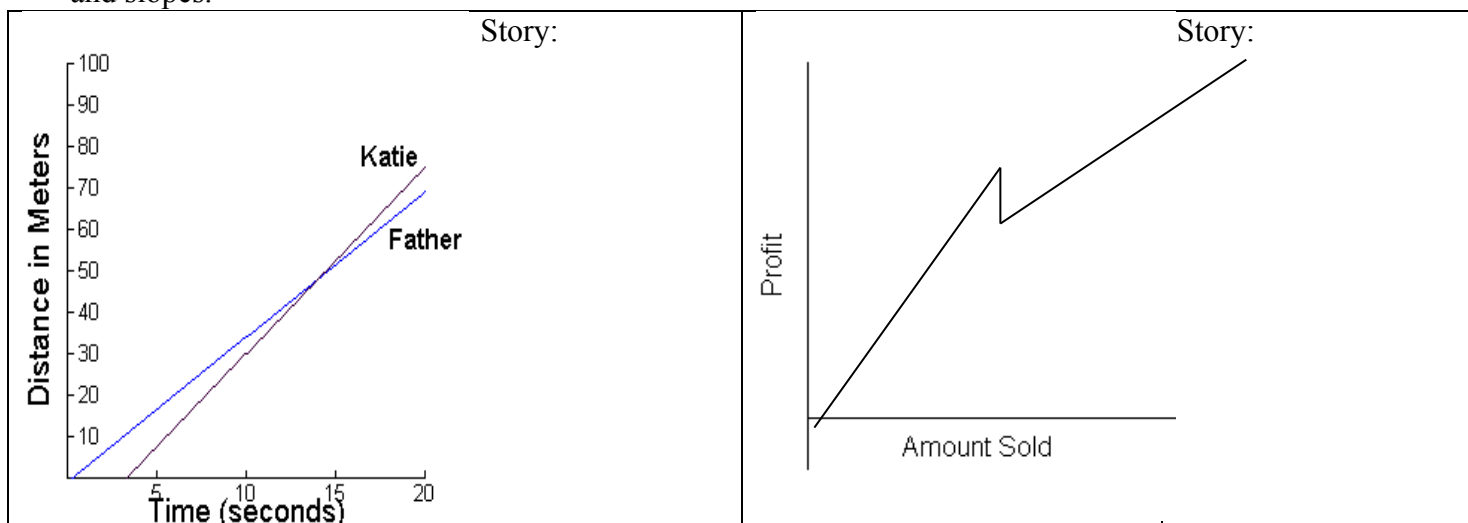
- Write a story about your family eating a birthday cake. You want to talk about amount of cake eaten related to passing time.
- Create the graph to tell the same story. You decide on the labels.

Story:

Graph



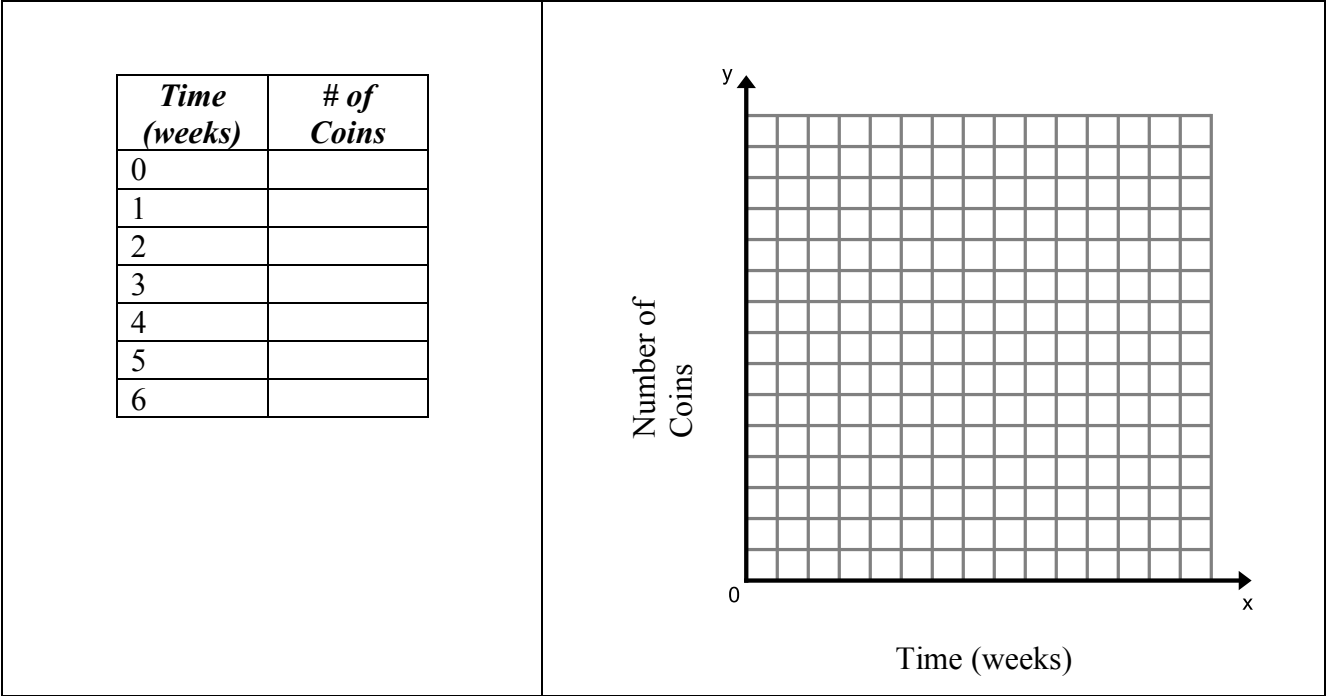
3. Make up stories to go with the following graphs. Include in the stories specific details about starting points and slopes.



Story:

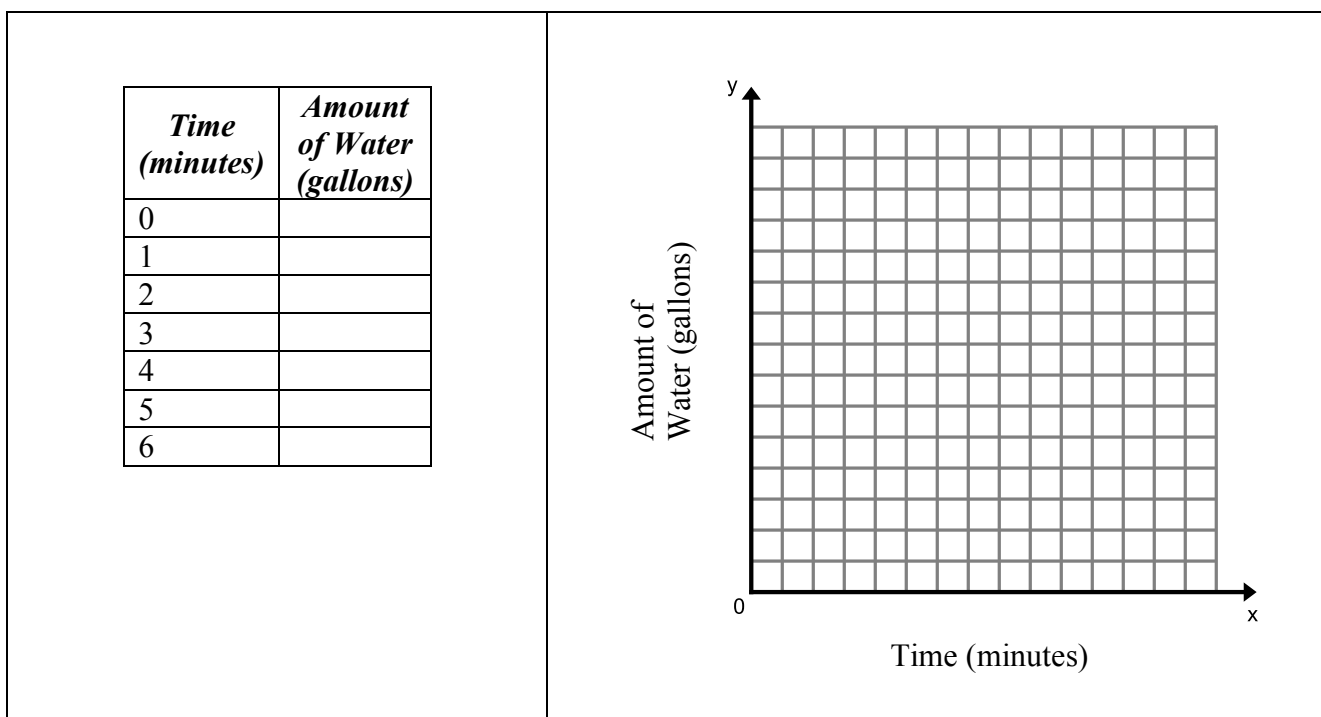
3.1d Classwork: Representations of a Linear Context

1. Courtney is collecting coins. She has 2 coins in her collection to start with and plans to add 4 coins each week.
- a. Complete the table and graph to show how many coins Courtney will have after 6 weeks.



- b. Write an equation for the number of coins c Courtney will have after w weeks.
- c. Is this context linear? Use evidence from the context, graph, table, and equation to support your answer.

2. Jack is filling his empty swimming pool with water. The pool is being filled at a constant rate of four gallons per minute.
- a. Complete the table and graph below to show how much water will be in the pool after 6 minutes.

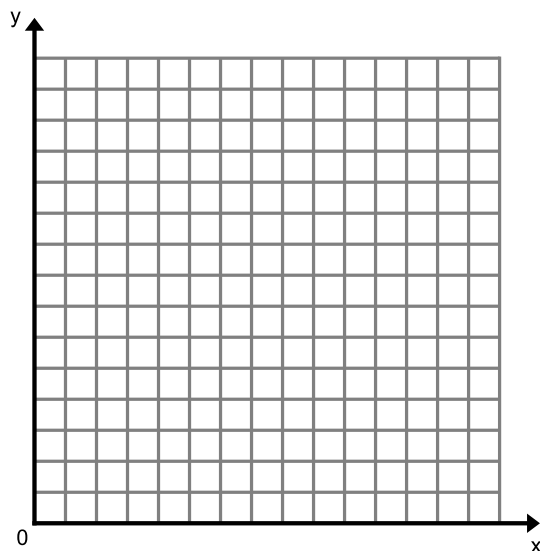


- b. Write an equation for the number of gallons g that will be in the pool after m minutes.
- c. Is this context linear? Use evidence from the context, graph, table, and equation to support your answer.
- d. Compare this swimming pool problem to the previous problem about coins. How are the problems similar? How are they different?
- e. How would you change the coin context so that it could be modeled by the same equation as the swimming pool context?
- f. How would you change the swimming pool context so that it could be modeled by the same equation as the coin context?

3.1d Homework: Representations of a Linear Context

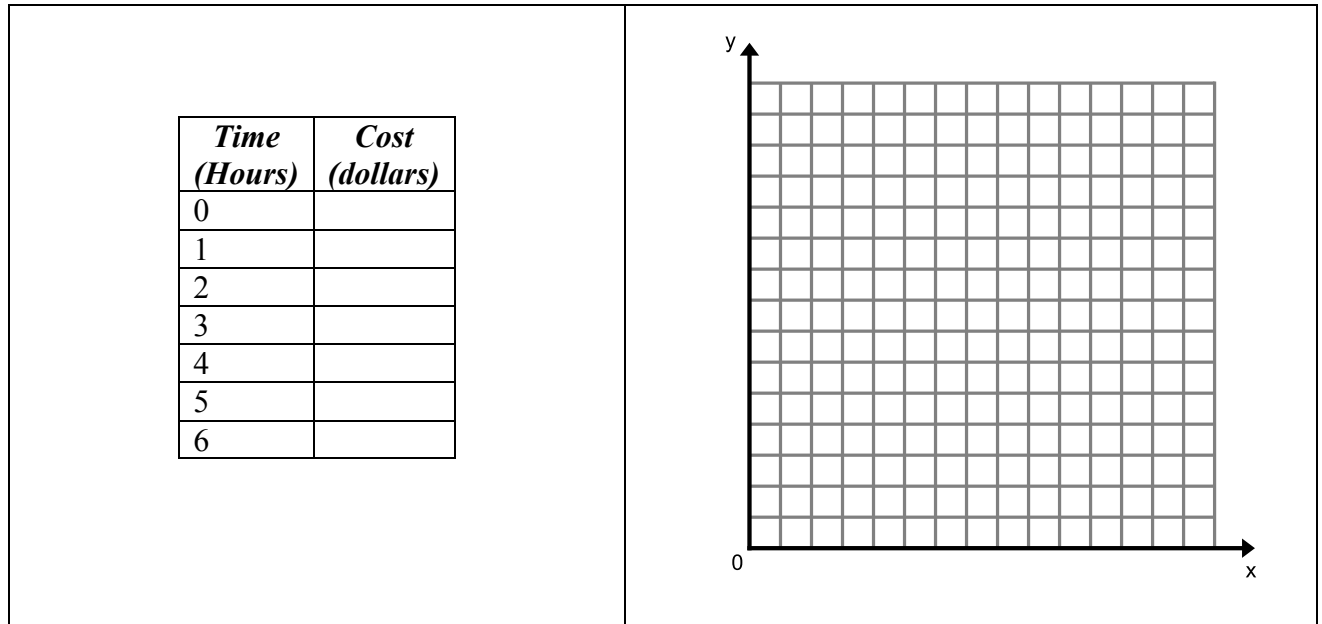
1. Hillary is saving money for college expenses. She is saving \$200 per week from her summer job. Currently, she does not have any money saved.
 - a. Complete the table and graph to show how much money Hillary will have 6 weeks from now.

<i>Time (weeks)</i>	<i>Amount Saved (dollars)</i>
0	
1	
2	
3	
4	
5	
6	



- b. Write an equation for the amount of money m Hillary will have saved after w weeks if she continues saving at the same rate.
- c. Is this context linear? Use evidence from the context, graph, table, and equation to support your answer.

2. The cost for a crew to come and landscape your yard is \$200 per hour. The crew charges an initial fee of \$100 for equipment.
- Complete the table and graph below to show how much it will cost for the crew to work on your yard for 6 hours.

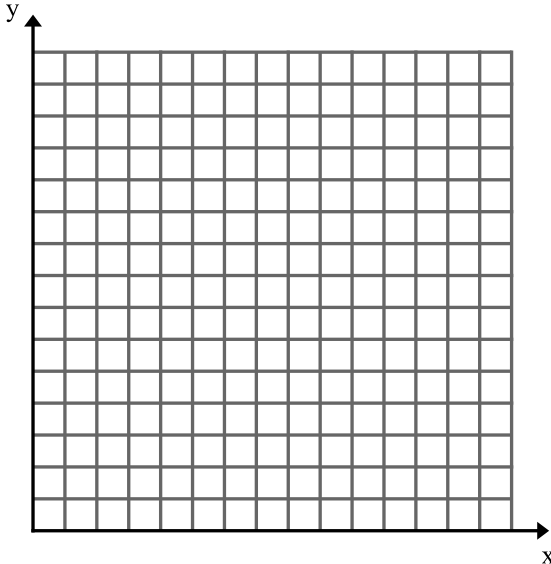


- Write an equation for the cost c of landscaping for h hours.
- Is this context linear? Use evidence from the context, graph, table, and equation to support your answer.
- Compare this landscaping problem to the problem with Hillary's savings. How are the problems similar? How are they different?
- How would you change the savings context so that it could be modeled by the same equation as the landscaping context?
- How would you change the landscaping context so that it could be modeled by the same equation as the savings context?

3.1e Classwork: More Representations of a Linear Context

Directions: In each of the following problems, you are given one of the representations of a linear relationship. Complete the remaining 3 representations. Be sure to label the columns in your table and the axes on your graph.

1. The State Fair

<p><u>Context</u></p> <p>You and your friends go to the state fair. It costs \$6 to get into the fair and \$2 each time you go on a ride. Consider the relationship between number of rides and total cost.</p>	<p><u>Table</u></p> <table border="1"><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table>														
<p><u>Graph</u></p> 	<p><u>Equation</u></p>														

- a. What is the rate of change in this problem? What does the rate of change represent in the context?
- b. What is the y -intercept of your graph? Where do you see the y -intercept in the table and in the equation? What does the y -intercept represent in the context?
- c. How would you change the context so that the relationship between total cost and number of rides was modeled by the equation $y = 2x$?
- d. How would you change the context so that the relationship between total cost and number of rides was modeled by the equation $y = 6$?

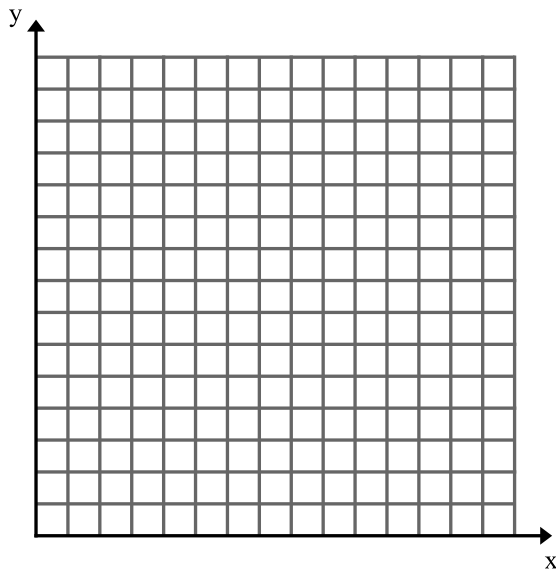
2. Road Trip

Context

You are taking a road trip. You start the day with a full tank of gas. Your tank holds 16 gallons of gas. On your trip, you use 2 gallons per hour. Consider the relationship between time in hours and amount of gas remaining in the tank.

Table

Graph



Equation

- What is the rate of change in this problem? What does the rate of change represent in the context?
- What is the y -intercept of your graph? Where do you see the y -intercept in the table and in the equation? What does the y -intercept represent in the context?
- How would your equation change if your gas tank held 18 gallons of gas and used 2.5 gallons per hour of driving? What would these changes do to your graph?

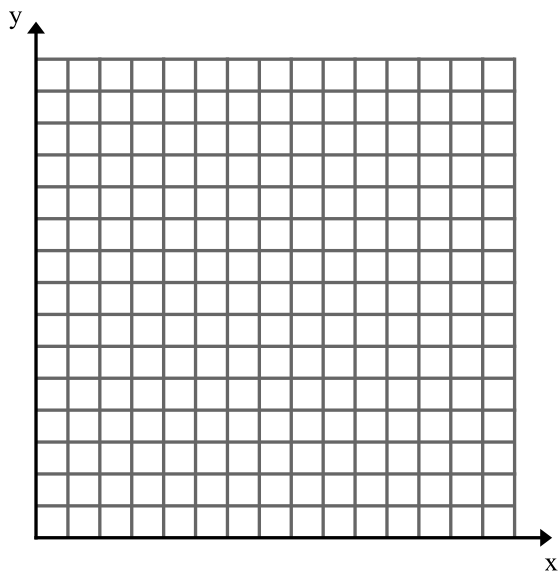
3.

Context

Table

Time (hours)	Cost (dollars)
0	7
1	9
2	11
3	13
4	15
5	17

Graph



Equation

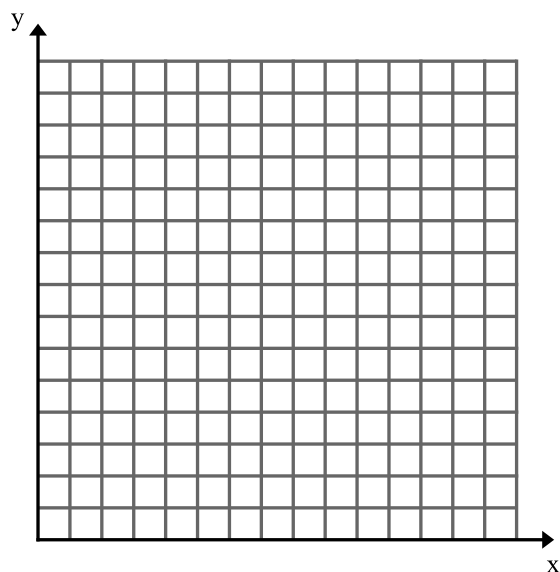
- What is the rate of change in this problem? What does the rate of change represent in your context?
- What is the y -intercept of your graph? Where do you see the y -intercept in the table and in the equation? What does the y -intercept represent in your context?
- How would your context change if the rate of change was 3?

4.

Context

Table

Graph



Equation

$$y = 4x + 10$$

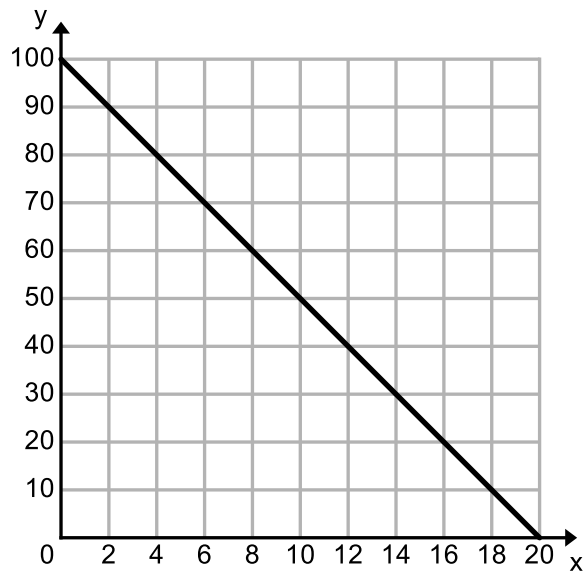
- How would your context change if the equation above was changed to $y = 2x + 10$? How would this change affect the graph?
- How would your context change if the equation above was changed to $y = 4x + 8$? How would this change affect the graph?

5.

Context

Table

Graph



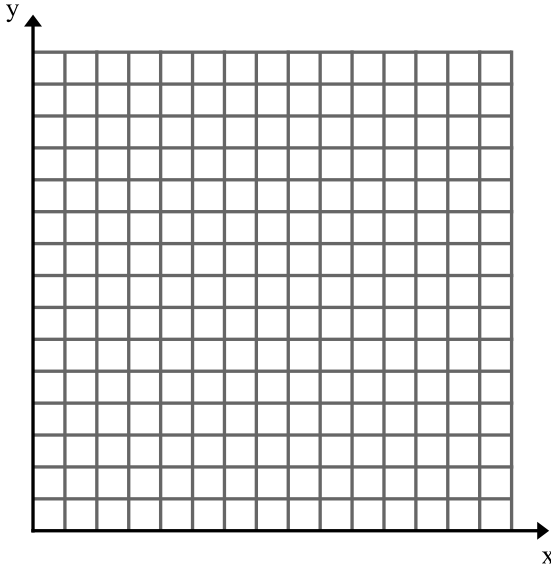
Equation

- What is the rate of change in this problem? What does the rate of change represent in your context?
- What is the y -intercept of the graph? Where do you see the y -intercept in the table and in the equation? What does the y -intercept represent in your context?
- How would your context and equation change if the y -intercept of the graph was changed to 75? How would this change affect the graph?
- How would your context and equation change if the rate of change in this problem was changed to -2 ? Would the graph of the new line be steeper or less steep than the original?

3.1e Homework: More Representations of a Linear Context

Directions: In each of the following problems, you are given one of the representations of a linear relationship. Complete the remaining 3 representations. Be sure to label the columns in your table and the axes on your graph.

1. A Community Garden

<p><u>Context</u></p> <p>Gavin is buying tomato plants to plant in his local community garden. Tomato plants are \$9 per flat (a flat contains 36 plants). Consider the relationship between total cost and number of flats purchased.</p>	<p><u>Table</u></p> <table border="1"><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr><tr><td></td><td></td></tr></table>														
<p><u>Graph</u></p> 	<p><u>Equation</u></p>														

- a. What is the rate of change in this problem? What does the rate of change represent in the context?
- b. What is the y -intercept of your graph? What does the y -intercept represent in the context?
- c. How would you change the context so that the relationship between total cost c and number of flats f purchased was $c = 12f$?

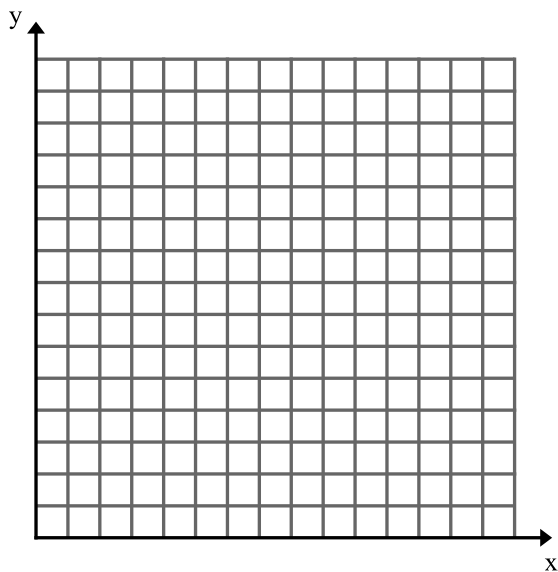
2. Enrollment

Context

The number of students currently enrolled at Discovery Place Preschool is 24. Enrollment is going up by 6 students each year. Consider the relationship between the number of years from now and the number of students enrolled.

Table

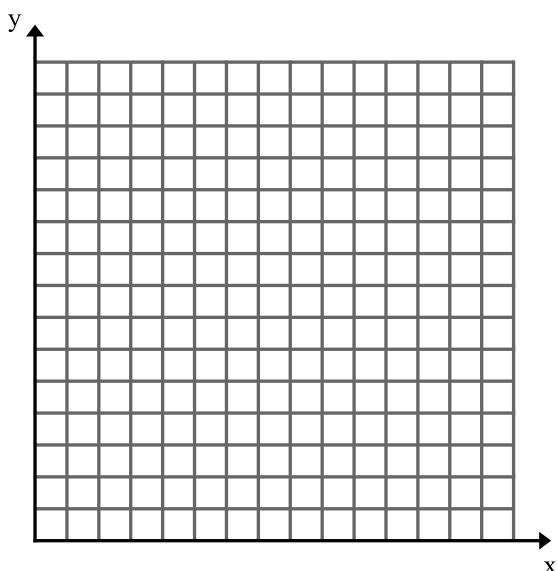
Graph



Equation

- What is the rate of change in this problem? What does the rate of change represent in the context?
- What is the y -intercept of your graph? What does the y -intercept represent in the context?
- How would you change the context so that the relationship between number of years and number of students enrolled was $y = 40 + 6x$?

3. Write your own context

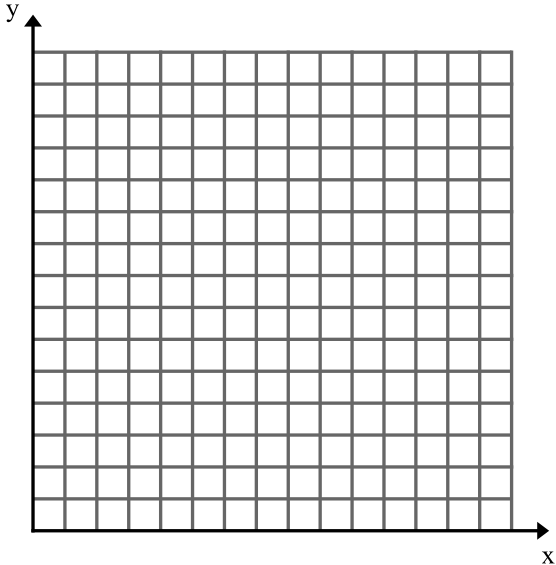
<u>Context</u>	<u>Table</u>														
	<table border="1" style="margin: auto; border-collapse: collapse;"> <thead> <tr> <th style="padding: 5px;">Time (hours)</th> <th style="padding: 5px;"># of Fish</th> </tr> </thead> <tbody> <tr><td style="text-align: center;">0</td><td style="text-align: center;">300</td></tr> <tr><td style="text-align: center;">2</td><td style="text-align: center;">270</td></tr> <tr><td style="text-align: center;">4</td><td style="text-align: center;">240</td></tr> <tr><td style="text-align: center;">6</td><td style="text-align: center;">210</td></tr> <tr><td style="text-align: center;">8</td><td style="text-align: center;">180</td></tr> <tr><td style="text-align: center;">10</td><td style="text-align: center;">150</td></tr> </tbody> </table>	Time (hours)	# of Fish	0	300	2	270	4	240	6	210	8	180	10	150
Time (hours)	# of Fish														
0	300														
2	270														
4	240														
6	210														
8	180														
10	150														
<u>Graph</u>	<u>Equation</u>														
															

- a. What is the rate of change in this problem? What does the rate of change represent in the context?

- b. What is the y -intercept of your graph? What does the y -intercept represent in the context?

- c. How would you change your context so that the amount of fish remaining y after x hours could be represented by the equation $y = 300 - 30x$?

4. Write your own context

<p><u>Context</u></p>	<p><u>Table</u></p> <table border="1" data-bbox="967 205 1351 543"> <tr><td></td><td></td></tr> <tr><td></td><td></td></tr> <tr><td></td><td></td></tr> <tr><td></td><td></td></tr> <tr><td></td><td></td></tr> <tr><td></td><td></td></tr> <tr><td></td><td></td></tr> </table>														
<p><u>Graph</u></p> 	<p><u>Equation</u></p> $y = 30 + 5x$														

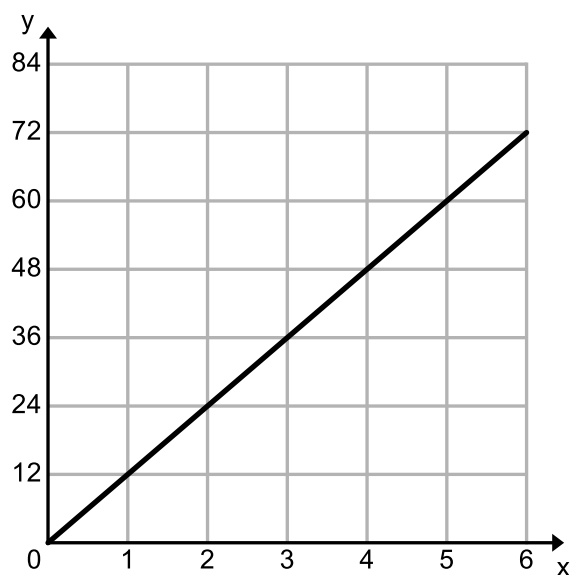
- What is the rate of change in this problem? What does the rate of change represent in the context?
- What is the y -intercept of your graph? What does the y -intercept represent in the context?

5. Write your own context

Context

Table

Graph



Equation

- What is the rate of change in this problem? What does the rate of change represent in the context?
- What is the y -intercept of your graph? What does the y -intercept represent in your context?
- How would your context and equation change if the rate of change in this problem was changed to 10? Would the graph of the new line be steeper or less steep?

3.1f Self-Assessment: Section 3.1

Consider the following skills/concepts. Rate your comfort level with each skill/concept by checking the box that best describes your progress in mastering each skill/concept.

Skill/Concept	Beginning Understanding	Developing Skill and Understanding	Deep Understanding, Skill Mastery
1. Write rules for linear patterns and connect the rule to the pattern (geometric model).			
2. Create the additional representations (table, graph, equation, context, geometric model) of a linear relationship when given one representation.			
3. Understand the meaning of slope and y -intercept.			
4. Identify the rate of change and initial value of a linear relationship in the table, graph, equation, context, and geometric model of a linear pattern and context.			
5. Make connections between the table, graph, equation, context, and geometric model of a linear relationship.			
6. Understand how a linear relationship grows and show how that growth can be seen in each of the representations.			

Section 3.2: Graph and Write Equations of Lines

Section Overview:

Now that students have an understanding of the parameters m and b in the slope-intercept form of a linear equation, this section will transition students into the procedural work of being able to write and graph the equation of a line from any set of givens. Students apply the skills they have learned to write linear equations that model real world situations. Students also investigate the effects of changes in the slope and y -intercept of a line, describing the transformation (translations, rotations, and reflections) that has taken place and writing new equations that reflect the changes in m and b .

Concepts and Skills to Master:

By the end of this section, students should be able to:

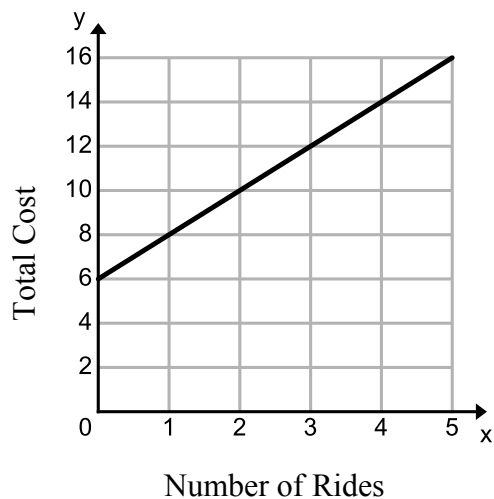
- Write a linear equation in the form $y = mx + b$ given any of the following:
 - slope and y -intercept
 - slope and a point
 - two points
 - a table, graph, or context of a real world situation
 - a shift in the graph of an equation (a change in the slope or y -intercept of an equation)
- Graph linear relationships given any of the following:
 - a table of values
 - an equation
 - slope and y -intercept
 - slope and a point
 - a shift in the graph of an equation (a change in the slope or y -intercept of an equation)

3.2a Class Activity: Write Equations in Slope-Intercept Form

Let's revisit a situation from the previous section:

You and your friends go to the state fair. It costs \$6 to get into the fair and \$2 each time you go on a ride. Consider the relationship between number of rides and total cost. Below are the table, graph, and equation that model this linear relationship.

Number of Rides (x)	Total Cost (y)
0	6
1	8
2	10
3	12
4	14
5	16



We modeled this situation with the equation $y = 2x + 6$

What is the slope of the graph? Where do you see the slope in the equation? What does the slope represent in the context?

What is the y-intercept of the graph? Where do you see the y-intercept in the equation? What does the y-intercept represent in the context?

From the problems we have studied in this chapter so far, we can see that one way to represent a linear equation is in slope-intercept form:

Slope-intercept form of a linear equation is

$$y = mx + b$$

where m represents the slope (rate of change)
and b represents the y-intercept (initial value or starting point)

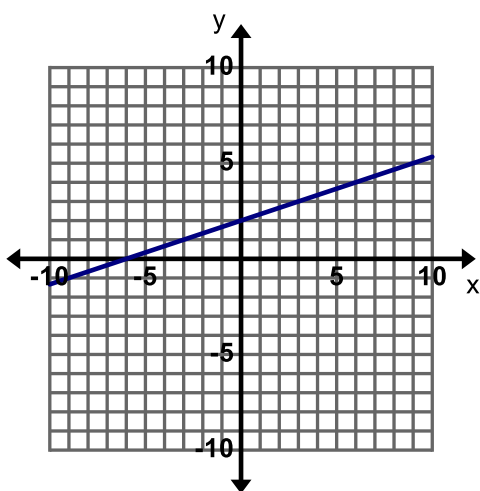
If we are given a representation of a linear relationship, we can write the equation for the relationship in slope-intercept form by finding the slope (m) and y-intercept (b) and plugging them into the slope-intercept form a linear equation shown above.

Directions: Write the equation of each line in slope-intercept form.

1. The slope of the line is 3. The y -intercept is $(0, 4)$.
2. The slope of the line is -2 . The y -intercept is $(0, 0)$.
3. The slope of the line is $\frac{1}{2}$. The y -intercept is $(0, -2)$.
4. The slope of the line is $-\frac{4}{3}$. The y -intercept is $(0, -1)$.
5. The slope of the line is 0. The y -intercept is $(0, 2)$.

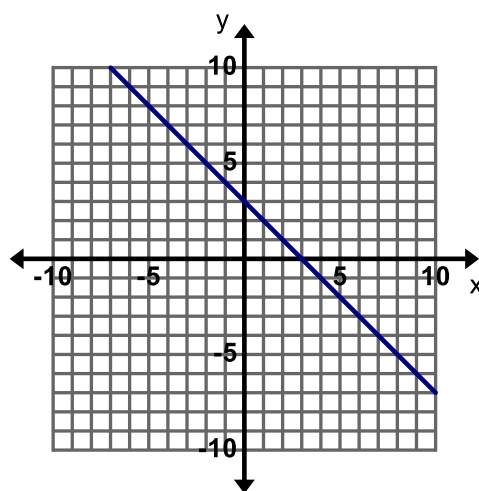
6. m : _____ b : _____

Equation: _____



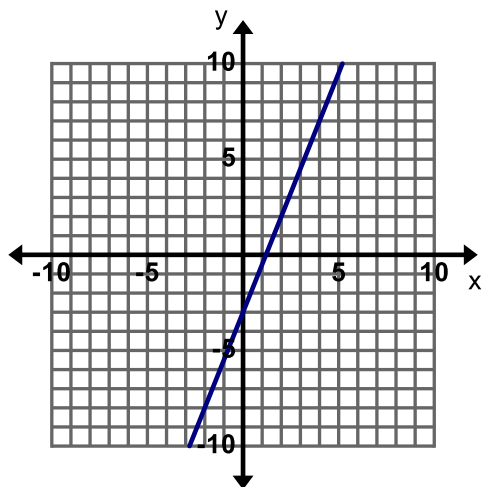
7. m : _____ b : _____

Equation: _____



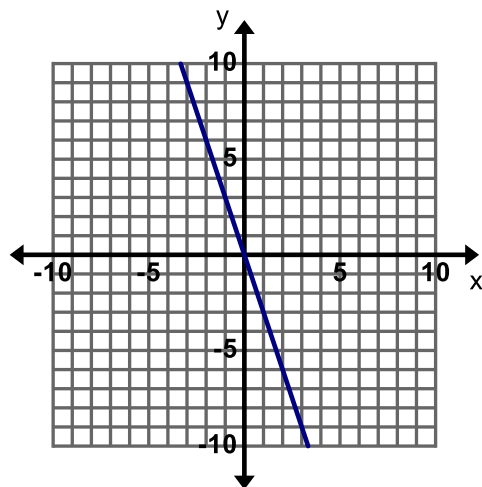
8. m : _____ b : _____

Equation: _____



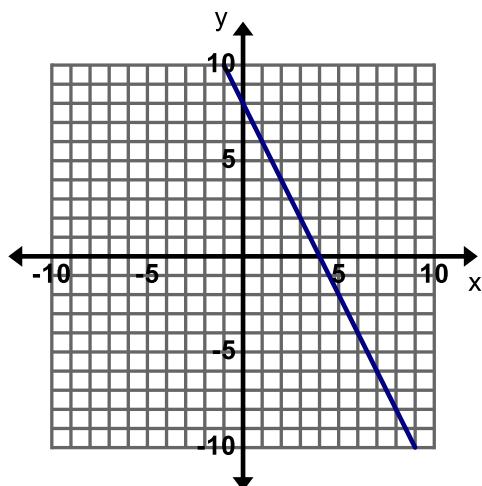
9. m : _____ b : _____

Equation: _____



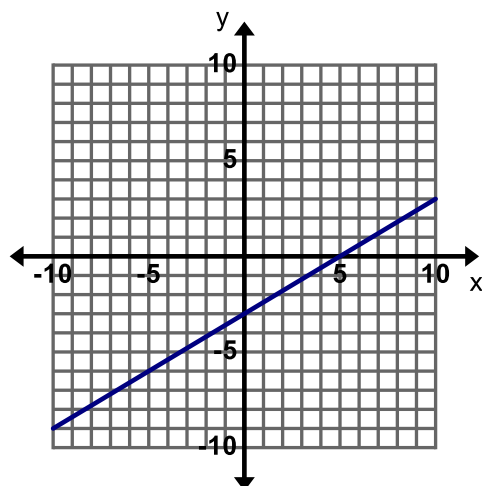
10. m : _____ b : _____

Equation: _____



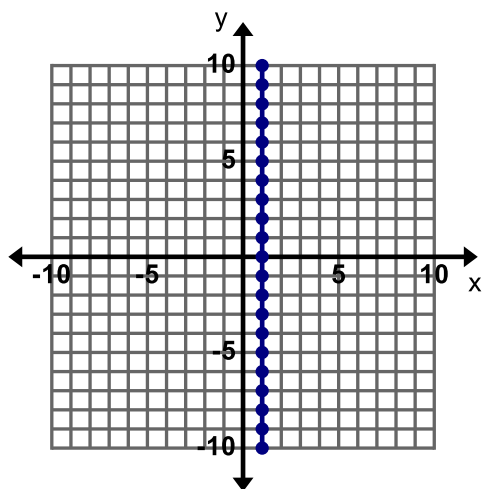
11. m : _____ b : _____

Equation: _____



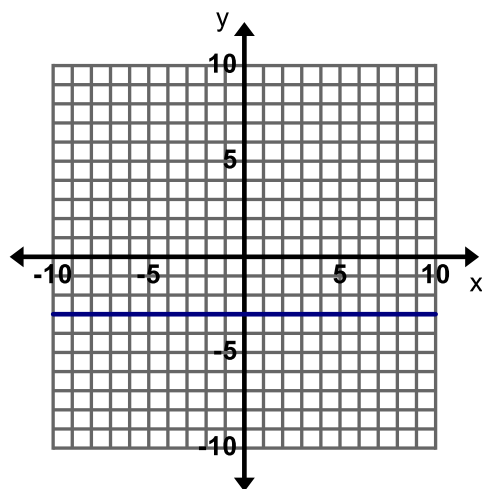
12. m : _____ b : _____

Equation: _____



13. m : _____ b : _____

Equation: _____



14. m : _____ b : _____

Equation: _____

x	y
0	4
1	6
2	8
3	10

15. m : _____ b : _____

Equation: _____

x	y
-1	-1
0	-2
1	-3
2	-4

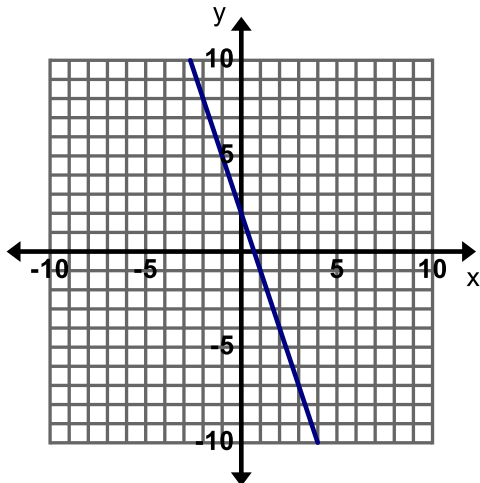
16. m : _____ b : _____

Equation: _____

x	y
-2	-1
0	0
2	1
4	2

Error Analysis: In each of the following problems, a common mistake of writing the equation of a line has been made. Describe the error and write the correct equation.

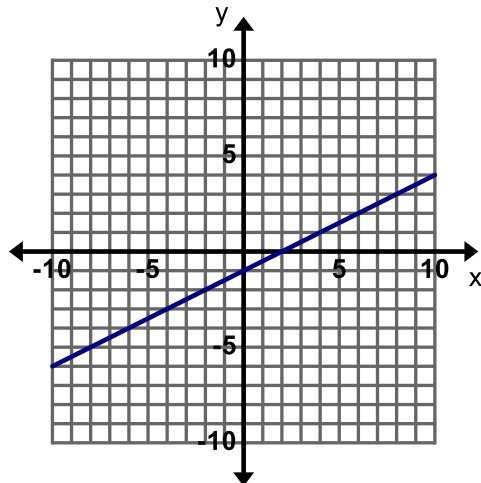
17. Incorrect Equation: $y = 3x + 2$



Mistake:

Correct Equation:

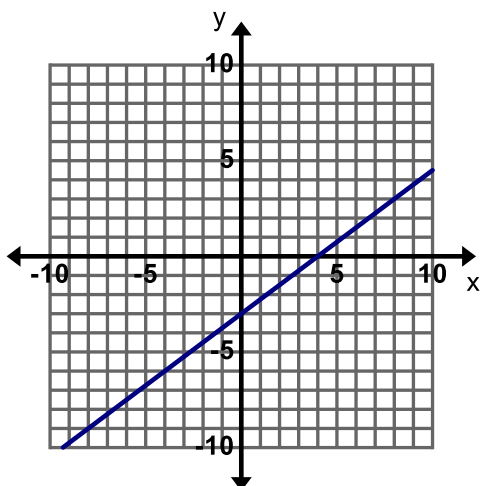
18. Incorrect Equation: $y = 2x - 1$



Mistake:

Correct Equation:

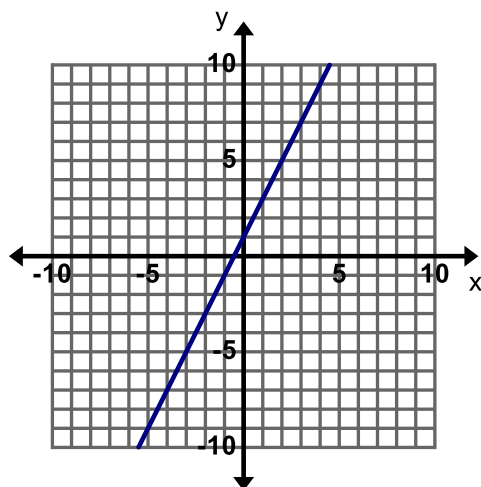
19. Incorrect Equation: $y = \frac{3}{4}x + 4$



Mistake:

Correct Equation:

20. Incorrect Equation: $y = x + 2$



Mistake:

Correct Equation:

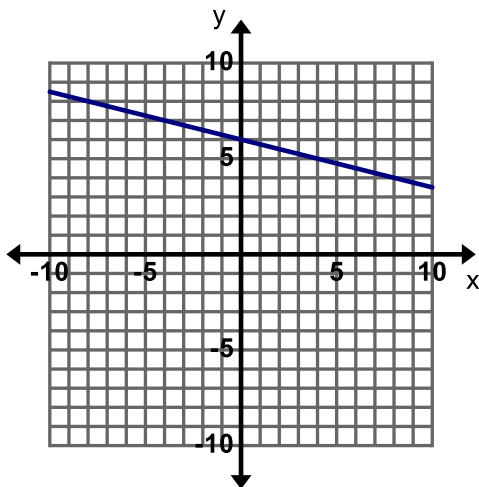
3.2a Homework: Write Equations in Slope-Intercept Form

Directions: Write the equation of each line in slope-intercept form.

1. The slope of the line is 5. The y -intercept is $(0, -1)$.
2. The slope of the line is -1 . The y -intercept is $(0, -6)$.
3. The slope of the line is $\frac{1}{4}$. The y -intercept is $(0, 0)$.
4. The slope of the line is $-\frac{3}{5}$. The y -intercept is $(0, 10)$.

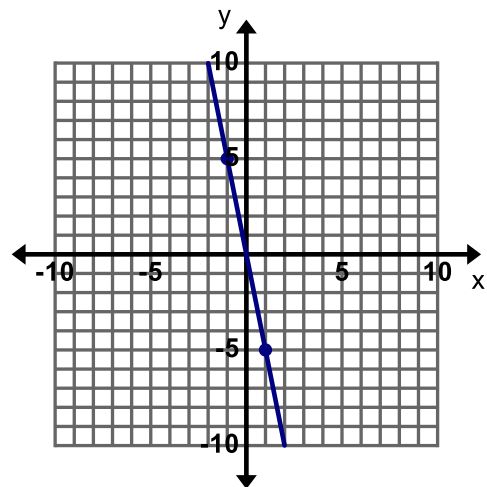
5. m : _____ b : _____

Equation: _____



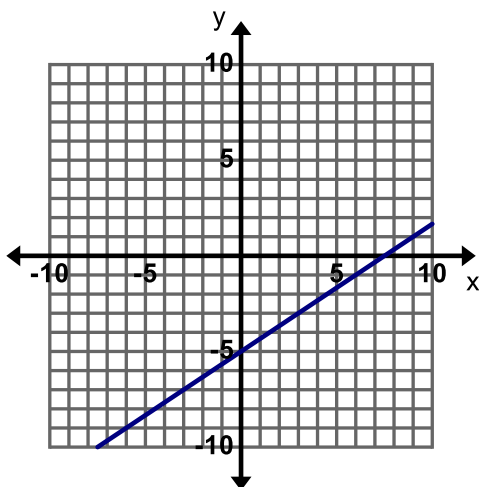
6. m : _____ b : _____

Equation: _____



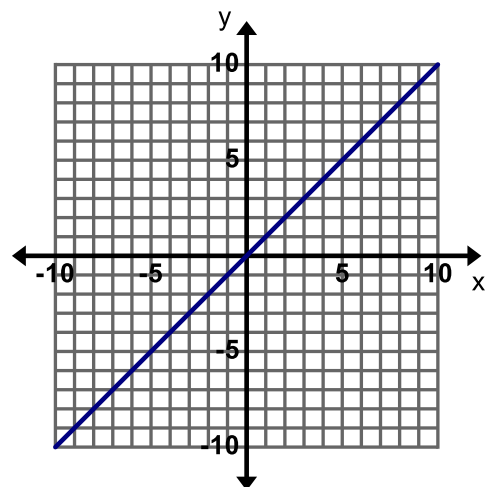
7. m : _____ b : _____

Equation: _____



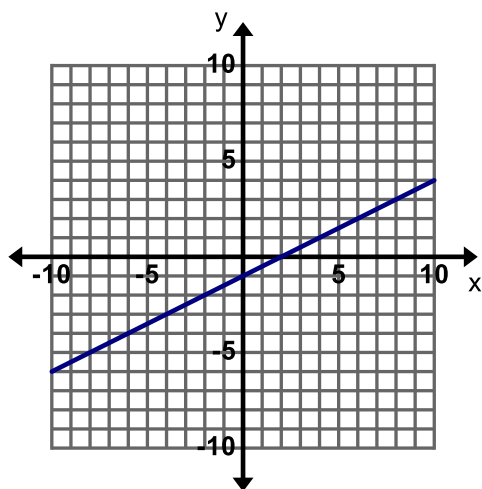
8. m : _____ b : _____

Equation: _____



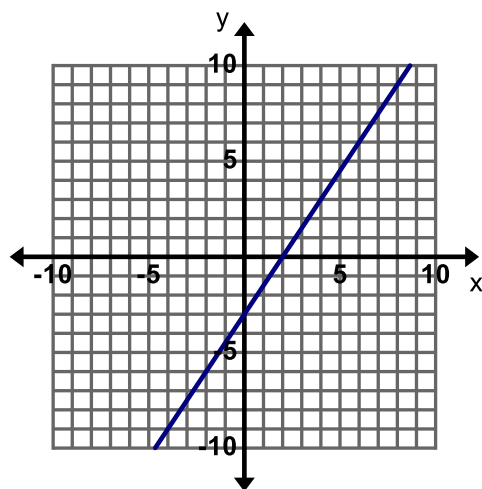
9. m : _____ b : _____

Equation: _____



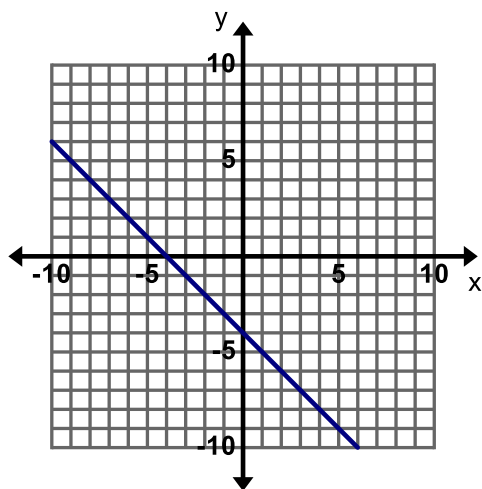
10. m : _____ b : _____

Equation: _____



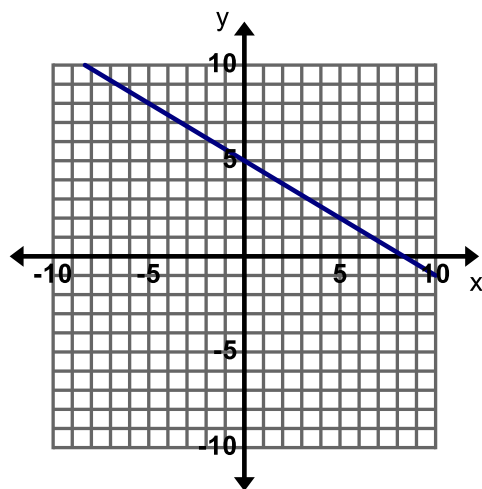
11. m : _____ b : _____

Equation: _____



12. m : _____ b : _____

Equation: _____



13. m : _____ b : _____

Equation: _____

x	y
0	2
1	0
2	-2
3	-4

14. m : _____ b : _____

Equation: _____

x	y
-3	3
0	4
3	5
6	6

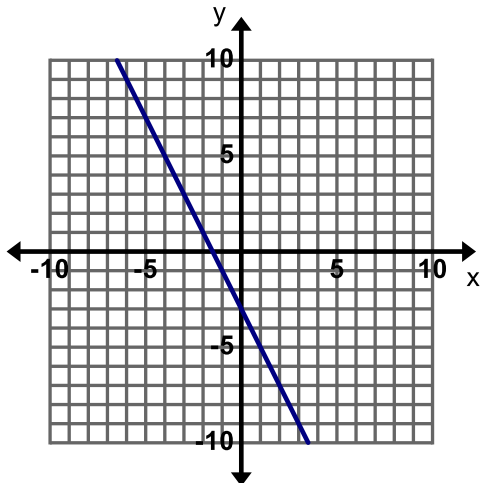
15. m : _____ b : _____

Equation: _____

x	y
-1	5
0	5
1	5
2	5

Error Analysis: In each of the following problems, a common mistake of writing the equation of a line has been made. Describe the error and write the correct equation.

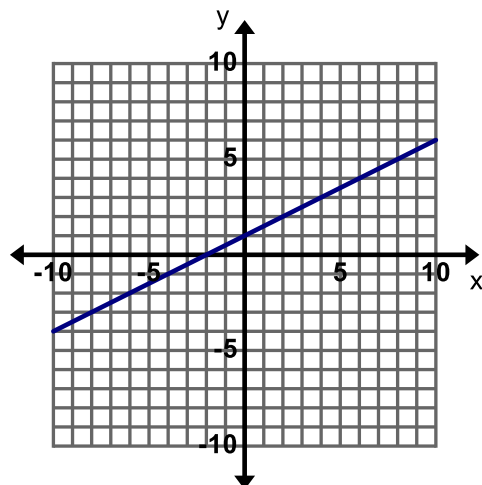
16. Incorrect Equation: $y = -2x + 3$



Mistake:

Correct Equation:

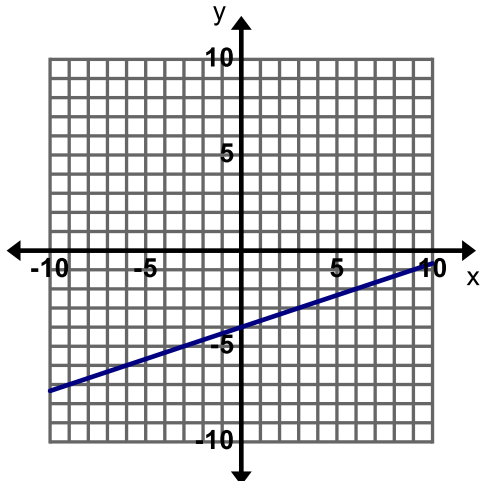
17. Incorrect Equation: $y = x + \frac{1}{2}$



Mistake:

Correct Equation:

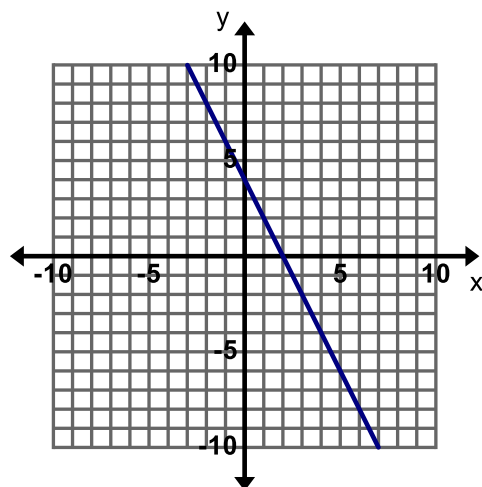
18. Incorrect Equation: $y = -\frac{1}{3}x - 4$



Mistake:

Correct Equation:

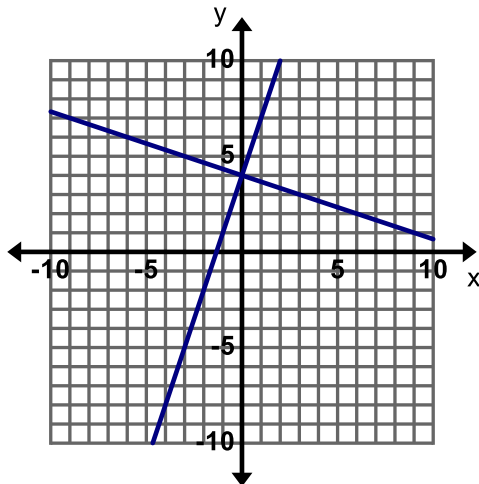
19. Incorrect Equation: $y = -2x + 2$



Mistake:

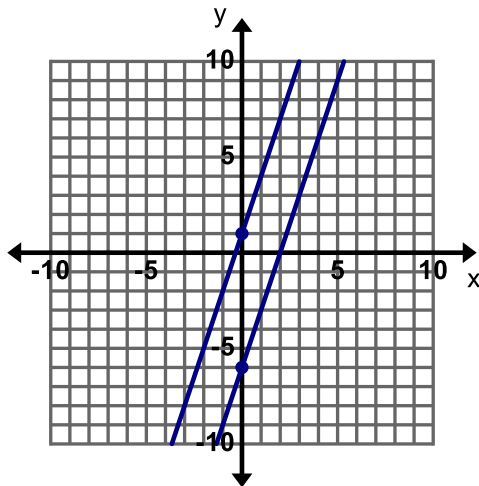
Correct Equation:

20. Write the equation of each line in the graph below. Label each line with its equation.



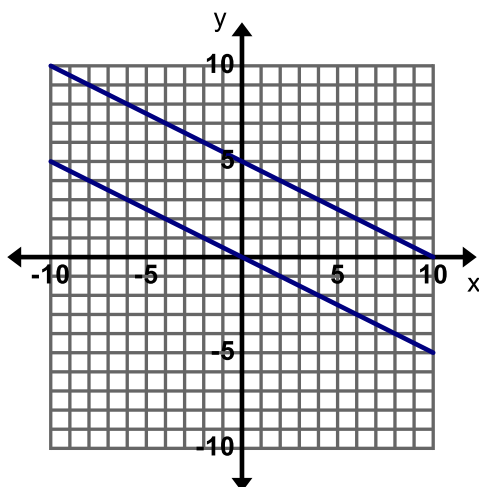
Compare the two lines. What is the same? What is different?

21. Write the equation of each line in the graph below. Label each line with its equation.



Compare the two lines. What is the same? What is different?

22. Write the equation of each line in the graph below. Label each line with its equation.



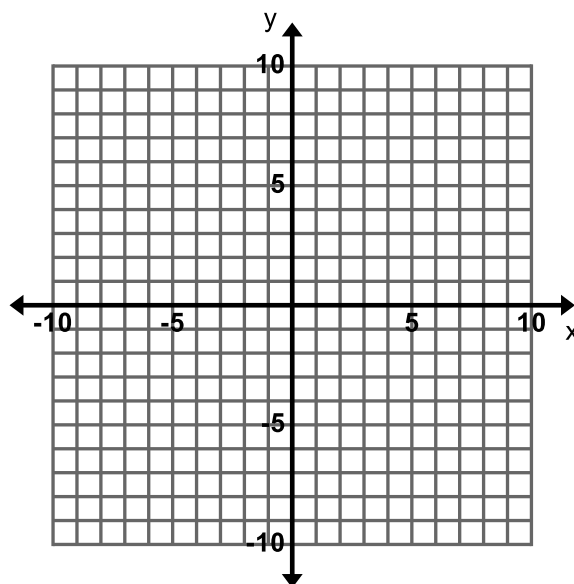
Compare the two lines. What is the same? What is different?

3.2b Classwork: Graph from Slope-Intercept Form

1. On the following coordinate plane, draw a line with a slope of $\frac{1}{3}$.

a. How do you know that your line has a slope of $\frac{1}{3}$?

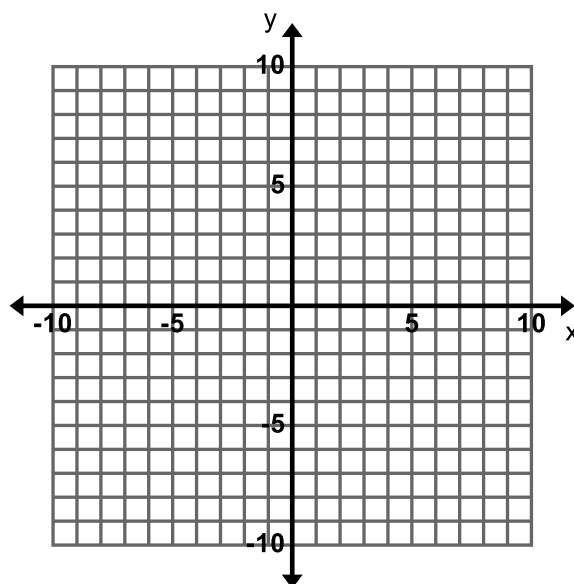
b. What did you do to draw your line to ensure that you ended with a slope of $\frac{1}{3}$?



2. Draw a line with a slope of -2.

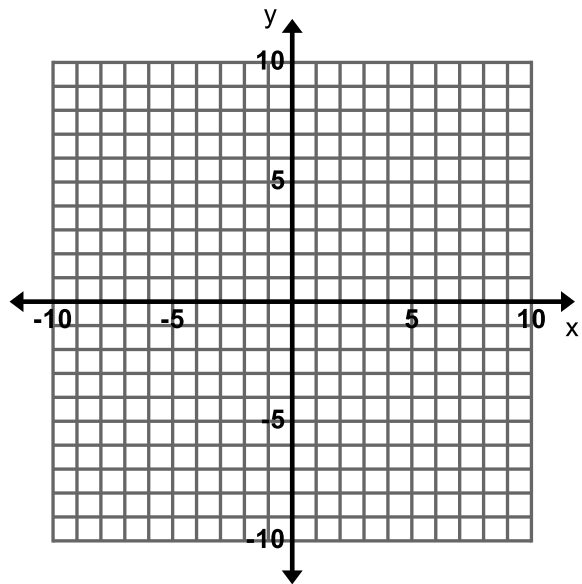
a. How do you know that your line has a slope of -2?

b. What did you do to draw your line to ensure that you ended with a slope of -2?

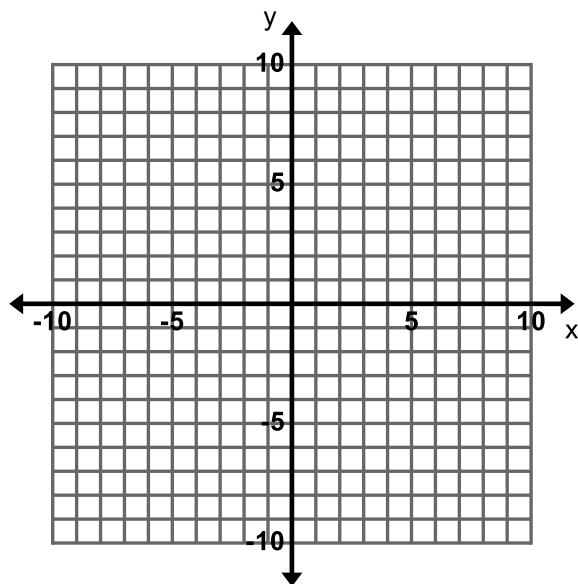


3. Consider the following equation $y = \frac{2}{3}x - 1$.

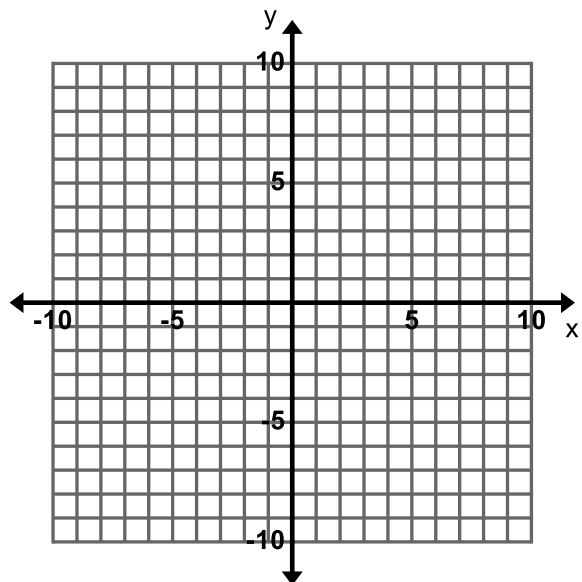
- What is the y -intercept?
- What is the slope?
- Graph the line on the grid to the right by first plotting the y -intercept and then drawing a line with the slope that goes through the y -intercept. Use what you wrote in the first two questions to help you.



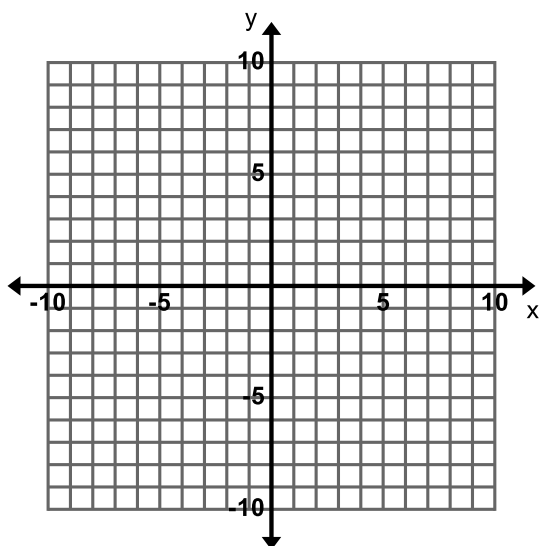
4. Graph $y = 3x + 1$



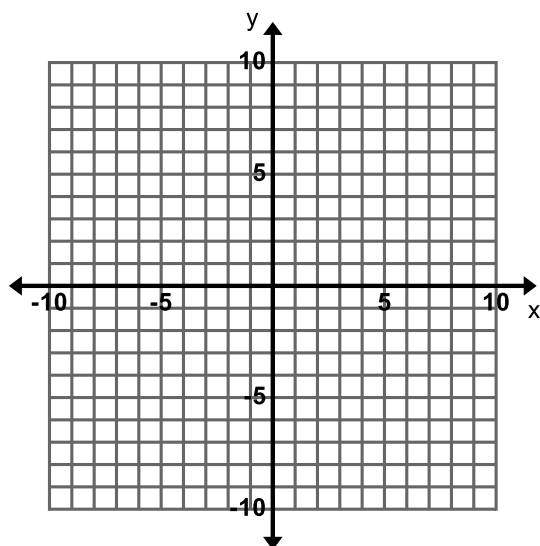
5. Graph $y = -\frac{3}{4}x$



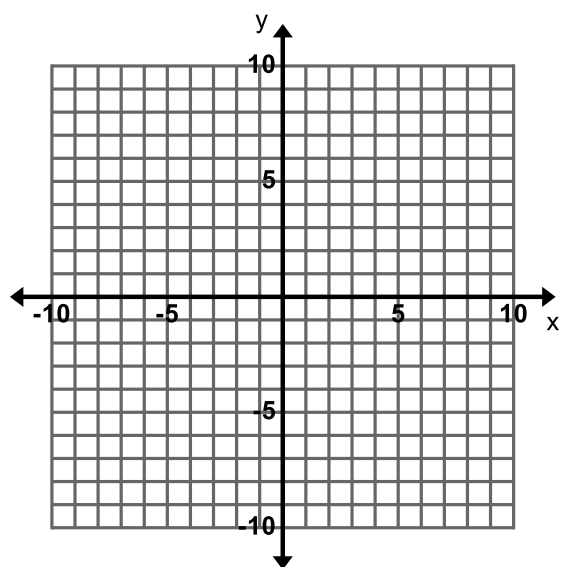
6. Graph $y = -2 + x$



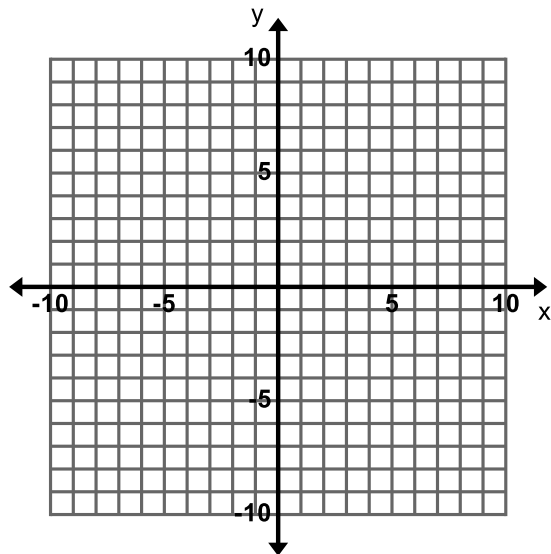
7. Graph $2x + y = 3$



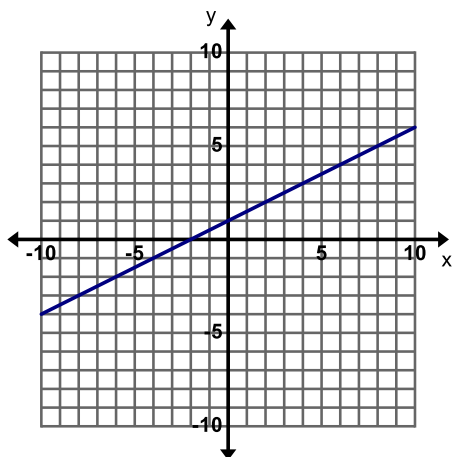
8. Graph $y = 5$



9. Graph $x = -1$

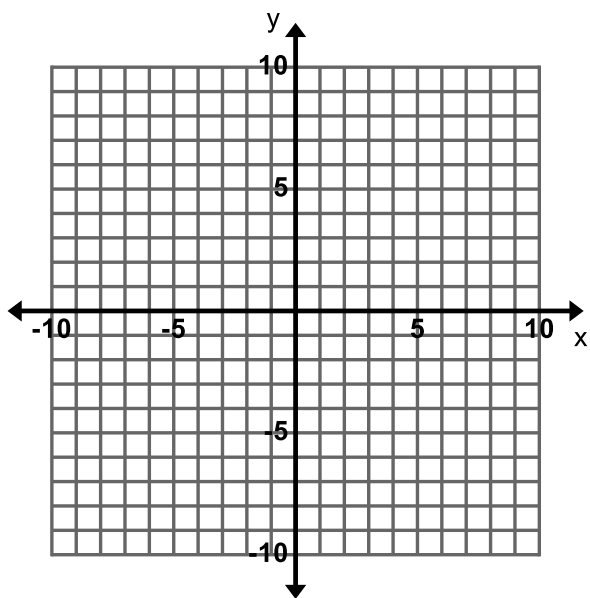


10. **Error Analysis:** Kevin was asked to graph the line $y = -\frac{1}{2}x + 1$. Kevin graphed the line below and made a common error. Describe Kevin's error and then graph the line correctly on the grid.

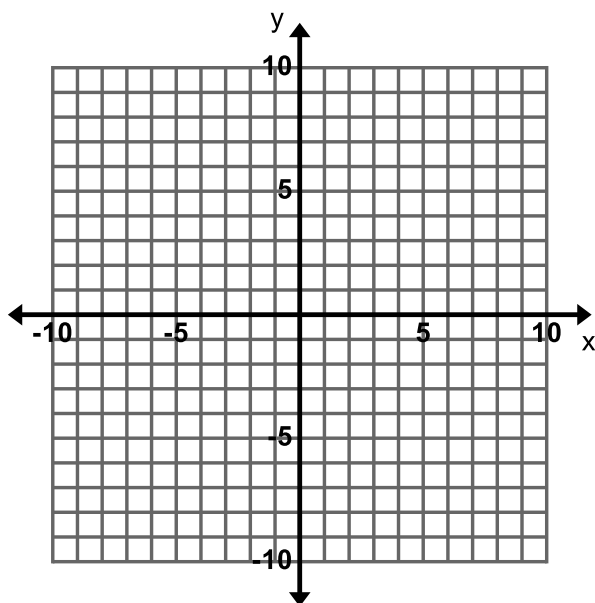


3.2b Homework: Graph from Slope-Intercept Form

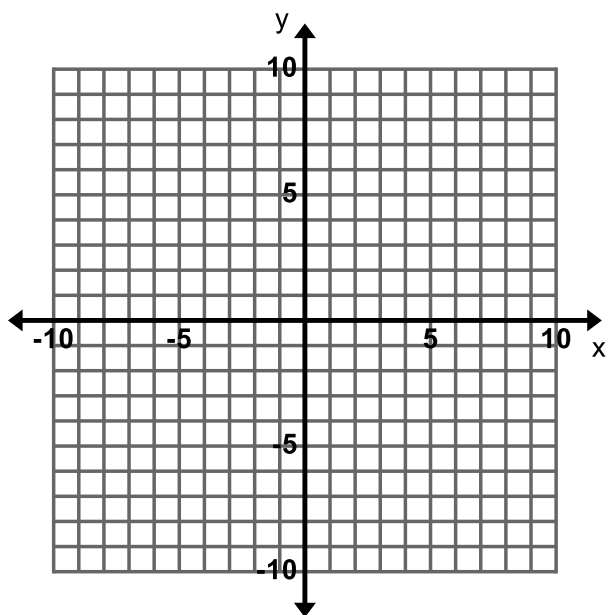
1. Graph $y = -2x + 3$



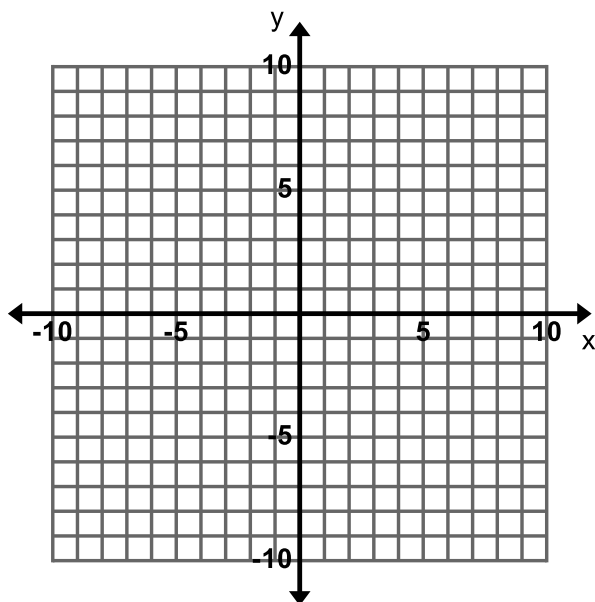
2. Graph $y = 4x - 3$



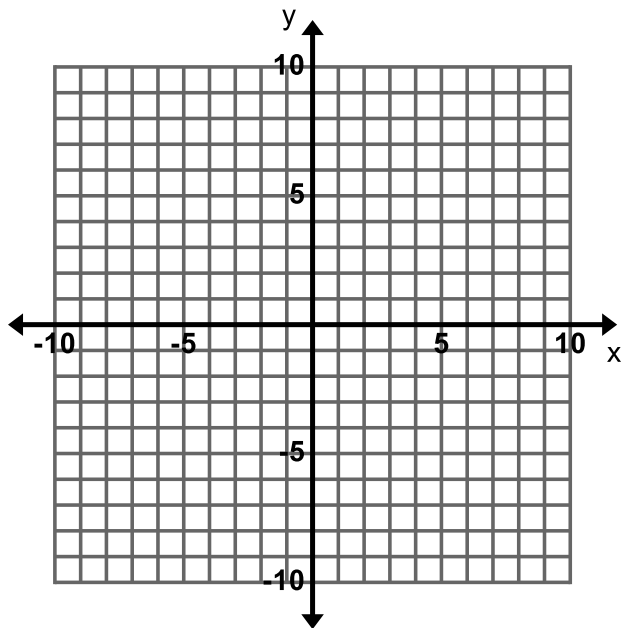
3. Graph $y = -4x$



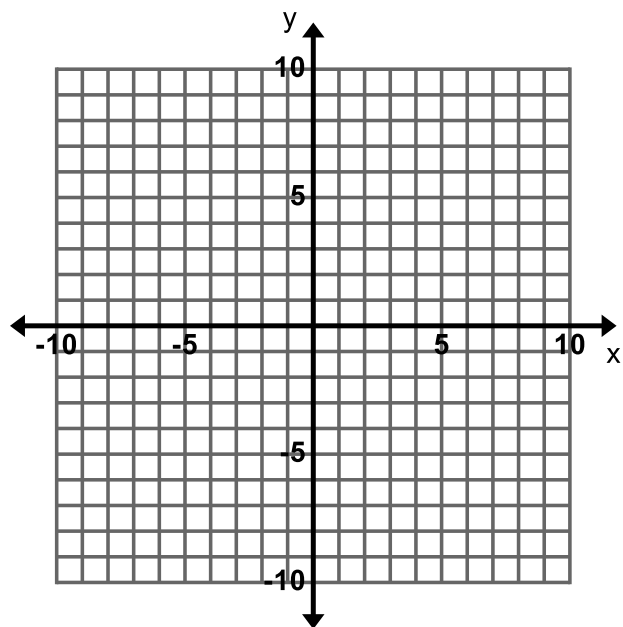
4. Graph $y = 5 + \frac{2}{3}x$



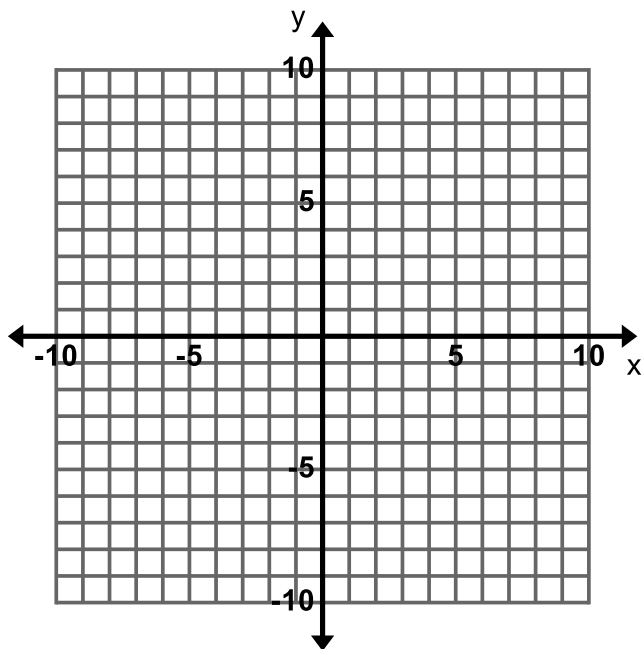
5. Graph $y = -\frac{2}{3}x - 1$



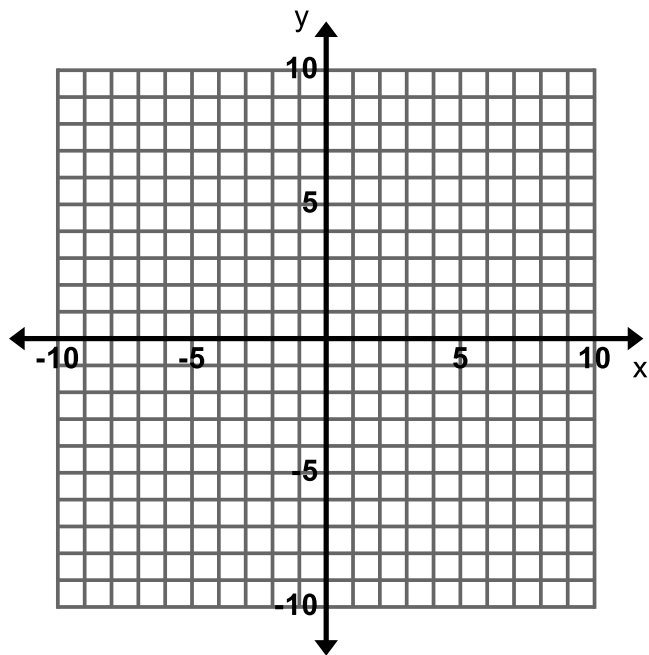
6. Graph $y - 3 = x$



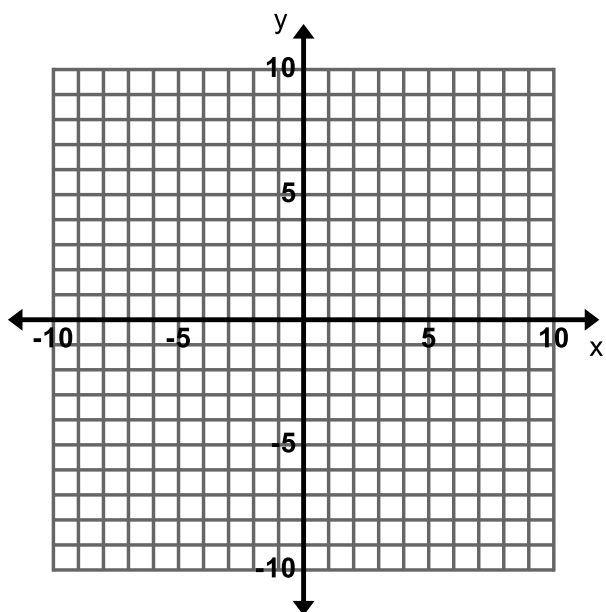
7. Graph $y = 2x - 9$



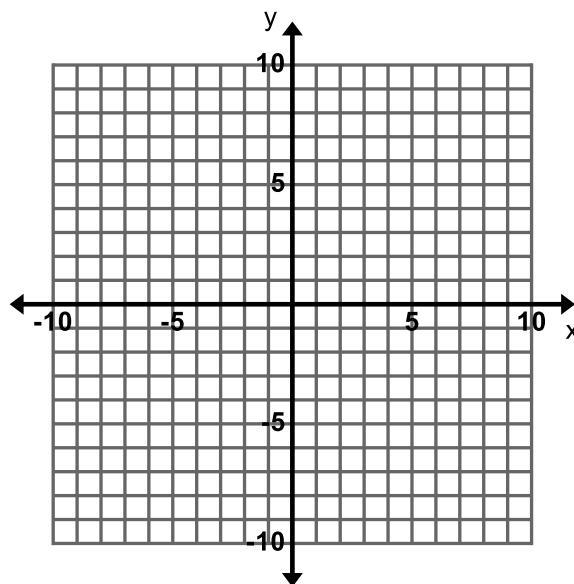
8. Graph $x + y = 9$



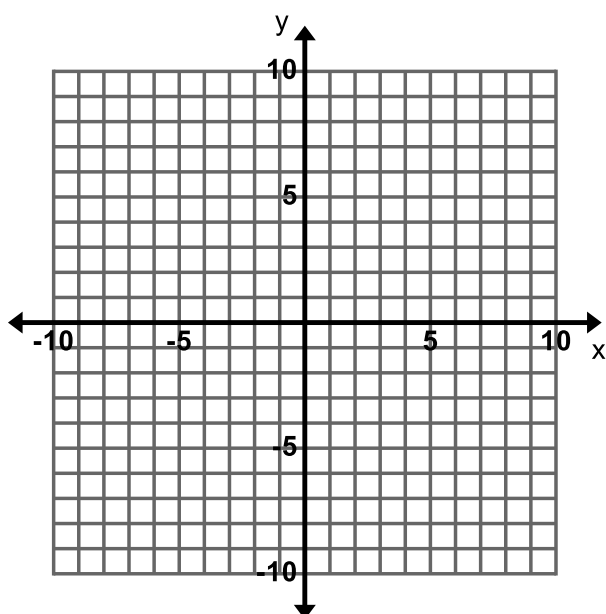
9. Graph $y = 3x - 2$



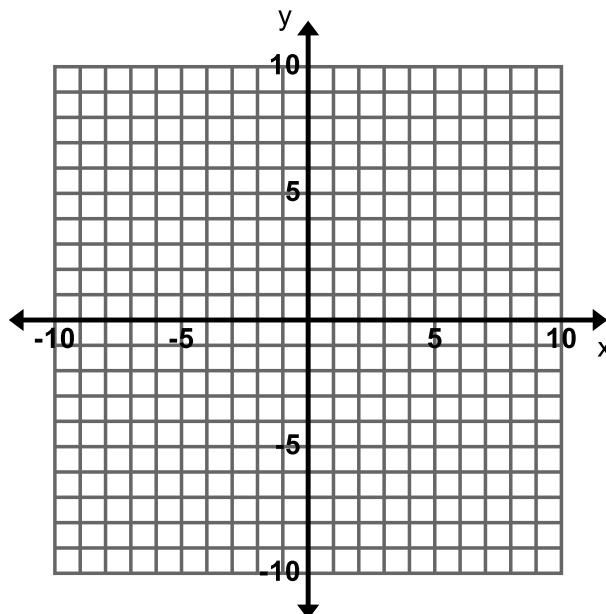
10. Graph $y = 4 - \frac{1}{3}x$



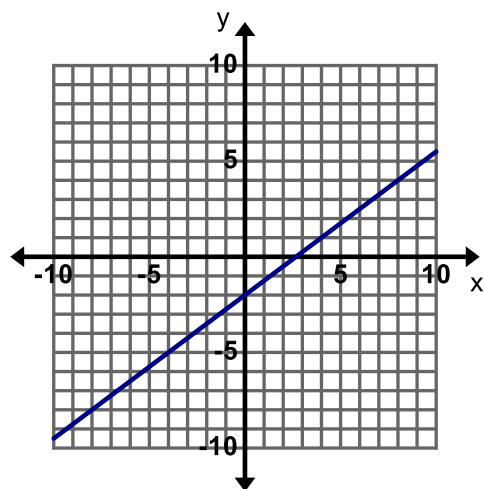
11. Graph $y = 0$



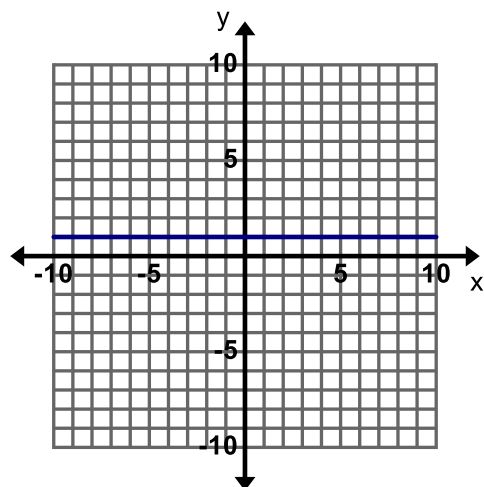
12. Graph $x = 1$



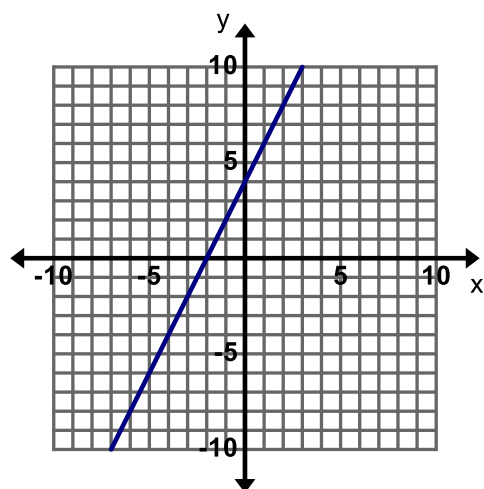
13. **Error Analysis:** Lani was asked to graph the line $y = \frac{4}{3}x - 2$. Lani graphed the line below and made a common error. Describe Lani's error and then graph the line correctly on the grid.



14. **Error Analysis:** Janeen was asked to graph the line $x = 1$. Janeen graphed the line below and made a common error. Describe Janeen's error and then graph the line correctly on the grid.

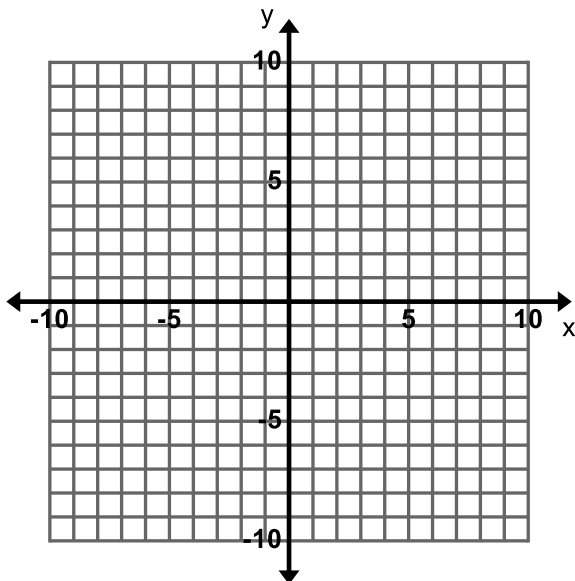


15. **Error Analysis:** Zach was asked to graph the line $2x + y = 4$. Zach graphed the line below and made a common error. Describe Zach's error and then graph the line correctly on the grid.



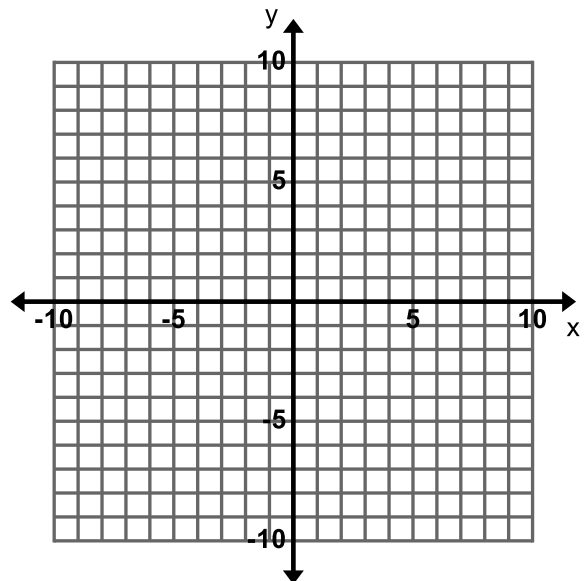
3.2c Class Activity: Graph and Write Equations for Lines Given the Slope and a Point

1. Graph the line that passes through the point $(2, 3)$ and has a slope of 1.



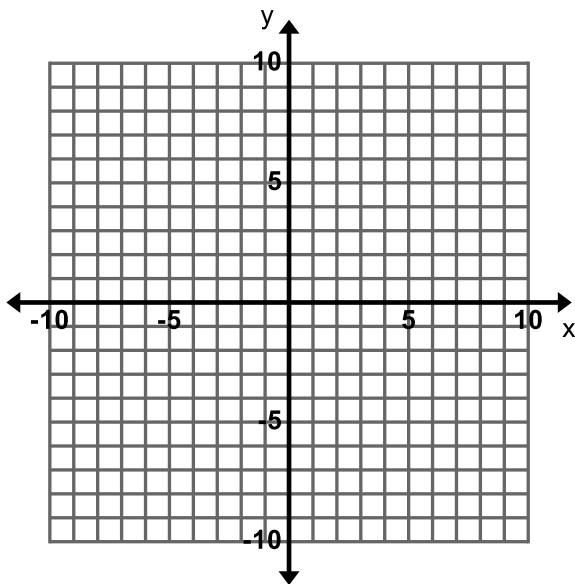
a. Write the equation of the line that you drew.

2. Graph the line that passes through the point $(-1, 5)$ and has a slope of 2.



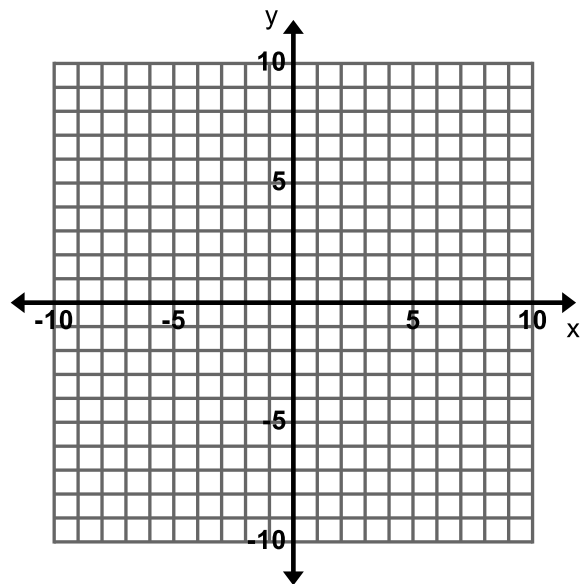
a. Write the equation of the line that you drew.

3. Graph the line that passes through the point $(4, 1)$ and has a slope of $-\frac{1}{2}$.



a. Write the equation of the line that you drew.

4. Graph the line that passes through the point $(-6, 2)$ and has a slope of $\frac{1}{3}$.



a. Write the equation of the line that you drew.

5. How did you use the graph to write the equation of the lines above?
6. Would it be practical to always graph to find the equation? Why or why not?
7. Brainstorm ideas on how you could write the equation of the line without graphing when you are given a point and the slope. Consider how you could use the equation $y = mx + b$ to find the y -intercept if you know the slope and a point on the line. Using an example from the previous page may help you work through the process.

Directions: Find the equation of the line that passes through the given point with the given slope.

8. Through $(-1, -6)$; $m = 4$

9. Through $(-3, 4)$; $m = -\frac{2}{3}$

10. Through $(4, -1)$; $m = \frac{3}{2}$

11. Through $(3, 2)$; $m = 1$

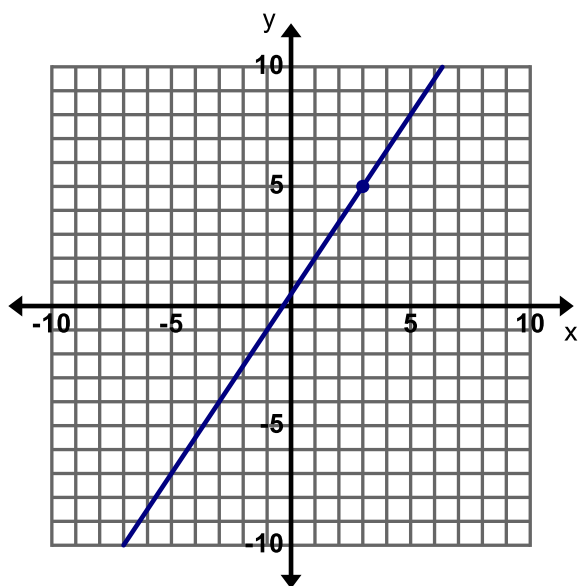
12. Through $(3, 5)$; $m = \text{undefined}$

13. Through $(3, -4)$; $m = 0$

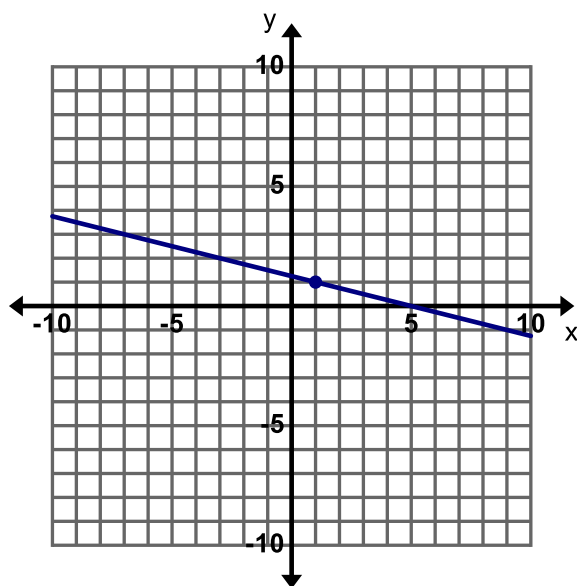
14. **Error Analysis:** Felipe was asked to write the equation of the line that has a slope of $\frac{1}{3}$ and passes through the point $(6, 4)$. Felipe made a common error and wrote the equation $y = \frac{1}{3}x + 4$. Describe Felipe's error and write the correct equation in the space below.

Directions: Write the equation of the line.

15. Equation: _____

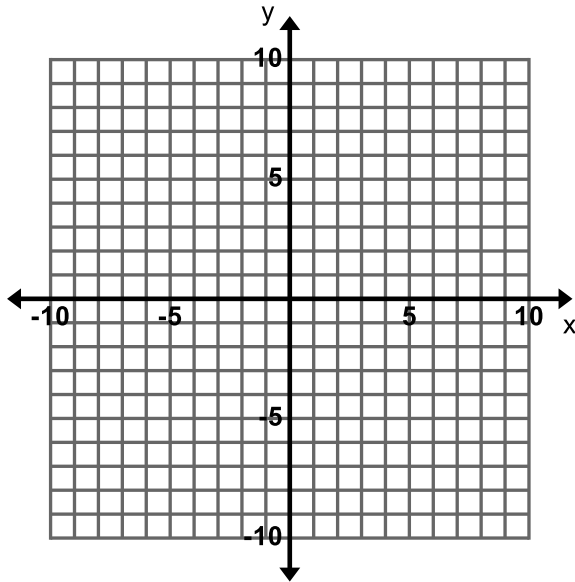


16. Equation: _____



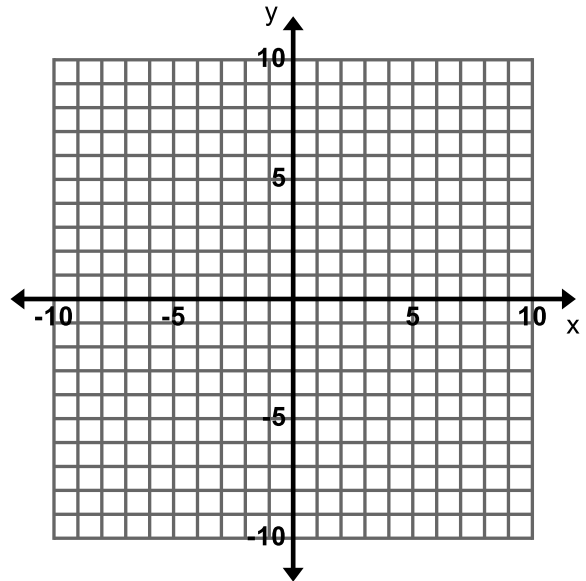
3.2c Homework: Graph and Write Equations for Lines Given the Slope and a Point

1. Graph a line that does the following:
Passes through the point (4, -3) and has a slope of -2.



Write the equation of the line that you drew.

2. Graph a line that does the following:
Passes through the point (-6, 3) and has a slope of $\frac{1}{3}$.



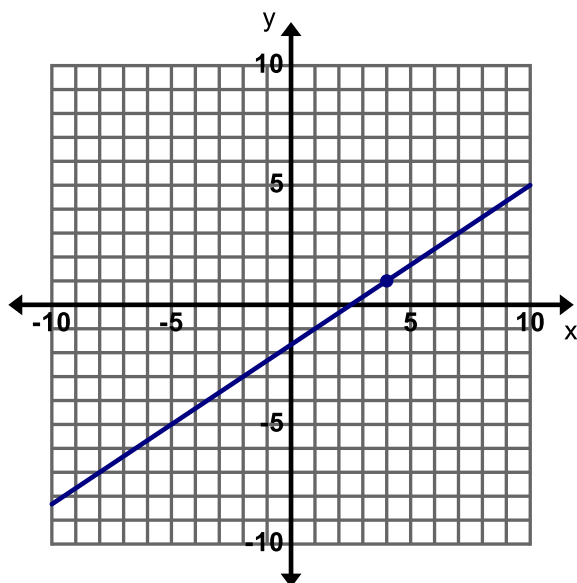
Write the equation of the line that you drew.

Directions: Write the equation for the line that has the given slope and contains the given point.

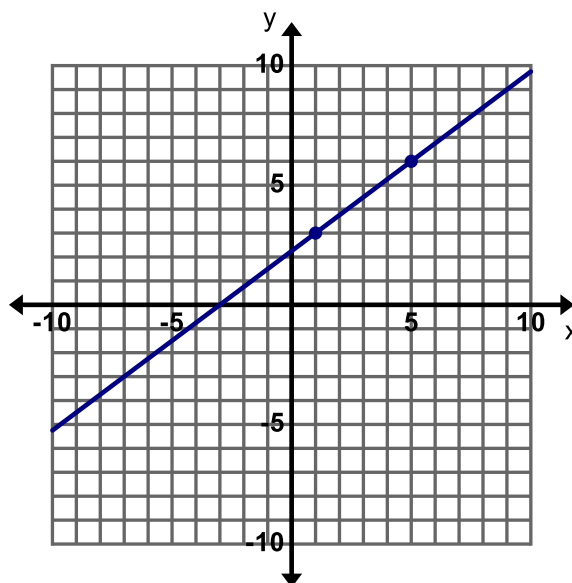
<p>3. slope = 1 passes through (3, 7)</p> <p>y =</p>	<p>4. slope = $\frac{2}{3}$ passes through (3, 4)</p> <p>y =</p>	<p>5. slope = 5 passes through (6, -10)</p> <p>y =</p>
<p>6. slope = -2 passes through (3, 1)</p> <p>y =</p>	<p>7. slope = 5 passes through (-2, 8)</p> <p>y =</p>	<p>8. slope = $\frac{1}{3}$ passes through (0, 2)</p> <p>y =</p>

Directions: Write the equation of the line.

9. Equation: _____



10. Equation: _____



11. In your own words, explain how to write the equation of a line in slope-intercept form when you are given the slope and a point.

12. Think about this...

In this lesson, you were given the slope and a point on the line and used this information to write the equation of the line in slope-intercept form. In the next lesson, you will be given 2 points and asked to write the equation in slope-intercept form. Write down your thoughts on how you might do this.

Now try it...

Write the equation of the line that passes through the points (1, 4) and (3, 10).

3.2d Classwork: Write Equations for Lines Given Two Points

1. Describe how to write the equation of a line in slope-intercept form when you are given two points on the line.

Directions: Write the equation of the line that passes through the points given.

2. $(0, 4), (-1, 3)$	3. $(-5, 9), (-2, 0)$	4. $(0, 0), (3, -6)$
$y =$	$y =$	$y =$
5. $(2, 2), (4, 3)$	6. $(1, 2), (1, -6)$	7. $(-2, 4), (0, 4)$
$y =$	$y =$	$y =$

8. Equation: _____

x	y
3	8
4	9
5	10
6	11

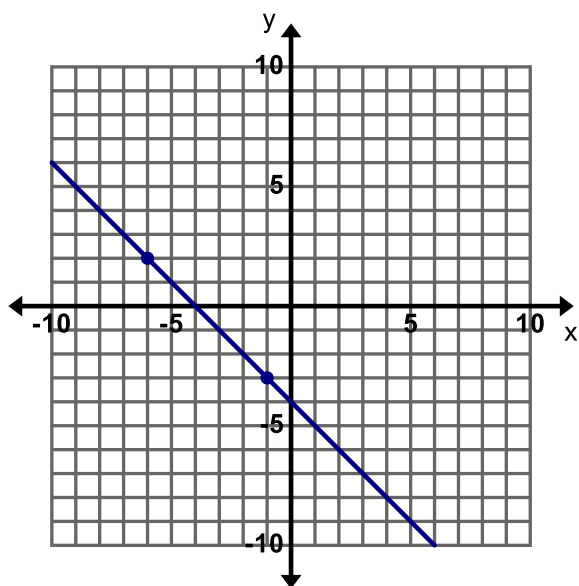
9. Equation: _____

x	y
2	3
4	6
6	9
8	12

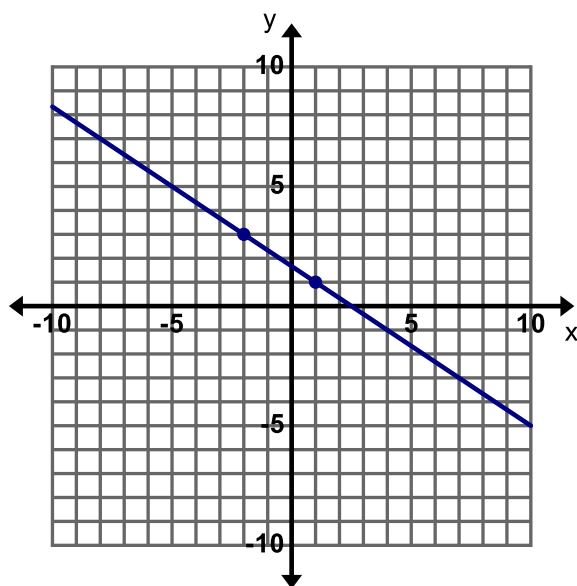
10. Equation: _____

x	y
-12	-1
-10	-1
-8	-1
-6	-1

11. Equation: _____



12. Equation: _____



3.2d Homework: Write Equations for Lines Given Two Points

Directions: Write the equation of the line that passes through the two points given.

1. (0, 2) and (-2, 0) y =	2. (5, 0) and (-10, -5) y =	3. (1, 1) and (3, 3) y =
4. (4, 2) and (0, -2) y =	5. (2, 3) and (-2, 3) y =	6. (0, -1) and (3, -2) y =

7. Equation: _____

x	y
-1	5
0	2
1	-1
2	-4

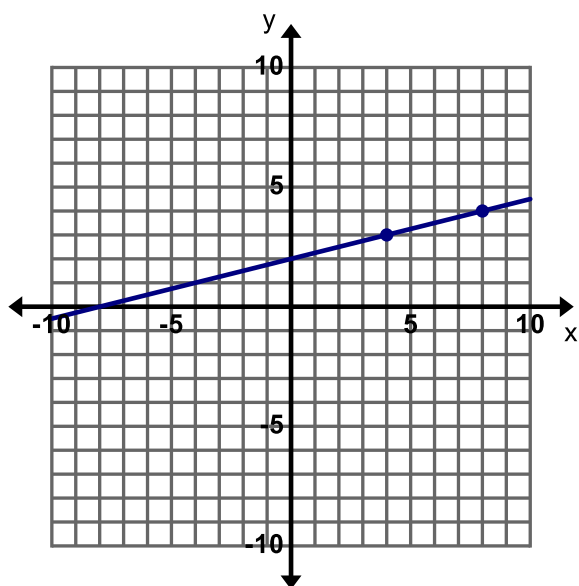
8. Equation: _____

x	y
-2	2
2	3
6	4
10	5

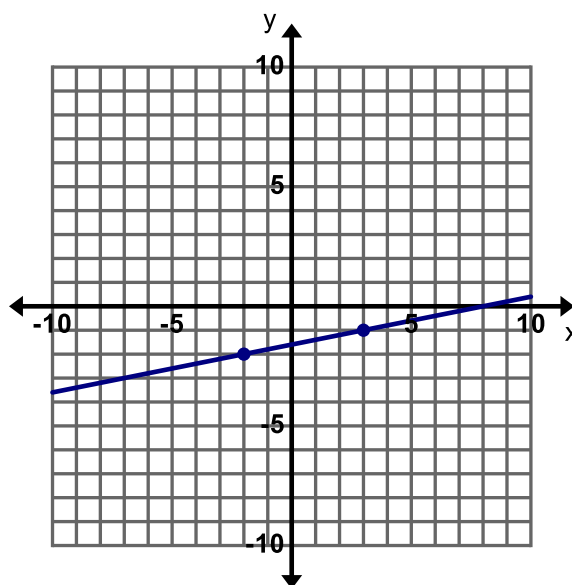
9. Equation: _____

x	y
0	-1
0	0
0	1
0	2

10. Equation: _____



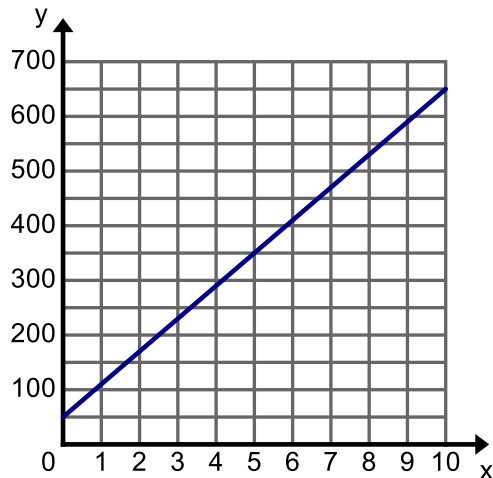
11. Equation: _____



3.2e Classwork: Write Equations to Solve Real-world Problems

Directions: Write the equation for each of the following real-world problems.

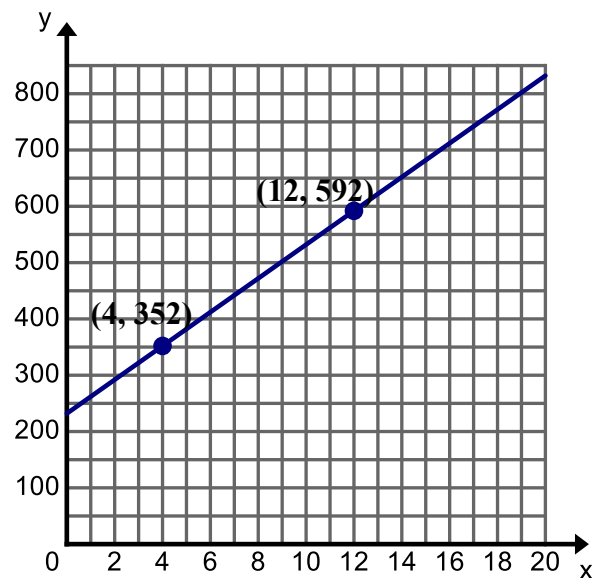
1. The graph below shows a trip taken by a car where x is time (in hours) the car has driven and y is the distance (in miles) from Salt Lake City. Label the axes of the graph.



Equation: _____

Use your graph and equation to tell the story of this trip taken by the car.

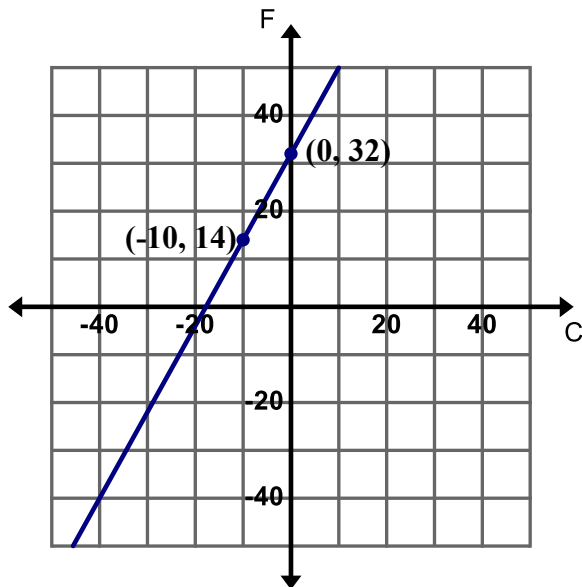
2. The graph below shows the weight of a baby elephant where x is the time (in weeks) since the elephant's birth and y is the weight (in pounds). At 4 weeks, the elephant weighed 352 lbs. and at 12 weeks, the elephant weighed 592 lbs. Label the axes of the graph.



Equation: _____

Use your graph and equation to tell the story of this elephant.

3. The graph below shows the relationship between temperature in degrees Celsius and temperature in degrees Fahrenheit.



Equation: _____

4. A handyman charges \$40 an hour plus the cost of materials. Rosanne received a bill from the handyman for \$477 for 8 hours of work.

Equation: _____

Use your equation to add more details to the story about the work the handyman did for Roseanne.

5. Peter is draining his hot tub so that he can clean it. He puts a hose in the hot tub to drain the water at a constant rate. After 5 minutes there are 430 gallons of water left in the hot tub. After 20 minutes there are 370 gallons of water left in the hot tub. Let x be time (in minutes) and y be water remaining (in gallons).

Equation: _____

Use your equation to add more details to the story of Peter draining the hot tub.

6. The table below shows the height h (in feet) of a hot air balloon t minutes after it takes off from the ground. It rises at a constant rate.

t (minutes)	h (feet)
2	300
5	750
9	1,350

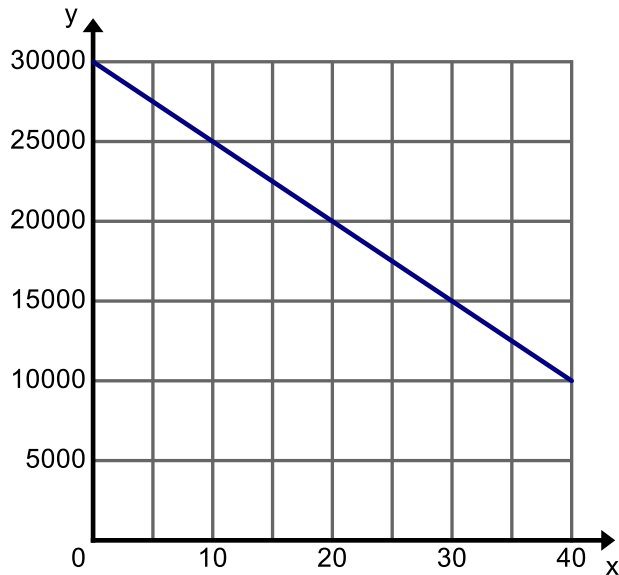
Equation: _____

Use the table and equation to tell the story of the hot air balloon.

3.2e Homework: Write Equations to Solve Real-world Problems

Directions: Write the equation for each of the following real-world problems.

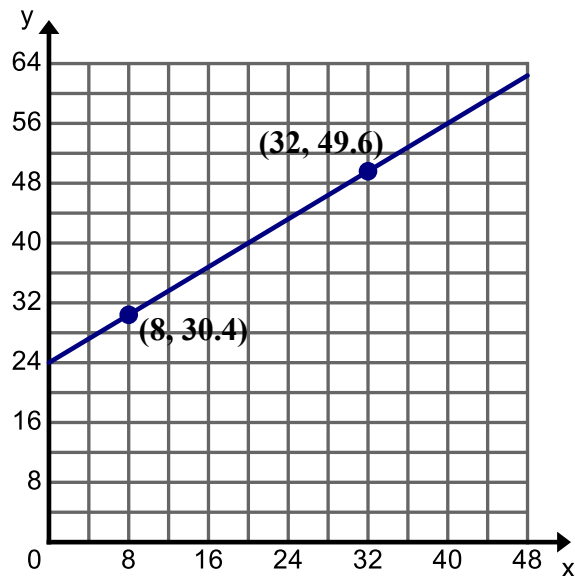
1. The graph below shows the descent of an airplane where x is time (in minutes) since the plane started its descent and y is the altitude (in feet) of the plane. Label the axes of the graph.



Equation: _____

Use the graph and equation to tell the story of this airplane.

2. The graph below shows the length of a boa constrictor where x is time (in weeks) since the boa constrictor's birth and y is length (in inches). The boa constrictor was 30.4 in. at 8 weeks and 49.6 in. at 32 weeks. Label the axes of the graph.



Equation: _____

Use the graph and equation to tell the story of this boa constrictor.

3. The table below shows the amount of money Lance has in his savings account where x is time (in months) and y is the account balance (in dollars).

x (time)	y (account balance)
0	160
3	385
6	610
9	835

Equation: _____

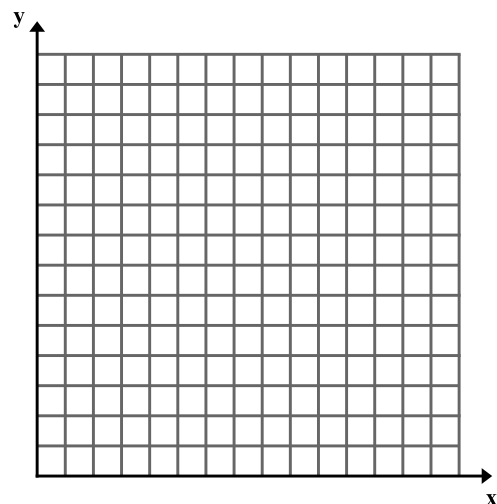
Use the table and equation to tell the story of Lance's savings.

4. The cost to rent a jet ski is \$80 per hour. The cost also includes a flat fee for a lesson on how to use the jet ski. Steve rented a jet ski for 3 hours and the total bill was \$265. Write the equation for the total cost of renting a jet ski y for x hours.

Equation: _____

Use your equation to add more details to the story about renting a jet ski.

5. The cost of a party at The Little Gym is \$250 which includes cake, pizza, and admission for up to 10 children. Create the graph and equation of this situation where x is the number of children and y is the total cost.



Equation: _____

3.2f Class Activity: Equations for Graph Shifts

1. Graph the equation $y = x + 3$ and label the line with the equation.

a. Predict how the graph of $y = x + 1$ will compare to the graph of $y = x + 3$.

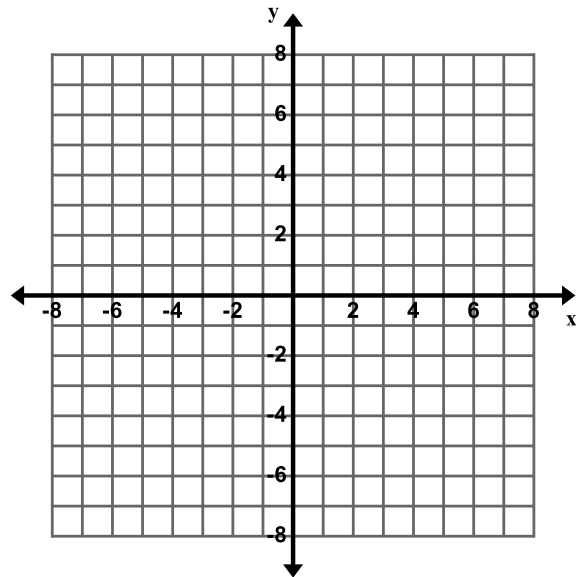
b. Predict how the graph of $y = x - 3$ will compare to the graph of $y = x + 3$.

c. Graph the following equations on the same grid and label each line with its equation.

$$y = x + 1$$

$$y = x - 3$$

d. Were your predictions correct? Why or why not?



e. What is the relationship between the lines $y = x + 3$, $y = x + 1$, and $y = x - 3$?

f. Write a different equation that would be parallel to the equations in this problem.

g. Describe the movement of a line when b is increased or decreased while m is held constant.

2. Graph the equation $y = 2x - 4$ and label the line with the equation.

a. Predict how the graph of $y = x - 4$ will compare to the graph of $y = 2x - 4$.

b. Predict how the graph of $y = \frac{1}{2}x - 4$ will compare to the graph of $y = 2x - 4$.

c. Predict how the graph of $y = -2x - 4$ will compare to the graph of $y = 2x - 4$.

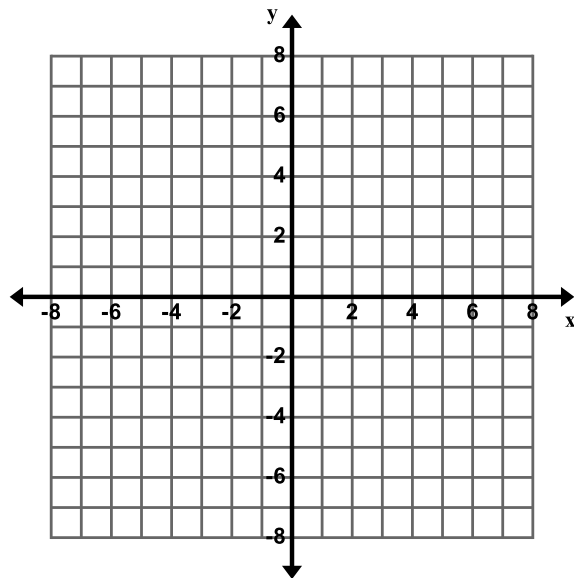
d. Graph the following equations and label each line with its equation.

$$y = x - 4$$

$$y = \frac{1}{2}x - 4$$

$$y = -2x - 4$$

e. Were your predictions correct? Why or why not?



f. Describe the movement of a line when the slope is increased or decreased while the y -intercept is held constant.

g. Describe the movement of a line when m is changed to $-m$.

h. Write the equation of a line that would be steeper than all of the equations in this problem.

3. Consider the equation $y = 2x + 4$. Write a new equation that would transform the graph of $y = 2x + 4$ in the ways described.
- I want the slope to stay the same but I want the line to be shifted up 2 units.
 - I want the y -intercept to stay the same but I want the line to be less steep.
 - I want a line that is parallel to $y = 2x + 4$ but I want the line to be translated down 7 units.
4. Describe the relationship and graph shift of the graphs of the following equations compared to the graph of the equation $y = 4x - 7$?
- $y = 2x - 7$
 - $y = 4x + 9$
 - $y = -4x - 7$
 - $y = 4x - 5$
5. Describe the relationship and graph shift of the graphs of the following equations compared to the graph of the equation $y = -\frac{1}{2}x - 3$?
- $y = -\frac{1}{2}x$
 - $y = -2x - 3$
 - $y = -\frac{1}{4}x - 3$
 - $y = \frac{1}{2}x - 3$
 - $y = -\frac{1}{2}x + 5$

6. Consider the equation $y = 3x + 2$. Complete the chart below if the equation $y = 3x + 2$ is changed in the ways described.

Change the equation $y = 3x + 2 \dots$	New Equation	Describe the Graph Shift (from the original Equation) (use the words rotation, reflection and/or translation)
Change the y -intercept to 5 while keeping the slope constant		
	$y = 3x - 3$	
Change the slope to 1 while keeping the y -intercept constant		
	$y = 4x + 2$	
		The new line is translated 2 units down from the original line $y = 3x + 2$.
Change the slope to -3 while keeping the y -intercept constant		
		The new line is a rotation of the original line $y = 3x + 2$ about the point $(0, 2)$ and the new line is steeper.

3.2f Homework: Equations for Graph Shifts

1. Consider the equation $y = x - 4$. Write a new equation that would transform the graph of $y = x - 4$ in the ways described.
 - a. I want the slope to stay the same but I want the line to be shifted up 3 units.
 - b. I want the y -intercept to stay the same but I want the line to be less steep.
 - c. I want a line that is parallel to $y = x - 4$ but I want the line to be translated down 6 units.
2. Describe the relationship and graph shift of the graphs of the following equations compared to the graph of the equation $y = -3x$?
 - a. $y = 3x$
 - b. $y = -3x - 4$
 - c. $y = -2x$
 - d. $y = -3x + 4$
3. Describe the relationship and graph shift of the graphs of the following equations compared to the graph of the equation $y = \frac{4}{3}x + 4$?
 - a. $y = \frac{4}{3}x - 1$
 - b. $y = \frac{4}{3}x$
 - c. $y = 2x + 4$
 - d. $y = -\frac{4}{3}x + 4$
 - e. $y = \frac{1}{3}x + 4$

4. Consider the equation $y = \frac{1}{2}x + 3$. Complete the chart below if the equation $y = \frac{1}{2}x + 3$ is changed in the ways described.

Change the equation $y = \frac{1}{2}x + 3 \dots$	New Equation	Describe the Graph Shift (from the original Equation) (use the words rotation, reflection and/or translation)
		The new line is translated 3 units up from the line $y = \frac{1}{2}x + 3$.
Change the slope to $-\frac{1}{2}$ while keeping the y -intercept constant		
	$y = \frac{1}{2}x - 2$	
Change the y -intercept to 0 while keeping the slope constant		
		The new line is a rotation of the equation $y = \frac{1}{2}x + 3$ about the point $(0, 3)$ and the new line is less steep.
Change the slope to 2 while keeping the y -intercept constant		
	$y = -2x - 2$	

5. Describe the transformation (graph shift) that occurs in each of the following situations. Use words like translation, reflection, and rotation.
- The slope is increased or decreased while the y -intercept is held constant
 - The y -intercept is decreased while the slope is held constant
 - The slope m is changed to $-m$
 - The y -intercept is increased while the slope is held constant

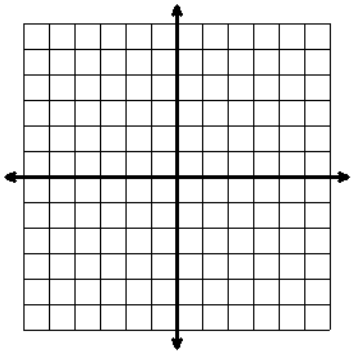
3.2g Self-Assessment: Section 3.2

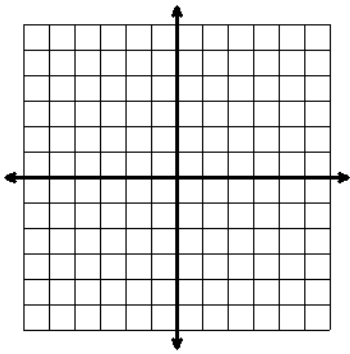
Consider the following skills/concepts. Rate your comfort level with each skill/concept by checking the box that best describes your progress in mastering each skill/concept.

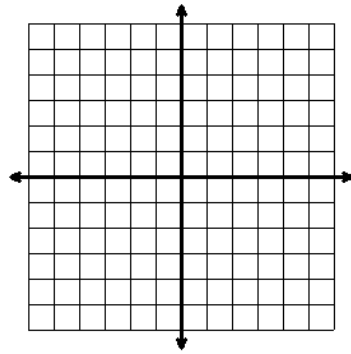
Skill/Concept	Beginning Understanding	Developing Skill and Understanding	Deep Understanding, Skill Mastery
1. Write a linear equation in the form $y = mx + b$ given any of the following: <ul style="list-style-type: none">○ slope and y-intercept○ slope and a point○ two points○ a table, graph, or context of a real world situation○ a shift in the graph of an equation (a change in the slope or y-intercept of an equation)			
2. Graph linear relationships given any of the following: <ul style="list-style-type: none">○ a table of values○ an equation○ slope and y-intercept○ slope and a point○ a shift in the graph of an equation (a change in the slope or y-intercept of an equation)			

Name: _____ Date: _____ Period: _____

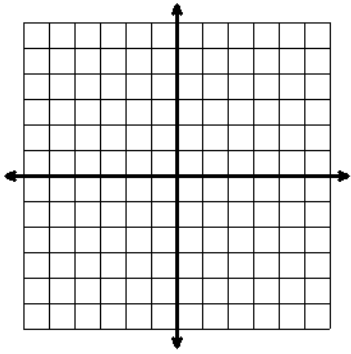
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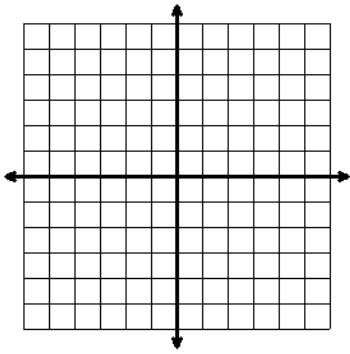


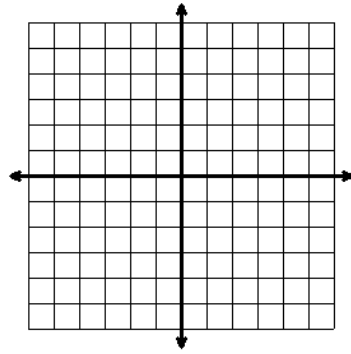




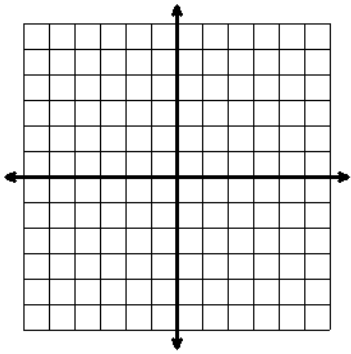
TUESDAY

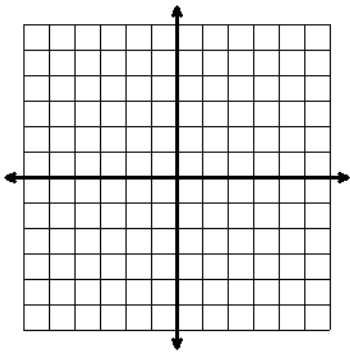


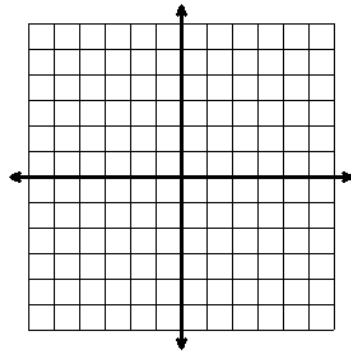




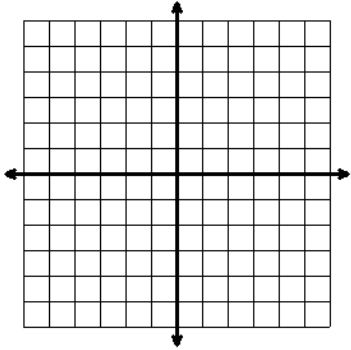
WEDNESDAY

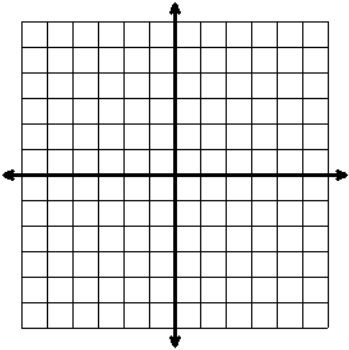


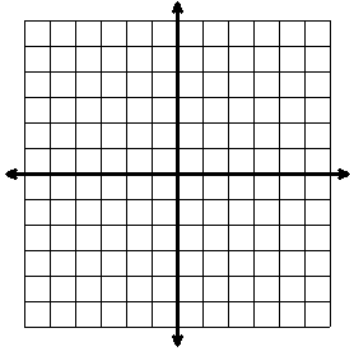




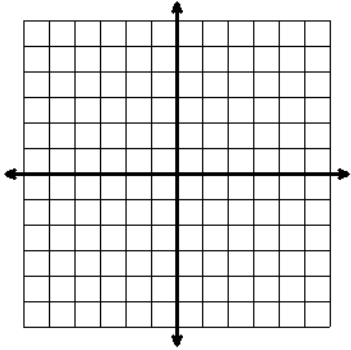
THURSDAY

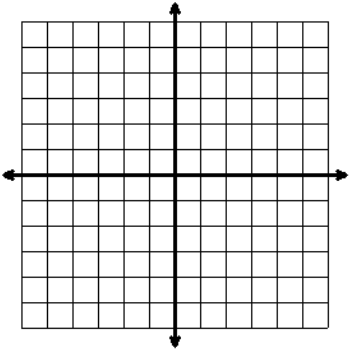


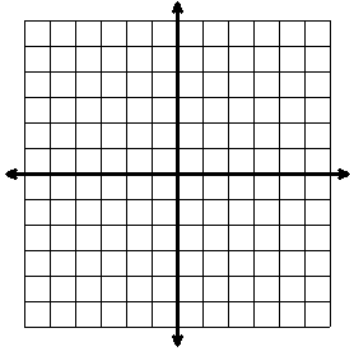




FRIDAY







Section 3.3: Relate Slopes and Write Equations for Parallel and Perpendicular Lines

Section Overview:

Students use transformations to discover how the slopes of parallel and perpendicular lines are related. Once students have an understanding of the relationship between the slopes of parallel and perpendicular lines, students write equations of lines that are parallel or perpendicular to a given line.

Concepts and Skills to Master:

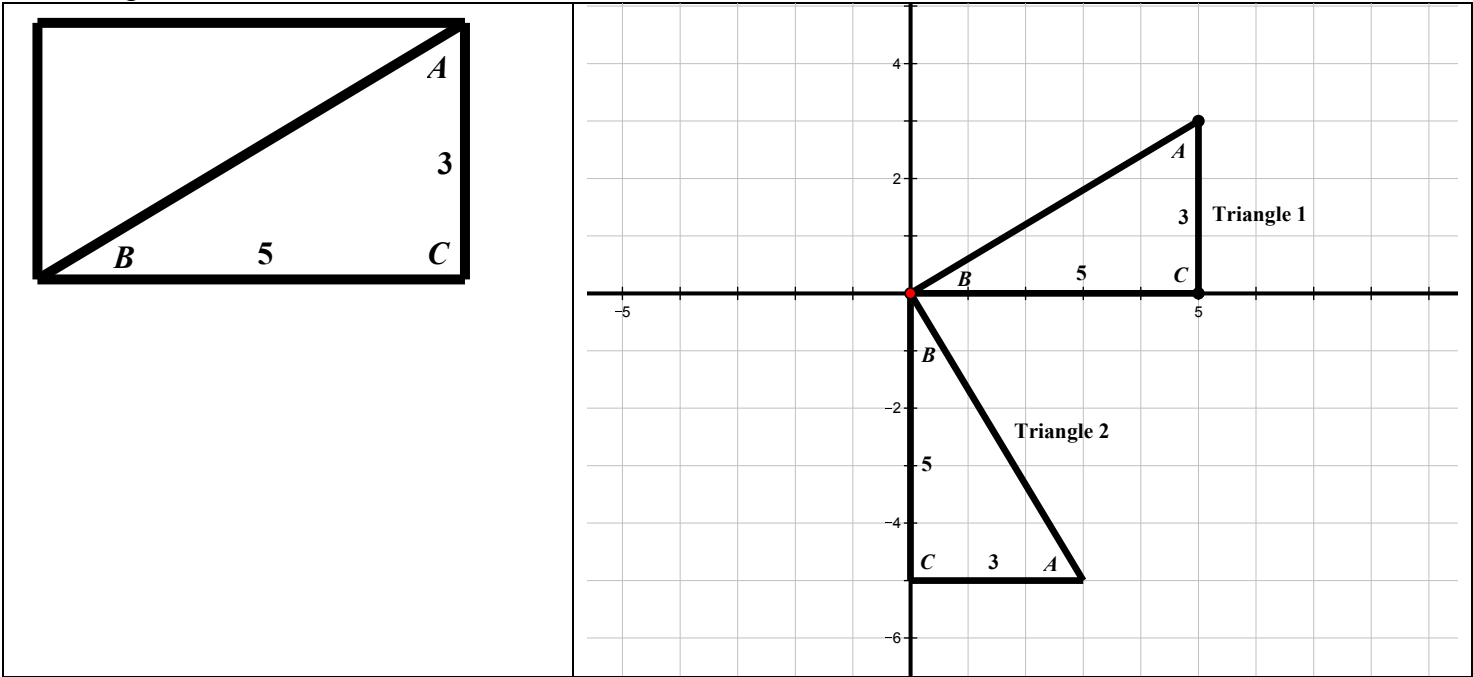
By the end of this section, students should be able to:

- Compare the slopes of parallel lines and explain the graph shift that creates parallel lines.
- Compare the slopes of perpendicular lines and explain the graph shift that creates perpendicular lines.
- Write the equation of a line parallel to a given line that passes through a given point.
- Write the equation of a line perpendicular to a given line that passes through a given point.

3.3a Class Activity: Slopes of Perpendicular Lines

Materials: Graph paper (one inch grid), 3 x 5 card, straight edge, scissors.

- On your 3 x 5 card, draw the diagonal (as shown in the 1st box below). Label as shown below. Then cut the card into two triangles.
- On your graph paper, draw the x - y axis. (as shown in the 2nd box below) Trace your triangle to create triangles 1 and 2 as shown below.



- Highlight the hypotenuse \overline{AB} of each triangle. Find the slope and equation of each hypotenuse:

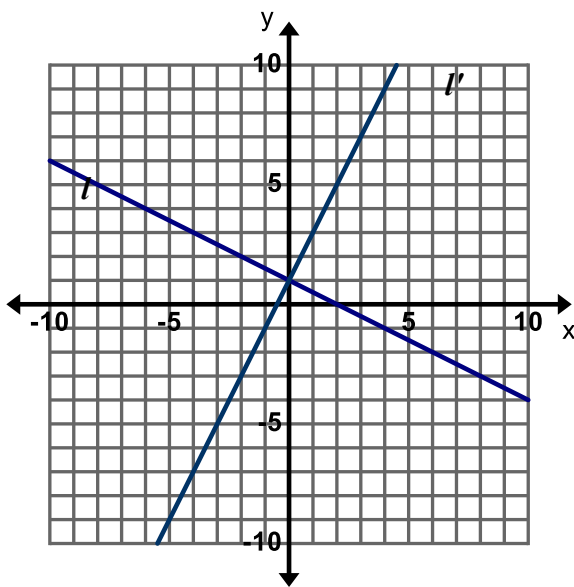
a. Triangle 1	b. Triangle 2
Hypotenuse Slope:	Hypotenuse Slope:
Equation of the Hypotenuse Line:	Equation of the Hypotenuse Line:

- Important NOTE:** For purposes of the questions below, it is given that the 3 x 5 card is a rectangle and therefore has 90 degree angles. Use the card to help view perpendicular lines or a 90 degree rotation.
- Describe the transformation(s) needed to carry Triangle 1 onto Triangle 2.
 - What is the angle formed by the two hypotenuses at their y -intercept intersection? How do you know? How can you prove the measure of that angle?
 - Consider the transformation that carries triangle 1 to triangle 2. What happens to the rise and run of the slope of the hypotenuse when you rotate the triangle 90° ? Relate this to the slopes in your equations above.

7. Is there another way you can rotate triangle 1 so that the hypotenuses of triangle 1 and triangle 2 are perpendicular? Observe what happens to the rise and run that form the slope of \overline{AB} .
8. What does this activity tell us about the slopes of perpendicular lines?

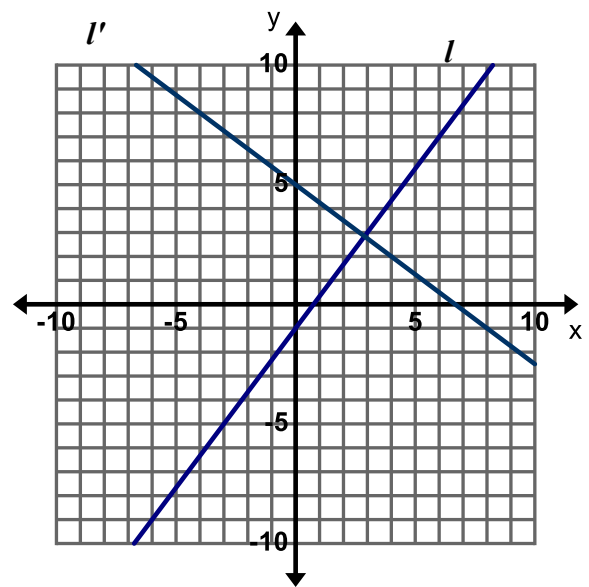
Directions: Use the pairs of lines in the graphs below to answer the questions that follow. Remember a transformation is a translation (slide), reflection (flip), or rotation (turn).

9. Pair 1



- Describe the transformation that carries line l to line l' .
- Find the slope of each of the lines.
- Describe how the lines and slopes are related.

10. Pair 2

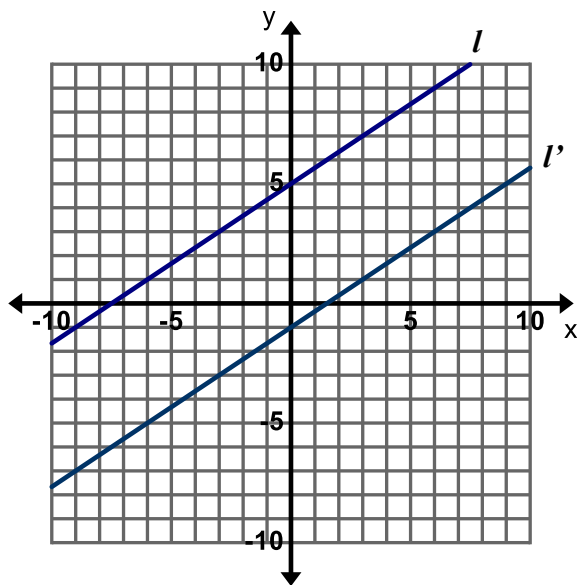


- Describe the transformation that carries line l to line l' .
- Find the slope of each of the lines.
- Describe how the lines and slopes are related.

3.3a Homework: Slopes of Parallel Lines

Directions: Use the pairs of lines in the graphs below to answer the questions that follow. Remember a transformation is a translation (slide), reflection (flip), or rotation (turn).

1. Pair 1



a. Describe the transformation that carries line l to line l' .

b. Find the slope of each line. What do you observe about the slopes?

l :

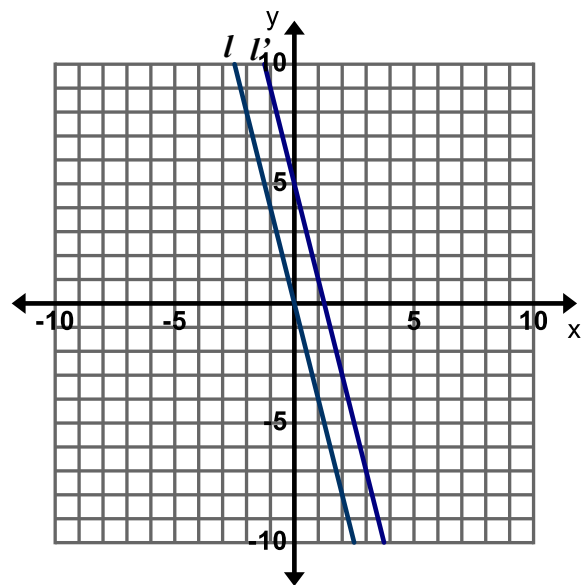
l' :

c. Write an equation for each line. How are the equations the same and how are they different?

l :

l' :

2. Pair 2



a. Describe the transformation that carries line l to line l' .

b. Find the slope of each line. What do you observe about the slopes?

l :

l' :

c. Write an equation for each line. How are the equations the same and how are they different?

l :

l' :

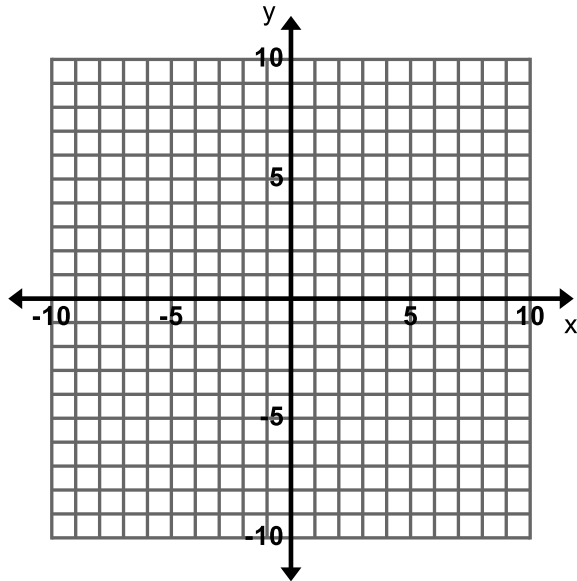
3. Given the graphs of two or more lines how can you determine if they are parallel?

3.3b Class Activity: Equations of Parallel and Perpendicular Lines

Directions: In the following problems, lines A and B are **parallel**. Graph and label both lines. Then write the equation of line B.

1. Line A: $y = 2x - 3$

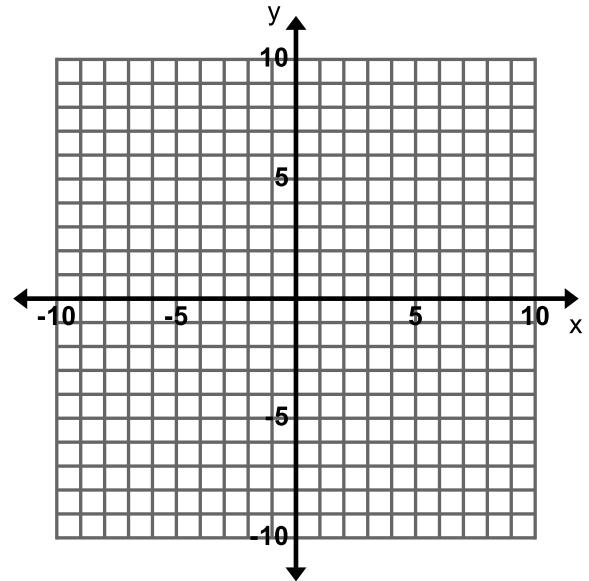
Line B: passes through (0, 4)



Equation of Line B: _____

2. Line A: $y = -4x + 1$

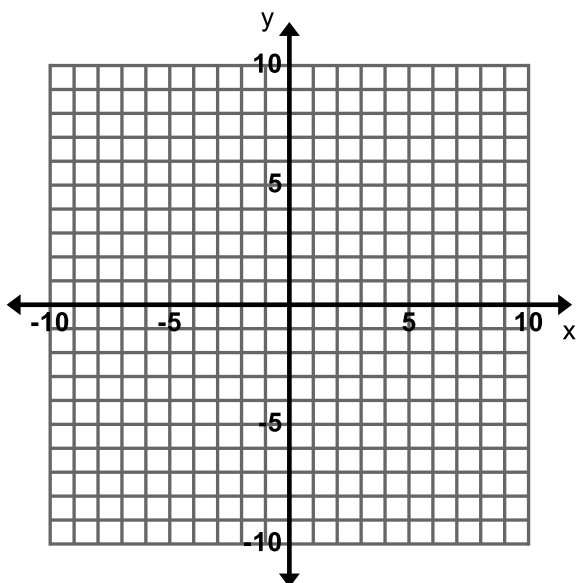
Line B: passes through (0, -5)



Equation of Line B: _____

3. Line A: $y = \frac{1}{2}x + 4$

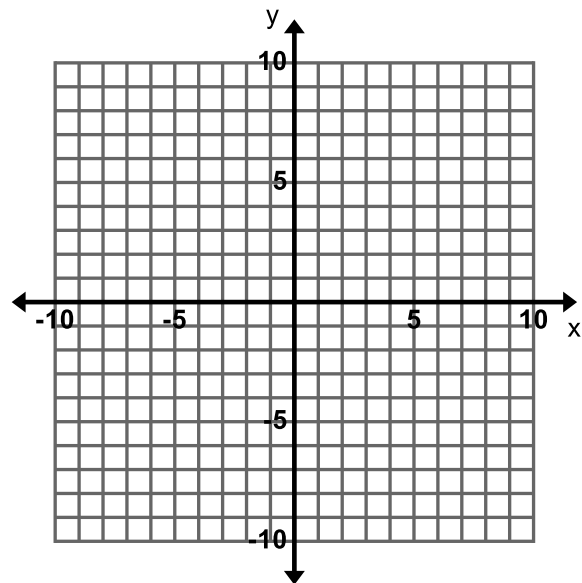
Line B: passes through (0, 7)



Equation of Line B: _____

4. Line A: $y = 4x$

Line B: passes through (3, -3)



Equation of Line B: _____

Directions: In the following problems, lines A and B are parallel. Find the equation for line B without graphing.

5. Find the equation of line B which is **parallel** to line A and passes through (2, 3).

Line A: $y = -3x + 7$

Line B: $y = \underline{\hspace{2cm}}$

6. Find the equation of line B which is **parallel** to line A and passes through (-6, 2).

Line A: $y = \frac{1}{3}x + 2$

Line B: $y = \underline{\hspace{2cm}}$

7. Given the slope of a line, how do you figure out the slope of a line **perpendicular** to it?

8. Give the slope of a line that is **perpendicular** to the following lines:

a. $y = 3x - 2$; m of perpendicular line: $\underline{\hspace{2cm}}$

b. $y = -\frac{2}{3}x$; m of perpendicular line: $\underline{\hspace{2cm}}$

c. $y = -x + 2$; m of perpendicular line: $\underline{\hspace{2cm}}$

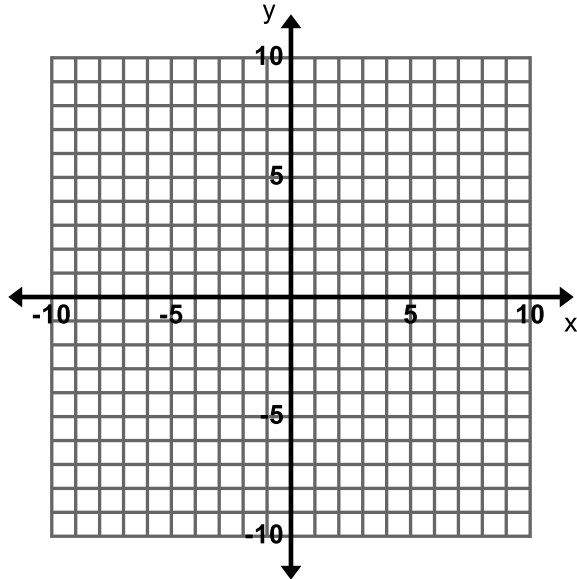
d. $y = -2x + 6$; m of perpendicular line: $\underline{\hspace{2cm}}$

Directions: In the following problems, lines A and B are **perpendicular**. Graph and label both lines. Then write the equation of line B.

9. Line A: $y = 4x + 9$

What is the slope of line B? _____

Line B: passes through (4, -7)



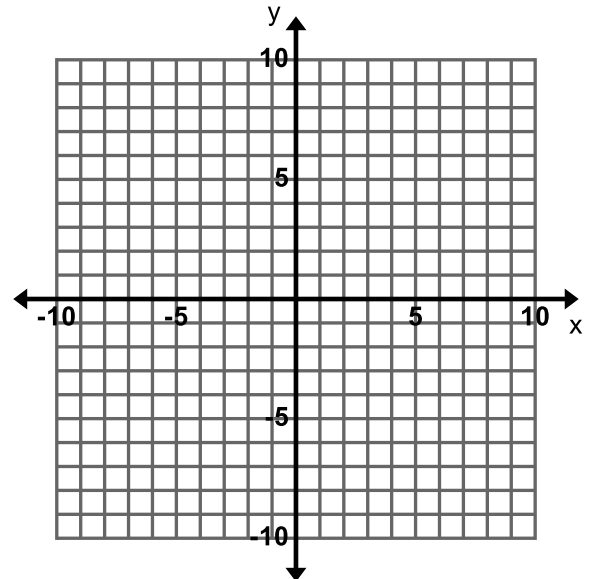
Equation of Line B: _____

10. Line A: $2y = 3x + 8$

Rewrite as $y =$ _____

What is the slope of line B? _____

Line B: passes through (3, 7)



Equation of Line B: _____

Directions: In the following problems, lines A and B are **perpendicular**. Find the equation for line B without graphing.

<p>11. Find the equation of the line B which is perpendicular to line A and passes through (3, 7).</p> <p>Line A: $y = -3x + 7$</p> <p>Line B: $y = \underline{\hspace{2cm}}$</p>	<p>12. Find the equation of Line B which is perpendicular to line A and passes through (2, 4).</p> <p>Line A: $y = -\frac{1}{2}x - 2$</p> <p>Line B: $y = \underline{\hspace{2cm}}$</p>
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Directions: Determine if the following sets of lines are parallel, perpendicular, or neither. Justify your answer.

<p>13. Line A: $y = \frac{3}{4}x + 1$</p> <p>Line B: $y = \frac{3}{4}x - 5$</p>	<p>14. Line A: $y = \frac{3}{4}x + 1$</p> <p>Line B: $y = -\frac{3}{4}x + 1$</p>
<p>15. Line A: $y = \frac{3}{4}x + 1$</p> <p>Line B: $y = \frac{4}{3}x + 1$</p>	<p>16. Line A: $y = \frac{3}{4}x + 1$</p> <p>Line B: $y = -\frac{4}{3}x + 1$</p>

17. Line A: $y = 3x + 2$ Line B: $y = -3x + 2$	18. Line A: $y = 3x + 2$ Line B: $y = 3x + 5$
19. Line A: $y = 3x + 2$ Line B: $y = -\frac{1}{3}x$	20. Line A: $y = 3x + 2$ Line B: $y = \frac{1}{3}x + 2$
21. Line A: $y = \frac{1}{2}x + 1$ Line B: $6x + 3y = 18$	22. Line A: $4x - 2y = -6$ Line B: $-6x + y = -4(x - 2)$

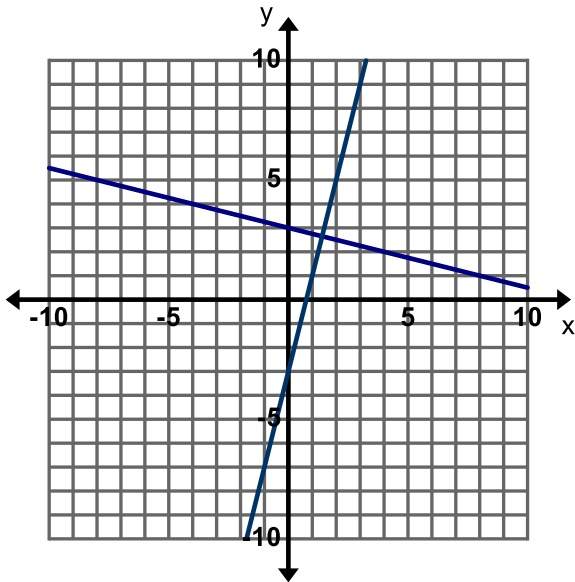
Directions: Determine whether the lines through the pairs of points are parallel, perpendicular, or neither.

23. $(-3, 1)$ and $(2, 3)$ $(-3, 5)$ and $(-1, 0)$	24. $(-3, -1)$ and $(-1, -3)$ $(-1, 2)$ and $(-4, -1)$	25. $(1, 8)$ and $(-1, 1)$ $(0, 7)$ and $(2, 4)$
26. $(2, 0)$ and $(1, 6)$ $(1, 3)$ and $(7, 4)$	27. $(-3, 0)$ and $(-2, 4)$ $(2, -1)$ and $(1, -5)$	28. $(-3, 4)$ and $(3, 7)$ $(4, 2)$ and $(-2, 6)$

3.3b Homework: Equations of Parallel and Perpendicular Lines

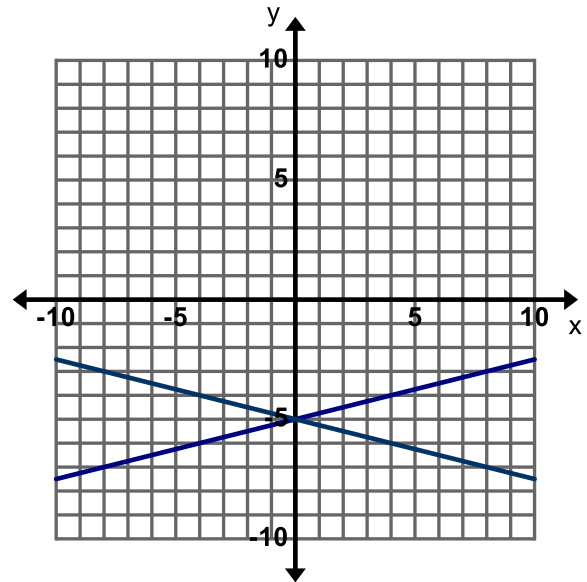
Directions: Determine if the following sets of lines in each graph are parallel or perpendicular. Justify your answer. If they are not parallel or perpendicular describe the transformation that carries one line to the other.

1. Parallel, Perpendicular, or Neither?



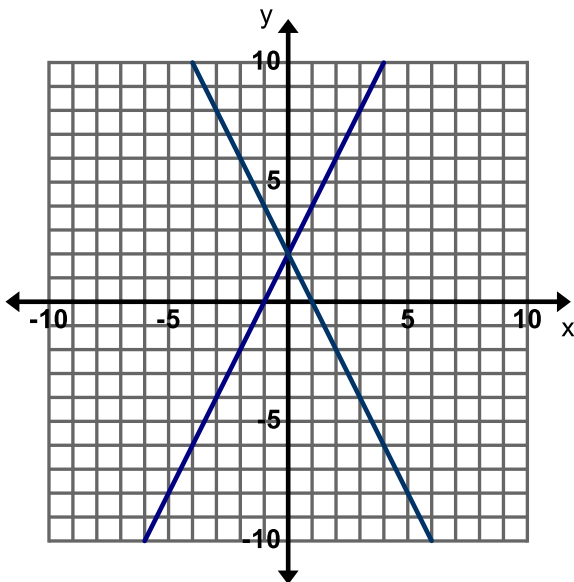
Justification:

2. Parallel, Perpendicular, or Neither?



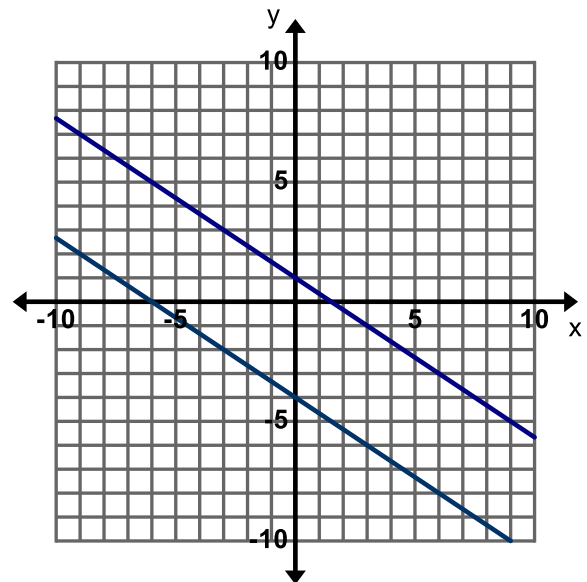
Justification:

3. Parallel, Perpendicular, or Neither?



Justification:

4. Parallel, Perpendicular, or Neither?



Justification:

Directions: Determine if the following sets of lines are parallel, perpendicular, or neither. Justify your answer.

<p>5. Line A: $y = \frac{1}{4}x - 3$</p> <p>Line B: $y = -4x + 3$</p>	<p>6. Line A: $y = \frac{1}{4}x - 3$</p> <p>Line B: $y = \frac{1}{4}x + 3$</p>
<p>7. Line A: $y = \frac{1}{4}x + 2$</p> <p>Line B: $y = -\frac{1}{4}x + 2$</p>	<p>8. Line A: $y = \frac{1}{4}x - 5$</p> <p>Line B: $y = 4x + 5$</p>
<p>9. Line A: $y = \frac{2}{3}x + 1$</p> <p>Line B: $2x - 3y = 6$</p>	<p>10. Line A: $2x - 3y = -9$</p> <p>Line B: $3x + 2y = -8$</p>

Directions: Determine whether the lines through the pairs of points are parallel, perpendicular, or neither.

<p>11. $(-2, 0)$ and $(4, 3)$ $(0, 0)$ and $(1, -2)$</p>	<p>12. $(-2, -11)$ and $(-1, -7)$ $(2, -11)$ and $(-1, 1)$</p>	<p>13. $(0, 0)$ and $(3, 4)$ $(-1, -1)$ and $(2, 3)$</p>
<p>14. $(4, 12)$ and $(2, 6)$ $(4, -12)$ and $(2, -6)$</p>	<p>15. $(-1, -5)$ and $(0, -4)$ $(-1, -3)$ and $(0, -4)$</p>	<p>16. $(-2, 9)$ and $(0, 1)$ $(3, 13)$ and $(-1, -3)$</p>

Directions: Write the equation of the line using algebra. (Do not graph the equations to write the equation.)

17. Write the equation of the line that is **perpendicular** to $y = \frac{2}{3}x - 5$ and passes through the point $(2, 5)$.
18. Write the equation of the line that is **perpendicular** to $y = -5x + 2$ and passes through the point $(10, -4)$.
19. Write the equation of the line that is **parallel** to $y = -3x + 2$ and passes through the point $(-3, -2)$.
20. Find the equation of the line that is **parallel** to $y = \frac{3}{5}x - 4$ and passes through the point $(5, 4)$.

3.3c Self-Assessment: Section 3.3

Consider the following skills/concepts. Rate your comfort level with each skill/concept by checking the box that best describes your progress in mastering each skill/concept.

Skill/Concept	Beginning Understanding	Developing Skill and Understanding	Deep Understanding, Skill Mastery
1. Compare the slopes of parallel lines and explain the graph shift that creates parallel lines.			
2. Compare the slopes of perpendicular lines and explain the graph shift that creates perpendicular lines.			
3. Write the equation of a line parallel to a given line that passes through a given point.			
4. Write the equation of a line perpendicular to a given line that passes through a given point.			