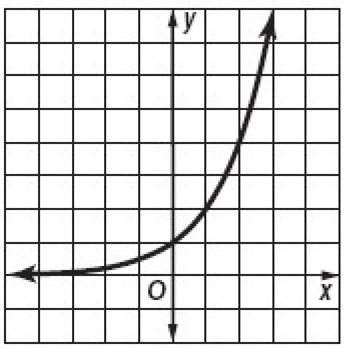
Graph each function. Find the *y*-intercept and state the domain and range.

1. $y = 2^x$

SOLUTION:

Complete a table of values for –2 < *x* < 2. Connect the points on the graph with a smooth curve.

x	2^x	y
–2	2^{-2}	0.25
–1	2^{-1}	0.5
0	2^0	1
1	2^1	2
2	2^2	4



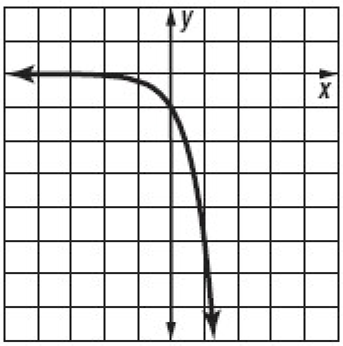
The graph crosses the *y*-axis at 1. The domain is all real numbers, and the range is all real numbers greater than 0.

2. $y = -5^x$

SOLUTION:

Complete a table of values for –2 < x < 2. Connect the points on the graph with a smooth curve.

x	$-(5^x)$	y
–2	$-(5^{-2})$	–0.04
–1	$-(5^{-1})$	–0.2
0	$-(5^0)$	–1
1	$-(5^1)$	–5
2	$-(5^2)$	–25



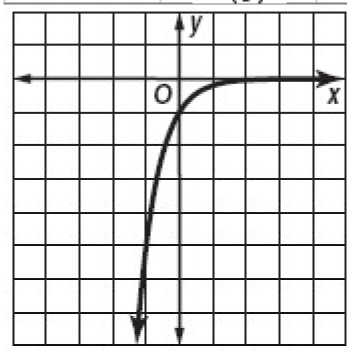
The graph crosses the y-axis at –1. The domain is all real numbers, and the range is all real numbers less than 0.

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

SOLUTION:

Complete a table of values for –**2 < *x* < 2. Connect the points on the graph with a smooth curve.**

x	$-\left(\frac{1}{5}\right)^x$	*y*
–2	$-\left(\frac{1}{5}\right)^{-2}$	–25
–1	$-\left(\frac{1}{5}\right)^{-1}$	–-5
0	$-\left(\frac{1}{5}\right)^{0}$	–1
1	$-\left(\frac{1}{5}\right)^{1}$	–0.2
2	$-\left(\frac{1}{5}\right)^{2}$	–0.04



The graph crosses the *y*-axis at –1. The domain is all real numbers, and the range is all real numbers less than 0.

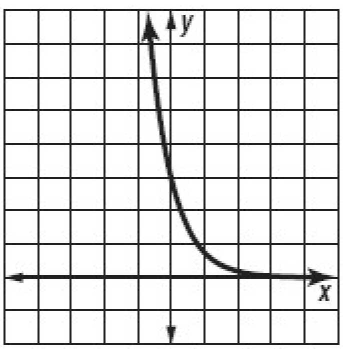
4. $y = 3\left(\frac{1}{4}\right)^x$

SOLUTION:

Complete a table of values for

–2 < *x* < 2. Connect the points on the graph with a smooth curve.

x	$3\left(\frac{1}{4}\right)^x$	y
–2	$3\left(\frac{1}{4}\right)^{-2}$	48
–1	$3\left(\frac{1}{4}\right)^{-1}$	12
0	$3\left(\frac{1}{4}\right)^{0}$	3
1	$3\left(\frac{1}{4}\right)^{1}$	0.75
2	$3\left(\frac{1}{4}\right)^{2}$	0.188



The graph crosses the y-axis at 3. The domain is all real numbers, and the range is all real numbers greater than 0.

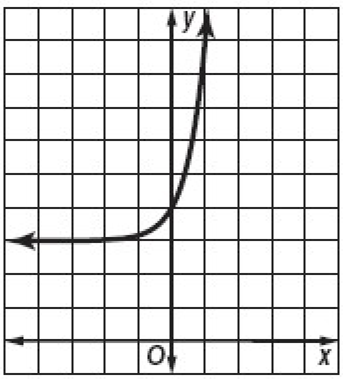
7-5 Exponential Functions

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

SOLUTION:

Complete a table of values for $-2 < x < 2$. Connect the points on the graph with a smooth curve.

x	$6^x + 3$	y
–2	$6^{-2} + 3$	3.03
–1	$6^{-1} + 3$	3.17
0	$6^0 + 3$	4
1	$6^1 + 3$	9
2	$6^2 + 3$	39



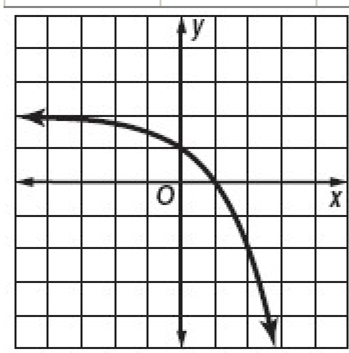
The graph crosses the y-axis at 4. The domain is all real numbers, and the range is all real numbers greater than 3.

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

SOLUTION:

Complete a table of values for $-2 < x < 2$. Connect the points on the graph with a smooth curve.

x	$2 - 2^x$	y
–2	$2 - 2^{-2}$	1.75
–1	$2 - 2^{-1}$	1.5
0	$2 - 2^0$	1
1	$2 - 2^1$	0
2	$2 - 2^2$	–2



The graph crosses the y-axis at 1. The domain is all real numbers, and the range is all real numbers less than 2.

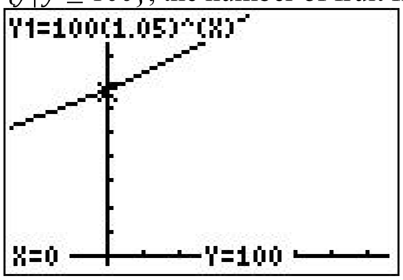
7. **BIOLOGY** The function $f(t) = 100(1.05)^t$ models the growth of a fruit fly population, where $f(t)$ is the number of flies and t is time in days.

a. What values for the domain and range are reasonable in the context of this situation? Explain.

b. After two weeks, approximately how many flies are in this population?

SOLUTION:

a. D = $\{t \mid t \geq 0\}$, the number of days is greater than or equal to 0; The y-intercept is (0, 100). Since $t \geq 0$, then R = $\{y \mid y \geq 100\}$, the number of fruit flies is greater than or equal to 100.



[-5, 15] scl: 2 by [-5, 145] scl: 15

b. $f(t) = 100(1.05)^{14}$

$= 197.99$

After two weeks, there will be about 198 fruit flies in this population.

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

8.

x	1	2	3	4	5	6
y	−4	−2	0	2	4	6

SOLUTION:

+1 +1 +1 +1 +1

x	1	2	3	4	5	6
y	−4	−2	0	2	4	6

−2 −2 −2 −2 −2

The data shown does not display exponential behavior. The domain values are at regular intervals. However the range values have a common difference of 2.

9.

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

SOLUTION:

+2 +2 +2 +2 +2

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

×4 ×4 ×4 ×4 ×4

The data in the table displays exponential behavior. The domain values are at regular intervals, and the range values have a common factor of 4.

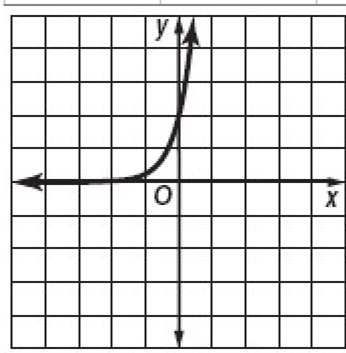
Graph each function. Find the y-intercept and state the domain and range.

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

SOLUTION:

Complete a table of values for $-2 < x < 2$. **Connect the points on the graph with a smooth curve.**

x	$2 \bullet 8^x$	y
–2	$2 \bullet 8^{-2}$	0.03
–1	$2 \bullet 8^{-1}$	0.25
0	$2 \bullet 8^0$	2
1	$2 \bullet 8^1$	16
2	$2 \bullet 8^2$	128



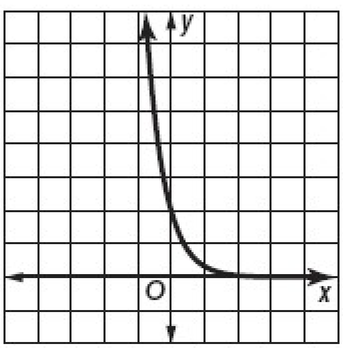
The graph crosses the y-axis at 2. The domain is all real numbers, and the range is all real numbers greater than 0.

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

SOLUTION:

Complete a table of values for $-2 < x < 2$. **Connect the points on the graph with a smooth curve.**

x	$2\left(\frac{1}{6}\right)^x$	y
–2	$2\left(\frac{1}{6}\right)^{-2}$	72
–1	$2\left(\frac{1}{6}\right)^{-1}$	12
0	$2\left(\frac{1}{6}\right)^{0}$	2
1	$2\left(\frac{1}{6}\right)^{1}$	0.33
2	$2\left(\frac{1}{6}\right)^{2}$	0.06



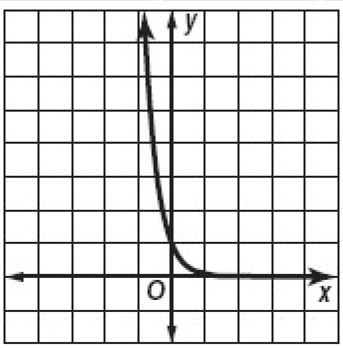
The graph crosses the y-axis at 2. The domain is all real numbers, and the range is all real numbers greater than 0.

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

SOLUTION:

Complete a table of values for $-2 < x < 2$. **Connect the points on the graph with a smooth curve.**

x	$\left(\frac{1}{12}\right)^x$	y
–2	$\left(\frac{1}{12}\right)^{-2}$	144
–1	$\left(\frac{1}{12}\right)^{-1}$	12
0	$\left(\frac{1}{12}\right)^{0}$	1
1	$\left(\frac{1}{12}\right)^{1}$	0.08
2	$\left(\frac{1}{12}\right)^{2}$	0.01



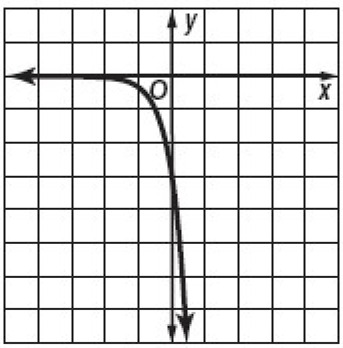
The graph crosses the y-axis at 1. The domain is all real numbers, and the range is all real numbers greater than 0.

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

SOLUTION:

Complete a table of values for $-2 < x < 2$. **Connect the points on the graph with a smooth curve.**

x	$-3 \bullet 9^x$	y
–2	$-3 \bullet 9^{-2}$	–0.04
–1	$-3 \bullet 9^{-1}$	–0.33
0	$-3 \bullet 9^{0}$	–3
1	$-3 \bullet 9^{1}$	–27
2	$-3 \bullet 9^{2}$	–243



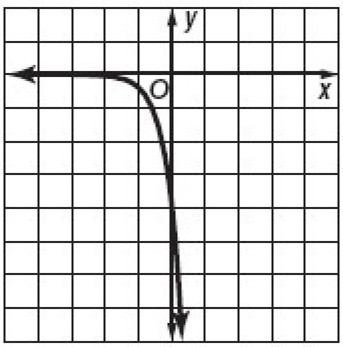
The graph crosses the y-axis at –3. The domain is all real numbers, and the range is all real numbers less than 0.

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

SOLUTION:

Complete a table of values for **$-2 < x < 2$. Connect the points on the graph with a smooth curve.**

x	$-4 \cdot 10^x$	y
–2	$-4 \cdot 10^{-2}$	–0.04
–1	$-4 \cdot 10^{-1}$	–0.4
0	$-4 \cdot 10^{0}$	–4
1	$-4 \cdot 10^{1}$	–40
2	$-4 \cdot 10^{2}$	–400



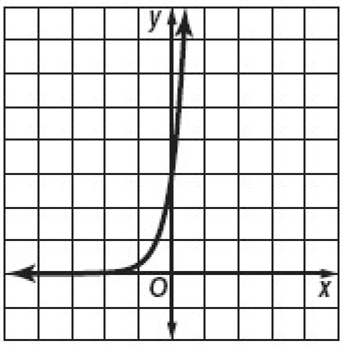
The graph crosses the y-axis at –4. The domain is all real numbers, and the range is all real numbers less than 0.

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

SOLUTION:

Complete a table of values for $-2 < x < 2$. **Connect the points on the graph with a smooth curve.**

x	$3 \cdot 11^x$	y
–2	$3 \cdot 11^{-2}$	0.02
–1	$3 \cdot 11^{-1}$	0.27
0	$3 \cdot 11^0$	3
1	$3 \cdot 11^1$	33
2	$3 \cdot 11^2$	363



The graph crosses the y-axis at 3. The domain is all real numbers, and the range is all real numbers greater than 0.

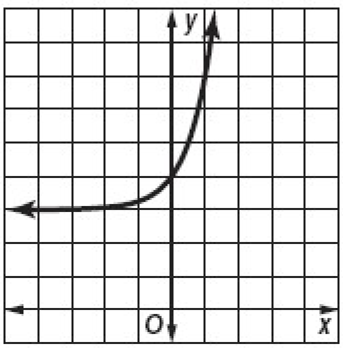
7-5 Exponential Functions

16. $y = 4^x + 3$

SOLUTION:

Complete a table of values for $-2 < x < 2$. Connect the points on the graph with a smooth curve.

x	$4^x + 3$	y
–2	$4^{-2} + 3$	3.06
–1	$4^{-1} + 3$	3.25
0	$4^0 + 3$	4
1	$4^1 + 3$	7
2	$4^2 + 3$	19



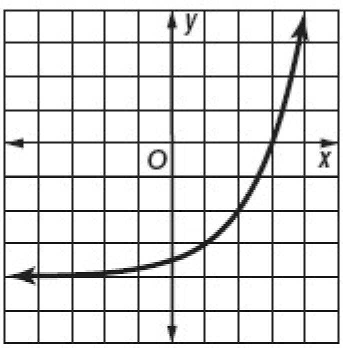
The y-intercept is (0, 4). The domain is all real numbers, and the range is all real numbers greater than 3.

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

SOLUTION:

Complete a table of values for $-2 < x < 2$. Connect the points on the graph with a smooth curve.

x	$\frac{1}{2}(2^x - 8)$	y
–2	$\frac{1}{2}(2^{-2} - 8)$	–3.9
–1	$\frac{1}{2}(2^{-1} - 8)$	–3.75
0	$\frac{1}{2}(2^{0} - 8)$	–3.5
1	$\frac{1}{2}(2^{1} - 8)$	–3
2	$\frac{1}{2}(2^{2} - 8)$	–2



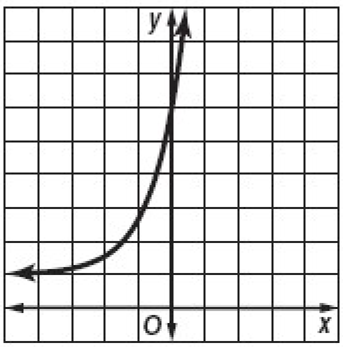
The y-intercept is (0, –3.5). The domain is all real numbers, and the range is all real numbers greater than –4.

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

SOLUTION:

Complete a table of values for $-2 < x < 2$. Connect the points on the graph with a smooth curve.

x	$5(3^x) + 1$	y
-2	$5(3^{-2}) + 1$	1.5
-1	$5(3^{-1}) + 1$	2.7
0	$5(3^0) + 1$	6
1	$5(3^1) + 1$	16
2	$5(3^2) + 1$	46



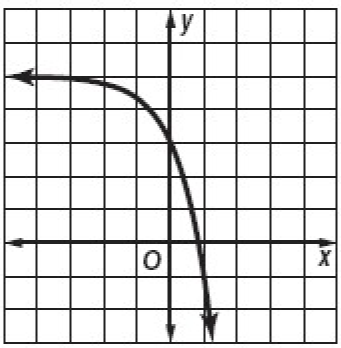
The y-intercept is (0, 6). The domain is all real numbers, and the range is all real numbers greater than 1.

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

SOLUTION:

Complete a table of values for $-2 < x < 2$. Connect the points on the graph with a smooth curve.

x	$-2(3^x) + 5$	y
-2	$-2(3^{-2}) + 5$	4.8
-1	$-2(3^{-1}) + 5$	4.3
0	$-2(3^0) + 5$	3
1	$-2(3^1) + 5$	-1
2	$-2(3^2) + 5$	-13



The y-intercept is (0, 3). The domain is all real numbers, and the range is all real numbers less than 5.

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.

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.

SOLUTION:

a.
$$\begin{aligned} p &= 300(2.7)^{0.02(2)} \\ &= 300(2.7)^{0.04} \\ &= 312.2 \end{aligned}$$

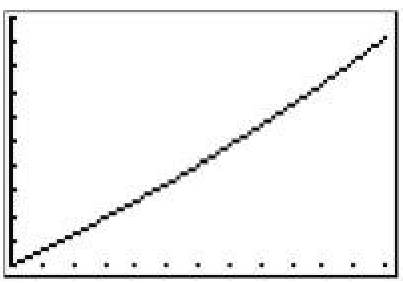
There will be about 312 bacteria at 11 A.M.

b. t at 0 is the p-intercept.

$$\begin{aligned} p &= 300(2.7)^{0.02(0)} \\ &= 300(2.7)^{0} \\ &= 300(1) \\ &= 300 \end{aligned}$$

The p-intercept is 300. This represents 300 bacteria in the culture at 9:00 A.M.

Enter the function as **Y1** on a graphing calculator and adjust the window to show 24 hours worth of bacteria growth.



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The domain is all real numbers greater than or equal to 0, because the time elapsed cannot be negative. The range is all real numbers greater than or equal to 300, because the number of bacteria in the culture starts at 300 and increases over time.

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

21.

x	−4	0	4	8	12
y	2	−4	8	−16	32

SOLUTION:

+4 +4 +4 +4

x	−4	0	4	8	12
y	2	−4	8	−16	32

×−2 ×−2 ×−2 ×−2

The data shown, does not display exponential behavior. The domain values are at regular intervals. However, the range values do not have a positive common factor.

22.

x	−6	−3	0	3
y	5	10	15	20

SOLUTION:

+3 +3 +3

x	−6	−3	0	3
y	5	10	15	20

+5 +5 +5

The data shown does not display exponential behavior. The domain values are at regular intervals. However, the range values have a common difference of 5.

23.

x	−8	−6	−4	−2
y	0.25	0.5	1	2

SOLUTION:

+2 +2 +2

x	−8	−6	−4	−2
y	0.25	0.5	1	2

×2 ×2 ×2

The data shown does display exponential behavior. The domain values are at regular intervals, and the range values have a common factor of 2.

24.

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

SOLUTION:

+10 +10 +10 +10 +10

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

×0.4 ×0.4 ×0.4 ×0.4 ×0.4

The data shown displays exponential behavior. The domain values are at regular intervals, and the range values have a common factor of 0.4.

25. **PHOTOGRAPHY** Jameka is enlarging a photograph to make a poster for school. She will enlarge the picture repeatedly at 150%. The function $P = 1.5^x$ models the new size of the picture being enlarged, where x is the number of enlargements. How many times as big is the picture after 4 enlargements?

SOLUTION:

$$\begin{aligned} P &= 1.5^x \\ &= 1.5^4 \\ &= 5.06 \end{aligned}$$

The picture is about 506% bigger than the original.

26. **FINANCIAL LITERACY** Daniel deposited \$500 into a savings account and after 8 years, his investment is worth \$807.07. The equation $A = d(1.005)^{12t}$ models the value of Daniel's investment A after t years with an initial deposit d.

a. What would the value of Daniel's investment be if he had deposited \$1000?
b. What would the value of Daniel's investment be if he had deposited \$250?
c. Interpret $d(1.005)^{12t}$ to explain how the amount of the original deposit affects the value of Daniel's investment.

SOLUTION:

a. Replace d with 1000 and t with 8 in the formula $A = d(1.005)^{12t}$ to determine the value of the investment.

$$\begin{aligned} A &= d(1.005)^{12t} && \text{Original formula} \\ A &= 1000(1.005)^{12(8)} && d = 1000, t = 8 \\ &= 1000(1.005)^{96} && \text{Multiply.} \\ &\approx 1614.14 && \text{Use a calculator.} \end{aligned}$$

So, if he deposits \$1000, after 8 years the investment will be worth about \$1614.14.

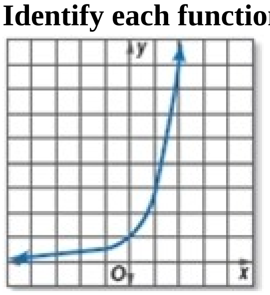
b. Replace d with 250 and t with 8 in the formula $A = d(1.005)^{12t}$ to determine the value of the investment.

$$\begin{aligned} A &= d(1.005)^{12t} && \text{Original formula} \\ A &= 250(1.005)^{12(8)} && d = 250, t = 8 \\ &= 250(1.005)^{96} && \text{Multiply.} \\ &\approx 403.54 && \text{Use a calculator.} \end{aligned}$$

So, if he deposits \$250, after 8 years the investment will be worth about \$403.54.

c. Sample answer: In the formula the amount deposited d is always multiplied by the same amount $(1.005)^{12t}$, which has a value greater than 1. Since Daniel's investment is the product of d and a factor not depending on d, it varies directly as the original deposit. That is, the greater the deposit, the greater the amount of the investment over time.

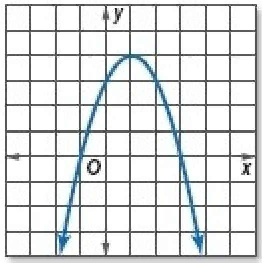
Identify each function as *linear, exponential*, or *neither*.

27. 

SOLUTION:

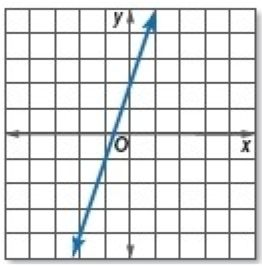
The graph is not a line, so the function is nonlinear. The graph contains the point (0, 1), is always positive, and increases rapidly as x increases. The function represented by the graph is exponential.

7-5 Exponential Functions

28. 

SOLUTION:

The graph is not a line, so the function is nonlinear. The graph does not contain the point (0, 1), is not always positive, or increases rapidly as x increases. The function represented by the graph is not exponential.

29. 

SOLUTION:

The graph displays a line with a constant slope. The function represented by the graph is linear.

30. $y = 4^x$

SOLUTION:

The function is in the form $y = ab^x$ with $a = 1$ and $b = 4$. The function is exponential.

31. $y = 2x(x - 1)$

SOLUTION:

$y = 2x(x - 1)$ Original function

$y = 2x^2 - 2x$ Distributive Property

The function is in the form of a linear or exponential function.

32. $5x + y = 8$

SOLUTION:

$5x + y = 8$ Original function

$y = -5x + 8$ Add $-5x$ to each side.

The function is now in $y = mx + b$ where $m = -5$ and $b = 8$. This is the form of a linear function.

33. **GRADUATION** The number of graduates at a high school has increased by a factor of 1.055 every year since 2001. In 2001, 110 students graduated. The function $N = 110(1.055)^t$ models the number of students N expected to graduate t years after 2001. How many students will graduate in 2012?

SOLUTION:

$$\begin{aligned} N &= 110(1.055)^t \\ &= 110(1.055)^{11} \\ &= 198.230 \end{aligned}$$

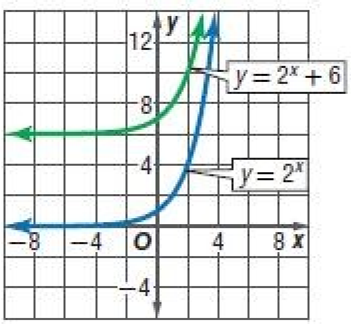
About 198 students will graduate in 2012.

Describe the graph of each equation as a transformation of the graph of $y = 2^x$.

34. $y = 2^x + 6$

SOLUTION:

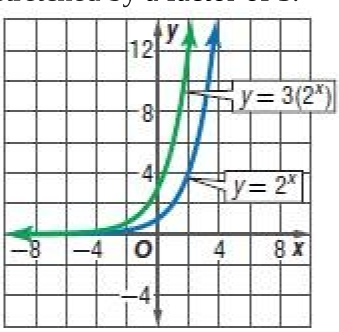
The graph of $f(x) = 2^x + c$ represents a vertical translation of the parent graph. The value of c is 6, and $6 > 0$. If $c > 0$, the graph of $f(x) = 2^x$ is translated $|c|$ units up. Therefore, the graph of $y = 2^x + 6$ is a translation of the graph of $y = 2^x$ 6 units up.



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

SOLUTION:

The graph of $f(x) = a(2)^x$ stretches or compresses the graph of $f(x) = 2^x$ vertically. The value of a is 3, and $3 > 1$. If $a > 1$, the graph of $f(x) = 2^x$ is stretched vertically. Therefore, the graph of $y = 3(2)^x$ is the graph of $y = 2^x$ vertically stretched by a factor of 3.

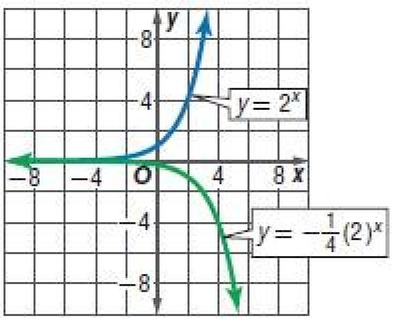


36. $y = -\frac{1}{4}(2)^x$

SOLUTION:

When $f(x)$ or the variable x is multiplied by –1, the graph is reflected over the x- or y-axis. The graph of the function $-f(x)$ reflects the graph of $f(x) = 2^x$ across the x-axis.

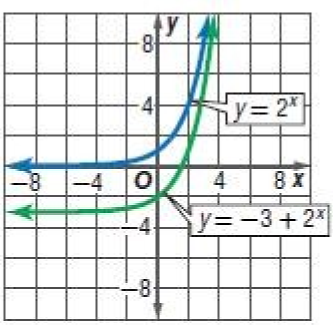
The graph of $f(x) = a(2)^x$ stretches or compresses the graph of $f(x) = 2^x$ vertically. The value of a is $\frac{1}{4}$, and $0 < \frac{1}{4} < 1$. If $0 < a < 1$, the graph of $f(x) = 2^x$ is compressed vertically. Therefore, the graph of $y = -\frac{1}{4}(2)^x$ is the graph of $y = 2^x$ reflected across the x-axis and vertically compressed.



37. $y = -3 + 2^x$

SOLUTION:

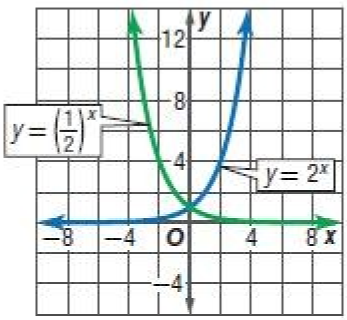
The graph of $f(x) = 2^x + c$ represents a vertical translation of the parent graph. The value of c is –3, and $-3 < 0$. If $c < 0$, the graph of $f(x) = 2^x$ is translated $|c|$ units down. Therefore, the graph of $y = -3 + 2^x$ is a translation of the graph of $y = 2^x$ shifted 3 units down.



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

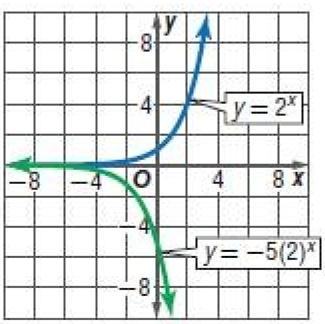
SOLUTION:

In the graph of $f(x) = 2^x$, $a > 1$, so y increases as x increases. In the graph of $y = \left(\frac{1}{2}\right)^x$, $0 < a < 1$, so y decreases as x increases. Therefore, the graph of $y = \left(\frac{1}{2}\right)^x$ is the graph of $y = 2^x$ reflected over the y-axis.



39. $y = -5(2)^x$

SOLUTION:
When $f(x)$ or the variable x is multiplied by –1, the graph is reflected over the x- or y-axis. The graph of the function $-f(x)$ reflects the graph of $f(x) = 2^x$ across the x-axis.
The graph of $f(x) = a(2)^x$ stretches or compresses the graph of $f(x) = 2^x$ vertically. The value of a is 5, and $5 > 1$. If $a > 1$, the graph of $f(x) = 2^x$ is stretched vertically. Therefore, the graph of $y = -5(2)^x$ is the graph of $y = 2^x$ reflected across the x-axis and vertically stretched by a factor of 5.



40. **DEER** A deer population at a national park doubles every year. In 2000, there were 25 deer in the park. The function $N = 25(2)^t$ models the number of deer N in the national park t years after 2000. Determine how many deer there will be in the park in 2015.

SOLUTION:

$$\begin{aligned} N &= 25(2)^t \\ &= 25(2)^{15} \\ &= 819{,}200 \end{aligned}$$

There will be 819,200 deer in the park in 2015.

41. **CCSS PERSEVERANCE** Write an exponential function for which the graph passes through the points at (0, 3) and (1, 6).

SOLUTION:

An exponential function is of the form $y = ab^x$. Substitute (0, 3) into the equation and solve for a.

$$y = ab^x$$
$$3 = ab^0$$
$$3 = a(1)$$
$$a = 3$$

Now use $a = 3$ and the point (1, 6) to solve for b.

$$6 = 3b^1$$
$$2 = b$$

So, $f(x) = 3(2)^x$ represents an exponential function that passes through the points (0, 3) and (1, 6).

42. **REASONING** Determine whether the graph of $y = ab^x$, where $a \neq 0$, $b > 0$, and $b \neq 1$, *sometimes*, *always*, or *never* has an x-intercept. Explain your reasoning.

SOLUTION:

The graph will never have an x-intercept because the graph will approach the x-axis, but never crosses it.

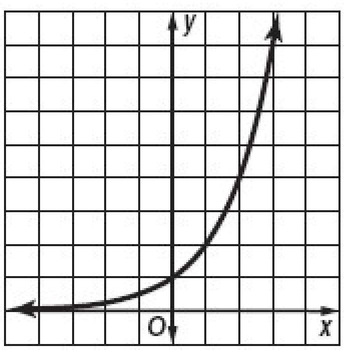
43. **OPEN ENDED** Find an exponential function that represents a real-world situation, and graph the function. Analyze the graph, and explain why the situation is modeled by an exponential function rather than a linear function.

SOLUTION:

The number of teams competing in a basketball tournament can be represented by $y = 2^x$, where the number of teams competing is y and the number of rounds is x. Make a table representing the number of rounds x and the number of teams y needed for the tournament.

x	2^x	y
0	2^0	1
1	2^1	2
2	2^2	4
3	2^3	8
4	2^4	16

Plot the points from the table and connect them with a smooth curve.



The y-intercept of the graph is 1. The graph increases rapidly for $x > 0$. The domain for this scenario is $\{x \mid x \geq 0\}$ indicating the the number of rounds are greater than or equal to 0 .
With an exponential model, each team that joins the tournament will play all of the other teams. If the scenario were modeled with a linear function, each team that joined would play a fixed number of teams.

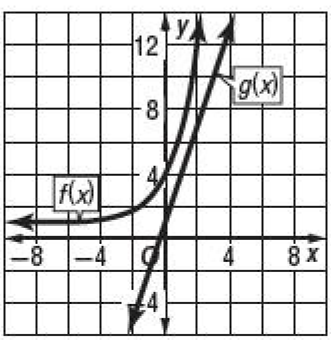
44. **REASONING** Use tables and graphs to compare and contrast an exponential function $f(x) = ab^x + c$, where $a \neq 0$, $b > 0$, and $b \neq 1$, and a linear function $g(x) = a^x + c$. Include intercepts, intervals where the functions are increasing, decreasing, positive, or negative, relative maxima and minima, symmetry, and end behavior.

SOLUTION:

Sample answer: Let $a = 3$, $b = 2$ and $c = 1$. Make a table using $x = –5$ to 5 showing the values of the functions $f(x) = 3(2)^x + 1$ and $g(x) = 3x + 1$.

x	$f(x) = 3 \times 2^x + 1$	$g(x) = 3x + 1$
−5	1.09375	−14
−4	1.1875	−11
−3	1.375	−8
−2	1.75	−5
−1	2.5	−2
0	4	1
1	7	4
2	13	7
3	25	10
4	49	13
5	97	16

Use the values from the table to plot the points for each function $f(x)$ and $g(x)$. Connect the points to draw the graph for each function.



The y-intercept of $f(x)$ is 4 and the y-intercept of $g(x)$ is 1. Both $f(x)$ and $g(x)$ increase as x increases. The function values for $f(x)$ are positive for all real numbers, while those for $g(x)$ are positive for $x > -\frac{1}{3}$ and are negative for $x < -\frac{1}{3}$. Neither $f(x)$ nor $g(x)$ have maximum or minimum points, and neither has symmetry.

45. **WRITING IN MATH** Explain how to determine whether a set of data displays exponential behavior.

SOLUTION:

First, look for a pattern by making sure that the domain values are at regular intervals and the range values differ by a common factor.

Consider the data set in the table.

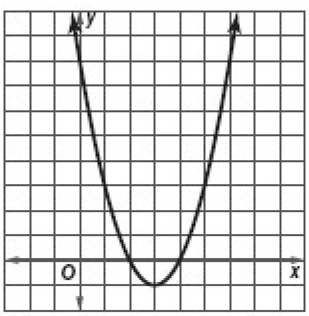
+1 +1 +1 +1 +1

x	1	2	3	4	5	6
y	1	4	16	64	256	1024

×4 ×4 ×4 ×4 ×4

The domain values are at regular intervals of 1. The range values have a common factor of 4. Thus the data in the data displays exponential behavior.

46. **SHORT RESPONSE** What are the zeros of the function graphed below?



SOLUTION:

The points where the graph crosses the *x*-axis are 2 and 4.

47. Hinto invested \$300 into a savings account. The equation $A = 300(1.005)^{12t}$ models the amount in Hinto's account A after t years. How much will be in Hinto's account after 7 years?

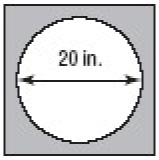
A \$25,326
B \$456.11
C \$385.01
D \$301.52

SOLUTION:

$$\begin{aligned} A &= 300(1.005)^{12t} \\ &= 300(1.005)^{84} \\ &= 456.11 \end{aligned}$$

There will be \$456.11 in Hinto's account after 7 years. So, the correct choice is B.

48. **GEOMETRY** Ayana placed a circular picture on a square picture as shown below. If the picture extends 4 inches beyond the circle on each side, what is the perimeter of the square picture?



F 64 in.
G 80 in.
H 94 in.
J 112 in.

SOLUTION:

$$\begin{aligned} P &= 2\ell + 2w \\ &= 2(20+4+4) + 2(20+4+4) \\ &= 2(28) + 2(28) \\ &= 56 + 56 \\ &= 112 \end{aligned}$$

The perimeter of the square paper is 112 in.
So, the correct choice is J.

49. The points with coordinates (0, –3) and (2, 7) are on line *l*. Line *p* contains (3, –1) and is perpendicular to line *l*. What is the *x*-coordinate of the point where *l* and *p* intersect?

A $\frac{1}{2}$
B $-\frac{2}{5}$
C $-\frac{1}{2}$
D -3

SOLUTION:

First, find the slope and equation of line ℓ.

$$m = \frac{y_2 - y_1}{x_2 - x_1} \quad \text{Slope formula}$$

$$m = \frac{7-(-3)}{2-0} \quad (x_1, y_1) = (0, -3); (x_2, y_2) = (2, 7)$$

$$m = \frac{10}{2} \text{ or } 5 \quad \text{Simplify.}$$

Since the line contains (0, –3), write the equation of the line in slope-intercept form using a $m = 5$ and $b = -3$.

$$y = mx + b \quad \text{Slope-intercept form of a line}$$

$$y = 5x - 3 \quad m = 5, b = -3$$

Next, find the slope and equation of line *p*. Since line *p* is perpendicular to line ℓ, their slopes are negative reciprocals.

$$m_p = -\frac{1}{m_\ell}$$

$$= -\frac{1}{5}$$

Use the point-slope form of a line and $m = -\frac{1}{5}$ and $(x, y) = (3, -1)$ to write the equation for line *p*.

$$y - y_1 = m(x - x_1) \quad \text{Point-slope form of a line}$$

$$y - (-1) = -\frac{1}{5}(x - 3) \quad (x_1, y_1) = (3, -1), m = -\frac{1}{5}$$

$$y + 1 = -\frac{1}{5}x + \frac{3}{5} \quad \text{Multiply.}$$

$$y = -\frac{1}{5}x - \frac{2}{5} \quad \text{Subtract 1 from each side.}$$

Lastly, set the equation for lines ℓ and *p* equal and solve for *x* to find the *x*-coordinate of the point where the lines intersect.

$$5x - 3 = -\frac{1}{5}x - \frac{2}{5} \quad \text{Equation of lines are equal at intersection}$$

$$25x - 15 = -1x - 2 \quad \text{Multiply each side by 5.}$$

$$26x - 15 = -2 \quad \text{Add } x \text{ to each side.}$$

$$26x = 13 \quad \text{Add 15 to each side.}$$

$$\frac{26x}{26} = \frac{13}{26} \quad \text{Divide each side by 26.}$$

$$x = \frac{1}{2} \quad \text{Simplify.}$$

The *x*-coordinate of the point where ℓ and *p* intersect is $\frac{1}{2}$. Thus, the correct choice is A.

Evaluate each product. Express the results in both scientific notation and standard form.

50. $(1.9 \times 10^2)(4.7 \times 10^6)$

SOLUTION:

$$\begin{aligned}(1.9\times10^2)(4.7\times10^6) &= (1.9\bullet4.7)\times10^{2+6}\\ &= 8.93\times10^8\\ &= 893{,}000{,}000\end{aligned}$$

51. $(4.5 \times 10^{-3})(5.6 \times 10^4)$

SOLUTION:

$$\begin{aligned}(4.5\times10^{-3})(5.6\times10^4) &= (4.5\bullet5.6)\times10^{-3+4}\\ &= 25.2\times10^1\\ &= 252\end{aligned}$$

52. $(3.8 \times 10^{-4})(6.4 \times 10^{-8})$

SOLUTION:

$$\begin{aligned}(3.8\times10^{-4})(6.4\times10^{-8}) &= (3.8\bullet6.4)\times10^{-4+(-8)}\\ &= 24.32\times10^{-12}\\ &= 2.432\times10^{-11}\\ &= 0.00000000002432\end{aligned}$$

Simplify.

53. $\sqrt[3]{343}$

SOLUTION:

$$\begin{aligned}\sqrt[3]{343} &= \sqrt[3]{7\cdot7\cdot7} && 343=7^3\\ &= 7 && \text{Simplify.}\end{aligned}$$

54. $\sqrt[6]{729}$

SOLUTION:

$$\begin{aligned}\sqrt[6]{729} &= \sqrt[6]{3\cdot3\cdot3\cdot3\cdot3\cdot3} && 729=3^6\\ &= 3 && \text{Simplify.}\end{aligned}$$

55. $\left(\frac{1}{32}\right)^{\frac{1}{5}}$

SOLUTION:

$$\begin{aligned}\left(\frac{1}{32}\right)^{\frac{1}{5}} &= \sqrt[5]{\frac{1}{32}} && b^{\frac{1}{n}} = \sqrt[n]{b}\\ &= \sqrt[5]{\frac{1}{2\cdot2\cdot2\cdot2\cdot2}} && 32 = 2^5\\ &= \frac{1}{2} && \text{Simplify.}\end{aligned}$$

56. $729^{\frac{5}{6}}$

SOLUTION:

$$\begin{aligned}729^{\frac{5}{6}} &= \left(\sqrt[6]{729}\right)^5 && b^{\frac{m}{n}} = \left(\sqrt[n]{b}\right)^m\\ &= \left(\sqrt[6]{3\cdot3\cdot3\cdot3\cdot3\cdot3}\right)^5 && 32 = 2^5\\ &= 3^5 \text{ or } 243 && \text{Simplify.}\end{aligned}$$

57. $216^{\frac{5}{3}}$

SOLUTION:

$$\begin{aligned}216^{\frac{5}{3}} &= \left(\sqrt[3]{216}\right)^5 && b^{\frac{m}{n}} = \left(\sqrt[n]{b}\right)^m\\ &= \left(\sqrt[3]{6\cdot6\cdot6}\right)^5 && 216 = 6^3\\ &= 6^5 \text{ or } 7776 && \text{Simplify.}\end{aligned}$$

58. $\left(\frac{1}{81}\right)^{\frac{3}{2}}$

SOLUTION:

$$\begin{aligned}\left(\frac{1}{81}\right)^{\frac{3}{2}} &= \left(\sqrt{\frac{1}{81}}\right)^3 && b^{\frac{m}{n}} = \left(\sqrt[n]{b}\right)^m\\ &= \left(\sqrt{\frac{1}{9\cdot9}}\right)^3 && 81 = 9^2\\ &= \left(\frac{1}{9}\right)^3 \text{ or } \frac{1}{729} && \text{Simplify.}\end{aligned}$$

59. **DEMOLITION DERBY** When a car hits an object, the damage is measured by the collision impact. For a certain car the collision impact I is given by $I = 2v^2$, where v represents the speed in kilometers per minute. What is the collision impact if the speed of the car is 4 kilometers per minute?

SOLUTION:

$$\begin{aligned} I &= 2v^2 \\ &= 2(4)^2 \\ &= 32 \end{aligned}$$

The collision impact is 32.

Use elimination to solve each system of equations.

60. $x + y = -3$
$x - y = 1$

SOLUTION:

$$\begin{array}{rl} & x + y = -3 \\ + & \underline{x - y = 1} \\ & 2x \quad = -2 \\ & x = -1 \end{array}$$

$$\begin{aligned} x + y &= -3 \\ -1 + y &= -3 \\ y &= -2 \end{aligned}$$

The solution is (–1, –2).

61. $3a + b = 5$
$2a + b = 10$

SOLUTION:

$$\begin{array}{rl} & 3a + b = 5 \\ - & \underline{2a + b = 10} \\ & a \quad = -5 \end{array}$$

$$\begin{aligned} 3a + b &= 5 \\ 3(-5) + b &= 5 \\ -15 + b &= 5 \\ b &= 20 \end{aligned}$$

The solution is (–5, 20).

62. $3x - 5y = 16$
$-3x + 2y = -10$

SOLUTION:

$$\begin{aligned} &3x - 5y = 16 \\ + \quad &-3x + 2y = -10 \\ \hline &-3y = 6 \\ &y = -2 \end{aligned}$$

$$\begin{aligned} 3x - 5y &= 16 \\ 3x - 5(-2) &= 16 \\ 3x + 10 &= 16 \\ 3x &= 6 \\ x &= 2 \end{aligned}$$

The solution is (2, –2).

Find the next three terms of each arithmetic sequence.

63. 1, 3, 5, 7, …

SOLUTION:

3 – 1 = 2; 5 – 3 = 2; 7 – 5 = 2. The common difference is 2.
The next three terms will be:
7 + 2 = 9
9 + 2 = 11
11 + 2 = 13

64. −6, −4, −2, 0, …

SOLUTION:

–2 – (–6) = 2; –2 – (–4) = 2; 0 – (–2) = 2. The common difference is 2.
The next three terms will be:
0 + 2 = 2
2 + 2 = 4
4 + 2 = 6

65. 6.5, 9, 11.5, 14, …

SOLUTION:

9 – 6.5 = 2.5; 11.5 – 9 = 2.5; 14 – 11.5 = 2.5. The common difference is 2.5.
The next three terms will be:
14 + 2.5 = 16.5
16.5 + 2.5 = 19
19 + 2.5 = 21.5

7-5 Exponential Functions

66. $10, 3, -4, -11, \ldots$

SOLUTION:

3 – 10 = – 7; –4 – 3 = – 7; –11 – (–4) = – 7. The common difference is –7.
The next three terms will be:
–11 + (–7) = –18
–18 + (–7) = –25
–25 + (–7) = –32

67. $\frac{1}{2}, \frac{5}{4}, 2, \frac{11}{4}, \ldots$

SOLUTION:

$\frac{5}{4} - \frac{1}{2} = \frac{5}{4} - \frac{2}{4} = \frac{3}{4}$

$\frac{2}{1} - \frac{5}{4} = \frac{8}{4} - \frac{5}{4} = \frac{3}{4}$

$\frac{11}{4} - \frac{2}{1} = \frac{11}{4} - \frac{8}{4} = \frac{3}{4}$

The common difference is $\frac{3}{4}$.

The next three terms will be:

$\frac{11}{4} + \frac{3}{4} = \frac{14}{4} = \frac{7}{2}$

$\frac{7}{2} + \frac{3}{4} = \frac{14}{4} + \frac{3}{4} = \frac{17}{4}$

$\frac{17}{4} + \frac{3}{4} = \frac{20}{4} = 5$

68. $1, \frac{3}{4}, \frac{1}{2}, \frac{1}{4}, \ldots$

SOLUTION:

$$\frac{3}{4} - \frac{1}{1} = \frac{3}{4} - \frac{4}{4} = -\frac{1}{4}$$
$$\frac{1}{2} - \frac{3}{4} = \frac{2}{4} - \frac{3}{4} = -\frac{1}{4}$$
$$\frac{1}{4} - \frac{1}{2} = \frac{1}{4} - \frac{2}{4} = -\frac{1}{4}$$

The common difference is $-\frac{1}{4}$.

The next three terms will be:

$$\frac{1}{4} + \left(-\frac{1}{4}\right) = 0$$
$$0 + \left(-\frac{1}{4}\right) = -\frac{1}{4}$$
$$-\frac{1}{4} + \left(-\frac{1}{4}\right) = -\frac{2}{4} = -\frac{1}{2}$$