Lesson 9
Slope and Linear Functions

Outline

Part A
Slope and Graphed Scenarios

- Calculating Slope
- Rate of Change
- Describing and Sketching Graphs

Part B
Point-Slope Form and Slope-Intercept Form

- Point-Slope Form
- Point-Slope Form from Context
- Slope-Intercept Form
- Slope-Intercept Form from a Graph

Targeted Review

Vocabulary

- slope formula
- point-slope form
- slope-intercept form

Check out **More to Explore** in the Digital Pack to see if there are additional activities for this part of the lesson.

Warm Up

Your student should spend no more than 5 minutes on the Warm Up. This should be a quick review to activate prior knowledge.

1) This is a review of finding slope from the previous lesson. If needed, sketch a line on the coordinate plane and have your student find the slope. Then they can generalize about slope from there.

2) If your student is unsure how to answer this, have them attempt to graph the given points by hand. This should make them see that they are extremely far apart.

9A EXPLORE

Part A: Slope and Graphed Scenarios

Objectives

In this part of the lesson, you will learn about slope and graphed scenarios.

By the end of this lesson you will be able to do the following:

- Use the slope formula, $m = \frac{\Delta y}{\Delta x}$, to calculate the slope of a line when given two points on the line.
- Describe a graph as a scenario using mathematical vocabulary and sketch a graph from a written scenario.

Why?

One of the most important things you will do in Algebra 1 is learn to use the slope formula. Linear equations that you will encounter throughout algebra are dependent on a solid understanding of slope.

Warm Up

1) How do you determine slope from a graph?

Sample:
Pick two points on the graph and count up and over to find the rise over run.

2) Why should you *not* use a graph to determine the slope of the line for the points $(-100, 234)$ and $(53, 3{,}412)$.

Sample:
The points are very far apart, and it would be difficult to count the rise and run without making a mistake.

Calculating Slope

- The slope of a line is **the same** between any two points on the line.
- Finding the slope between any two points provides the slope for the **entire line**.
- If the ordered pairs are provided in a table, you can find the slope by finding the **change in values**.
- Remember that the slope is the **change in y** over the **change in x** (rise over run).
- Organizing points in a **table** is one way to help ensure that the order of the coordinates is correct.

EXPLORE 9A

Example 1

Find the slope from the given table.

x	y
-2	-3
4	5

$+6$ $+8$ $m=\frac{\Delta y}{\Delta x}=\frac{8}{6}=\frac{4}{3}$

- The slope formula is the **most efficient** way to find the slope when given **two points**.
- Write the formula for slope:

  $m=\frac{\Delta y}{\Delta x}=\frac{y_2-y_1}{x_2-x_1}$
- The symbol Δ is the capital Greek letter delta and means "**the change in**."
- The subscripts represent different points: point one is (x_1, y_1) and point two is (x_2, y_2).
- It is important that the coordinates of each point align **vertically** in the slope formula.

Example 2

Find the slope of the line that includes the points (−2, −3) and (4, 5). Label the provided information. (x_1, y_1) (x_2, y_2)

$m=\frac{\Delta y}{\Delta x}=\frac{y_2-y_1}{x_2-x_1}=\frac{5-(-3)}{4-(-2)}=\frac{5+3}{4+2}=\frac{8}{6}=\frac{4}{3}$

- When using the slope formula, it is important to remember that the formula **subtracts** the values from one another.
- If negative numbers are substituted into the formula, you may be able to **add** the values depending on which point is labeled (x_1, y_1) or (x_2, y_2). This is because subtracting a **negative number** is the same as adding its **positive** value.
- To use the slope formula to find a missing coordinate, you find the **cross-product** once the known values are substituted into the slope formula.

Example 1

Making a table is an optional way to organize the ordered pairs. It is only necessary if your student cannot find the slope using the slope formula.

Example 2

Finding the cross-product was covered in Lesson 5.

Checkpoint

To continue past this checkpoint, students should confidently and correctly answer this problem.

Have your student write the points vertically to help organize the information. The x-values will be on the left and belong in the denominator. The y-values will be on the right and will be placed in the numerator. The ordered pairs should align vertically.

Example 3

Find the value of r.

$m = -\frac{6}{5}$, $(-6, 8)$ and $(4, r)$

Plan Label the given points.
Substitute all known values into the slope formula.

Implement

Point 1 $(-6, 8)$ $\quad \frac{m}{1} = \frac{y_2 - y_1}{x_2 - x_1}$

Point 2 $(4, r)$ $\quad \frac{-6}{5} = \frac{r - 8}{4 - (-6)}$

$\frac{-6}{5} = \frac{(r-8)}{10}$

$(-6)(10) = 5(r - 8)$

$-60 = 5r - 40$

$-20 = 5r$

$r = -4$

Checkpoint

Find the slope of the line passing through $(-6, 13)$ and $(3, 7)$. Show your work.

$m = \frac{13 - 7}{-6 - 3} = \frac{6}{-9} = -\frac{2}{3}$

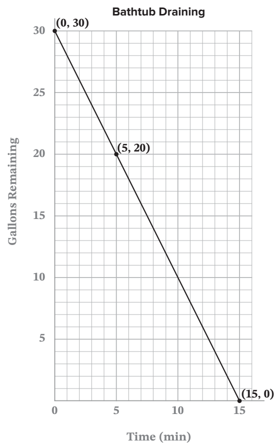
Rate of Change

- When a problem asks for the rate of change, it is usually referring to the slope.
- Using these strategies can be helpful when solving rate of change problems:
  - defining variables as an ordered pair in words
  - labeling the numbers
- When asked to find slope, the answer should be a numerical value written as a simplified ratio.
- When asked to find the rate of change, the answer should include the value of the slope with labels related to the problem.
- The context will relate to the independent (x) and dependent (y) variables.
- rate of change $= \frac{\Delta \text{ dependent}}{\Delta \text{ independent}} = \frac{\Delta y}{\Delta x}$

EXPLORE 9A

Example 4

Plan Write an ordered pair in words.
Find the rate of change.
Answer in a sentence.



Implement

The ordered pair in words:

(minutes, gallons remaining)
x y

(0, 30)

(15, 0)
You can use the ordered pair in words to help make sense of the numbers.

- (0, 30) At **0** minutes, there are **30** gallons of water in the bathtub.
- (15, 0) At 15 **minutes**, there are 0 **gallons** of water in the bathtub.

Rate of Change: $m = \frac{30-0}{0-15} = \frac{30}{-15} = -\frac{2}{1} = -2$

Explain **The bathtub is losing 2 gallons per minute.**

Checkpoint

Define the variables as an ordered pair in words. Find the rate of change using the slope formula. Show your work.

Ethan drove 165 miles in 3 hours. Then it took him 2 hours to drive 110 miles. How fast is Ethan driving in miles per hour?

(hours, miles)
(3, 165)
(2, 110)
$m = \frac{165-110}{3-2} = \frac{55}{1}$
Ethan is driving 55 miles PER hour or 55 miles for every 1 hour.

Describing and Sketching Graphs

- Even on a non-linear graph, there can be parts of the graph that are **linear**.

Checkpoint

To continue past this checkpoint, students should confidently and correctly answer this problem.

Make sure that your student defines the variables in words. This makes writing the ordered pairs in the correct order more evident because they can write the number under the corresponding word.

Q: What is the independent variable?

A: *time/hours*

9A EXPLORE

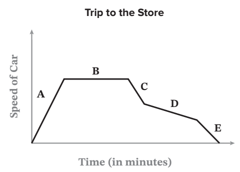
- Whether a graph is linear or nonlinear, each section of the graph can be described using words like these:
  - **increasing**
  - **decreasing**
  - **stays the same (constant)**

Example 5

Describe each part of the graph.

The variables can be defined as

(minutes, speed of the car)



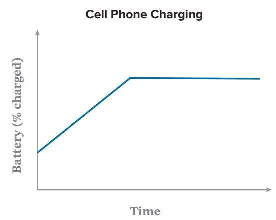
A	The speed of the car is **increasing** at a **positive** rate.
B	The car reaches the speed limit and drives at a **constant speed** for a few minutes.
C	**The car decreases speed quickly.**
D	**The car continues to decrease in speed but not as much as in Part C.**
E	**The speed of the car decreases, and the car stops.**

Example 6

Sketch a graph for the given scenario.

- You need to charge your cell phone.
- The battery is at 10% power when you start.
- You leave it plugged in overnight.
- The phone will charge at a constant rate until fully charged.

The variables are defined as **(time, battery level)**



When the graph is sketched, it should show what is happening in the given description.

Explain
The graph shows the battery starting slightly above the origin and increasing in percent charged until the phone is fully charged but still plugged in.

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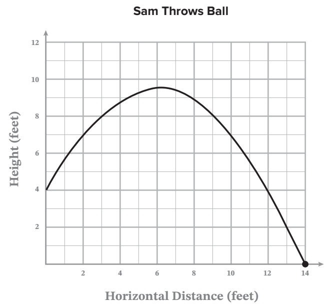
EXPLORE 9A

Example 7

Describe the graph.

Define the variables as an ordered pair: **(distance in feet, height in feet)**



Why did the ball start 4 feet above the ground $(0, 4)$?

Sam was holding the ball in his hand, **4 feet** above the ground.

Why does the graph stop at $(14, 0)$?

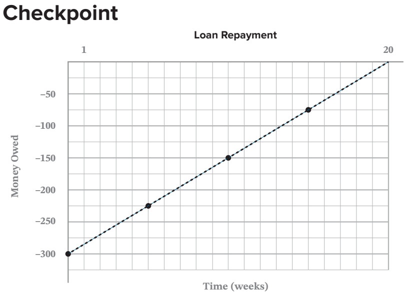
The ball hit the ground 14 feet from where Sam was standing.

Explain

Sam was holding the ball **4 feet above** the ground and threw it into the air.

The ball reached a **maximum height** of about **10 feet** and landed on the ground **14 feet away from Sam**.

☑ Checkpoint



Joe borrowed $300 from his brother. They set up a weekly payment schedule. Joe's brother plotted the points on the graph to show the money still owed. Joe added the dashed line to determine if he could find a pattern.

A) **Determine if the graphed scenario is linear or nonlinear.**

B) **Define the variables as an ordered pair.**

C) **Explain the meaning of the intercept(s).**

D) **If linear, determine the rate of change.**

A) **Linear**

B) **(time in weeks, money owed)**

C) **$(0, -300)$ At week 0, Joe borrowed $300.**

$(20, 0)$ At week 20, Joe owed $0. Joe paid off the loan.

D) **Joe repaid the loan at a rate of $15 per week.**

☑ Checkpoint

To continue past this checkpoint, students should confidently and correctly answer this problem.

Q: To incorporate personal finance, you may ask your student this question: Why would Joe's brother graph this as a positive slope?

A: *Because it shows that each week Joe is closer to being debt-free.*

The answer can be determined from the graph by finding the rise over run or using the slope formula.

Practice 1

Worked solutions for these problems are located in the Digital Pack.

1) $m = \frac{y_2 - y_1}{x_2 - x_1}$

The variable m is the slope.

The variables (x_1, y_1) are the coordinates of one point on the line.

The variables (x_2, y_2) are the coordinates of another point on the line.

Your student can look up this formula in their notes or on the formula sheet.

6–7)

Be sure to have your student set up and substitute all values into the slope formula before finding r. This should be a combination of using the slope formula and finding the cross-product, not a guess and check.

8) The rate of change is $35 per month. This means that each month (independent variable), Josie pays $35 (dependent variable).

(month, payment)

In Algebra 1, when a fee is added, this nearly always indicates the y-intercept.

Q: What word can help identify the slope, or rate of change, in a word problem?

A: *Per*

9) The tree will grow 5 feet every two years, or 2.5 feet per year.

Some of the numbers in the problem are spelled out. Be sure that your student looks for all information that they need to answer the question.

Q: What are the ages of the tree?

A: *Three years old and five years old*

10) A) linear

B) (month, cost)

C) The cell phone was purchased for about $80 because (0, 80) represents 0 months with an $80 cost. The total cost of the phone increased every month the bill was due.

D) The bill (or rate of change) was about $50 a month.

When the graph is linear, have your student plot two points to find the slope from the graph.

11) A) nonlinear

B) (years, percent depreciation)

C) The car starts at 100% of its value. Each year the car loses about 15% of its value. Around year 20, the car is worth almost 0% of what it was purchased for.

Your student could also say "Decreases by some percent a year," since they will not have experience estimating the decrease in percent at this time.

D) not possible

Practice 1

Complete the problems on a separate sheet of paper.

1) Write the slope formula, then explain what each variable stands for.

Use the slope formula to determine the slope of the line.

2) (8, 4) and (−8, −4) $m = \frac{1}{2}$

3) (4, −1) and (−7, 3) $m = -\frac{4}{11}$

4) (−12, 14) and (−10, 12) $m = -1$

5) (−15, 75) and (−10, 50) $m = -5$

Using the slope formula, find the missing value, r.

6) $m = \frac{4}{7}$, (−5, 2), (9, r) $r = 10$

7) $m = \frac{5}{2}$, (3, 1), (r, 6) $r = 5$

8) Josie's cell phone bill is $35 per month. Name the rate of change. Explain what it means in context and define your variables.

9) A three-year-old maple tree was 7 feet tall. When the tree was five years old, it had reached a height of 12 feet. How fast does the tree grow each year, assuming it grows at a constant rate?

Given the graph, describe the function by completing all of the following:

A) Determine if the situation is linear or nonlinear.

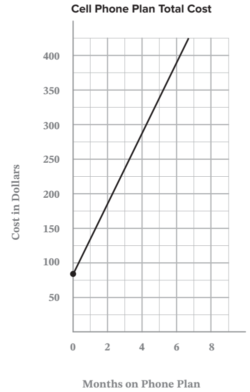
B) Define your variables.

C) Explain the intercepts when possible.

D) Explain the slope and rate of change when possible.

Answers may be estimates.

10)



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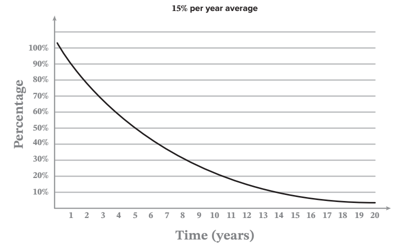

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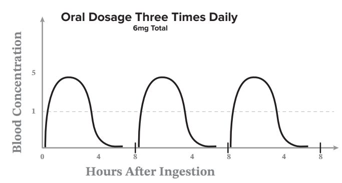


12) A) nonlinear

B) (hours, blood concentration)

C) A person took 3 doses of medicine in one day. Each dose lasted 8 hours until no medicine was in the blood (when the graph touched the x-axis).

D) not possible

PRACTICE 1 9A

Sketch a graph to provide a visual representation of the given scenario. Remember to label each axis, include a title, and label any points you think are important.

13) Sergio was standing at the edge of a cliff overlooking the ocean. He tossed a stone into the air and watched it fall into the water.

Use the ordered pair (time, height above water) to sketch your graph.

14) Jude was mowing lawns for \$20 per hour, and he had already saved \$150.

Use the ordered pair (hours, money) to help sketch your graph.

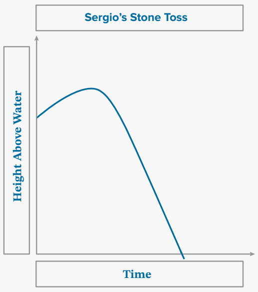
15) Malik started his run from the door of his house. He ran 1.5 miles away from his house and then turned around and ran back. Malik ran at a steady pace for his entire run, which took 30 minutes.

Use the ordered pair (minutes, miles from house) to help sketch your graph.

13–15)

The sketched graphs are samples of what your student could draw. Your student may have a slightly different sketch but should justify their sketch and have correct labels.

13)



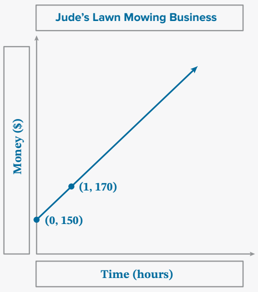
Q: Is this graph linear or nonlinear?

A: *nonlinear*

Q: Where does the graph represent the stone under the water?

A: *Below the x-axis.*

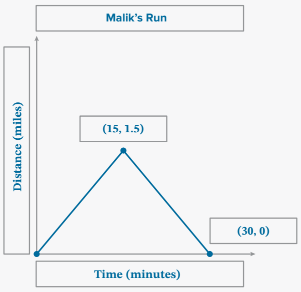
14)



Q: Could this graph continue forever? Explain.

A: *No, because he will eventually run out of lawns to mow, and there will be periods of time where he must wait for the grass to grow back.*

15)



Q: Why is it important that you know the distance is how far Malik ran from his house?

A: *Because you have to show that he eventually runs back to his house on the graph.*

Mastery Check

Show What You Know

A) Q: What is the ordered pair in words for this graph?

A: *(minutes, miles) or (time, distance)*

B) Have your student write the rate of change in a sentence. This helps make sense of the numbers. If they mix up x and y in the slope formula, Rory will run 8 miles in 1 minute!

C) The slope from 24 to 30 minutes is 0. This means that x is increasing while y does not change.

D) Q: What is the slope from 30 to 60 minutes?

A: $\frac{2}{30} = \frac{1}{15}$

Q: Why should you include this in the description of the graph?

A: *Because it gives more detail as to what is happening.*

Say What You Know

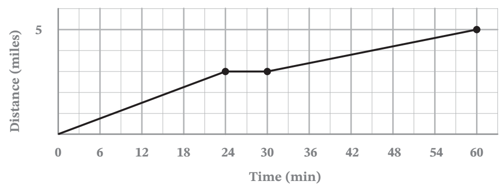
Your student should be able to restate the objectives of the lesson in their own words. If your student is unable to restate the lesson objectives, have them go back and reread the objectives and then explain them.

- Use the slope formula, $m = \frac{\Delta y}{\Delta x}$, to calculate the slope of a line when given two points on the line.
- Describe a graph as a scenario using mathematical vocabulary and sketch a graph from a written scenario.

Mastery Check

Show What You Know

Rory was training for a 5-mile run. She did not run at the same pace the entire time and wanted to know what her rate was for different distances and time intervals.



A) Explain the meaning of the ordered pairs (0, 0) and (60, 5).

(minutes, miles)
The ordered pair (0, 0) means at 0 minutes, 0 miles have been run. The ordered pair (60, 5) means after 60 minutes, Rory ran 5 miles.

Use the slope formula to help determine the rate of change from the graph.

B) What was Rory's pace for the first 24 minutes of the run?

(0, 0) and (24, 3)

$$m = \frac{3-0}{(24-0)} = \frac{3}{24} = \frac{1}{8}$$

Rory ran 1 mile every 8 minutes.

C) When did Rory take a rest during the run? How long was the break? Use the slope formula to support your answer.

Sample:
Rory took a break from minute 24 to minute 30. The break was 6 minutes long.

You can see this on the graph when the time continues to increase but the distance does not change. If you calculate the slope using the points (24, 3) and (30, 3), the slope is zero:

$$m = \frac{(3-3)}{(30-24)} = \frac{0}{6} = 0$$

This means that Rory ran 0 miles in 6 minutes (she took a break).

D) Write a scenario that describes the graph.

Sample:
Rory runs 1 mile every 8 minutes from the time she starts running until minute 24. Then she takes a 6-minute break. From minute 30 to minute 60, Rory runs 2 more miles (or has a pace of 1 mile every 15 minutes). After 60 minutes, Rory is finished running because the distance does not change.

Say What You Know

In your own words, talk about what you have learned using the objectives for this part of the lesson and your work on this page.

PRACTICE 2 9A

Practice 2

Complete the problems on a separate sheet of paper.

Find the slope using the slope formula.

1) $(2, 0)$ and $(5, -1)$ $m = -\frac{1}{3}$ **2)** $(-4, 1)$ and $(-3, 5)$ $m = 4$ **3)** $h(x)$: $(-2, -3)$ and $(-1, -2)$ $m = 1$

Using the slope formula, find the missing value, *r*.

4) $m = -\frac{2}{3}, (-7, 2), (r, -4)$ $r = 2$ **5)** $m = 8, (3, 2), (0, r)$ $r = -22$

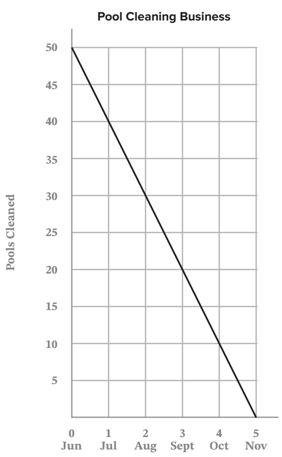
6) Suzy and Florence went to Milky Way Farm for milk sold by the ounce. Suzy's milk weighed 6 ounces and cost \$2.88. Florence spent \$6.72 for 14 ounces of milk. What is the cost per ounce of milk? Use the slope formula to solve. $m = 0.48$ **The cost per ounce is \$0.48 (or 1 ounce is \$0.48).**

7) Micah was running a marathon and wanted to find his average pace during the race. At the five-mile mark, Micah had been running for 55 minutes. After 220 minutes, he had run 20 miles. How many minutes does it take Micah to run one mile? Use the slope formula.

Given the graph, describe the function by completing all of the following:

A) Determine if the situation is linear or nonlinear.
B) Define your variables.
C) Explain the intercepts when possible.
D) Explain the slope and rate of change when possible.

8)



9)

Practice 2

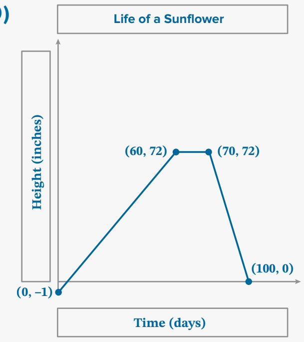
Worked solutions for these problems are located in the Digital Pack.

7) $m = \frac{1}{11}$
Micah ran 1 mile every 11 minutes.

8) A) linear
B) (month, pools cleaned)
C) The pool business started with 50 pools to clean in June. Their business steadily decreased until there were 0 pools to clean in November.
D) The rate of change is 10 fewer pools per month.

9) A) nonlinear
B) (year, stock price)
C) The price of the tech company's stock before 1985 was nearly zero. The price of the tech company's stock was below \$25 until about 2007. From 2007 on, the stock mostly increased year after year. The graph shows the price of the tech company's stock was about \$160 in 2017.
D) not linear

10)



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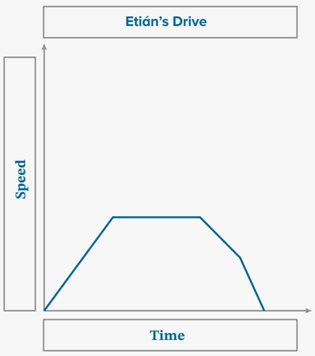

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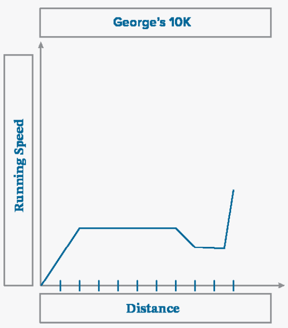


If needed, have your student go back to the Mastery Check and reapply what they have learned to say and show what they know.

Sketch a graph to provide a visual representation of the given scenario. Remember to label each axis, include a title, and label any points you think are important.

10) A sunflower was planted 1 inch below the ground and grew steadily to a maximum of 72 inches after 60 days. It stood tall for 10 days and then slowly drooped for 30 days until it fell to the ground.

Use the ordered pair (days, height) to sketch the graph.

11) Etián started driving to the grocery store. He increased the speed of his car as he entered the highway. He drove at a constant speed until he exited the highway and had to slow down. He slowed down even more to enter the parking lot and park his car.

Use the ordered pair (time, speed) to sketch a graph.

12) Georges was running a 10 kilometer race. He steadily increased his running speed for the first 2 kilometers until he found a constant pace for the next 5 kilometers. He started getting tired and slowed down for 1 kilometer and ran at about half speed for another 1.5 kilometers. For the last half a kilometer, he sprinted to the finish line.

Use the ordered pair (running speed, distance ran) to sketch a graph.

13) Explain how creating a sketch of a scenario can help you make sense of a problem.

Creating a sketch helps you understand what a scenario looks like. When the sketch is labeled, it also helps make the independent and dependent variables clearer and shows how they relate to one another.

EXPLORE 9B

Part B: Point-Slope Form and Slope-Intercept Form

Objectives

In this part of the lesson, you will learn about point-slope form and slope-intercept form.

By the end of this lesson, you will be able to do the following:

- Write linear equations in point-slope form from a given graph or a point and the slope.
- Write linear equations in slope-intercept form from a graph or given the slope and the y-intercept.
- Graph equations on the coordinate plane in point-slope or slope-intercept form.

Why?

Being able to write linear equations in more than one form and represent them as an equation or graph is an integral part of Algebra 1. These skills will help you solve problems involving linear equations when given a variety of information about the line.

Warm Up

Substitute the values into the given equations: $A = 3$, $B = -\frac{3}{4}$, $C = \frac{1}{2}$

1) $Ax + By = C$

$3x - \frac{3}{4}y = \frac{1}{2}$

2) $y = A(x - B) + C$

$y = 3\left(x + \frac{3}{4}\right) + \frac{1}{2}$

Point-Slope Form

- Point-slope form is a way to write a **linear equation** when provided the slope and the coordinates of any point on the line.
- Point-slope form is written as $y - y_1 = m(x - x_1)$, where
  - (x_1, y_1) is a **point on the line**
  - m is the **slope** of the line, and
  - **x and y** represent the independent and dependent variables.

Check out **More to Explore** in the Digital Pack to see if there are additional activities for this part of the lesson.

Warm Up

Your student should spend no more than 5 minutes on the Warm Up. This should be a quick review to activate prior knowledge.

2) Your student is only substituting values and simplifying signs. The remainder of this lesson will focus on finding the slope of a line and a point and writing the equation of the line in various forms.

Example 1

Given the slope of line d is $-\frac{1}{3}$ and the point $(6, 2)$ is on line d, find the point-slope form of the equation for line d.

Plan Identify m and (x_1, y_1)
Substitute what is known into the slope formula.
Write in point-slope form.

$m = -\frac{1}{3}$ (x_1, y_1) $(6, 2)$

Implement	Explain
$\frac{-1}{3} = \frac{y_2 - 2}{x_2 - 6}$	Substitute values into the slope formula.
$-1(x_2 - 6) = 3(y_2 - 2)$	Find the cross product.
$-\frac{1}{3}(x_2 - 6) = y_2 - 2$	Multiplication Property of Equality
$-\frac{1}{3}(x - 6) = y - 2$	The remaining x and y represent any ordered pair that satisfies the equation of the line
$y - 2 = -\frac{1}{3}(x - 6)$	Point-slope form specifically has the y-values on the left side of the equation. The final solution must be in this form.

Example 2

Write the equation of a line in point-slope form when the slope is 2 and the line includes the point $(3, -4)$.

Implement	Explain
$y - y_1 = m(x - x_1)$	
$y - (-4) = 2 (x - 2)$	Substitute values into the point-slope formula
$y + 4 = 2(x - 3)$	Simplify.

Example 3

Write the equation for the line that passes through the points $(-3, 2)$ and $(1, -6)$ in point-slope form.

Plan Find the slope using the slope formula.
Write the equation in point-slope form for the point $(-3, 2)$.
Write the equation in point-slope form for the point $(1, -6)$.

Implement

$m = \frac{2 - (-6)}{-3 - 1} = \frac{8}{-4} = -2$

Point-slope form using the point $(-3, 2)$ is $y - 2 = -2(x + 3)$

Point-slope form using the point $(1, -6)$ is $y + 6 = -2(x - 1)$

Both equations represent the same linear equation but show different points on that same line.

EXPLORE 9B

Checkpoint

Write an equation in point-slope form where the slope is −3 and the line passes through the point $(-6, 7)$.

$y - 7 = -3(x + 6)$

Point-Slope Form from Context

- Point-slope form can be determined from a given context when the **rate of change** (the slope) and a **specific instance** (point) is known.

Example 4

Write the equation in point-slope form for the scenario below.

Nathaniel had a cart where he sold flavored ice. He started his day off with some money in his cash box from the previous day's sales. He then earned $3 per cup of flavored ice that he sold. After selling 12 cups of flavored ice, Nathaniel had $76.

Plan (Independent variable, dependent variable)
Use the context to define the slope and a point on the line.
Use them to write the equation in point-slope form.

Implement

Any point on the line: **(cups sold, money earned)**

The rate of change is $3 per cup: $m = 3$

At one *specific* instance, Nathaniel sold 12 cups and had $76: $(12, 76)$

In point-slope form, the equation is $y - 76 = 3(x - 12)$

Checkpoint

The average cost for gas in 2019 was $2.47 per gallon. It cost $29.64 to fill a car with 12 gallons of gas.

Define your variables as an ordered pair. Write an equation in point-slope form.

(gallons of gas, cost)

$(12, 29.64)$, $m = 2.47$

$y - 29.64 = 2.47(x - 12)$

Checkpoint

To continue past this checkpoint, students should confidently and correctly answer this problem.

Your student needs to simplify their signs. Anytime "−(−value)" is written, it should be replaced with "+ value."

Make sure that your student has the x and y-coordinate in the correct location. Some will switch this because of the order of coordinates in ordered pairs: (x, y).

Checkpoint

To continue past this checkpoint, students should confidently and correctly answer this problem.

Checkpoint

To continue past this checkpoint, students should confidently and correctly answer this problem.

Q: What would be the direction of the line if this were graphed?

A: *positive*

Q: What does the ordered pair (9, 6,125) represent?

A: *After 9 months, $6,125 was spent on owning and maintaining the car.*

Slope-Intercept Form

- Slope-intercept form is written as $y = mx + b$.
- Slope-intercept form can be used to identify the rate of change (or slope) and the **starting point** (y-intercept) of the function.
- In slope-intercept form, y is written in terms of x which means y is **isolated** on one side of the equation.
- Given the **slope** and **y-intercept**, you should be able to write the equation in slope-intercept form.

Example 5

Use the context to write the problem in slope-intercept form.

Liz hired a plumber to fix her washing machine. The plumber charged $50 per hour plus a one-time assessment fee of $80.

Plan Identify the variables **(hours, cost)**

Figure out which value is the slope and which is the y-intercept

Implement

$m = 50$, $b = 80$, $y = 50x + 80$

This equation could also be written in function notation: $f(x) = 50x + 80$.

Maybe you defined your variables as something other than x and y like (h, c). In this case, you would write $c(h) = 50h + 80$. All of these equations represent the **same** problem but using different notations.

Checkpoint

Shelly purchased a car for $5,000. She paid $175 per month for car insurance and gas.

Write the equation in slope-intercept form to represent the cost of owning the car. Remember to define your variables as an ordered pair in words.

(month, cost)

$m = \$175$ $\quad$ $y = 175x + 5000$

$b = 5{,}000$

EXPLORE 9B

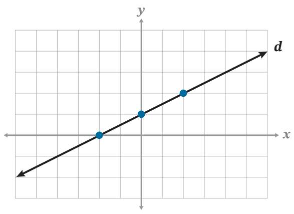
Slope-Intercept Form from a Graph

- You can write an equation in slope-intercept form from a graph by identifying the **y-intercept** or an **ordered pair** from a graph and find the **slope** between points.

Example 6

Write an equation in slope-intercept form given line d.

Plan Mark the y-intercept of the graph.
Mark another point on the line. Find the slope.



Implement

$b = 1$

$m = \frac{1}{2}$

$y = \frac{1}{2}x + 1$

Checkpoint

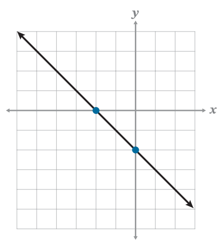
Write the equation in slope-intercept form for the function represented below.

$m = -1, b = -2$

$y = -1x - 2$

OR

$y = -x - 2$



Checkpoint

To continue past this checkpoint, students should confidently and correctly answer this problem.

Q: What is the direction of the line?

A: *negative*

Practice 1

Worked solutions for these problems are located in the Digital Pack.

1) Q: How can you find the slope from a graph?

A: *Mark two points and find the rise over the run.*

2) A) Since one of the numbers is 0, your student may write $y - 2 = -1x$ or $y - 2 = -x$ as well.

B) This is asking your student to solve in terms of x as they have in Lesson 2.

3) B) Using $(-7, -3)$: $y + 3 = -\frac{2}{5}(x + 7)$

Using $(-2, -5)$: $y + 5 = -\frac{2}{5}(x + 2)$

Q: How many lines exist between two points?

A: *one*

5) (hour, texts)

$y - 120 = 15(x - 8)$

6) (hour, dollars)

$y - 150 = 12(x - 8)$

13–15)

Q: What is the y-intercept for all of the lines on this graph?

A: *1, or (0, 1)*

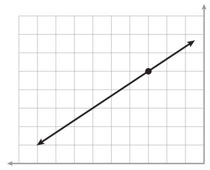
Q: How are there three unique lines when they all have the same y-intercept.

A: *They all have different slopes and go through other points.*

9B PRACTICE 1

Practice 1

Complete the problems on a separate sheet of paper.



1) Use the graph and marked point to write the equation in point-slope form. $(-3, 5)$, $m = \frac{2}{3}$ $y - 5 = \frac{2}{3}(x + 3)$

2) Given the slope of a line is $m = -1$ and a point on the line is $(0, 2)$.

A) Write the equation in point-slope form. $y - 2 = -1(x - 0)$

B) Use the equation to find the value of x when $y = 0$. $x = 2$ point: $(2, 0)$

3) Given the points $(-7, -3)$ and $(-2, -5)$,

A) Find the slope for this line. $m = -\frac{2}{5}$

B) Write this line in point-slope form (using both points).

4) Given the points $(2, 3)$ and $(10, 9)$,

A) Find the slope for this line. $m = \frac{3}{4}$

B) Write the equation of this line in point-slope form. Use the point $(2, 3)$. $y - 3 = \frac{3}{4}(x - 2)$

Write an equation in point-slope form for the following scenarios. Define your independent and dependent variables as an ordered pair.

5) Mike sends an average of 15 texts per hour. After 8 hours, he had sent 120 texts.

6) Jessica works as a server for \$12 per hour plus tips. She earned \$150 after working an 8 hour shift.

Write in slope-intercept form.

7) $m = -\frac{3}{4}, b = 11$ $y = -\frac{3}{4}x + 11$

8) $m = 5, b = -\frac{6}{7}$ $y = 5x - \frac{6}{7}$

9) $m = -1, (0, 9)$ $y = -x + 9$

10) $b = 2.5, m = 7.65$ $y = 7.65x + 2.5$

11) $(0, 25), m = -\frac{5}{8}$ $y = -\frac{5}{8}x + 25$

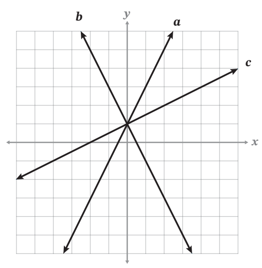
12) $m = 0, b = 3$ $y = 0x + 3$

Write the equation in slope-intercept form from the graph.

13) Line a $y = 2x + 1$

14) Line b $y = -2x + 1$

15) Line c $y = \frac{1}{2}x + 1$



PRACTICE 1 9B

Name the slope and the point. Then graph the equation of the line on a coordinate plane.

16) $y - 2 = \frac{1}{3}(x - 4)$ **$m = \frac{1}{3}$, (4, 2)**

17) $y + 3 = -4(x - 1)$ **$m = -4$, (1, −3)**

18) $y = \frac{3}{2}x - 4$ **$m = \frac{3}{2}$, $b = -4$**

19) $y = -2x + 3$ **$m = -2$, $b = 3$**

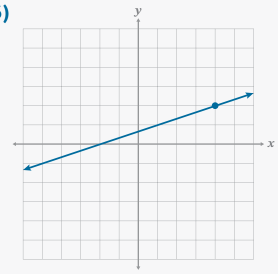
20) Melissa has already saved $1,200 for a car. She plans on saving $200 each month until she can purchase a car. Identify the independent and dependent variables as an ordered pair. Name the value of m and b. Write an equation in slope-intercept form.

(month, money)
$m = 200$, $b = 1{,}200$
$y = 200x + 1{,}200$

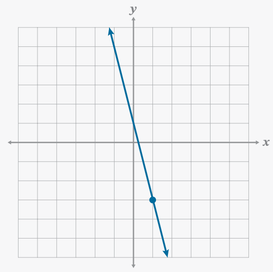
16–19)

The point can be the y-intercept or a point from point-slope form. This is a continuation of Lessons 8 and 9.

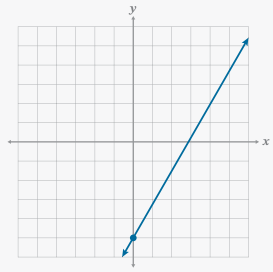
16)



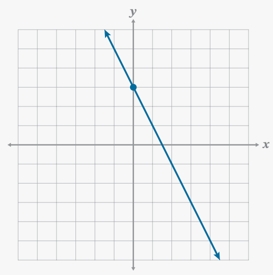
17)



18)



19)



Remind your student that "$b =$" represents the y-intercept and can be written $(0, b)$. However, "$y =$" represents the equation of a line.

Mastery Check

Show What You Know

B) Have your student extend their line until they reach the y-axis.

C) Q: Why does the graph of the line stop at the y-axis?

A: *Because the plant cannot be planted before day 0.*

D) Q: How would the y-intercept change if the seed was planted 3 inches below the soil?

A: *The y-intercept would be –3.*

Say What You Know

Your student should be able to restate the objectives of the lesson in their own words. If your student is unable to restate the lesson objectives, have them go back and reread the objectives and then explain them.

- Write linear equations in point-slope form from a graph or point and slope.
- Write linear equations in slope-intercept form from a graph or given the slope and the y-intercept.
- Graph equations on the coordinate plane in point-slope or slope-intercept form.

Mastery Check

Show What You Know

A tree was planted when it was 40 inches tall. It continued to grow 2.5 inches per year.

A) Define the variables as an ordered pair and define what the values in the given information represent.

(year, inches)
$m = 2.5$
$b = 40$ OR $(0, 40)$

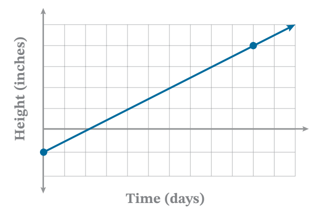
B) Write an equation in slope-intercept form to represent the growth of the tree.

$y = 2.5x + 40$

C) A seed was planted in the soil and grew at a rate of 1 inch every two days. After ten days, the plant was 4 inches tall.

Write an equation in point-slope form and graph your equation.

$y - 4 = \frac{1}{2}(x - 10)$



D) How far below the soil was the seed planted in part C? Explain.
Write the equation in slope-intercept form for the graph in part C.

The seed was planted 1-inch below the soil because this is the y-intercept.
$b = -1$, OR $(0, -1)$
$y = \frac{1}{2}x - 1$

Say What You Know

In your own words, talk about what you have learned using the objectives for this part of the lesson and your work on this page.

Lesson Test

After achieving mastery for Parts A and B of this lesson, your student has the option to take the test. Before taking the test, ask your student these questions:

- Do you know all the new vocabulary words?
- Can you explain the objectives?
- Do you know how to check your work?
- Do you know how to use your Formula Sheet?
- Were you able to complete the practice questions without help?

YES

If your student can answer "yes" to all of these questions, decide if your student is ready to take the Lesson Test.

NOT YET

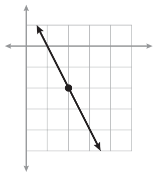
If your student cannot answer "yes" to all of these questions, consider having your student complete some of these options:

- Rework Practice 1.
- Complete Practice 2.
- Review the videos, Guided Notes, and Examples.

PRACTICE 2 9B

Practice 2

Complete the problems on a separate sheet of paper.



1) Use the graph and marked point to write the equation in point-slope form. $\mathbf{y + 2 = -2(x - 2)}$

2) Given the slope $-\frac{2}{3}$ and the point $(3, -2)$, write the equation in point-slope form. $\mathbf{y + 2 = -\frac{2}{3}(x - 3)}$

3) Given the slope of a line is $m = \frac{3}{4}$ and a point on the line is $(-5, 1)$,

   A) Write the equation in point-slope form. $\mathbf{y - 1 = \frac{3}{4}(x + 5)}$

   B) Use the equation to find the value of y when $x = -1$ $\mathbf{y = 4}$

4) Given that the points $(0, 3)$ and $(-1, 5)$ are both on the same line,

   A) Find the slope for this line. $\mathbf{m = -2}$

   B) Write this line in point-slope form (using either point).

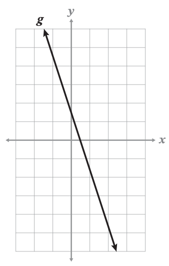
   C) Using either equation, find the x-intercept by making $y = 0$. $\mathbf{\left(\frac{3}{2}, 0\right)}$

Write an equation in point-slope form for the following scenarios. Define your independent and dependent variables as an ordered pair.

5) Rose sold bows for \$5 each. After selling 25 bows, she had earned \$125.

6) Jacob was a bricklayer and found that on average he laid 45 bricks per hour. After working 4 hours, he had 270 bricks laid for this project.

Use the graph of the line g to answer the following questions.

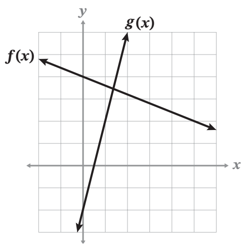


7) What is the y-intercept for this line? **Anything between $1\frac{1}{2}$ and $1\frac{2}{3}$**

8) If no exact values are provided, why can a graph only represent an estimate of the exact values for a function?

9) The equation for this graph is $y = -3x + \frac{3}{2}$. Explain the advantage of an equation of a function over the graph of a function.
Sample:
The scales on a graph provide a type of measurement, so the graph of a function can only provide estimates for any values that fall between marked points. However, an equation of a function uses numerical values, which are exact values.

Write an equation in slope-intercept form that represents the graph.



10) $f(x)$ $\mathbf{f(x) = -\frac{2}{5}x + 4}$

11) $g(x)$ $\mathbf{g(x) = 4x - 2}$

Practice 2

Worked solutions for these problems are located in the Digital Pack.

3) B) The point is $(-1, 4)$

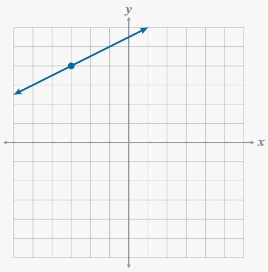
4) B) Using $(0, 3)$: $y - 3 = -2x$
Using $(-1, 5)$: $y - 5 = -2(x + 1)$

5) (bows, dollars)
$y - 125 = 5(x - 25)$

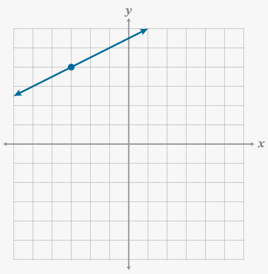
6) (hours, bricks)
$y - 270 = 45(x - 4)$

8) The scales provide a measurement, but any values in-between the marked points are estimated.

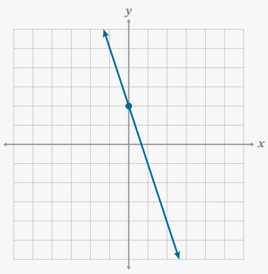
15)



16)



17)



If needed, have your student go back to the Mastery Check and reapply what they have learned to say and show what they know.

Lesson Test

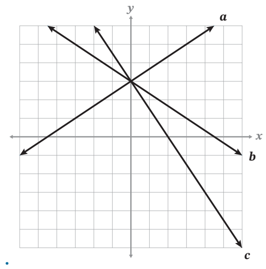
Refer to the Part B Mastery Check instructor note to determine if your student is ready for the test.

Match the equation to the appropriate line provided.

12) $f(x) = -\frac{3}{2}x + 3$ line c

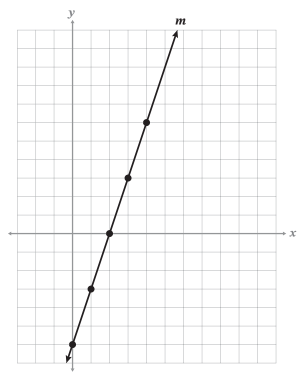
13) $g(x) = -\frac{2}{3}x + 3$ line b

14) $h(x) = 2\frac{2}{3}x + 3$ line a



15) Lana drew line m on the graph. Allyson drew line p with twice the slope of line m and half the y-intercept of line m. Write the equation for line p in slope-intercept form. Graph line p on the coordinate plane.

line p: $y = 6x - 3$



Name the slope and the point. Then graph the equation of the line on a coordinate plane.

16) $y - 4 = \frac{1}{2}(x + 3)$ $m = \frac{1}{2}$, $(-3, 4)$

17) $y = -3x + 2$ $m = -3$, $b = 2$

Bobbie noticed her electric bill had two parts, a fixed charge of $8.20 and a rate of $0.10 per kilowatt-hour (kWh).

18) Write an equation in slope-intercept form to represent the bill. $y = 0.10x + 8.20$

19) If Bobbie's electric bill was $106.20, how many kilowatt-hours did she use? $x = 980$ kWh were used

TARGETED REVIEW 9

Targeted Review

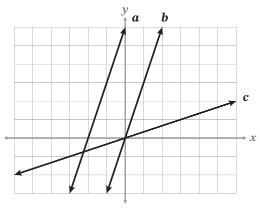
In the Targeted Review, you will practice topics you have mastered in earlier lessons. Reviewing these concepts will help you be successful as you work through this unit.

Complete the problems on a separate sheet of paper.

1) Which graph represents the function $f(x) = 3x$? Explain. (Hint: Use $f(2) = 6$ to help explain your reasoning.)

2) Why would $f(-2)$ and $f(0)$ be poor choices for determining which graph represents $f(x)$?

Two different lines share each of those points at the given values of x.

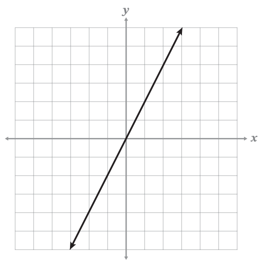


Use the graph to answer problems 3–6.

3) What are the intercept(s) of the graph?

4) Complete the table using the graph of the function.

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

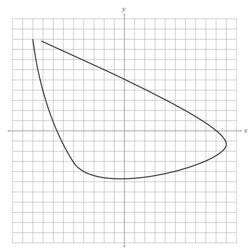


5) Determine the slope by marking the graph. **$m = 2$**

6) Name the domain and range using the table from problem 4. **domain: $\{-2, -1, 0, 1\}$ range: $\{-4, -2, 0, 2\}$**

7) Determine if the given relation is a function. Explain.

This is not a function because it fails the vertical line test. There is at least one value of x that has more than one corresponding y-value. For example, $x = 0$ has two solutions, $y = 5$ and $y = -4.6$.



Targeted Review

Worked solutions for these problems are located in the Digital Pack.

If your student is going to take the Lesson Test, it is recommended that they do so before beginning the Targeted Review.

1) Line b is correct. When substituting $x = 2$ into $f(x) = 3x$, $f(2) = 3(2) = 6$. The only line that has the point $(2, 6)$ is line b.

3) The x- and y-intercept are both $(0, 0)$ because the point goes through the origin.

8) Sample:
No, the first ordered pair, in function notation, is written as $f(-2) = 4$, which means that when -2 is the input value, 4 is the output value. The second ordered pair, written in function notation, is $f(4) = -2$, which means that when 4 is the input value, -2 is the output.

The words input and output can be replaced with x and y.

11) Distractor Rationale:
A) This is the y-intercept.
B) This is the slope.
C) This ignores the sign of the y-intercept or forgets to multiply the x-intercept by 2 when solving for x.

12) Distractor Rationale:
A) The sign of $\frac{1}{2}$ is incorrect.
C) The value $\frac{4}{5}$ is not an element of the range given the domain.
D) The values $\frac{1}{2}$ and 5 are not elements of the range given the domain.

8) As ordered pairs for the function f, do $(-2, 4)$ and $(4, -2)$ mean the same thing? Explain.

9) Solve for y. $6x - 5y = 2$ $\quad y = \frac{-6x+2}{-5}$

10) Solve for the interquartile range (IQR) of the following data set: $\{3, 7, 2, 0, 4, 3, 5, 3\}$ **IQR = 2**

Multiple Choice

__D__ **11)** Determine the x-intercept for the function: $f(x) = \frac{1}{2}x - 7$

A) -7
B) $\frac{1}{2}$
C) 7
D) **14**

__B__ **12)** Determine the range given the domain $\left\{-3, 0, \frac{1}{2}\right\}$ for the function: $h(x) = \frac{1}{2}x + 1$.

A) $\left\{\frac{1}{2}, 1, \frac{5}{4}\right\}$
B) $\left\{-\frac{1}{2}, 1, \frac{5}{4}\right\}$
C) $\left\{-\frac{1}{2}, 1, \frac{4}{5}\right\}$
D) $\left\{\frac{1}{2}, 1, 5\right\}$

Problem	1	2	3	4	5	6	7	8	9	10	11	12
Lesson Origin	15	15	15	15	2	7	14	10	2	11	15	15