| **Grade Level/Course:** |
| Algebra 1 |
| **Lesson/Unit Plan Name:** |
| Evaluating Functions (Linear Function) |
| **Rationale/Lesson Abstract:** |
| Students will learn to evaluate a function written as an expression by substituting a value into the given expression. Students will also learn that they can substitute another expression into the original expression of the function. They will recognize that $g(x)$ is the output of a function and the expression "x" is the input. Students will also evaluate functions using tables and graphs. |
| **Timeframe:** |
| 1 period (55 min) |
| **Common Core Standard(s):** |

F.IF.1: Interpreting Functions
Understand the concept of a function and use function notation.
Understand that a function from one set (called the domain) to another set (called the range) assigns each element of the domain to exactly one element of the range.

F.IF.2: Evaluating Functions
Use function notation, evaluate functions for inputs in their domains, and interpret statements that use function notation in terms of context.

F.IF.9: Comparing Functions
Compare properties of two functions each represented in a different way(algebraically, graphically, and numerically in tables) |

Warm Up

ALG 16.0/F.IF.9

Two functions, *f* and *g* are described below. Which of these statements about *f* and *g* are true?

$$f(x) = -\frac{7}{3}x + 1$$
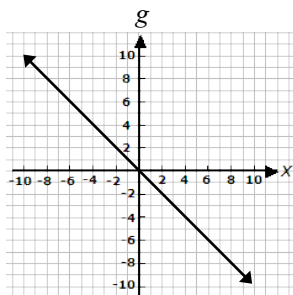
A *f* and *g* are both increasing, and *f* is increasing faster than *g*.
B *f* and *g* are both decreasing, and *g* is decreasing faster than *f*.
C *f* and *g* are both decreasing, and *f* is decreasing faster than *g*.
D *g* is decreasing and *f* is decreasing.

Justify your answer.

Review: ALG 7.0

The data in the table show the cost of renting a bicycle by the hour, including a deposit.

Renting a Bicycle

| Hours (*h*)	Cost in dollars (*c*)
2	15
5	30
8	45

If hours, *h*, were graphed on the horizontal axis and cost, *c*, were graphed on the vertical axis, what would be the equation of a line that fits the data?

A $c = 5h$ 　　　　　　　**C** $c = 5h + 5$

B $c = \dfrac{1}{5}h + 5$ 　　　　**D** $c = 5h - 5$

Current: ALG 16.0/F.IF.9

Tanya thinks that the graph and table below represent the same linear function. Carla disagrees. Who is correct? Explain your reasoning.

x	f(x)
0	-1
1	1
2	3
3	5
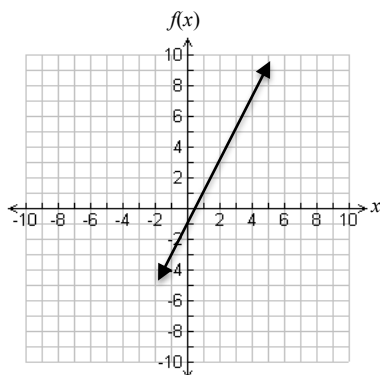
Other: Grade 7 AF 1.2

If $h = 3$ and $k = 4$, then

$$\frac{hk + 4}{2} - 2 =$$

A 6
B 7
C 8
D 10

Instructional Resources/Materials:

Ruler, Graph Paper, paper, pencil

Activity/Lesson:

Warm-up Solutions

A False; neither *f* or *g* is increasing.	The answer is C.
B False; we know that *f* and *g* are decreasing. $\quad$ slope of $g = \dfrac{-1}{1} = -1$ $\qquad\qquad f = \dfrac{-7}{3} = -2\dfrac{1}{3}$ $\quad$ so *f* is decreasing faster than *g*.	Solution: $\quad$ Rate of change $= \dfrac{\text{change in cost}}{\text{change in time}}$ $\qquad\qquad = \dfrac{30-15}{5-2}$ $\qquad\qquad = \dfrac{15}{3}$ $\qquad\qquad = 5$
C True; *f* is decreasing at a rate of –2.333 and *g* is decreasing slower at a rate of –1.	Using point-slope form; where $m = 5$ at pt. (5, 30) $\qquad c - c_1 = m(h - h_1)$ $\qquad c - 30 = 5h - 5(5)$
D True; they are both decreasing	$\qquad c - 30 = 5h - 25$ $\quad c - 30 + 30 = 5h - 25 + 30$ $\qquad\qquad c = 5h + 5$
Tanya is correct. The linear function of the table and the graph is $f(x) = 2x - 1$.	The answer is A $\qquad h = 3, \ k = 4$ $\qquad \dfrac{hk + 4}{2} - 2$ $\qquad = \dfrac{(3)(4) + 4}{2} - 2$ $\qquad = \dfrac{16}{2} - 2$ $\qquad = 6$

Evaluating Functions:

We have seen linear functions written in the slope-intercept form of $y = mx + b$. If we name a function f, we can write it using function notation: $f(x) = mx + b$.

The symbol $f(x)$ is another name for "y" and is read as "f of x", or "the value of f at x". It does not mean "f times x". We can also use other letters such as d or g to name a function. Functions can be represented by equations, tables, and graphs.

Evaluate a function represented by an equation:

Consider the function $g(x) = 8x + 2$. Evaluate the function when $x = 0$ and $x = -5$.

The values of g are the input values. To evaluate the function, we substitute x with the input values and calculate, resulting in the output values.

Given: $g(x) = 8x + 2$. Find $g(0)$ and $g(-5)$.

Solution:

$$g(x) = 8x + 2 \qquad \text{Write original function.}$$
$$g(0) = 8(0) + 2 \qquad \text{Substitute 0 for } x$$
$$g(0) = 0 + 2 \qquad \text{Multiply}$$
$$g(0) = 2 \qquad \text{Simplify}$$

Solution:

$$g(x) = 8x + 2 \qquad \text{Write original function}$$
$$g(-5) = 8(-5) + 2 \qquad \text{Substitute -5 for } x$$
$$g(-5) = -40 + 2 \qquad \text{Multiply}$$
$$g(-5) = -38 \qquad \text{Simplify}$$

We can also use expressions as our input values.

Given: $g(x) = 8x + 2$. Find $g(2x + 3)$

$$g(x) = 8x + 2 \qquad \text{Write original function}$$
$$g(2x + 3) = 8(2x + 3) + 2 \qquad \text{Substitute "}2x + 3\text{" for } x$$
$$g(2x + 3) = 16x + 24 + 2 \qquad \text{Distributive Property}$$
$$g(2x + 3) = 16x + 26 \qquad \text{Simplify}$$

You try: Given the function $d(x) = 3x - 14$. Find $d(0)$, $d(-2)$, and $d(4x + 3)$.

Evaluate a function represented by a table:

Given $f(x) = 5x - 4$. Find $f(2)$ from the table.

Solution: Analyze the table. Find the output value that corresponds with the input value.

x	$f(x) = 5x - 4$	$f(x)$	$(x, f(x))$
-2	5(-2) – 4	-14	(-2, -14)
-1	5(-1) – 4	-9	(-1, -9)
0	5(0) – 4	-4	(0, -4)
1	5(1) – 4	1	(1, 1)
2	5(2) – 4	6	(2, 6)

Therefore, $f(2) = 6$.

You Try: The linear relationship shown in the table below uses the rule $f(x) = 3(x - 2)$.

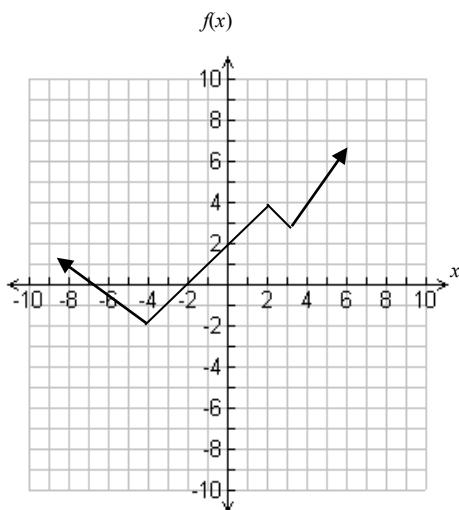| x	$f(x)$
2	0
3	3
4	6
10	24

Which of the following are the possible solutions of $f(x)$ when $x = 10$?

	Yes	No
A. $f(x) = 3(10 - 2)$	◯	◯
B. $f(x) = 3(10) + 3(-2)$	◯	◯
C. $f(x) = 3(8)$	◯	◯
D. $f(x) = 30 - 6$	◯	◯

Justify your answers.

Evaluate a function represented by a graph:

The function $f(x)$ is graphed below. Find $f(-3)$.

$f(x)$

Solution: $f(-3)$ is the point on the graph of $f(x)$ where $x = -3$. Drawing the line $x = -3$ can help us find that point. At what point on $f(x)$ does $x = -3$?

$$f(x) = -3 \text{ at the point } (-3, -1). \text{ Therefore } f(-3) = -1.$$

You try: Using the graph above, find $f(-1)$, $f(0)$ and $f(1)$.

Activity/Lesson continued:

1. For each of the following function evaluate.

   I. $f(x) = -2x + 3$

   II. $f(x) = \dfrac{5(2-x)}{11}$

   a) $f(-3)$
   b) $f(7)$
   c) $f(0)$
   d) $f(z)$

2. A photo finishing store charges customers a rate of $0.29 per photo to print pictures. For new customers, the store offers a one time discount of $3.00
   a) Write a function representing the amount that a new customer would have to pay to have x number of photos printed.
   b) How much would a new customer pay to develop 50 pictures.

Homework:

1. In Bicycle Motor Cross (BMX) racing, racers purchase a one year membership to a track. They also pay an entry fee for each race at that track. One racer paid a total of $125 after 5 races. A second racer paid a total of $95 after 3 races.
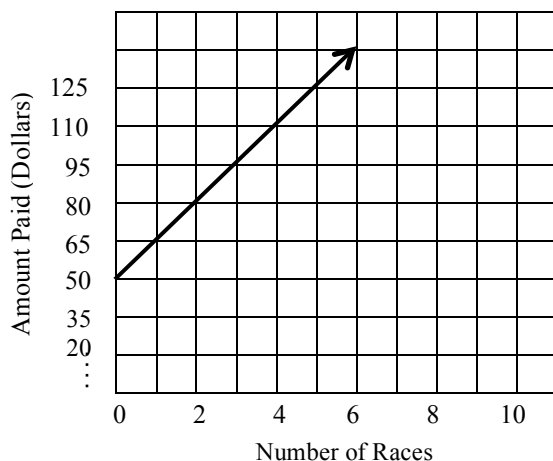
a) How much does the track membership cost?
b) What is the entry fee per race?
c) How much did a member pay for 2, 4, and 7 races?

2. The table shows the cost of ordering sets of prints of digital photos from an online service. The cost per print is the same for the first 30 prints. There is also a shipping charge.

Number of prints	1	2	3	4	5	6	7	8
Total cost (dollars)	1.98	2.47	?	?	3.94	?	?	5.41

a) What is the shipping charge for 3, 4, 6, and 7 prints?
b) The cost of 15 prints is $9.14. The shipping charge increases after the first 10 prints. Find the shipping charge for 15 prints.

Key Answers to Lesson Activity and Homework:

1. For each of the following function evaluate.

    I. $f(x) = -2x + 3$

    II. $f(x) = \dfrac{5(2-x)}{11}$

       a) $f(-3)$
       b) $f(7)$
       c) $f(0)$
       d) $f(z)$

I. $f(x) = -2x + 3$

a) $f(-3) = -2(-3) + 3$
$= 6 + 3$
$f(-3) = 9$

b) $f(7) = -2(7) + 3$
$= -14 + 3$
$f(7) = -11$

c) $f(0) = -2(0) + 3$
$= 0 + 3$
$f(0) = 3$

d) $f(z) = -2(z) + 3$
$f(z) = -2z + 3$

II. $f(x) = \dfrac{5(2-x)}{11}$

a) $f(-3) = \dfrac{5(2-(-3))}{11}$
$= \dfrac{5(2+3)}{11}$
$= \dfrac{5(5)}{11}$
$f(-3) = \dfrac{25}{11}$

b) $f(7) = \dfrac{5(2-7)}{11}$
$= \dfrac{5(-5)}{11}$
$f(7) = \dfrac{-25}{11}$

c) $f(0) = \dfrac{5(2-0)}{11}$
$= \dfrac{5(2)}{11}$
$f(0) = \dfrac{10}{11}$

d) $f(z) = \dfrac{5(2-z)}{11}$
$= \dfrac{5(2) - 5(z)}{11}$
$f(z) = \dfrac{10 - 5z}{11}$

2. A photo finishing store charges customers a rate of $0.29 per photo to print pictures. For new customers, the store offers a one time discount of $3.00
    a) Write a function representing the amount that a new customer would have to pay to have *x* number of photos printed.
    Answer: $f(x) = \$0.29x - \$3.00$
    b) How much would a new customer pay to develop 50 pictures.
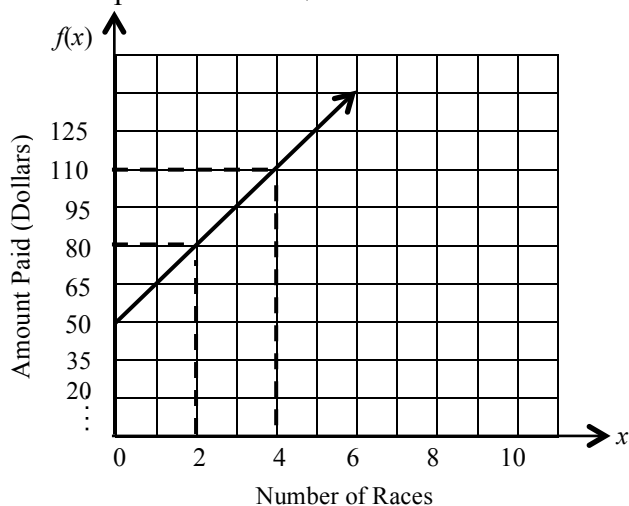   Answer: $f(x) = \$0.29x - \$3$
$$f(50) = \$0.29(50) - \$3$$
$$= \$14.50 - \$3$$
$$f(50) = \$11.50$$

Homework:

1. In Bicycle Motor Cross (BMX) racing, racers purchase a one year membership to a track. They also pay an entry fee for each race at that track. One racer paid a total of $125 after 5 races. A second racer paid a total of $95 after 3 races.

a) How much does the track membership cost?
   Answer: The $f(x)$ is 50. So, the track membership is $50.
b) What is the entry fee per race?
   Answer:

c) How much did a member pay for 2, 4, and 7 races?
   Answer: Refer to graph. $\{x, f(x)\}$
   $\{2, \$80\}$, $\{4, \$110\}$, $\{7, \$155\}$

2. The table shows the cost of ordering sets of prints of digital photos from an online service. The cost per print is the same for the first 30 prints. There is also a shipping charge.

Number of prints	1	2	3	4	5	6	7	8
Total cost (dollars)	1.98	2.47	?	?	3.94	?	?	5.41

a) What is the shipping charge for 3, 4, 6, and 7 prints?
   Answer:

$$f(x) = 0.49(x) + 1.49$$

$$f(3) = 0.49(3) + 1.49 \qquad\qquad f(4) = 0.49(4) + 1.49$$

$$= 1.47 + 1.49 \qquad\qquad\qquad = 1.96 + 1.49$$

$$f(3) = 2.96 \qquad\qquad\qquad\qquad f(4) = 3.45$$

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$$f(6) = 0.49(6) + 1.49 \qquad\qquad f(7) = 0.49(7) + 1.49$$
$$= 2.94 + 1.49 \qquad\qquad\qquad = 3.43 + 1.49$$
$$f(6) = 4.43 \qquad\qquad\qquad f(7) = 4.92$$

b) The cost of 15 prints is $9.14. The shipping charge increases after the first 10 prints. Find the shipping charge for 15 prints.

Answer:

Since $f(15) = 9.14$ and the shipping charge increases after 10 prints.

then $f(x) = 0.49x + b$

$$9.14 = 0.49(15) + b$$
$$9.14 = 7.35 + b$$
$$9.14 - 7.35 = 7.35 - 7.35 + b$$
$$1.79 = b$$

$\therefore$ The shipping charge for 15 prints is $1.79