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LESSON 1

Slope, Intercepts, and Rates of Change

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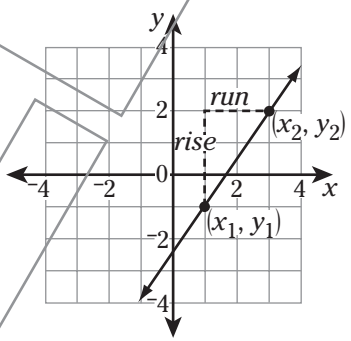
Slope

Slope is a measure of the steepness of a line. It describes a rate of change. The slope of a line can be found using either of these methods:

1. On the graph of a line, determine the vertical change (the "rise") over the horizontal change (the "run") from one point to another.



$$\text{slope} = \frac{\text{vertical change}}{\text{horizontal change}} = \frac{\text{"rise"}}{\text{"run"}}$$

2. Use the **slope formula.** For any two points on a line, (x_1, y_1) and (x_2, y_2) and $x_1 \neq x_2$,

$$\text{slope} = \frac{y_2 - y_1}{x_2 - x_1}.$$

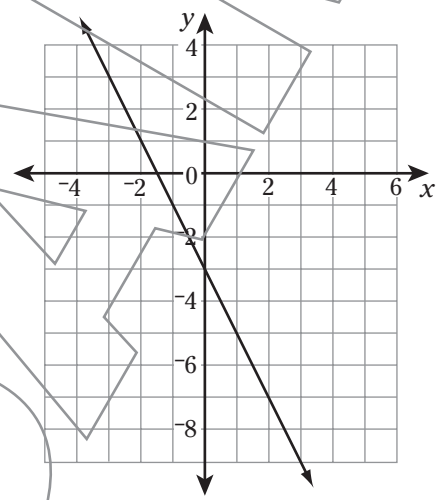
A line that slants upward from left to right always has a positive slope. A line that slants downward from left to right always has a negative slope.

Horizontal lines have a slope of 0. Vertical lines have an undefined slope.

It is a good idea to check the slope of a line found when looking at a graph using rise over run by also using the slope formula.

Try this sample question.

S-1 What is the slope of the line graphed below?



A -3 **B** -2 **C** $-\frac{1}{2}$ **D** $-\frac{1}{3}$

SAMPLE

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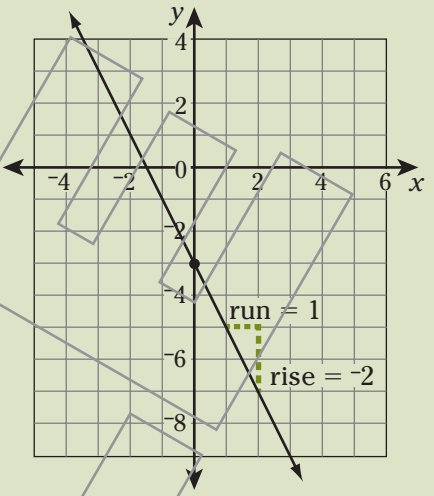
Find the slope using the rise over the run, or $\frac{rise}{run}$. By looking at the graph, you can see that the line has a rise of -2 and a run of 1, so the slope is $\frac{-2}{1}$ or -2. Verify this slope by using the slope formula with any two points on the graph.



$$\text{Slope} = \frac{-5 - (-3)}{1 - 0} = \frac{-5 + 3}{1} = \frac{-2}{1} \text{ or } -2.$$

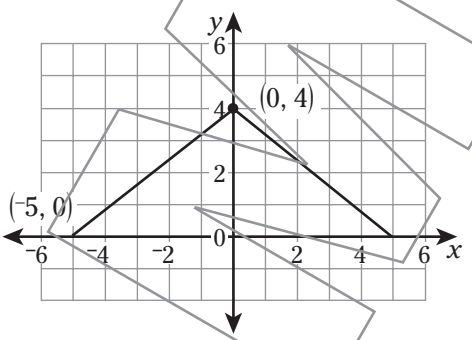
Both methods result in the same slope. Choice B is correct.

Rates of Change and Applications of Slope

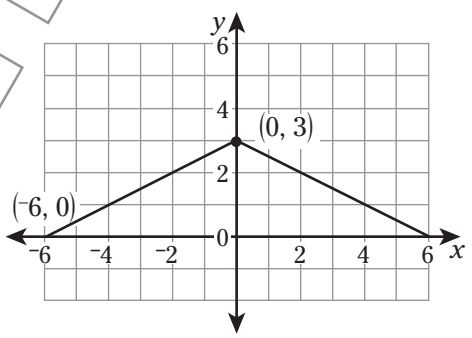
A **rate of change** shows the relationship between two quantities that are changing. This change can be constant or it can vary. The rate of change of a linear function is constant and the same as the slope of the function.

Slope can be used to find different rates of change, such as the grade of a road or the pitch of a roof. The greater the slope, the steeper the road or the roof pitch. For example, suppose an architect draws the two roofs shown on the coordinate planes below.

Roof A



Roof B



The coordinates of the left side of each roof drawing are shown. Use these coordinates and the slope formula to find the slope of each roof.

The slope of roof A is $\frac{4 - 0}{0 - (-5)} = \frac{4}{5}$. The slope of roof B is $\frac{3 - 0}{0 - (-6)} = \frac{3}{6} = \frac{1}{2}$. The slope of roof A is greater than the slope of roof B since $\frac{4}{5} > \frac{1}{2}$. So roof A is steeper than roof B.

For any two points on a line (x_1, y_1) and (x_2, y_2) and $x_1 \neq x_2$, the slope of the line is $\frac{y_2 - y_1}{x_2 - x_1}$.

SAMPLE

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Try this sample question.

S-2 Rosemary grows a plant from seed. In 2 weeks, the plant is 5 centimeters tall. In 6 weeks, the plant is 17 centimeters tall. What is the average growth rate each week of this plant between weeks 2 and 6?

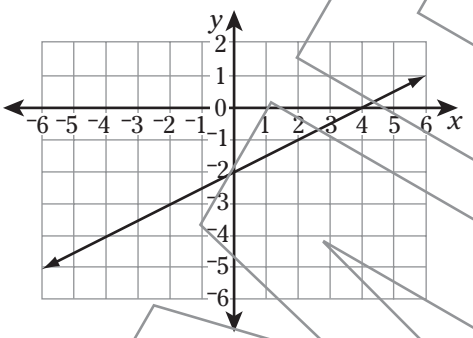
A 3 cm **B** 4 cm **C** 8 cm **D** 12 cm

To find the average growth rate each week, find the slope of the line between the points $(2, 5)$ and $(6, 17)$. Slope $m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{17 - 5}{6 - 2} = \frac{12}{4} = 3$. Choice A is correct.

Finding Intercepts from Graphs

On the graph of a line, the point where the line touches the x-axis is the ***x*-intercept** of the line. The point where the line touches the y-axis is the ***y*-intercept** of the line.

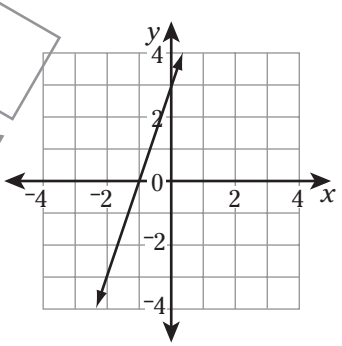
For example, on the graph below, the line touches the x-axis at $x = 4$ and the y-axis at $y = -2$. The x-intercept of this line is the point $(4, 0)$. The y-intercept is the point $(0, -2)$.



If a line touches the x-axis at $x = a$, the x-intercept is the point $(a, 0)$.
If a line touches the y-axis at $y = b$, the y-intercept is the point $(0, b)$.

Try this sample question.

S-3 Which statement best describes the graph of the line shown below?



A The slope is positive and the x-intercept is -1.

B The slope is negative and the x-intercept is 3.

C The slope is positive and the y-intercept is -1.

D The slope is negative and the y-intercept is 3.

SAMPLE

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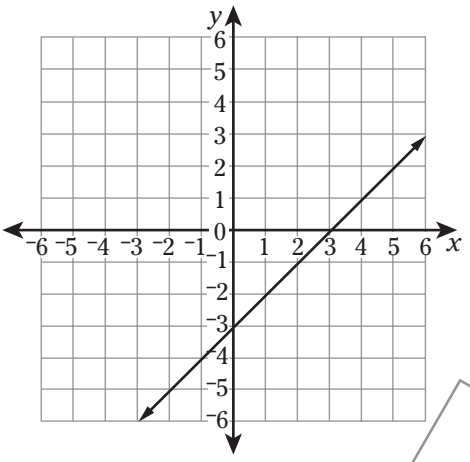
The line on the graph slants upward from left to right, so the slope is positive. The line touches the x-axis at -1 and it touches the y-axis at 3. So the x-intercept is -1 and the y-intercept is 3. Choice A is correct.

IT'S YOUR TURN

Read each problem. Circle the letter of the best answer.

1. A linear equation is graphed on the coordinate plane below.



What are the slope and y-intercept of the graphed line?

A The slope is 1, and the y-intercept is 3.

B The slope is 1, and the y-intercept is -3.

C The slope is 3, and the y-intercept is 1.

D The slope is 3, and the y-intercept is -1.

2. A pole is placed against a house, 6 feet from the base of the wall. In this position, the pole has a slope of $\frac{5}{3}$. What height off the ground does the top of the pole rest against the house?

A 2.5 feet

B 5 feet

C 10 feet

D 30 feet

3. A snowstorm laid down more snow on top of an existing base. The equation below can be used to find the total inches of snow, s, on the ground after any number of hours, h, of the storm.

$$s = 0.75h + 4$$

What does the number 0.75 represent in the equation?

A the length of time in hours the snowstorm lasted

B the inches of snow that fell per hour during the storm

C the inches of snow on the ground after $\frac{3}{4}$ of an hour

D the inches of snow on the ground at the beginning of the storm

SAMPLE

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Read each problem. Circle the letter of the best answer.

4. The table below shows the rate charged to park in a parking garage.

Number of Hours	Cost to Park ($)
0.5	1.00
1.0	1.75
1.5	2.50
2.0	3.25

Melissa has parked her car in the garage for 2 hours already. How much more will it cost for her car to be parked for 1 additional hour?

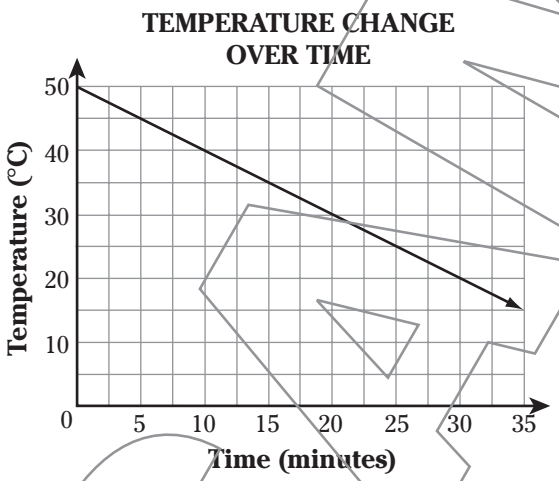
A $0.75

B $1.00

C $1.50

D $1.75

5. What is the rate of change shown on the graph below?



A -20°C per minute

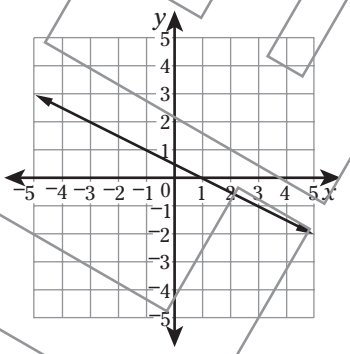
B -10°C per minute

C -5°C per minute

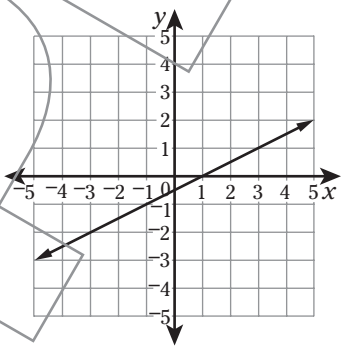
D -1°C per minute

6. In which graph does the line have a slope of -2 and a *y*-intercept of 1?

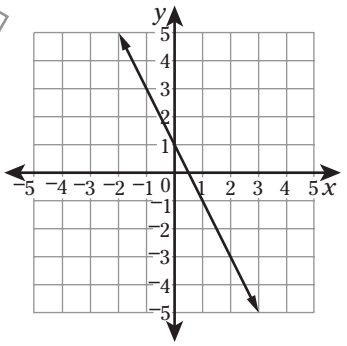
A



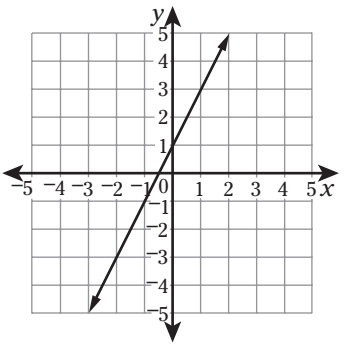
B



C



D



SAMPLE

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Read each problem. Circle the letter of the best answer.

7. A balloon is released into the air at a height of 25 meters, and rises at a rate of 1.4 meters per second. Which expression gives the number of seconds the balloon will take to reach a height of 80 meters?

A $1.4(80) - 25$

B $1.4(80) + 25$

C $1.4(80 - 25)$

D $1.4(80 + 25)$

8. Dimitri is buying a camera on an installment plan. He makes equal monthly payments. The equation below can be used to find the amount he owes after any number of months of payments.

$$y = -25x + 400$$

What does the number 400 represent in the equation?

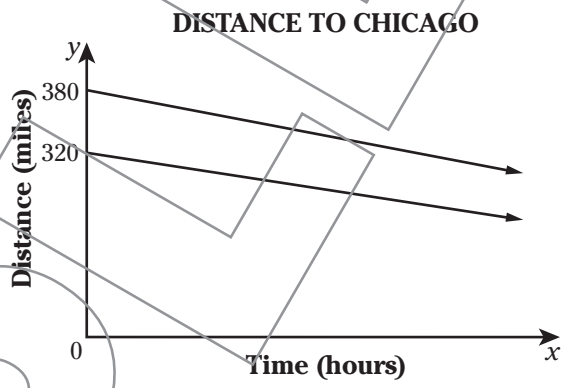
A the total cost of the camera

B the amount Dimitri pays each month

C the amount Dimitri put down as a deposit

D the number of months Dimitri will make payments

9. Two trains are approaching Chicago. The graph shows how each train's distance to Chicago is changing over time.



The slope of the line describing train 1 has slope -60. The slope of the line describing train 2 has slope -50. Which statement best compares the two trains' expected arrival times in Chicago?

A Train 1 will arrive 4 minutes before train 2.

B Train 1 will arrive 6.7 minutes before train 2.

C Train 2 will arrive 6 minutes before train 1.

D Train 2 will arrive 3.3 minutes before train 1.

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Unit 6
Constructed-Response Review

Read the problem. Write your answer for each part.

1. There is a linear relationship between the number of people in a group and the cost to enter a museum. The museum charges $20 for two people and $28 for three people.

A Write the equation in slope-intercept form that relates the number of people in a group to the cost of entering the museum. Show your work.

Answer: _____

B How much will it cost for a single individual to enter the museum?

Answer: _____

C How many people can enter the museum for $100?

Answer: _____

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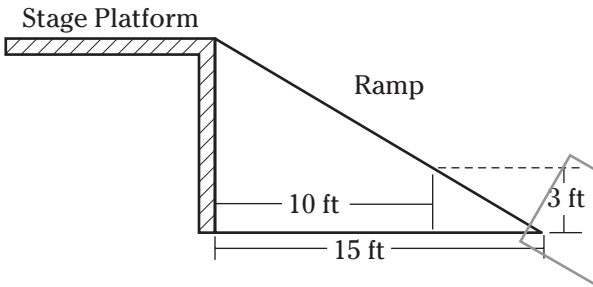
Read the problem. Write your answer for each part.

2. The bottom of a ramp is placed 15 feet from the edge of a stage platform. The ramp is 3 feet off the ground when it is 10 feet from the edge of the stage.



A What is the slope of the ramp? Show your work.

Answer: _____

B How many feet off the ground is the top of the ramp?

Answer: _____

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C Write a linear equation in slope-intercept form that represents the height (y) of the ramp at any distance (x) from the stage.

Answer: _____

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