## LESSON 11-2 Practice A
### *Exponential Functions*

**1.** If a superball is bounced from a height of 20 feet, the function $f(x) = 20(0.9)^x$ gives the height of the ball in feet of each bounce, where $x$ is the bounce number. What will be the height of the 6th bounce? Round your answer to the nearest tenth of a foot. **10.6 feet**

**Tell whether each set of ordered pairs satisfies an exponential function. Explain your answer.**

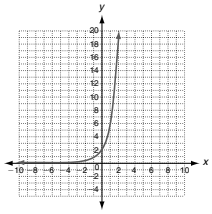
**2.** $\{(1, 10), (2, 20), (3, 40), (4, 80)\}$ **yes, as the *x*-values increase by 1, the *y*-values are multiplied by 2.**

**3.** $\{(1, 5), (2, 10), (3, 15), (4, 20)\}$ **no, as the *x*-values increase by 1, the *y*-values are not multiplied by a constant amount.**

**Graph each exponential function.**

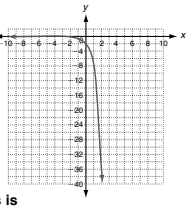
**4.** $y = 2(3)^x$

| $x$ | $y = 2(3)^x$ | $y$ | $(x, y)$ |
|---|---|---|---|
| $-2$ | $y = 2(3)^{-2}$ | $0.2\overline{2}$ | $(-2, 0.2\overline{2})$ |
| $-1$ | $y = 2(3)^{-1}$ | $0.6\overline{6}$ | $(-1, 0.6\overline{6})$ |
| 0 | $y = 2(3)^0$ | 2 | (0, 2) |
| 1 | $y = 2(3)^1$ | 6 | (1, 6) |
| 2 | $y = 2(3)^2$ | 18 | (2, 18) |



**5.** $y = -2(4)^x$

| $x$ | $y = -2(4)^x$ | $y$ | $(x, y)$ |
|---|---|---|---|
| $-2$ | $y = -2(4)^{-2}$ | $-0.125$ | $(-2, -0.125)$ |
| $-1$ | $y = -2(4)^{-1}$ | $-0.5$ | $(-1, -0.5)$ |
| 0 | $y = -2(4)^0$ | $-2$ | $(0, -2)$ |
| 1 | $y = -2(4)^1$ | $-8$ | $(1, -8)$ |
| 2 | $y = -2(4)^2$ | $-32$ | $(2, -32)$ |



**In the absence of predators, the natural growth rate of rabbits is 4% per year. A population begins with 100 rabbits. The function $f(x) = 100(1.04)^x$ gives the population of rabbits in $x$ years.**

**6.** How long will it take the population of rabbits to double? **18 years**

**7.** How long will it take the population of rabbits to reach 1000? **59 years**

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## LESSON 11-2 Practice B
### *Exponential Functions*

**1.** If a basketball is bounced from a height of 15 feet, the function $f(x) = 15(0.75)^x$ gives the height of the ball in feet of each bounce, where $x$ is the bounce number. What will be the height of the 5th bounce? Round to the nearest tenth of a foot. **3.6 feet**

**Tell whether each set of ordered pairs satisfies an exponential function. Explain your answer.**

**2.** $\{(2, 4), (4, 8), (6, 16), (8, 32)\}$ **yes, as the *x*-values increase by 2, the *y*-values are multiplied by 2.**

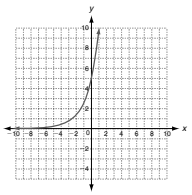
**3.** $\{(-2, 5), (-1, 10), (0, 15), (1, 20)\}$ **no, as the *x*-values increase by 1, the *y*-values are not multiplied by a constant amount.**

**4.** $\{(1, 750), (2, 150), (3, 30), (4, 6)\}$ **yes, as the *x*-values increase by 1, the *y*-values are multiplied by $\frac{1}{5}$.**

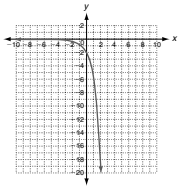
**5.** $\left\{\left(-5, \frac{1}{3}\right), (0, 1), (5, 3), (10, 9)\right\}$ **yes, as the *x*-values increase by 5, the *y*-values are multiplied by 3.**

**Graph each exponential function.**

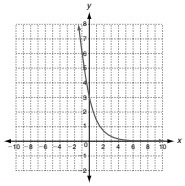
**6.** $y = 5(2)^x$



**7.** $y = -2(3)^x$



**8.** $y = 3\left(\frac{1}{2}\right)^x$



**In the year 2000, the population of Virginia was about 7,400,000. Between the years 2000 and 2004, the population in Virginia grew at a rate of 5.4%. At this growth rate, the function $f(x) = 7{,}400{,}000(1.054)^x$ gives the population $x$ years after 2000.**

**9.** In what year will the population reach 15,000,000? **2014**

**10.** In what year will the population reach 20,000,000? **2019**

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## LESSON 11-2 Practice C
### *Exponential Functions*

**1.** If a golf ball is dropped from a height of 25 feet, the function $f(x) = 25\left(\frac{2}{3}\right)^x$ gives the height in feet of each bounce. What will be the height of the golf ball on the 6th bounce? Round to the nearest tenth of a foot. **2.2 feet**

**Tell whether each set of ordered pairs satisfies an exponential function. Explain your answer.**

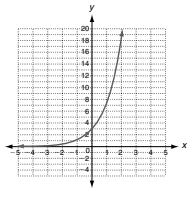
**2.** $\left\{\left(0, \frac{3}{4}\right), \left(1, \frac{1}{2}\right), \left(2, \frac{1}{4}\right), (3, 0)\right\}$ **no, as the *x*-values increase by 1, the *y*-values are not multiplied by a constant amount.**

**3.** $\{(0, 3), (1, 7.5), (2, 18.75), (3, 46.875)\}$ **yes, as the *x*-values increase by 1, the *y*-values are multiplied by 2.5.**

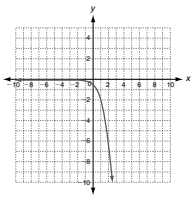
**4.** $\{(3, 7.5), (6, 6), (9, 4.8), (12, 3.84)\}$ **yes, as the *x*-values increase by 3, the *y*-values are multiplied by 0.8.**

**Graph each exponential function.**

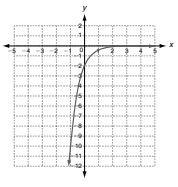
**5.** $y = 3(2.5)^x$



**6.** $y = -0.5(3.5)^x$



**7.** $y = -2\left(\frac{1}{5}\right)^x$



**The Mendez family bought two used cars: one domestic and one foreign. The domestic car was purchased for \$11,600. The foreign car was purchased for \$9700. The functions in the table represent the value of each car $x$ years from now due to depreciation.**

| | |
|---|---|
| Domestic Car | $f(x) = 11{,}600(0.88)^x$ |
| Foreign Car | $f(x) = 9700(0.93)^x$ |

**8.** How much is each car worth 2 years from now? **domestic: \$8983.04**
**foreign: \$8389.50**

**9.** In how many years will the foreign car be worth more than the domestic car? **4 years**

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## LESSON 11-2 Reteach
### *Exponential Functions*

An **exponential function** has the independent variable as the exponent.

$y = 3^x$ and $y = -2(0.5)^x$ are exponential functions.

A set of ordered pairs satisfies an exponential function if the $y$-values are multiplied by a constant amount as the $x$-values change by a constant amount.

**Tell whether the following ordered pairs satisfy an exponential function.**

| $x$ | $y$ | |
|---|---|---|
| 3 | 4 | *Think* $4 \times ? = 12$. |
| 5 | 12 | *Think* $12 \times ? = 36$. |
| 7 | 36 | *Think* $36 \times ? = 108$. |
| 9 | 108 | |

The $x$-values increase by the constant amount 2.

Each $y$-value is multiplied by the constant amount 3.

This is an exponential function.

| $x$ | $y$ | |
|---|---|---|
| 1 | 2 | *Think* $2 \times ? = 4$. |
| 2 | 4 | *Think* $4 \times ? = 6$. |
| 3 | 6 | *Think* $6 \times ? = 8$. |
| 4 | 8 | |

The $x$-values increase by the constant amount 1.

The $y$-value is multiplied by 2, then 1.5, then $1.\overline{3}$. There is no constant ratio.

This is not an exponential function.

**The population of a school can be described by the function $f(x) = 1500(1.02)^x$, where $x$ represents the number of years since the school was built. What will be the population of the school in 12 years?**

$f(x) = 1500(1.02)^x$

$f(12) = 1500(1.02)^{12}$ *Substitute 12 for x.*

$\approx 1902$ *Round number of people to the nearest whole number.*

**Tell whether the ordered pairs satisfy an exponential function.**

**1.**

| $x$ | $y$ |
|---|---|
| $-1$ | 1.5 |
| $-2$ | 3 |
| $-3$ | 6 |
| $-4$ | 12 |

yes

**2.**

| $x$ | $y$ |
|---|---|
| 1 | 1 |
| 2 | 2 |
| 3 | 6 |
| 4 | 24 |

no

**3.**

| $x$ | $y$ |
|---|---|
| $-2$ | $-2$ |
| $-1$ | $-10$ |
| 0 | $-50$ |
| 1 | $-250$ |

yes

**4.** If a rubber ball is dropped from a height of 10 feet, the function $f(x) = 20(0.6)^x$ gives the height in feet of each bounce, where $x$ is the bounce number. What will be the height of the 5th bounce? Round to the nearest tenth of a foot. **1.6 feet**

**5.** A population of pigs is expected to increase at a rate of 4% each year. If the original population is 1000, the function $f(x) = 1000(1.04)^x$ gives the population in $x$ years. What will be the population in 12 years? **$\approx$1601**

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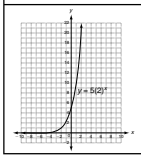
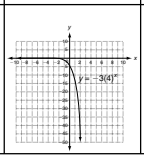
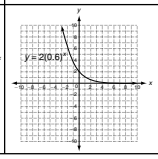
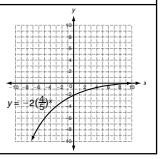

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LESSON 11-2

## Reteach

### *Exponential Functions (continued)*

The graph of an exponential function is always a curve in two quadrants. $y = ab^x$

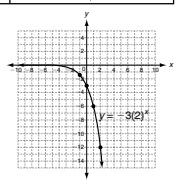
| $a > 0$ and $b > 1$ | $a < 0$ and $b > 1$ | $a > 0$ and $0 < b < 1$ | $a < 0$ and $0 < b < 1$ |
|---|---|---|---|
|  |  |  |  |

**Graph $y = -3(2)^x$.**

Create a table of ordered pairs. Plot the points.

Because $a < 0$ and $b > 1$, this graph should look similar to the second graph above.

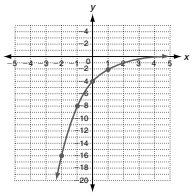
| $x$ | $y = -3(2)^x$ | $y$ |
|---|---|---|
| $-1$ | $y = -3(2)^{-1}$ | $-1.5$ |
| 0 | $y = -3(2)^0$ | $-3$ |
| 1 | $y = -3(2)^1$ | $-6$ |
| 2 | $y = -3(2)^2$ | $-12$ |



**Graph each exponential function.**

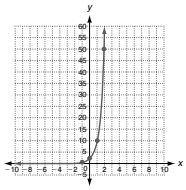
**6.** $y = -4(0.5)^x$

| $x$ | $y = -4(0.5)^x$ | $y$ |
|---|---|---|
| $-2$ | $y = -4(0.5)^{-2}$ | $-16$ |
| $-1$ | $y = -4(0.5)^{-1}$ | $-8$ |
| 0 | $y = -4(0.5)^0$ | $-4$ |
| 1 | $y = -4(0.5)^1$ | $-2$ |



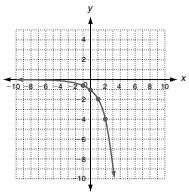
**7.** $y = 2(5)^x$

| $x$ | $y = 2(5)^x$ | $y$ |
|---|---|---|
| $-1$ | $y = 2(5)^{-1}$ | 0.4 |
| 0 | $y = 2(5)^0$ | 2 |
| 1 | $y = 2(5)^1$ | 10 |
| 2 | $y = 2(5)^2$ | 50 |



**8.** $y = -1(2)^x$

| $x$ | $y = -1(2)^x$ | $y$ |
|---|---|---|
| $-1$ | $y = -1(2)^{-1}$ | $-0.5$ |
| 0 | $y = -1(2)^0$ | $-1$ |
| 1 | $y = -1(2)^1$ | $-2$ |
| 2 | $y = -1(2)^2$ | $-4$ |



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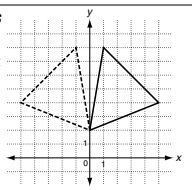


LESSON 11-2

## Challenge

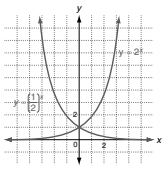
### *Exploring Reciprocals and Reflections*

The diagram at right shows a triangle and its reflection across the $y$-axis. Notice that the triangle and its reflection are congruent figures.



**Graph each pair of functions on the grid provided. Describe how the bases of the exponential functions are related. Then describe how each graph is related to the other.**

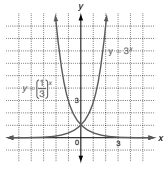
**1.** $y = 2^x$ and $y = \left(\frac{1}{2}\right)^x$



The bases are reciprocals.

The graphs are reflections across the $y$-axis.

**2.** $y = 3^x$ and $y = \left(\frac{1}{3}\right)^x$



The bases are reciprocals.

The graphs are reflections across the $y$-axis.

**3.** Let $b$ be a number greater than 1. Consider $y = b^x$ and $y = \left(\frac{1}{b}\right)^x$. Write a statement that describes how the bases are related and how the graphs are related.

The bases are reciprocals of one another and the graphs are reflections of one another across the $y$-axis.

**Explain why the graphs in each pair are reflections of one another across the $y$-axis.**

**4.** $y = 10^x$ and $y = \left(\frac{1}{10}\right)^x$

Because 10 and $\frac{1}{10}$ are reciprocals

**5.** $y = 5^x$ and $y = 0.2^x$

Because $0.2 = \left(\frac{1}{5}\right)$ and 5 and $\frac{1}{5}$ are reciprocals

**6.** $y = 4^x$ and $y = 4^{-x}$

Because $4^{-x} = \left(\frac{1}{4}\right)^x$ and 4 and $\frac{1}{4}$ are reciprocals

**7.** $y = \left(\frac{5}{4}\right)^x$ and $y = 1.25^{-x}$

Because $1.25^{-x} = \left(\frac{5}{4}\right)^{-x} = \left(\frac{4}{5}\right)^x$ and $\frac{5}{4}$ and $\frac{4}{5}$ are reciprocals

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LESSON 11-2

## Problem Solving

### *Exponential Functions*

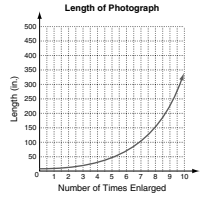
**Write the correct answer.**

**1.** The function $f(x) = 6(1.5)^x$ models the length of a photograph in inches after the photo has been enlarged by 50% $x$ times.

**a.** What is the length of the photograph after it has been enlarged 4 times?

30.375 in.

**b.** Graph the function.




**2.** A population of 550 rabbits is increasing by 2.5% each year. The function $y = 5.5(1.025)^x$ gives the population of rabbits, in hundreds, $x$ years from now. About how long will it take the population to reach 600 rabbits? 1200 rabbits?

4 years;

32 years

**3.** The function $y = 200(1.0004)^x$ models the balance on a customer's line of credit $x$ days after the end of the grace period (the time when no interest accumulates). If Jack does not make any payments, determine Jack's balance 30 days after the grace period ends.

$202.41

**4.** The function $f(x) = 2300(0.995)^x$ models enrollment in a high school, where $x$ is the number of years after 2005. Use the model to estimate the enrollment in 2013.

2210

**A lake was stocked with fish in early April. Select the best answer.**

**5.** The function $f(x) = 300(0.85)^x$ models the number of landlocked salmon in the lake $x$ months after the lake was stocked. Which is the best estimate of the number of landlocked salmon in early July?

**A** 157 **C** 217

(**B**) 184 **D** 255

**7.** The function $f(x) = 400(1.05)^x$ models the number of bass $x$ months after the lake was stocked. During what month will the population reach 600?

**F** September **H** November

**G** October (**J**) December

**6.** The function $f(x) = 75(1.2)^x$ models the number of rainbow trout in the lake $x$ years after 2005. Likewise, the function $f(x) = 105(1.08)^x$ models the number of perch in the lake for the same time period. Which statement is NOT true?

**A** The population of perch will reach 120 before the population of rainbow trout does.

**B** In 2009, the number of rainbow trout will exceed the number of perch.

(**C**) In 2007, the number of rainbow trout will be less than 100.

**D** In 10 years, there will be at least twice as many rainbow trout as perch.

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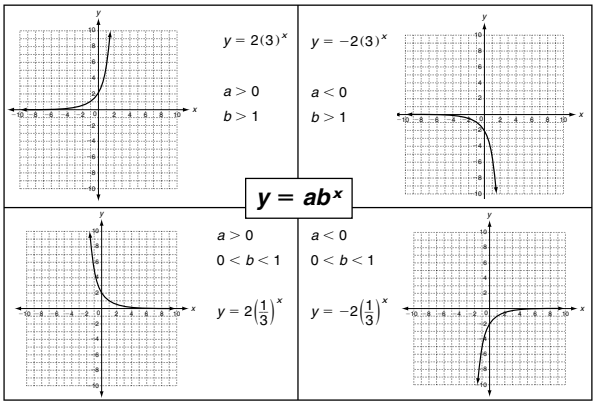


LESSON 11-2

## Reading Strategies

### *Analyzing Information*

An *exponential function* is always in the form $f(x) = ab^x$. And the graph of an exponential function is always the same general shape. But the values of $a$ and $b$ determine the quadrants the graph is in, and the "direction" in which the graph is facing. Analyze the information in the examples below.




**Respond to each statement by writing *sometimes*, *always*, or *never*.**

**1.** When $a$ is negative, the graph of $y = ab^x$ is contained entirely in quadrants III and IV.

always

**2.** When $b$ is a fraction, the graph of $y = ab^x$ is contained entirely in quadrants I and II.

sometimes

**3.** The $y$-intercept of $y = ab^x$ is at $a$.

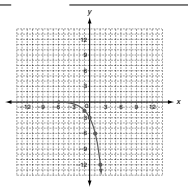
always

**4.** The graph of $y = ab^x$ is a straight line.

never

**5.** Complete the table of values and sketch the graph of $y = -3(2)^x$.

| $x$ | $y$ |
|---|---|
| $-1$ | $-\frac{3}{2}$ |
| 0 | $-3$ |
| 1 | $-6$ |
| 2 | $-12$ |



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