

## Applications

1. A pump is used to empty a swimming pool. The equation  $w = -275t + 1,925$  represents the gallons of water  $w$  that remain in the pool  $t$  hours after pumping starts.
  - a. How many gallons of water are pumped out each hour?
  - b. How much water is in the pool at the start of pumping?
  - c. Suppose there are 1,100 gallons of water left in the pool. How long has the pump been running?
  - d. After how many hours will the pool be empty?
  - e. Write an equation that is equivalent to  $w = -275t + 1,925$ . What information does it tell you about the situation?
  - f. Without graphing, describe the shape of the graph of the relationship between  $w$  and  $t$ .
2. A new pump is used to empty the pool in Exercise 1. The equation  $w = -275(2t - 7)$  represents the gallons of water  $w$  that remain in the pool  $t$  hours after pumping starts.
  - a. How many gallons of water are pumped out each hour?
  - b. How much water is in the pool at the start of pumping?
  - c. Suppose there are 1,000 gallons of water left in the pool. How long has the pump been running?
  - d. After how many hours will the pool be empty?
  - e. Write an equation that is equivalent to  $w = -275(2t - 7)$ . What information does it tell you about the situation?
3. A truck has a broken fuel gauge. Luckily, the driver keeps a record of mileage and gas consumption. The driver uses the data to write an equation for the relationship between the number of gallons of gas in the tank  $g$  and the number of miles driven  $m$  since the last fill-up.
$$g = 25 - \frac{1}{15}m$$
  - a. How many gallons of gasoline are in a full tank? Explain.
  - b. Suppose the driver travels 50 miles after filling the tank. How much gas is left?

- c. After filling the tank, how many miles can the driver travel before 5 gallons remain?
  - d. After filling the tank, how many miles can the driver travel before the tank is empty?
  - e. How many miles does the driver have to travel in order to use 1 gallon of gas? Explain.
  - f. In the equation, what do the numbers 25 and  $\frac{1}{15}$  tell you about the situation?
4. A middle school pays \$2,500 to print 400 copies of the yearbook. They give some free copies to the yearbook advisor and staff and sell the rest to students. The equation below tells how close the school is to paying for the printing bill.

$$y = 2,500 - 15(N - 8)$$

Describe what information the numbers and variables represent in this situation.



For: Help with Exercise 4  
Web Code: ape-6404



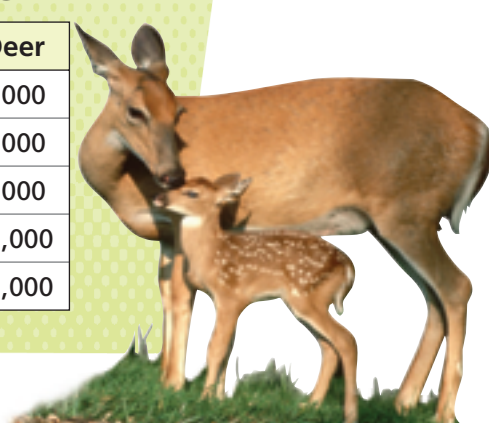
5. The Department of Natural Resources is collecting data on three different species of animals. They find that these species show different patterns of population growth. They write the equations below to represent the population  $P$  of each species after  $x$  years.

Species 1	Species 2	Species 3
$P_1 = 10,000 + 100x$	$P_2 = 10(3^x)$	$P_3 = 800 + 10x^2$

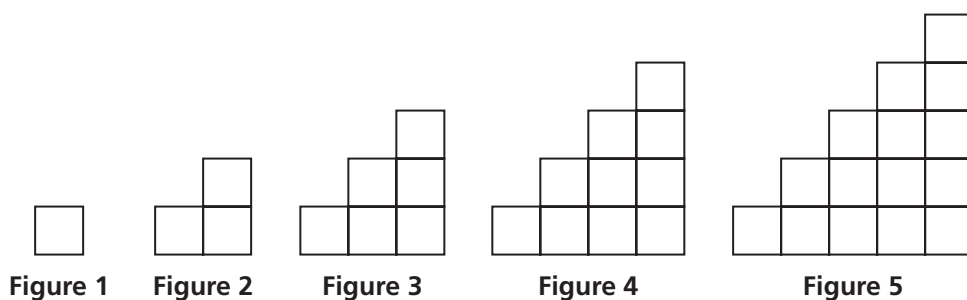
- a. Describe what information the numbers and variables represent in each equation.
- b. Describe the pattern of growth for each species. Explain how the patterns differ.
- c. Pick any two species. After how many years will the populations of the two species be equal? Explain how you got your answer.

6. The tables below represent the projected growth of certain species of deer. Use the three tables to answer parts (a)–(c).

Table 1		Table 2		Table 3	
Year	Deer	Year	Deer	Year	Deer
2000	1,000	2000	1,000	2000	1,000
2001	1,030	2001	1,030	2001	3,000
2002	1,061	2002	1,060	2002	9,000
2003	1,093	2003	1,090	2003	27,000
2004	1,126	2004	1,120	2004	81,000



- Describe the growth represented in each table. Are any of these patterns linear, exponential, or quadratic?
  - Write an equation for each linear, exponential, or quadratic pattern in part (a).
  - Does any table show a population of deer growing at a rate of 300% per year? Explain.
7. Suppose the figures shown are made with toothpicks.

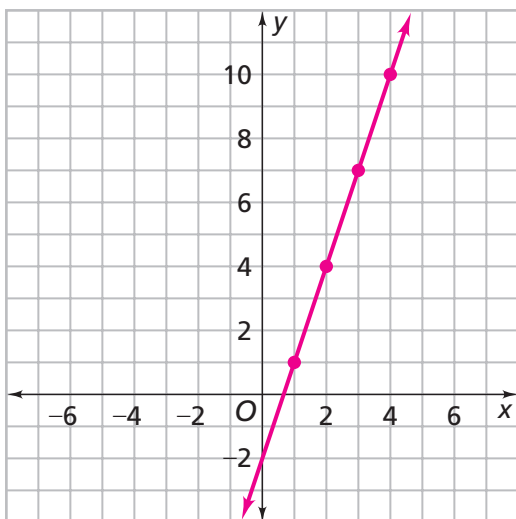


- What patterns in the set of figures do you notice?
- How many toothpicks do you need to make Figure 7?
- Is the relationship between the perimeter and the figure number linear, quadratic, or exponential? Explain.
- Is the relationship between the total number of toothpicks and the figure number linear, quadratic, or exponential?

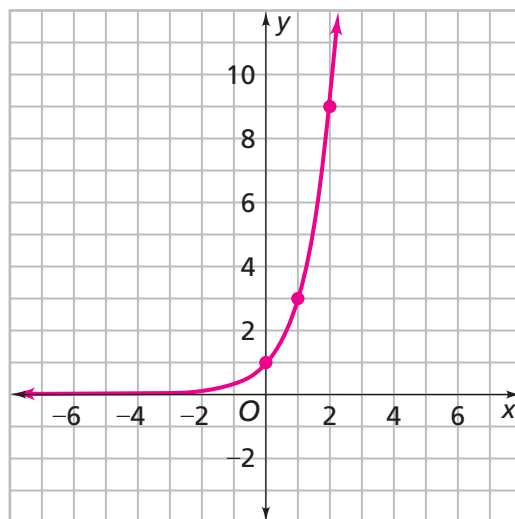
- e. Write an equation to represent the perimeter of Figure  $N$ . Explain your rule.
- f. Write an equation to represent the total number of toothpicks needed to make Figure  $N$ . Explain your rule.

For Exercises 8–10, use the graphs below.

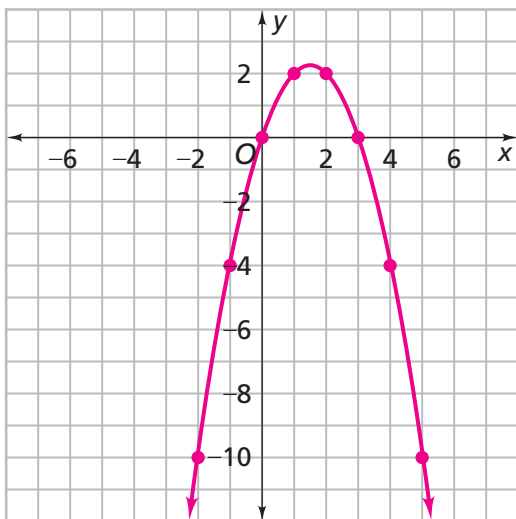
Graph 1



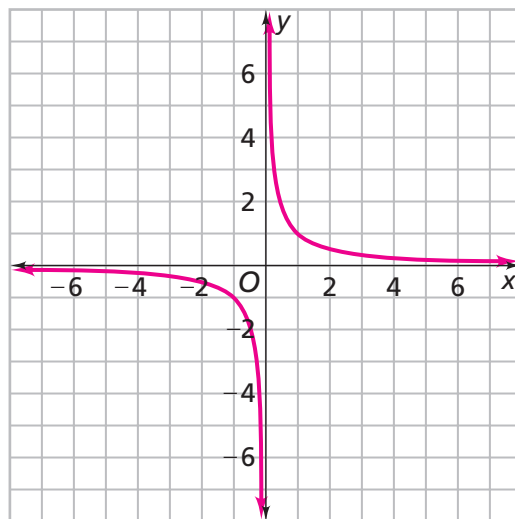
Graph 2



Graph 3



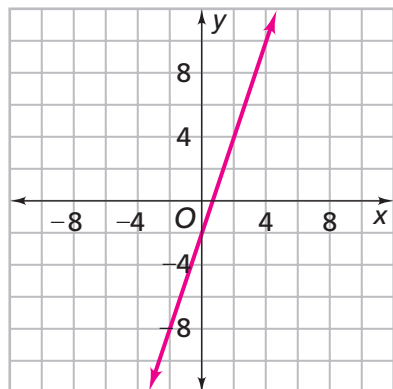
Graph 4



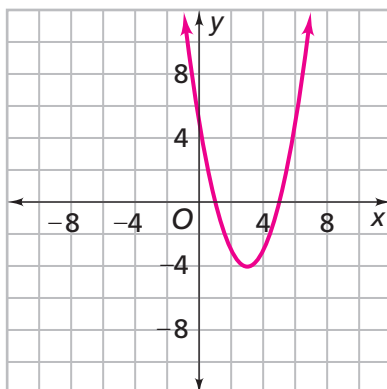
8. Which graphs represent linear, quadratic, or exponential functions?
9. Make a table of  $y$ -values for  $x = 1, 2, 3, \dots, 6$  for each linear, quadratic, or exponential function.
10. Write an equation for each linear, quadratic, or exponential function. Describe your strategy.

For Exercises 11–17, match each equation with one of the graphs below.

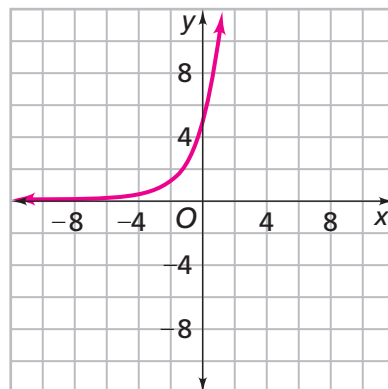
Graph A



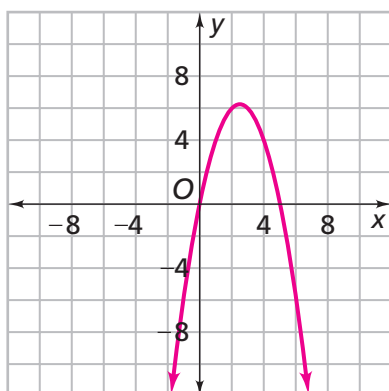
Graph B



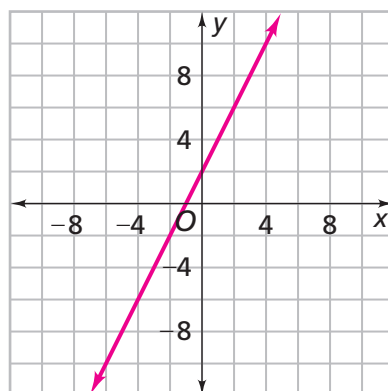
Graph C



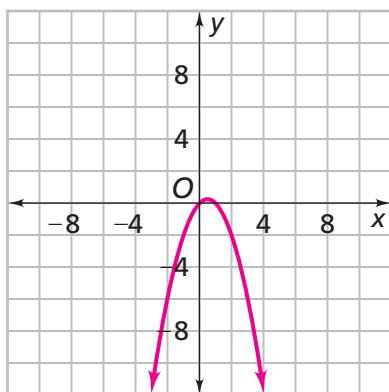
Graph D



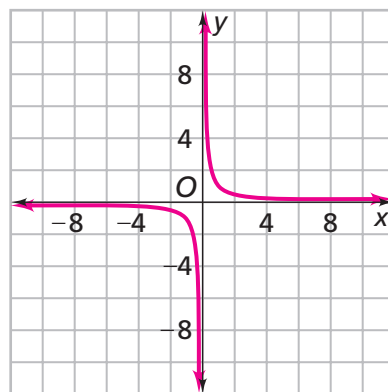
Graph E



Graph F



Graph G



11.  $y = \frac{1}{x}$

12.  $y = x(5 - x)$

13.  $y = (x - 1)(x - 5)$

14.  $y = x(1 - x)$

15.  $y = 2 + 2x$

16.  $y = 5(2^x)$

17.  $y = -2 + 3x$

**18.** For parts (a)–(c), use the set of equations below.

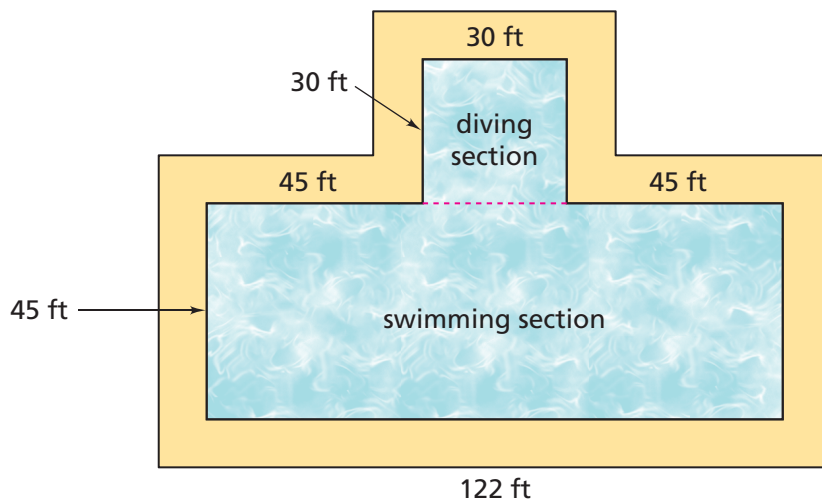
- |                    |                        |                           |
|--------------------|------------------------|---------------------------|
| (1) $y = x^2 + 8x$ | (4) $y = 2(x - 3) + 6$ | (7) $y = 0.25^x$          |
| (2) $y = 2x$       | (5) $y = x(x + 8)$     | (8) $y = 17 + x(x + 3)$   |
| (3) $y = 4^{x-1}$  | (6) $y = 0.25(4^x)$    | (9) $y = (x + 1)(x + 17)$ |

- Which equations represent linear, quadratic, or exponential functions?
- Find any equations that represent the same function.
- Without graphing the equation, describe the shape of the graph of each equation in part (b). Give as much detail as possible, including patterns of change, intercepts, and maximum and minimum points.

**19.** Pick a linear, quadratic, and exponential equation from Exercise 18. Describe a problem that can be represented by each equation.

## Connections

**20.** Use the figure of the pool for parts (a)–(d). Drawing is not to scale.



- How many 1-foot square tiles do you need to build a border that is 1-tile wide around the pool?
- What is the surface area of the water?
- The swimming section is 4 feet deep. The diving section is 10 feet deep. What is the volume of the pool?
- The pool is filled at a rate of 600 cubic feet per hour. How long does it take to fill the pool?



- 21.** **a.** Give the formula for the circumference of a circle with radius  $r$ .  
**b.** Give the formula for the area of a circle with radius  $r$ .  
**c.** Give the formula for the volume of a cylinder with a height of  $h$  and radius of  $r$ .  
**d.** For parts (a)–(c), which equations are linear? Explain.
- 22.** A line has a slope of 1.5 and goes through the point  $(2, 5)$ .  
**a.** Find the coordinates of three other points that lie on the line.  
**b.** Find the coordinates of the  $y$ -intercept.  
**c.** Find the  $y$ -coordinate of the point whose  $x$ -coordinate is  $-4$ .  
**d.** Write an equation for the line.
- 23.** Sabrina uses an area model to find the product  $(x + 2)(x + 3)$ .

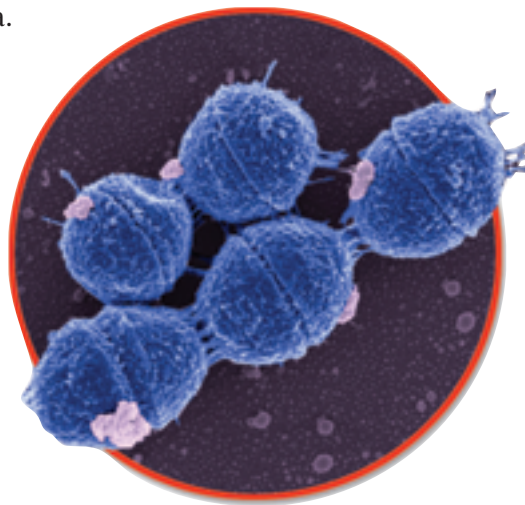
$x$	$x^2$	$3x$
$2$	$2x$	$6$
	$x$	$3$

Tara uses the Distributive Property to multiply  $(x + 2)(x + 3)$ .

$$\begin{aligned}
 (x + 2)(x + 3) &= (x + 2)x + (x + 2)3 \\
 &= x^2 + 2x + 3x + 6 \\
 &= x^2 + x(2 + 3) + 6 \\
 &= x^2 + 5x + 6
 \end{aligned}$$

- a.** Explain each step in Tara's method.  
**b.** Explain how Tara's method relates to Sabrina's area model.  
**c.** Use the Distributive Property to find each product.  
**i.**  $(x + 5)(x + 3)$       **ii.**  $(x + 4)(x + 1)$       **iii.**  $(x - 2)(x + 4)$

- 24.** The equation  $d = -16t^2 + 16t + 6.5$  represents the distance  $d$  in feet, from the ground to the top of a basketball player's head  $t$  seconds after the player jumps.
- Find the distance to the top of the player's head after 0.1 second.
  - Find the distance to the top of the player's head after 0.3 second.
  - Find the distance to the top of the player's head after 1 second.
  - What operations did you perform to calculate your answers in parts (a)–(c)? In what order did you perform the operations?
- 25.** A bacteria colony begins with 5,000 bacteria. The population doubles every hour. This pattern of exponential growth can be modeled by the equation  $b = 5,000(2^t)$ , where  $b$  is the number of bacteria and  $t$  is the number of hours.
- What is the population of the colony after 3 hours? After 5 hours?
  - What mathematical operations did you perform to calculate your answers in part (a)? In what order did you perform these operations?



**Write an expression equivalent to the given expression.**

- |                                                         |                                      |
|---------------------------------------------------------|--------------------------------------|
| <b>26.</b> $5 - 6(x + 10) - 4$                          | <b>27.</b> $-3(x - 4) - (x + 3)$     |
| <b>28.</b> $x(x + 2) - 5x + 6$                          | <b>29.</b> $6x^2 + 5x(x - 10) + 10$  |
| <b>30.</b> $\frac{1}{2}x^2 + \frac{1}{4}x^2 + x^2 + 3x$ | <b>31.</b> $7x^2 - 3.5x + 0.75x - 8$ |

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**32.** Write an equation for

- a.**  $y$  in terms of  $z$  given  $y = 6x + 10$  and  $x = 2z - 7$
- b.**  $P$  in terms of  $n$  given  $P = xn - 6n$ , and  $x = 12 - n$
- c.**  $A$  in terms of  $w$  given  $A = \ell w$  and  $\ell = 15 - w$

**For Exercises 33–35, give an equation for each function.**

- 33.** a parabola with  $x$ -intercepts  $(-3, 0)$  and  $(2, 0)$
- 34.** a line with a slope of  $-4$  and an  $x$ -intercept of  $(2, 0)$
- 35.** an exponential function with a growth factor of  $1.25$

**36. a.** Sketch each equation on the same coordinate grid.

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

**b.** What is the effect of the variable  $a$  in the equation  $y = ax^2$ ?

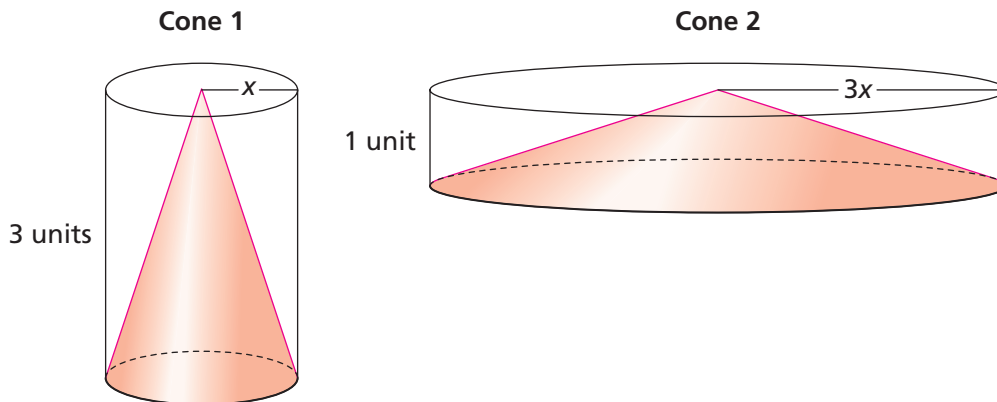
**37. a.** Sketch each equation on the same coordinate grid.

$$y = 4x^2 + 5 \qquad y = 4x^2 - 5 \qquad y = 4x^2 + 3 \qquad y = 4x^2 - 3$$

**b.** What is the effect of the variable  $c$  in the equation  $y = 4x^2 + c$ ?

**38.** You want to tie the anchor wire of a flagpole to the ground at a distance that is half the height of the pole. What is the height of the tallest flagpole you can support with a 60-foot anchor wire?

**39.** The figures show cones inside cylinders with the same radius and height. Which cone has a volume of  $3\pi x^2$  cubic units? Explain.



## Extensions

- 40.** Caley's cell phone company offers two different monthly billing options for local phone service.

Plan I: \$25 for up to 100 minutes, plus \$0.50 for each extra minute.

Plan II: \$50 for an unlimited number of minutes.

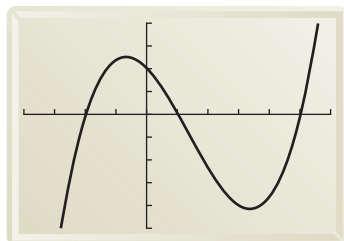
- Suppose Caley uses about 200 minutes each month. What is the best option for her? Explain.
  - For what number of minutes are the costs of the two plans equal? Explain.
  - Write an equation for each plan. Describe how the variables and numbers represent the growth patterns of the plans.
  - Graph each equation on the same coordinate grid. Describe how the graphs describe the growth patterns of the phone plans.
- 41.** The equation below represents the space  $s$  in feet between cars that is considered safe given the average velocity  $v$  in feet per second on a busy street.

$$s = \frac{v^2}{32} + v + 18$$

- Suppose a car travels at a rate of 44 feet per second. How far should it be from the car ahead of it in order to be safe?
- What is 44 feet per second in miles per hour?
- Suppose a taxi is 100 feet behind a car. At what velocity is it safe for the taxi to be traveling in feet per second? In miles per hour?



- 42. a.** Graph  $y = x^2 + 4$ . Is it possible to find  $x$  when  $y = 0$ ? Explain.
- b.** Give two examples of a quadratic equation ( $ax^2 + bx + c = 0$ , where  $a, b$ , and  $c$  are real numbers) with no solution.
- c.** Give two examples of a quadratic equation with 1 solution.
- d.** Give two examples of a quadratic equation with 2 solutions.
- 43.** Below is the graph of  $y = (x + 2)(x - 1)(x - 5)$ . The scale on the  $x$ -axis is 1. The scale on the  $y$ -axis is 5.



- a.** What are the solutions to  $(x + 2)(x - 1)(x - 5) = 0$ ? How are the solutions shown on the graph?
- b.** What values of  $x$  satisfy the inequality  $(x + 2)(x - 1)(x - 5) < 0$ ? How is your answer shown on the graph?
- c.** How can you find the answer to part (b) without using the graph?

For part (c),  
use what you know  
about multiplying  
positive and negative  
numbers.

