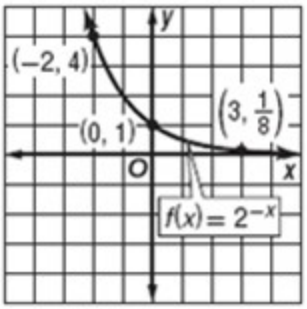
3-1 Exponential Functions

Sketch and analyze the graph of each function. Describe its domain, range, intercepts, asymptotes, end behavior, and where the function is increasing or decreasing.

1. $f(x) = 2^{-x}$

ANSWER:

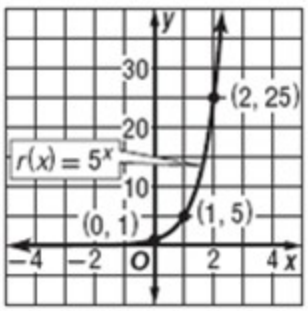
D = $(-\infty, \infty)$; R = $(0, \infty)$; y-intercept: 1; asymptote: x-axis; $\lim_{x \to -\infty} f(x) = \infty, \lim_{x \to \infty} f(x) = 0;$ decreasing on $(-\infty, \infty)$



2. $r(x) = 5^x$

ANSWER:

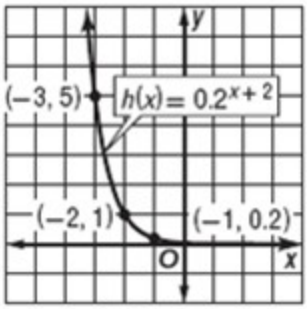
D = $(-\infty, \infty)$; R = $(0, \infty)$; y-intercept: 1; asymptote: x-axis; $\lim_{x \to -\infty} r(x) = 0, \lim_{x \to \infty} r(x) = \infty;$ increasing on $(-\infty, \infty)$



3. $h(x) = 0.2^{x+2}$

ANSWER:

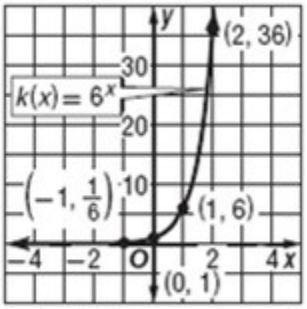
D = $(-\infty, \infty)$; R = $(0, \infty)$; y-intercept: 0.04; asymptote: x-axis; $\lim_{x \to -\infty} h(x) = \infty, \lim_{x \to \infty} h(x) = 0;$ decreasing on $(-\infty, \infty)$



4. $k(x) = 6^x$

ANSWER:

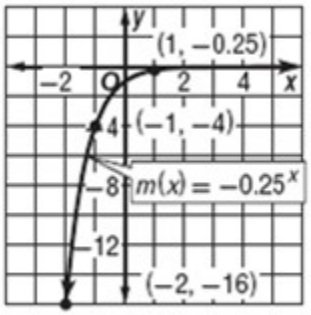
D = $(-\infty, \infty)$; R = $(0, \infty)$; y-intercept: 1; asymptote: x-axis; $\lim_{x \to -\infty} k(x) = 0, \lim_{x \to \infty} k(x) = \infty$; increasing on $(-\infty, \infty)$



5. $m(x) = -(0.25)^x$

ANSWER:

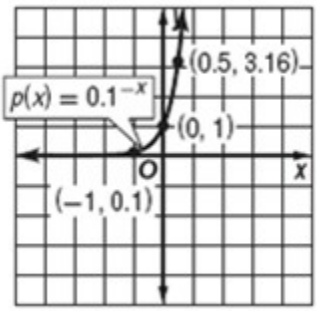
D = $(-\infty, \infty)$; R = $(-\infty, 0)$; y-intercept: −1; asymptote: x-axis; $\lim_{x \to -\infty} m(x) = -\infty, \lim_{x \to \infty} m(x) = 0$; increasing on $(-\infty, \infty)$



6. $p(x) = 0.1^{-x}$

ANSWER:

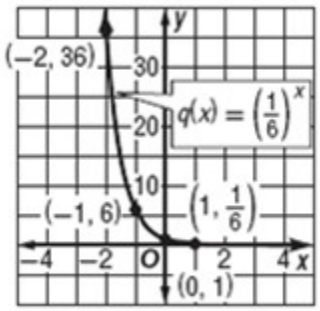
D = $(-\infty, \infty)$; R = $(0, \infty)$; y-intercept: 1; asymptote: x-axis; $\lim_{x \to -\infty} p(x) = 0, \lim_{x \to \infty} p(x) = \infty$; increasing for $(-\infty, \infty)$



7. $q(x) = \left(\frac{1}{6}\right)^x$

ANSWER:

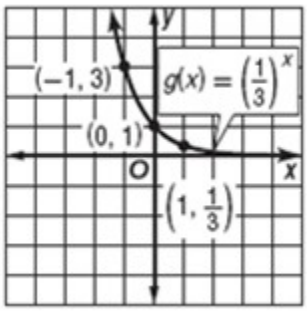
D = $(-\infty, \infty)$; R = $(0, \infty)$; y-intercept: 1; asymptote: x-axis; $\lim_{x \to -\infty} q(x) = \infty, \lim_{x \to \infty} q(x) = 0;$ decreasing on $(-\infty, \infty)$



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

ANSWER:

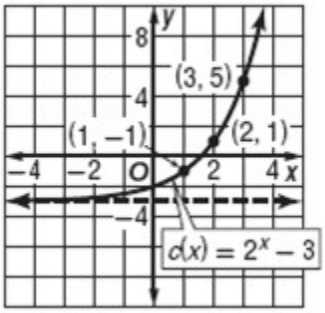
D = $(-\infty, \infty)$; R = $(0, \infty)$; y-intercept: 1; asymptote: x-axis; $\lim_{x \to -\infty} g(x) = \infty, \lim_{x \to \infty} g(x) = 0;$ decreasing on $(-\infty, \infty)$



9. $c(x) = 2^x - 3$

ANSWER:

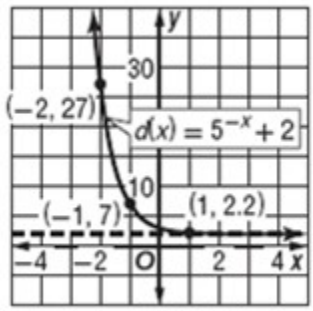
D = $(-\infty, \infty)$; R = $(-3, \infty)$; y- intercept: –2; x-intercept: 1.6; asymptote: $y = -3$;
$\lim_{x \to -\infty} c(x) = -3, \lim_{x \to \infty} c(x) = \infty;$ increasing on $(-\infty, \infty)$



10. $d(x) = 5^{-x} + 2$

ANSWER:

D = $(-\infty, \infty)$; R = $(2, \infty)$; y-intercept: 3; asymptote: $y = 2$; $\lim_{x \to -\infty} d(x) = \infty, \lim_{x \to \infty} d(x) = 2$; decreasing for $(-\infty, \infty)$

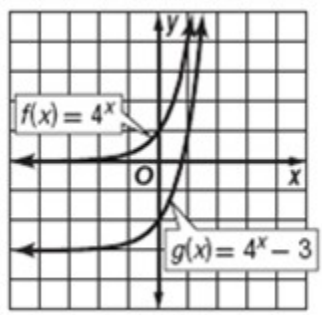


Use the graph of $f(x)$ to describe the transformation that results in the graph of $g(x)$. Then sketch the graphs of $f(x)$ and $g(x)$.

11. $f(x) = 4^x$; $g(x) = 4^x - 3$

ANSWER:

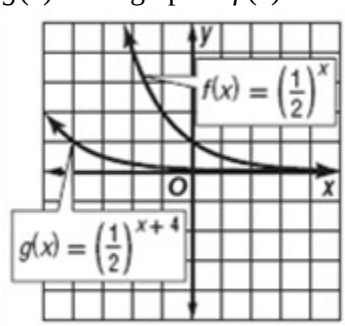
$g(x)$ is the graph of $f(x)$ translated 3 units down.



12. $f(x) = \left(\frac{1}{2}\right)^x$; $g(x) = \left(\frac{1}{2}\right)^{x+4}$

ANSWER:

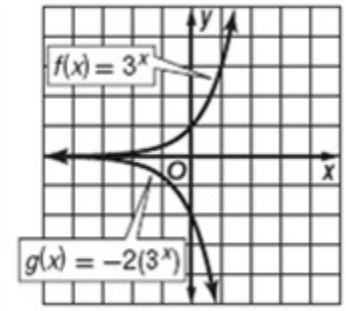
$g(x)$ is the graph of $f(x)$ translated 4 units to the left.



13. $f(x) = 3^x$; $g(x) = -2(3^x)$

ANSWER:

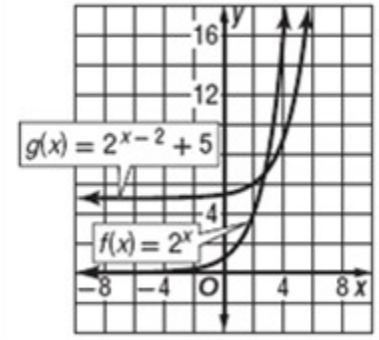
$g(x)$ is the graph of $f(x)$ reflected in the x-axis and expanded vertically by a factor of 2.



14. $f(x) = 2^x$; $g(x) = 2^{x-2} + 5$

ANSWER:

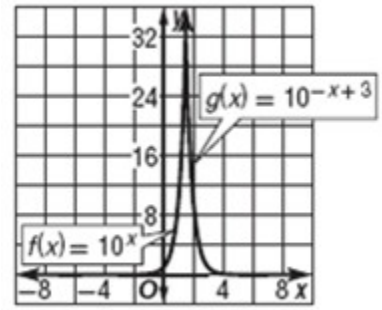
$g(x)$ is the graph of $f(x)$ translated 2 units to the right and 5 units up.



15. $f(x) = 10^x$; $g(x) = 10^{-x+3}$

ANSWER:

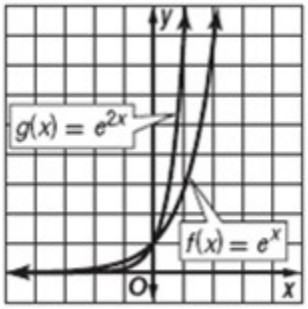
$g(x)$ is the graph of $f(x)$ reflected in the y-axis and translated 3 units to the right.



16. $f(x) = e^x$; $g(x) = e^{2x}$

ANSWER:

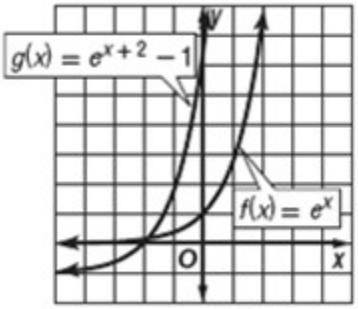
$g(x)$ is the graph of $f(x)$ compressed horizontally by a factor of 2.



17. $f(x) = e^x$; $g(x) = e^{x+2} - 1$

ANSWER:

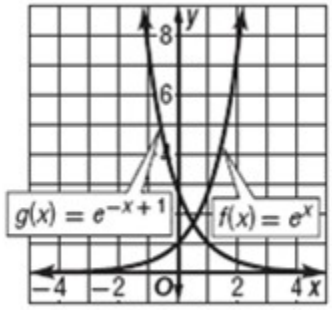
$g(x)$ is the graph of $f(x)$ translated 2 units to the left and 1 unit down.



18. $f(x) = e^x$; $g(x) = e^{-x+1}$

ANSWER:

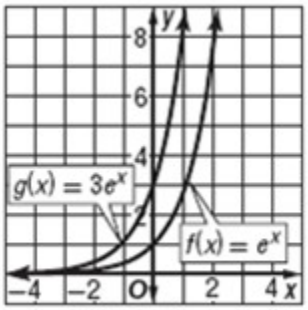
$g(x)$ is the graph of $f(x)$ reflected in the y-axis and translated 1 unit to the right.



19. $f(x) = e^x$; $g(x) = 3e^x$

ANSWER:

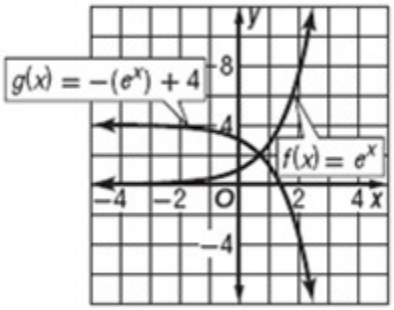
$g(x)$ is the graph of $f(x)$ expanded vertically by a factor of 3.



20. $f(x) = e^x$; $g(x) = -(e^x) + 4$

ANSWER:

$g(x)$ is the graph of $f(x)$ reflected in the x-axis and translated 4 units up.



FINANCIAL LITERACY Copy and complete the table below to find the value of an investment A for the given principal P, rate r, and time t if the interest is compounded n times annually.

n	1	4	12	365	continuously
A					

21. P = \$500, r = 3%, t = 5 years

ANSWER:

n	1	4	12	365	continuously
A	\$579.64	\$580.59	\$580.81	\$580.91	\$580.92

22. P = \$1000, r = 4.5%, t = 10 years

ANSWER:

n	1	4	12	365	continuously
A	\$1552.97	\$1564.38	\$1566.99	\$1568.27	\$1568.31

23. $P = \$1000$, $r = 5\%$, $t = 20$ years

ANSWER:

n	1	4	12	365	continuously
A	$2653.30	$2701.48	$2712.64	$2718.10	$2718.28

24. $P = \$5000$, $r = 6\%$, $t = 30$ years

ANSWER:

n	1	4	12	365	continuously
A	$28,717.46	$29,846.61	$30,112.88	$30,243.76	$30,248.24

25. **FINANCIAL LITERACY** Brady acquired an inheritance of $20,000 at age 8, but he will not have access to it until he turns 18.

a. If his inheritance is placed in a savings account earning 4.6% interest compounded monthly, how much will Brady's inheritance be worth on his 18th birthday?

b. How much will Brady's inheritance be worth if it is placed in an account earning 4.2% interest compounded continuously?

ANSWER:

a. $31,653.63

b. $30,439.23

26. **FINANCIAL LITERACY** Katrina invests $1200 in a certificate of deposit (CD). The table shows the interest rates offered by the bank on 3- and 5-year CDs.

CD Offers		
Years	3	5
Interest	3.45%	4.75%
Compounded	continuously	monthly

a. How much would her investment be worth with each option?

b. How much would her investment be worth if the 5-year CD was compounded continuously?

ANSWER:

a. 3-year CD: $1330.85, 5-year CD: $1520.98

b. $1521.69

POPULATION Copy and complete the table to find the population N of an endangered species after a time t given its initial population N_0 and annual rate r or continuous rate k of increase or decline.

t	5	10	15	20	50
N					

27. $N_0 = 15{,}831$, $r = -4.2\%$

ANSWER:

t	5	10	15	20	50
N	12,774	10,308	8317	6711	1853

28. $N_0 = 23{,}112$, $r = 0.8\%$

ANSWER:

t	5	10	15	20	50
N	24,051	25,029	26,046	27,105	34,424

29. $N_0 = 17{,}692$, $k = 2.02\%$

ANSWER:

t	5	10	15	20	50
N	19,572	21,652	23,953	26,499	48,575

30. $N_0 = 9689$, $k = -3.7\%$

ANSWER:

t	5	10	15	20	50
N	8053	6693	5562	4623	1523

31. **WATER** Worldwide water usage in 1950 was about 294.2 million gallons. If water usage has grown at the described rate, estimate the amount of water used in 2000, and predict the amount in 2050.
a. 3% annually
b. 3.05% continuously

ANSWER:

a. about 1289.75 million or 1.29 billion gallons; about 5654.12 million or 5.65 billion gallons
b. about 1351.89 million or 1.35 billion gallons; about 6212.13 million or 6.21 billion gallons

32. **WAGES** Jasmine receives a 3.5% raise at the end of each year from her employer to account for inflation. When she started working for the company in 1994, she was earning a salary of $31,000.
a. What was Jasmine's salary in 2000 and 2004?
b. If Jasmine continues to receive a raise at the end of each year, how much money will she earn during her final year if she plans on retiring in 2024?

ANSWER:

a. about $38,107; about $43,729
b. about $87,011

33. **PEST CONTROL** Consider the termite guarantee made by Exterm-inc in their ad below.

If the first statement in this claim is true, assess the validity of the second statement. Explain your reasoning.

ANSWER:

No; Exterm-inc has to spray 5 times in order to guarantee that it has eliminated all but 1% of a termite colony.

34. **INFLATION** The Consumer Price Index (CPI) is an index number that measures the average price of consumer goods and services. A change in the CPI indicates the growth rate of inflation. In 1958 the CPI was 28.6, and in 2008 the CPI was 211.08.

a. Determine the growth rate of inflation between 1958 and 2008. Use this rate to write an exponential equation to model this situation.

b. What will the CPI be in 2015? At this rate, when will the CPI exceed 350?

ANSWER:

a. $r = 0.04079$; $N(t) = 28.6(1.04079)^t$

b. About 279.3; the CPI will exceed 350 somewhere during 2020-2021.

35. **GASOLINE** Jordan wrote an exponential equation to model the cost of gasoline. He found the average cost per gallon of gasoline for two years and used these data for his model.

Average Cost per Gallon of Gasoline	
Year	Cost($)
1990	1.19
2011	3.91

a. If the average cost of gasoline increased at an exponential rate, identify the rate of increase. Write an exponential equation to model this situation.

b. Use your model to predict the average cost of a gallon of gasoline in 2015 and 2017.

c. When will the average cost per gallon of gasoline exceed $7?

d. Why might an exponential model not be an accurate representation of average gasoline prices?

ANSWER:

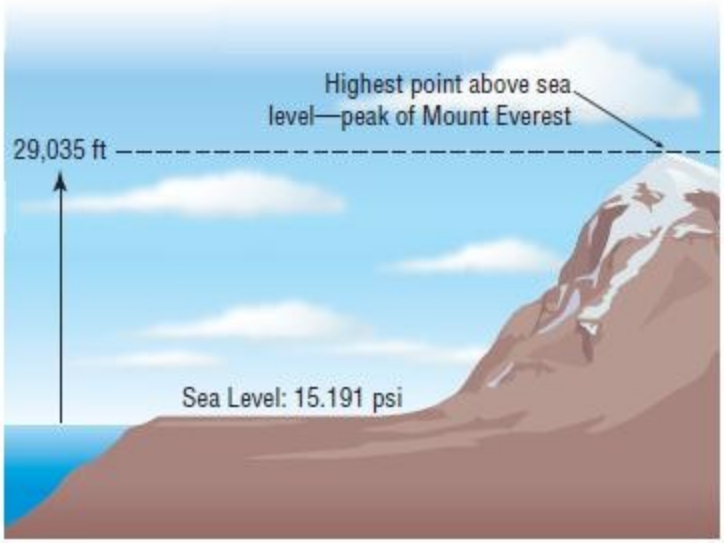
a. 0.0586; $N(t) = 1.19(1.0586)^t$

b. about $4.94; about $5.54

c. sometime during 2021-2022

d. Sample answer: The cost of gasoline usually does not increase or decrease at a constant rate. It fluctuates in response to many factors such as the economy, the availability of oil, etc.

36. **PHYSICS** The pressure of the atmosphere at sea level is 15.191 pounds per square inch (psi) . It decreases continuously at a rate of 0.004% as altitude increases by x feet.
a. Write a modeling function for the continuous exponential decay representing the atmospheric pressure $a(x)$.
b. Use the model to approximate the atmospheric pressure at the top of Mount Everest.



c. If a certain rescue helicopter can fly only in atmospheric pressures greater than 5.5 pounds per square inch, how high can it fly up Mount Everest?

ANSWER:

a. $a(x) = 15.191e^{-0.00004x}$
b. about 4.76 psi
c. about 25,399 ft

37. **RADIOACTIVITY** The half-life of a radioactive substance is the amount of time it takes for half of the atoms of the substance to disintegrate. Uranium-235 is used to fuel commercial power plants and has a half-life of 704 million years.
a. How many grams of uranium-235 will remain after 1 million years if you start with 200 grams?
b. How many grams of uranium-235 will remain after 4540 million years if you start with 200 grams?

ANSWER:

a. about 199.8 g
b. about 2.29 g

38. **BOTANY** Under the right growing conditions, a particular species of plant has a doubling time of 12 days. Suppose a pasture contains 46 plants of this species. How many plants will there be after 20, 65, and x days?

ANSWER:

about 146; about 1965; $N(x) = 46e^{0.05776227x}$

39. **RADIOACTIVITY** Radiocarbon dating uses carbon-14 to estimate the age of organic materials found commonly at archaeological sites. The half-life of carbon-14 is approximately 5.73 thousand years.
a. Write a modeling equation for the exponential decay.
b. How many grams of carbon-14 will remain after 12.82 thousand years if you start with 7 grams?
c. Use your model to estimate when only 1 gram of the original 7 grams of carbon-14 will remain.

ANSWER:

a. $N(t) = N_0 e^{-0.1209681t}$
b. about 1.48 g
c. in about 16.09 thousand years

40. **MICROBIOLOGY** A certain bacterium used to treat oil spills has a doubling time of 15 minutes. Suppose a colony begins with a population of one bacterium.
a. Write a modeling equation for this exponential growth.
b. About how many bacteria will be present after 55 minutes?
c. A population of 8192 bacteria is sufficient to clean a small oil spill. Use your model to predict how long it will take for the colony to grow to this size.

ANSWER:

a. $N(t) = N_0 e^{0.04620981t}$
b. 13
c. The colony will reach a population of 8192 in about 195 minutes or 3 hours and 15 minutes.

41. **ENCYCLOPEDIA** The number of articles making up an online open-content encyclopedia increased exponentially during its first few years. The number of articles, $A(t)$, t years after 2001 can be modeled by $A(t) = 16{,}198 \cdot 2.13^t$.
a. According to this model, how many articles made up the encyclopedia in 2001? At what rate is the number of articles increasing?
b. During which year did the encyclopedia reach 1 million articles?
c. Predict the number of articles there will be at the beginning of 2018.

ANSWER:

a. 16,198 articles; 113%
b. 2006
c. 6,193,193,554 articles

42. **RISK** The chance of having an automobile accident increases exponentially if the driver has consumed alcohol. The relationship can be modeled by $A(c) = 6e^{12.8c}$, where A is the percent chance of an accident and c is the driver's blood alcohol concentration (BAC).
a. The legal BAC is 0.08. What is the percent chance of having a car accident at this concentration?
b. What BAC would correspond to a 50% chance of having a car accident?

ANSWER:

a. 16.7%
b. 0.166

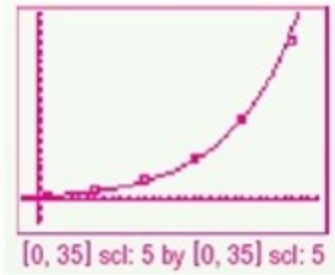
43. **GRAPHING CALCULATOR** The table shows the number of blogs, in millions, in existence every six months.

Months	1	7	13	19	25	31
Blogs	0.7	2	4	8	16	31

a. Using the calculator's exponential regression tool, find a function that models the data.
b. After how many months did the number of blogs reach 20 million?
c. Predict the number of blogs after 48 months.

ANSWER:

a. $f(x) = 0.7378 \cdot 1.131^x$



b. 26.8 months
c. 271.7 million

44. **LANGUAGES** *Glottochronology* is an area of linguistics that studies the divergence of languages. The equation $c = e^{-Lt}$, where c is the proportion of words that remain unchanged, t is the time since two languages diverged, and L is the rate of replacement, models this divergence.
a. If two languages diverged 5 years ago and the rate of replacement is 43.13%, what proportion of words remains unchanged?
b. After how many years will only 1% of the words remain unchanged?

ANSWER:

a. 0.1157
b. 10.68 yr

45. **FINANCIAL LITERACY** A couple just had a child and wants to immediately start a college fund. Use the information below to determine how much money they should invest.

ANSWER:

about $11,876.29

GRAPHING CALCULATOR Determine the value(s) of *x* that make(s) each equation or inequality below true. Round to the nearest hundredth, if necessary.

46. $2^x < 4$

ANSWER:

$x < 2$

47. $e^{2x} = 3$

ANSWER:

$x = 0.55$

48. $-e^x > -2$

ANSWER:

$x < 0.69$

49. $2^{-4x} \leq 8$

ANSWER:

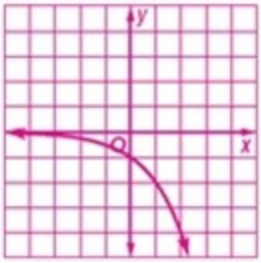
$x \geq -0.75$

Describe the domain, range, continuity, and increasing /decreasing behavior for an exponential function with the given intercept and end behavior. Then graph the function.

50. $f(0) = -1, \lim_{x \to -\infty} f(x) = 0, \lim_{x \to \infty} f(x) = -\infty$

ANSWER:

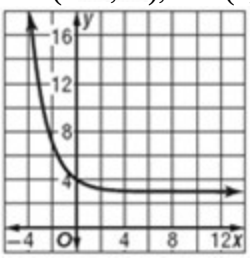
D = $(-\infty, \infty)$; R = $(-\infty, 0)$; continuous; decreasing for $(-\infty, \infty)$; Sample answer:



51. $f(0) = 4, \lim_{x \to -\infty} f(x) = \infty, \lim_{x \to \infty} f(x) = 3$

ANSWER:

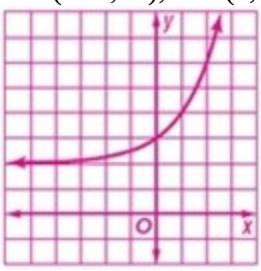
D = $(-\infty, \infty)$; R = $(3, \infty)$; continuous; decreasing for $(-\infty, \infty)$; Sample answer:



52. $f(0) = 3, \lim_{x \to -\infty} f(x) = 2, \lim_{x \to \infty} f(x) = \infty$

ANSWER:

D = $(-\infty, \infty)$; R = $(2, \infty)$; continuous; increasing for $(-\infty, \infty)$; Sample answer:



Determine the equation of each function after the given transformation of the parent function.

53. $f(x) = 5^x$ translated 3 units left and 4 units down

ANSWER:

$f(x) = 5^{x+3} - 4$

54. $f(x) = 0.25^x$ compressed vertically by a factor of 3 and translated 9 units left and 12 units up

ANSWER:

$f(x) = (3)0.25^{x+9} + 12$

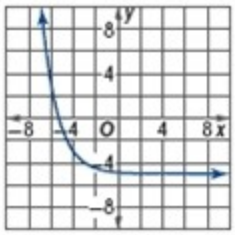
55. $f(x) = 4^x$ reflected in the x-axis and translated 1 unit left and 6 units up

ANSWER:

$f(x) = -4^{x+1} + 6$

Determine the transformations of the given parent function that produce each graph.

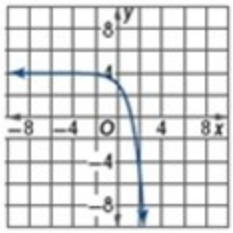
56. $f(x) = \left(\frac{1}{2}\right)^x$



ANSWER:

translation 2 units left and 5 units down

57. $f(x) = 3^x$



ANSWER:

reflection in the x-axis and translation 4 units up

58. **MULTIPLE REPRESENTATIONS** In this problem, you will investigate the average rate of change for exponential functions.

a. GRAPHICAL Graph $f(x) = b^x$ for b = 2, 3, 4, and 5.

b. ANALYTICAL Find the average rate of change of each function on the interval [0, 2].

c. VERBAL What can you conclude about the average rate of change of $f(x) = b^x$ as b increases? How is this shown in the graphs in part **a**?

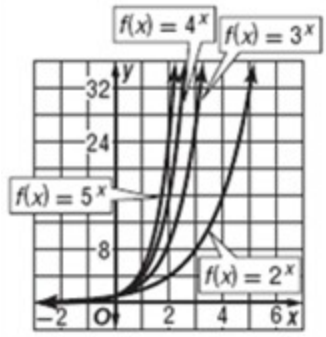
d. GRAPHICAL Graph $f(x) = b^{-x}$ for b = 2, 3, 4, and 5.

e. ANALYTICAL Find the average rate of change of each function on the interval [0, 2].

f. VERBAL What can you conclude about the average rate of change of $f(x) = b^{-x}$ as b increases. How is this shown in the graphs in part **d**?

ANSWER:

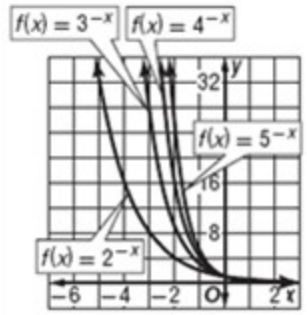
a.



b. The average rate of change is 1.5, 4, 7.5, and 12 for b = 2, 3, 4, and 5 respectively.

c. As the value of b increases, the average rate of change increases. This results in a graph that is expanded vertically, as shown in part **a**.

d.



e. For values of b, 2 = −0.375, 3 = −0.444, 4 = −0.469, and 5 = −0.48.

f. As the value of b increases, the average rate of change decreases. Graphs that have larger values for b are greater for negative values of x, but when x is positive, the graphs decrease and approach 0 faster.

59. **ERROR ANALYSIS** Eric and Sonja are determining the worth of a $550 investment after 12 years in a savings account earning 3.5% interest compounded monthly. Eric thinks the investment is worth $837.08, while Sonja thinks it is worth $836.57. Is either of them correct? Explain.

ANSWER:

Sample answer: Sonja; she used the equation

$$\begin{aligned} A &= P\left(1+\frac{r}{n}\right)^{nt} \\ &= 550\cdot\left(1+\frac{0.035}{12}\right)^{(12)(12)} \\ &= \$836.57. \end{aligned}$$

Eric determined the worth if the interest was compounded continuously.

$A = Pe^{rt}$

$= 550 \cdot e^{(0.035)(12)}$

$= \$837.08.$

REASONING State whether each statement is *true* or *false* . Explain your reasoning.

60. Exponential functions can never have restrictions on the domain.

ANSWER:

True; sample answer: Exponential functions are defined as $f(x) = ab^x$ where $b > 0$, $b \neq 1$, and $a \neq 0$. Any input for the domain will result in a real value for the function.

61. Exponential functions always have restrictions on the range.

ANSWER:

True; sample answer: The range of an exponential function will always approach a value that it will never reach, so there will always be a restriction on the range.

62. Graphs of exponential functions always have an asymptote.

ANSWER:

True; sample answer: Since an exponential function will always approach, but never reach, a specific range value, it will always have an asymptote.

63. **OPEN ENDED** Write an example of an increasing exponential function with a negative y-intercept.

ANSWER:

Sample answer: $f(x) = 2^x - 4$

64. **CHALLENGE** Trina invests $1275 in an account that compounds quarterly at 8%, but at the end of each year, she takes $100 out. How much is the account worth at the end of the fifth year?

ANSWER:

about $1305.07

65. **REASONING** Two functions of the form $f(x) = b^x$ *sometimes*, *always*, or *never* have at least one ordered pair in common.

ANSWER:

Always; sample answer: All functions of the form $f(x) = b^x$ have the point (0, 1) in common because any number b raised to the 0 power is 1.

66. ***Writing in Math*** Compare and contrast the domain, range, intercepts, symmetry, continuity, increasing/decreasing behavior, and end behavior of exponential and power parent functions.

ANSWER:

Sample answer: We will analyze power functions of the form ax^n where a and n are positive integers and power functions of the form ab^x where a is a positive integer. The domain of both functions is $(-\infty, \infty)$ but the ranges differ. For power functions, if n is even, the range is $[0, \infty)$, but when n is odd, the range is $(-\infty, \infty)$. For exponential functions, the range is always $(0, \infty)$. Power functions have x and y-intercepts at the origin while exponential functions have a y-intercept at a and are without an x-intercept. Even power functions are symmetric in respect to the y-axis while odd power functions are symmetric in respect to the origin. Exponential functions have no symmetry. Both functions are continuous. Odd power functions increase while even power functions decrease on $(-\infty, 0)$ but increase on $(0, \infty)$. Exponential functions increase if $b > 1$ but decrease if $b < 1$. Finally, the end behavior of power functions approaches ∞ while exponential functions approach ∞ when $b > 1$ but approach 0 when $b < 1$.

Solve each inequality.

67. $(x - 3)(x + 2) \leq 0$

ANSWER:

$[-2, 3]$

68. $x^2 + 6x \leq -x - 4$

ANSWER:

$[-6.372281, -0.6277187]$

69. $3x^2 + 15 \geq x^2 + 15x$

ANSWER:

$(-\infty, 1.1882623] \cup [6.3117377, \infty)$

Find the domain of each function and the equations of any vertical or horizontal asymptotes, noting any holes.

70. $f(x) = \dfrac{3}{x^2 - 4x + 4}$

ANSWER:

D = $\{x \mid x \neq 2\}$, asymptote: $x = 2, y = 0$

71. $f(x) = \dfrac{x-1}{x^2+4x-5}$

ANSWER:

D = {x | $x \neq -5$ or 1}, asymptote: $x = -5$, $y = 0$; hole: $x = 1$

72. $f(x) = \dfrac{x^2-8x+16}{x-4}$

ANSWER:

D = {x | $x \neq 4$}, hole: $x = 4$

73. **TEMPERATURE** A formula for converting degrees Celsius to Fahrenheit is $F(x) = \frac{9}{5}x + 32$.

a. Find the inverse $F^{-1}(x)$. Show that $F(x)$ and $F^{-1}(x)$ are inverses.

b. Explain what purpose $F^{-1}(x)$ serves.

ANSWER:

a. $F^{-1}(x) = \frac{5}{9}(x - 32)$; $F[F^{-1}(x)] = F^{-1}[F(x)] = x$

b. It can be used to convert Fahrenheit to Celsius.

74. **SHOPPING** Lily wants to buy a pair of inline skates that are on sale for 30% off the original price of $149. The sales tax is 5.75%.

a. Express the price of the inline skates after the discount and the price of the inline skates after the sales tax using function notation. Let x represent the price of the inline skates, $p(x)$ represent the price after the 30% discount, and $s(x)$ represent the price after the sales tax.

b. Which composition of functions represents the price of the inline skates, $p[s(x)]$ or $s[p(x)]$? Explain your reasoning.

c. How much will Lily pay for the inline skates?

ANSWER:

a. $p(x) = 0.70x$; $s(x) = 1.0575x$

b. Since $s[p(x)] = p[s(x)]$, either function represents the price of the skates.

c. $110.30

75. **EDUCATION** The table shows the number of freshmen who applied to and the number of freshmen attending selected universities in a certain year.
a. State the relation as a set of ordered pairs.
b. State the domain and range of the relation.
c. Determine whether the relation is a function. Explain.
d. Assuming the relation is a function, is it reasonable to determine a prediction equation for this situation? Explain.

University	Applied	Attending
Auburn University	13,264	4184
University of California-Davis	27,954	4412
University of Illinois-Urbana-Champaign	21,484	6366
Florida State University	13,423	4851
State University of New York-Stony Brook	16,849	2415
The Ohio State University	19,563	5982
Texas A&M University	17,284	6949

Source: *How to Get Into College*

ANSWER:

a. {(13,264, 4184), (27,954, 4412), (21,484, 6366), (13,423, 4851), (16,849, 2415), (19,563, 5982), (17,284, 6949)}
b. {13,264, 16,849, 17,284, 19,563, 21,484, 13,423, 27,954}; {2415, 4184, 4412, 4851, 5982, 6366, 6949}
c. Yes; no member of the domain is paired with more than one member of the range.
d. Sample answer: No; it is not reasonable to make a prediction equation for this situation because you cannot determine the number of attendees at a school based on the number of applications they received.

76. **SAT/ACT** A set of n numbers has an average (arithmetic mean) of $3k$ and a sum of $12m$, where k and m are positive. What is the value of n in terms of k and m?

A $\frac{4m}{k}$
B $36km$
C $\frac{4k}{m}$
D $\frac{m}{4k}$
E $\frac{k}{4m}$

ANSWER:

A

77. The number of bacteria in a colony were growing exponentially. Approximately how many bacteria were there at 7 P.M.?

Time	Number of Bacteria
2 P.M.	100
4 P.M.	4000

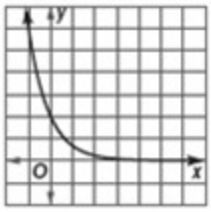
F 15,700
G 159,540
H 1,011,929
J 6,372,392

ANSWER:
H

78. **REVIEW** If $4^{x+2} = 48$, then $4^x = ?$
A 3.0
B 6.4
C 6.9
D 12.0

ANSWER:
A

79. **REVIEW** What is the equation of the function?



F $y = 2(3)^x$
G $y = 2\left(\frac{1}{3}\right)^x$
H $y = 3\left(\frac{1}{2}\right)^x$
J $y = 3(2)^x$

ANSWER:
G