Activity

1-3 Piecewise-Defined Functions

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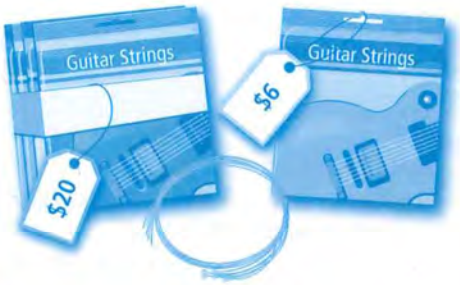
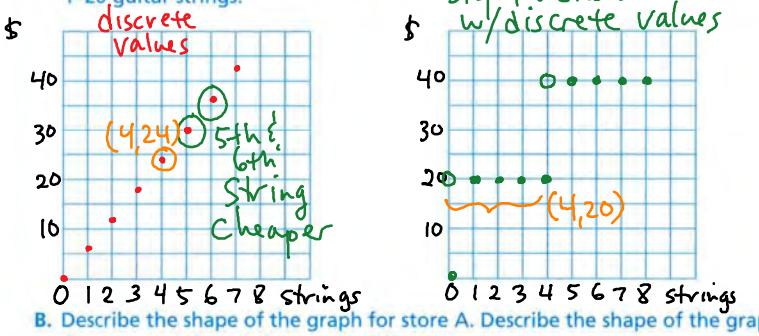
MODEL & DISCUSS

A music teacher needs to buy guitar strings for her class. At store A, the guitar strings cost $6 each. At store B, the guitar strings are $20 for a pack of 4.



A. Make graphs that show the income each store receives if the teacher needs 1–20 guitar strings.



B. Describe the shape of the graph for store A. Describe the shape of the graph for store B. Why are the graphs different?

Store A: linear function
Store B: step function

C. **Communicate Precisely** Compare the graphs for stores A and B. For what numbers of guitar strings is it cheaper to buy from store B? Explain how you know. MP.6

4 strings, 7, 8

HABITS OF MIND

Communicate Precisely Why do you use dots rather than line segments to graph these two functions? MP.6

discrete values: distinct • integer values

Notes

Assess

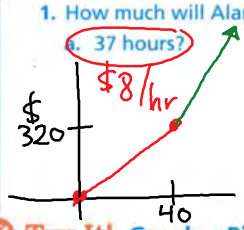
ex 1) Alani
$8/hr (up to 40 hrs)
$12/hr (overtime)
"time and a half"

EXAMPLE 1 **Try It! Model With a Piecewise-Defined Function**

1. How much will Alani earn if she works:

a. 37 hours? $8/hr

b. 43 hours? $12/hr



EXAMPLE 2 **Try It! Graph a Piecewise-Defined Function**

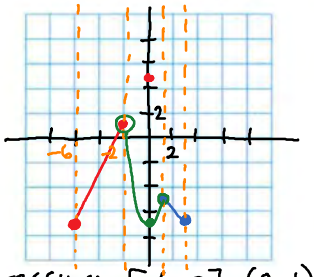
2. Graph the piecewise-defined function. What are the domain and range? Over what intervals is the function increasing or decreasing?

domain

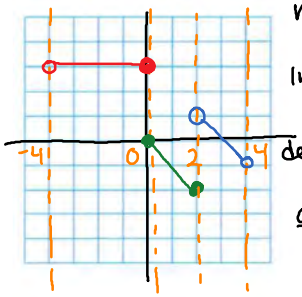
a. $f(x) = \begin{cases} 2x+5 & -6 \le x \le -2 \\ 2x^2 - 7 & -2 < x < 1 \\ -4 - x, & 1 \le x \le 3 \end{cases}$ (closed closed; y-int; open open; closed closed)

b. $f(x) = \begin{cases} 3, & -4 < x \le 0 \\ -x, & 0 \le x \le 2 \\ 3 - x, & 2 < x < 4 \end{cases}$

range: $-7 \le y \le 1$ or $[-7, 1]$



Increasing: $[-6, -2], (0, 1)$
decreasing: $(-2, 0), [1, 3]$



range: $-2 \le y \le 3$
incr: none
decr: $0 \le x \le 2$, $2 < x < 4$
or $[0, 2]$, $(2, 4)$

HABITS OF MIND

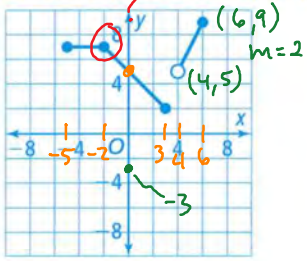
Reason Why is the interval for the domain of the second piece of the function in Try It! 2(a) defined using the < symbol rather than the ≤ symbol? MP.2

EXAMPLE 3 **Try It! Write a Piecewise-Defined Rule From a Graph**

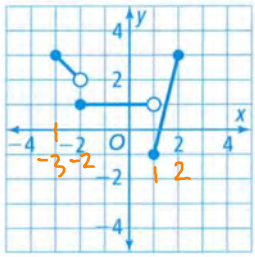
3. What rule defines the function in the following graph?

$f(x) = \begin{cases} 7 & -5 \le x \le -2 \\ 1x + 5 & -2 \le x \le 3 \\ 2x - 3 & 4 < x \le 6 \end{cases}$

a.



b.



$f(x) = \begin{cases} -x & -3 \le x < -2 \\ 1 & -2 \le x < 1 \\ 4x - 5 & 1 \le x \le 2 \end{cases}$

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Notes

Assess

EXAMPLE 4 **Try It! Write a Rule for an Absolute Value Function**

4. How can you rewrite each function as a piecewise-defined function?

   a. $f(x) = |-5x - 10|$

   b. $f(x) = -|x| + 3$

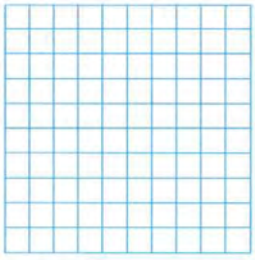
HABITS OF MIND

Use Structure Why can the graph of an absolute value function also be defined as a piecewise-defined function? MP.7

EXAMPLE 5 **Try It! Graph a Step Function**

5. The table below represents fees for a parking lot. Times are always rounded to the nearest tenth of an hour. Graph the function. What are the domain and range of the function? What are the maximum and minimum values?

Time	0.1 – 3 h	3.1 – 6 h	6.1 – 9 h	9.1 – 12 h
Cost	$10	$15	$20	$25



HABITS OF MIND

Make Sense and Persevere How would a piecewise-defined rule for the function in the Try It! show that the graph is a step function? MP.1

Do You UNDERSTAND?

1. **ESSENTIAL QUESTION** How do you model a situation in which a function behaves differently over different parts of its domain?

2. **Vocabulary** How do piecewise-defined functions differ from step functions?

3. **Error Analysis** Given the function

$$f(x) = \begin{cases} 2x + 5, & -2 < x \leq 4 \\ -4x - 7, & 4 < x \leq 9 \end{cases},$$

Rebecca says there is an open circle at $x = 4$ for both pieces of the function. Explain her error. MP.3

4. **Communicate Precisely** What steps do you follow when graphing a piecewise-defined function? MP.6

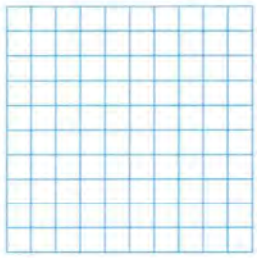
5. **Make Sense and Persevere** Is the relation defined by the following piecewise rule a function? Explain. MP.1

$$y = \begin{cases} 7x - 4, & x < 2 \\ -x + 5, & x \geq -2 \end{cases}$$

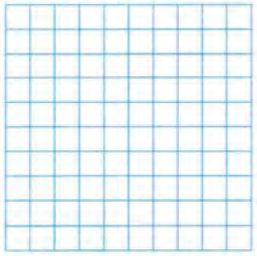
Do You KNOW HOW?

Graph the function.

6. $f(x) = \begin{cases} -x + 1, & -10 \leq x < -3 \\ x^2 - 9, & -3 \leq x \leq 3 \\ 2x + 1, & 3 < x < 5 \end{cases}$



7. $g(x) = \begin{cases} 1, & 0 \leq x < 2 \\ 3, & 2 \leq x < 4 \\ 5, & 4 \leq x < 6 \\ 7, & 6 \leq x < 8 \end{cases}$



8. Given the function

$$f(x) = \begin{cases} -2x + 4, & 0 \leq x < 8 \\ -5x + 11, & x \geq 8 \end{cases}$$

is the function increasing or decreasing over the interval [2, 7]? Find the rate of change over this interval.

9. What is the rule that defines the function shown in the graph?