

 5-Minute Check

Over Lesson 7-4

5 Evaluate the quotient $\frac{6.33 \times 10^5}{2.11 \times 10^{-3}}$.

A. 3×10^6

B. 3×10^7

C. 3×10^8

D. 30×10^8

 5-Minute Check

Over Lesson 7-4

5 Evaluate the quotient $\frac{6.33 \times 10^5}{2.11 \times 10^{-3}}$.

A. 3×10^6

B. 3×10^7

 C. 3×10^8

D. 30×10^8

KeyConcept Graphs of Exponential Functions

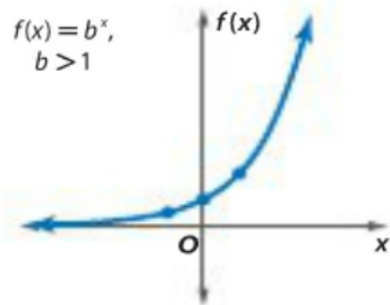
Exponential Growth Functions

Equation: $f(x) = ab^x$, $a > 0$, $b > 1$

Domain, Range: all reals; all positive reals

Intercepts: one y -intercept, no x -intercepts

End behavior: as x increases, $f(x)$ increases;
as x decreases, $f(x)$ approaches 0



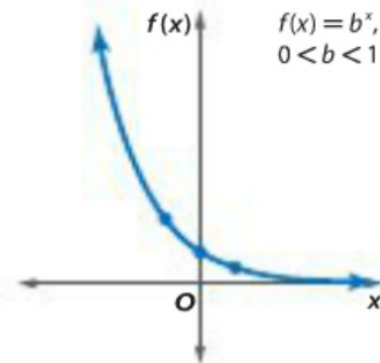
Exponential Decay Functions

Equation: $f(x) = ab^x$, $a > 0$, $0 < b < 1$

Domain, Range: all reals; all positive reals

Intercepts: one y -intercept, no x -intercepts

End behavior: as x increases, $f(x)$ approaches 0;
as x decreases, $f(x)$ increases



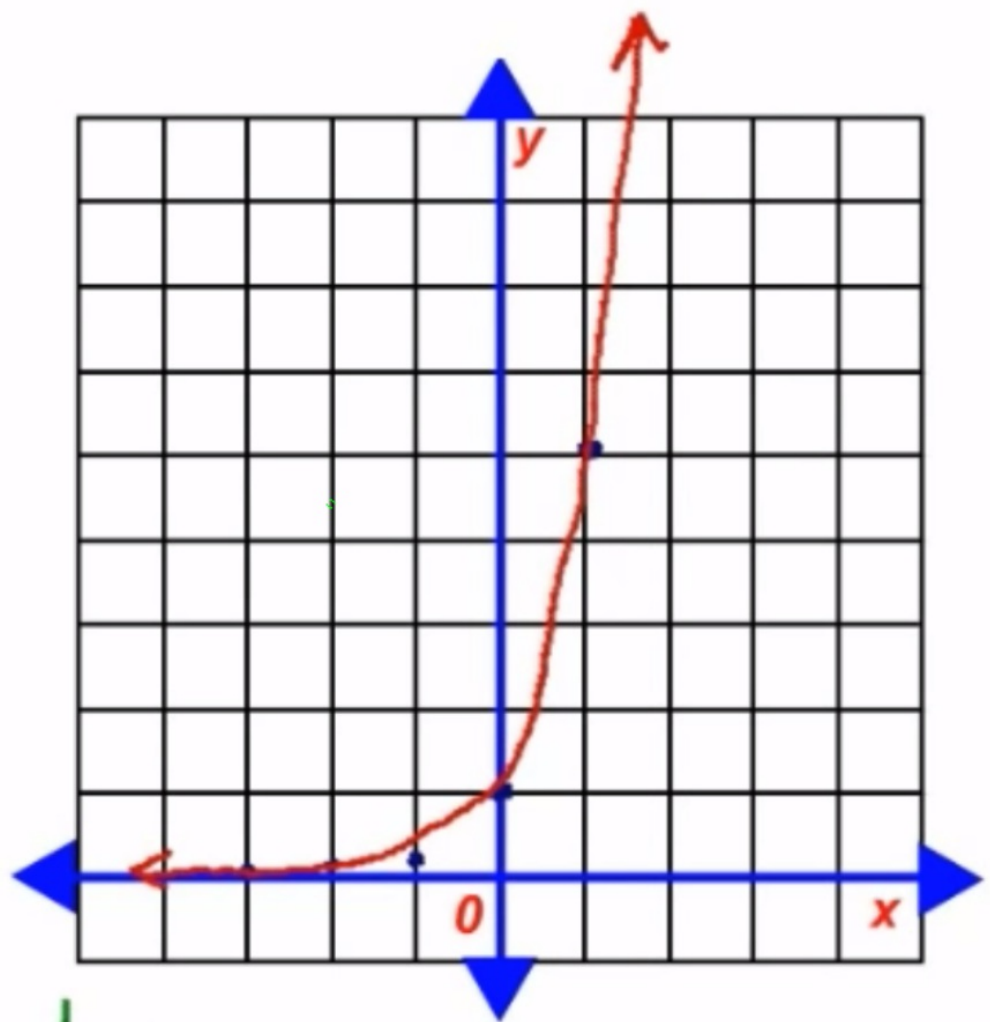
Graph $y = 5^x$. Find the y-intercept, and state the domain and range.

x	5^x	y
-3	5^{-3}	$1/125$
-2	5^{-2}	$1/25$
-1	5^{-1}	$1/5$
0	5^0	1
1	5^1	5
2	5^2	25
3	5^3	125

y-intercept: 1

Domain: real

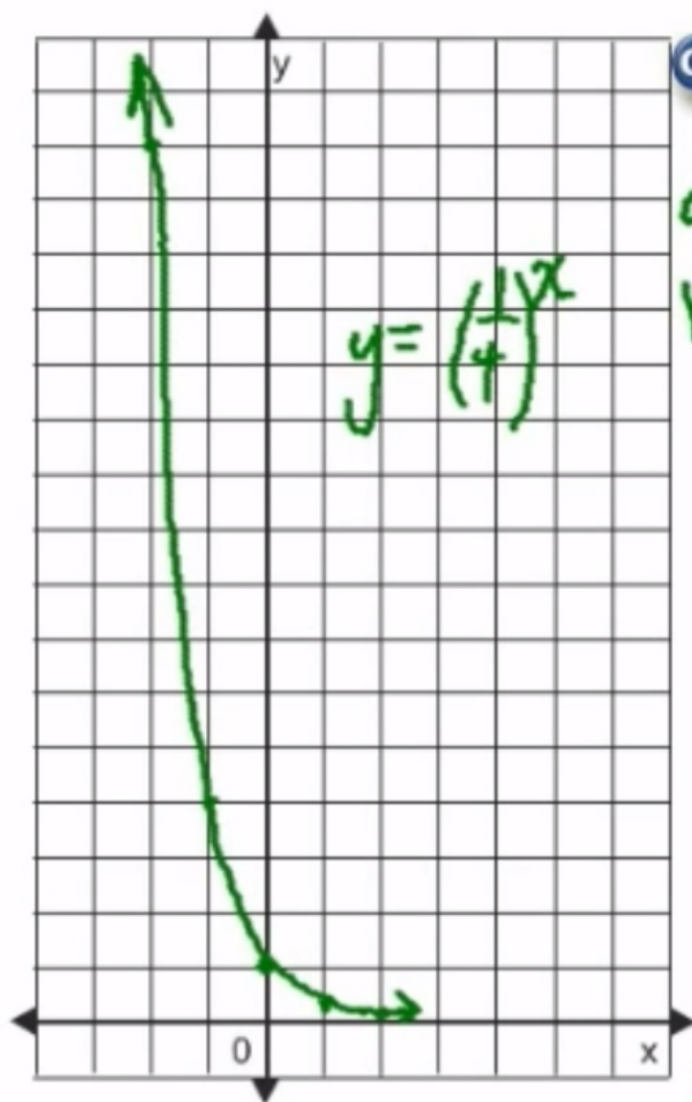
Range: positive real



x	$(\frac{1}{4})^x$	y
-2	$(\frac{1}{4})^{-2}$	16
-1	$(\frac{1}{4})^{-1}$	4
0	$(\frac{1}{4})^0$	1
1	$(\frac{1}{4})^1$	$\frac{1}{4}$
2	$(\frac{1}{4})^2$	$\frac{1}{16}$

$$y = \left(\frac{1}{4}\right)^x$$

$$\left(\frac{1}{4}\right)^x \neq 0$$



Glencoe Personal Tutor

domain = reals
range = positive reals

$$y = \left(\frac{1}{4}\right)^1 = \frac{1}{4} = 0.25$$

$$y = \left(\frac{1}{4}\right)^{1.5} \approx 0.1$$

$$y = \left(\frac{1}{4}\right)^{1.5} = 0.125$$

Then use the graph to approximate the value of $(\frac{1}{4})^{1.5}$.



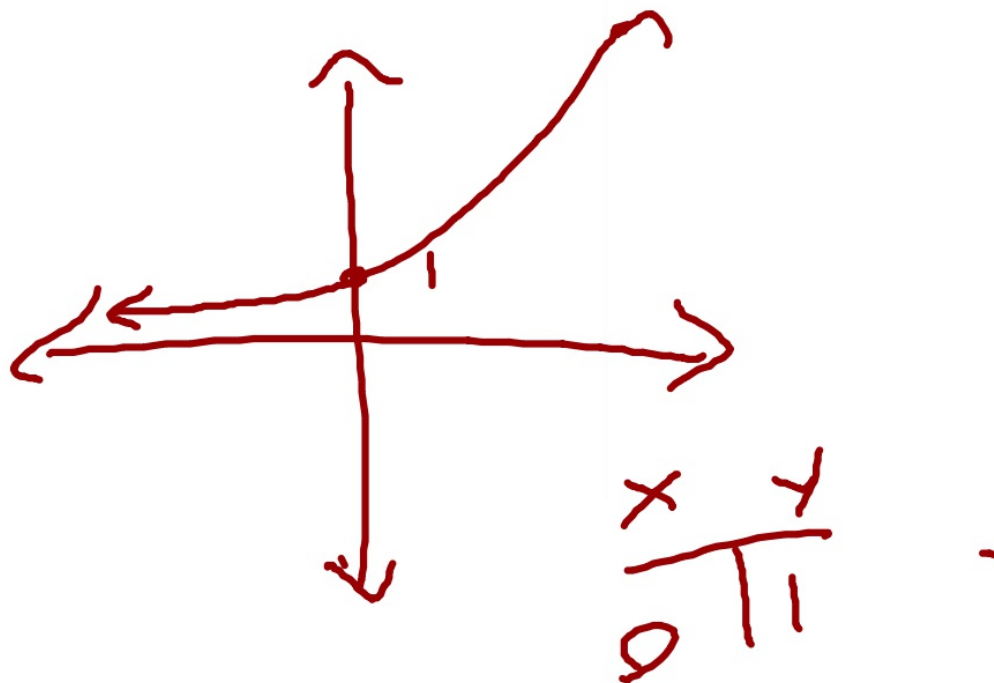
LESSON 7-5 Exponential Functions

EXAMPLE 1 Graph with $a > 0$ and $b > 1$

A. Graph $y = 4^x$. Find the y-intercept and state the domain and range.

x	4^x	y
-1	4^{-1}	$\frac{1}{4}$
0	4^0	1
1	4^1	4
2	4^2	16

This will not be given to you in the HW... you'll need to create it!

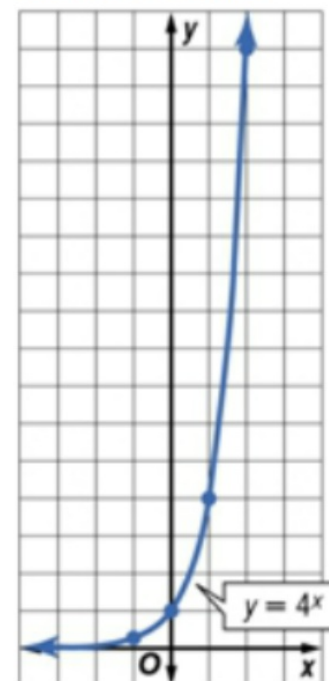


EXAMPLE 1 Graph with $a > 0$ and $b > 1$

A. Graph $y = 4^x$. Find the y -intercept and state the domain and range.

x	4^x	y
-1	4^{-1}	$\frac{1}{4}$
0	4^0	1
1	4^1	4
2	4^2	16

Graph the ordered pairs and connect the points with a smooth curve.

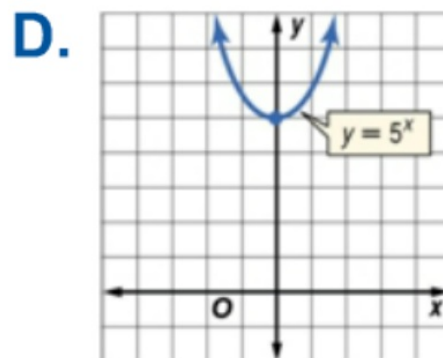
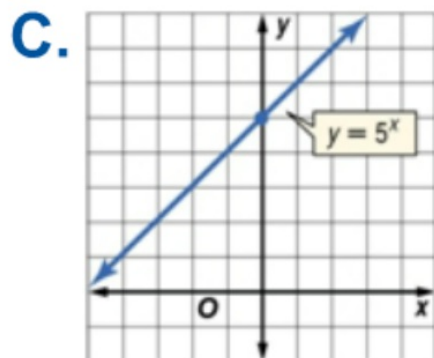
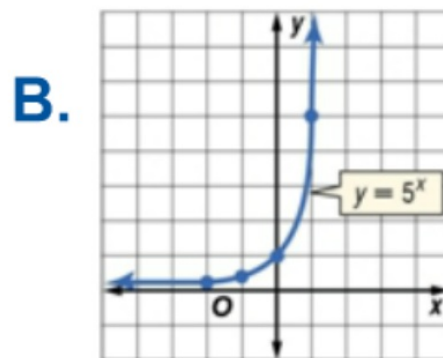
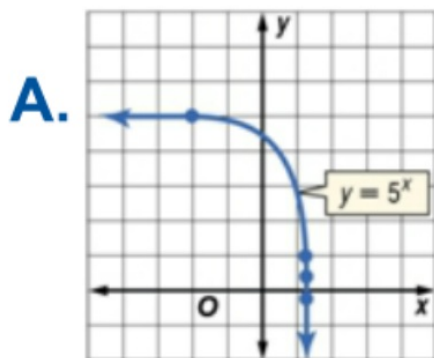


Answer: The graph crosses the y -axis at 1, so the y -intercept is 1. The domain is all real numbers and the range is all positive real numbers.

EXAMPLE 1

✓ Check Your Progress

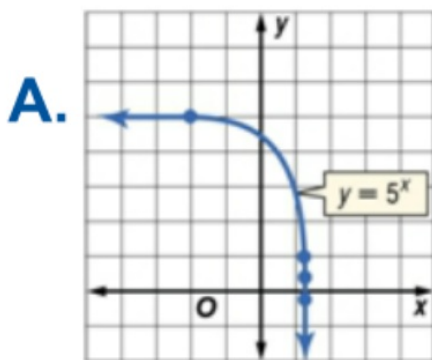
A. Graph $y = 5^x$.



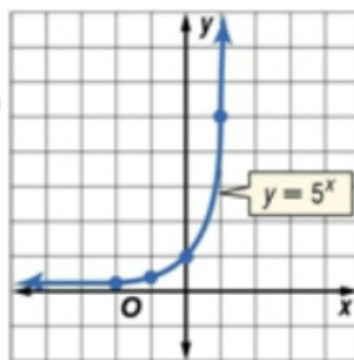
EXAMPLE 1

✓ Check Your Progress

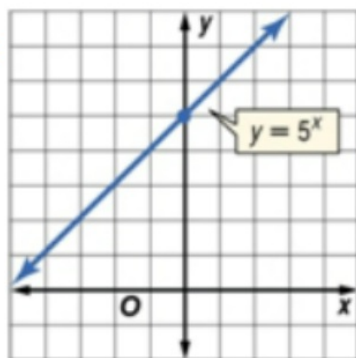
A. Graph $y = 5^x$.



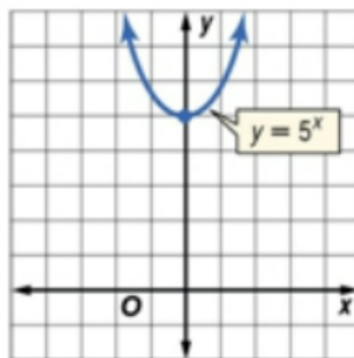
B.



C.



D.

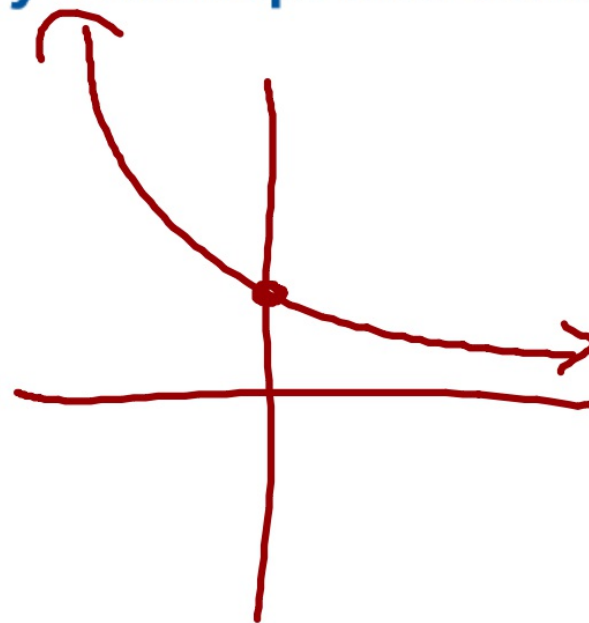


LESSON 7-5 Exponential Functions

EXAMPLE 2 Graph with $a > 0$ and $0 < b < 1$

A. Graph $y = \left(\frac{1}{4}\right)^x$. Find the y-intercept and state the domain and range.

x	$\left(\frac{1}{4}\right)^x$	y
-1	$\left(\frac{1}{4}\right)^{-1}$	4
0	$\left(\frac{1}{4}\right)^0$	1
1	$\left(\frac{1}{4}\right)^1$	$\frac{1}{4}$



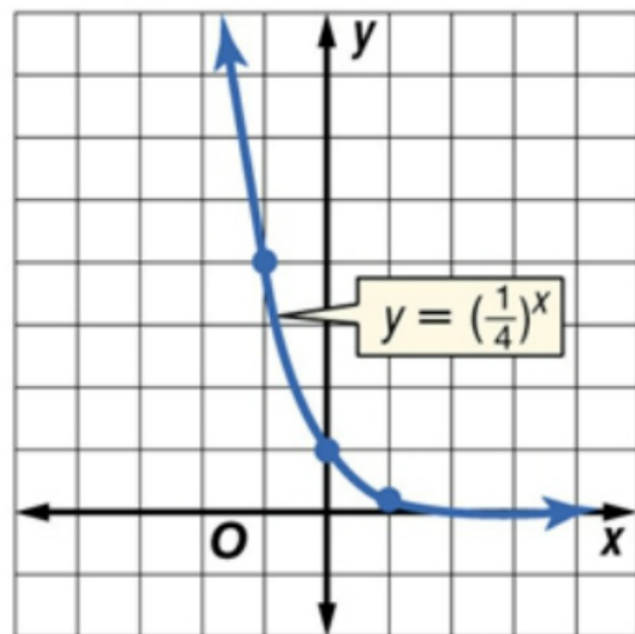
again, you'll have to create your own table.

EXAMPLE 2 Graph with $a > 0$ and $0 < b < 1$

A. Graph $y = \left(\frac{1}{4}\right)^x$. Find the y -intercept and state the domain and range.

x	$\left(\frac{1}{4}\right)^x$	y
-1	$\left(\frac{1}{4}\right)^{-1}$	4
0	$\left(\frac{1}{4}\right)^0$	1
1	$\left(\frac{1}{4}\right)^1$	$\frac{1}{4}$

Graph the ordered pairs and connect the points with a smooth curve.

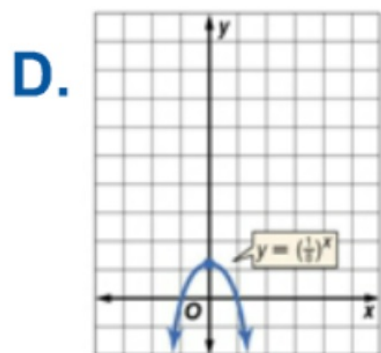
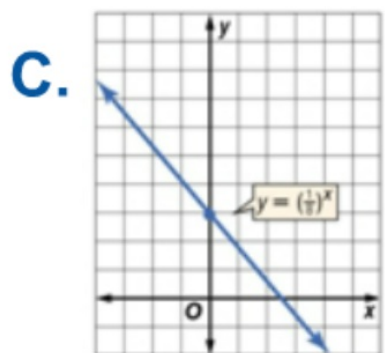
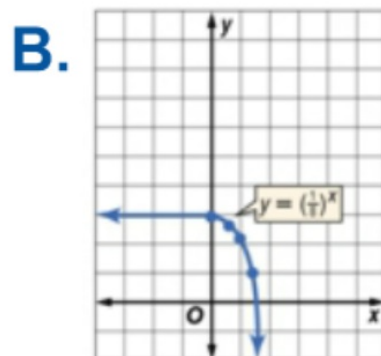
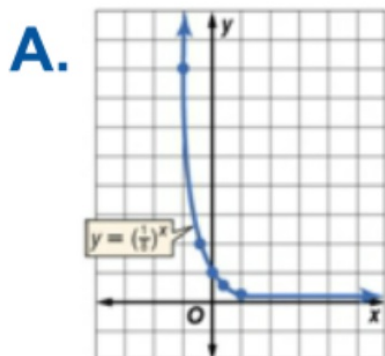


Answer: The y -intercept is 1. The domain is all real numbers and the range is all positive real numbers.

EXAMPLE 2

✓ Check Your Progress

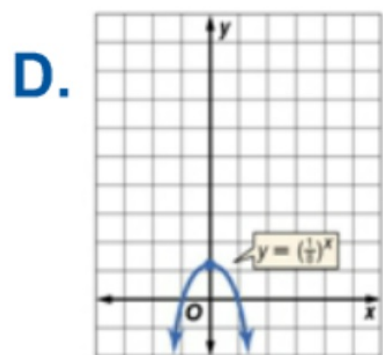
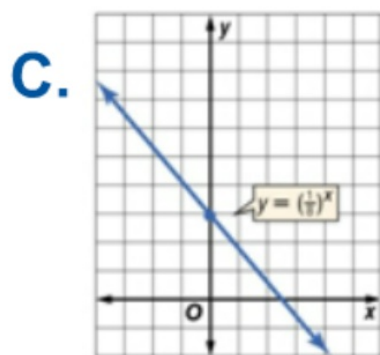
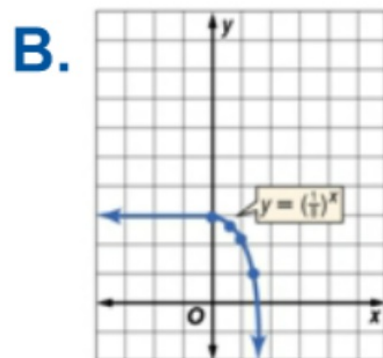
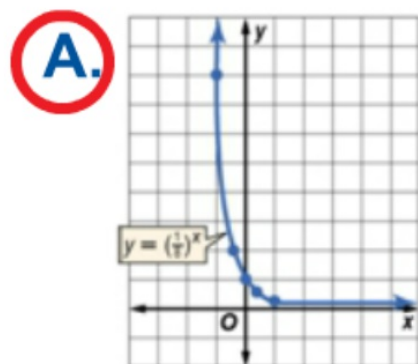
A. Graph $y = \left(\frac{1}{8}\right)^x$.



EXAMPLE 2

✓ Check Your Progress

A. Graph $y = \left(\frac{1}{8}\right)^x$.



LESSON 7-5 Exponential Functions

Key Concept Exponential Function

Words An exponential function is a function that can be described by an equation of the form $y = ab^x$, where $a \neq 0$, $b > 0$, and $b \neq 1$.

Examples

$$y = 2(3)^x$$

$$y = 4^x$$

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

Check Your Understanding

 = Step-by-Step Solutions begin on page R13.

Examples 1–2 Graph each function. Find the y -intercept and state the domain and range.

1. $y = 2^x$

2. $y = -5^x$

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

4. $y = 3\left(\frac{1}{4}\right)^x$

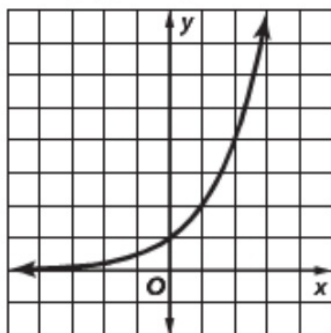
5. $f(x) = 6^x + 3$

6. $f(x) = 2 - 2^x$

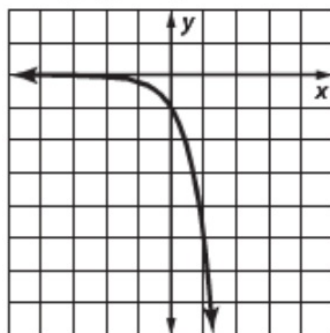
1–6. See Ch. 7 Answer Appendix.

Lesson 7-5

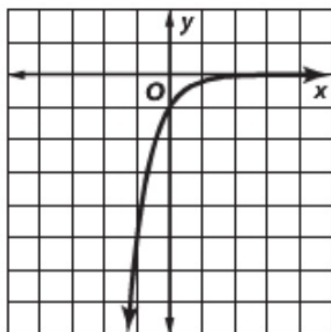
1. 1; $D = \{\text{all real numbers}\}$;
 $R = \{y \mid y > 0\}$



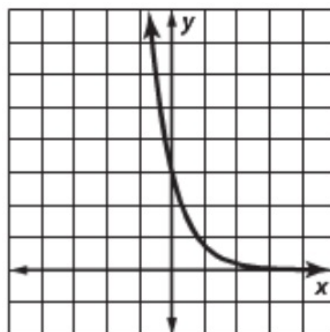
2. -1; $D = \{\text{all real numbers}\}$;
 $R = \{y \mid y < 0\}$



3. -1; $D = \{\text{all real numbers}\}$;
 $R = \{y \mid y < 0\}$



4. 3; $D = \{\text{all real numbers}\}$;
 $R = \{y \mid y > 0\}$



Check Your Understanding

 = Step-by-Step Solutions begin on page R13.

Examples 1–2 Graph each function. Find the y -intercept and state the domain and range.

1. $y = 2^x$

2. $y = -5^x$

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

4. $y = 3\left(\frac{1}{4}\right)^x$

5. $f(x) = 6^x + 3$

6. $f(x) = 2 - 2^x$

1–6. See Ch. 7 Answer Appendix.

Handwritten work for problem 5:

$$6^1 + 3$$

$$6^{-1} + 3$$

$$6^{\frac{1}{2}} + 3$$

$$6^0 + 3$$

$$1 + 3$$

5

x	y
-2	$3\frac{1}{36}$
-1	$3\frac{1}{6}$
0	4
1	9
2	39
	$6^2 + 3$
	$36 + 3$
	39

Handwritten calculations for x = -2 and x = -1:

$$6^{-2} + 3 = \frac{1}{36} + 3$$

$$6^{-1} + 3 = \frac{1}{6} + 3$$

EXAMPLE 4 Identify Exponential Behavior

Determine whether the set of data displays exponential behavior. Explain why or why not.

x	0	10	20	30
y	10	25	62.5	156.25

EXAMPLE 4 Identify Exponential Behavior

Determine whether the set of data displays exponential behavior. Explain why or why not.

x	0	10	20	30
y	10	25	62.5	156.25

For any exponential behavior, $y = ab^x$, you are either multiplying or dividing by a common factor (or ratio).

EXAMPLE 4 Identify Exponential Behavior

Answer: Since the domain values are at regular intervals and the range values differ by a positive common factor, the data are probably exponential. The equation for the data may involve $(2.5)^x$.

EXAMPLE 4

 Check Your Progress

Determine whether the set of data displays exponential behavior.

x	0	10	20	30
y	100	50	25	12.5

- A. no
- B. yes
- C. cannot be determined

EXAMPLE 4



Check Your Progress

Determine whether the set of data displays exponential behavior.

x	0	10	20	30
y	100	50	25	12.5

- A. no
- B. yes
- C. cannot be determined

Check Your Understanding

 = Step-by-Step Solutions begin on page R13.



Examples 1–2 Graph each function. Find the y -intercept and state the domain and range.

1. $y = 2^x$

2. $y = -5^x$

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

4. $y = 3\left(\frac{1}{4}\right)^x$

5. $f(x) = 6^x + 3$

6. $f(x) = 2 - 2^x$

1–6. See Ch. 7 Answer Appendix.

Example 3

7. **BIOLOGY** The function $f(t) = 100(1.05)^t$ models the growth of a fruit fly population, where $f(t)$ is the number of flies and t is time in days.

- What values for the domain and range are reasonable in the context of this situation? Explain. **$D = \{d \mid d \geq 0\}$, the number of days is greater than or equal to 0; $R = \{y \mid y \geq 100\}$, the number of fruit flies is greater than or equal to 100.**
- After two weeks, approximately how many flies are in this population? **about 198 fruit flies**

Example 4

Determine whether the set of data shown below displays exponential behavior. Write *yes* or *no*. Explain why or why not. **8–9. See margin.**

8.

x	1	2	3	4	5	6
y	-4	-2	0	2	4	6

9.

x	2	4	6	8	10	12
y	1	4	16	64	256	1024

10. $y = 2 \cdot 8^x$

11. $y = 2 \cdot \left(\frac{1}{6}\right)^x$

12. $y = \left(\frac{1}{12}\right)^x$

13. $y = -3 \cdot 9^x$

14. $y = -4 \cdot 10^x$

15. $y = 3 \cdot 11^x$

16. $y = 4^x + 3$

17. $y = \frac{1}{2}(2^x - 8)$

18. $y = 5(3^x) + 1$

19. $y = -2(3^x) + 5$

Example 3

20. **CCSS MODELING** A population of bacteria in a culture increases according to the model $p = 300(2.7)^{0.02t}$, where t is the number of hours and $t = 0$ corresponds to 9:00 A.M.

- a. Use this model to estimate the number of bacteria at 11 A.M. **about 312**
- b. Graph the function and name the p -intercept. Describe what the p -intercept represents, and describe a reasonable domain and range for this situation. **See Ch. 7 Answer Appendix.**

Example 4

Determine whether the set of data shown below displays exponential behavior. Write *yes* or *no*. Explain why or why not. **21–24. See margin.**

21.

x	-4	0	4	8	12
y	2	-4	8	-16	32

22.

x	-6	-3	0	3
y	5	10	15	20

23.

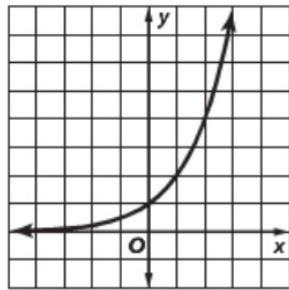
x	-8	-6	-4	-2
y	0.25	0.5	1	2

24.

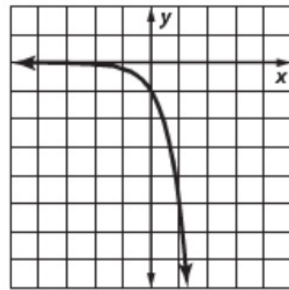
x	20	30	40	50	60
y	1	0.4	0.16	0.064	0.0256

Lesson 7-5

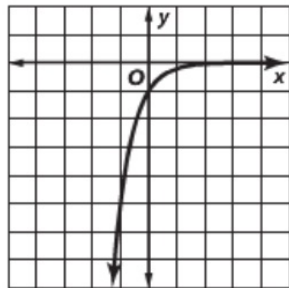
1. 1; $D = \{\text{all real numbers}\}$;
 $R = \{y \mid y > 0\}$



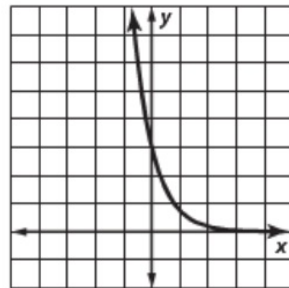
2. -1; $D = \{\text{all real numbers}\}$;
 $R = \{y \mid y < 0\}$



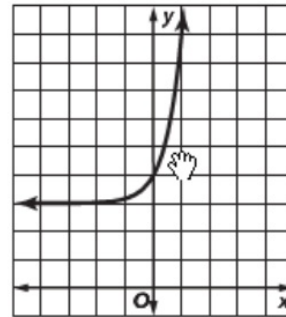
3. -1; $D = \{\text{all real numbers}\}$;
 $R = \{y \mid y < 0\}$



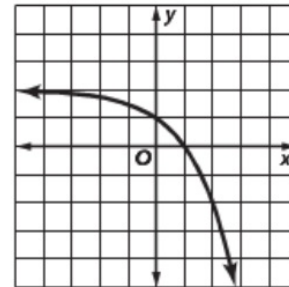
4. 3; $D = \{\text{all real numbers}\}$;
 $R = \{y \mid y > 0\}$



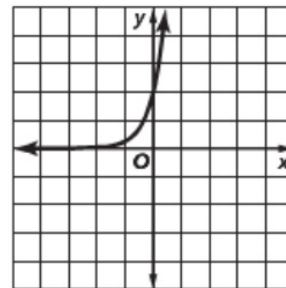
5. 4; $D = \{\text{all real numbers}\}$;
 $R = \{y \mid y > 3\}$



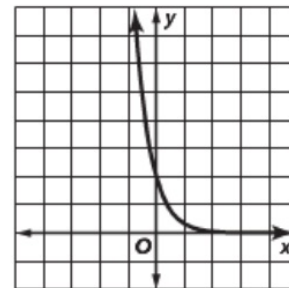
6. 1; $D = \{\text{all real numbers}\}$;
 $R = \{y \mid y < 2\}$



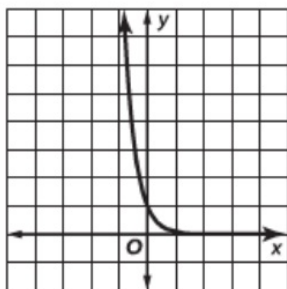
10. 2; $D = \{\text{all real numbers}\}$;
 $R = \{y \mid y > 0\}$



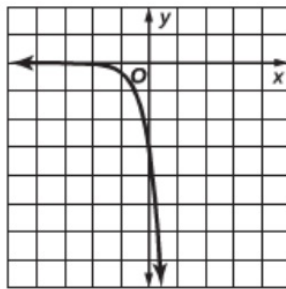
11. 2; $D = \{\text{all real numbers}\}$;
 $R = \{y \mid y > 0\}$



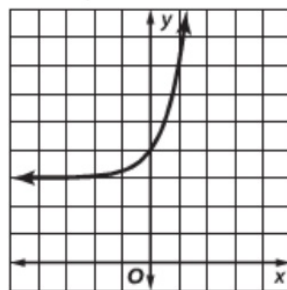
12. 1; $D = \{\text{all real numbers}\}$;
 $R = \{y \mid y > 0\}$



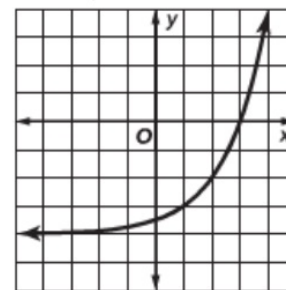
13. -3; $D = \{\text{all real numbers}\}$;
 $R = \{y \mid y < 0\}$



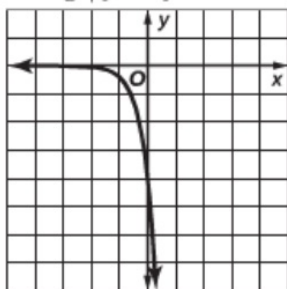
16. 4; $D = \{\text{all real numbers}\}$;
 $R = \{y \mid y > 3\}$



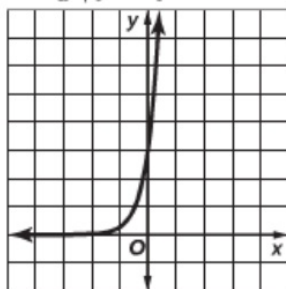
17. -3.5; $D = \{\text{all real numbers}\}$;
 $R = \{y \mid y > -4\}$



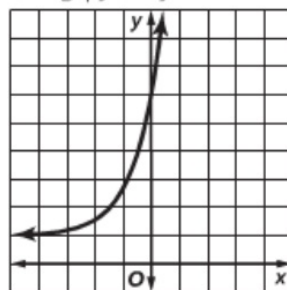
14. -4; $D = \{\text{all real numbers}\}$;
 $R = \{y \mid y < 0\}$



15. 3; $D = \{\text{all real numbers}\}$;
 $R = \{y \mid y > 0\}$



18. 6; $D = \{\text{all real numbers}\}$;
 $R = \{y \mid y > 1\}$



19. 3; $D = \{\text{all real numbers}\}$;
 $R = \{y \mid y < 5\}$

