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6-1 *Graphing Exponential Functions*

An **exponential growth function** has the form $y = b^x$, where $b > 1$.
The graphs of exponential equations can be transformed by changing the value of the constants a, h, and k in the exponential equation: $f(x) = ab^{x-h} + k$.

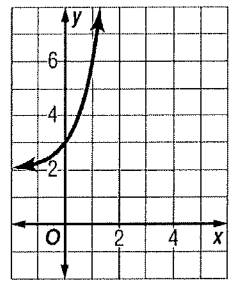
Parent Function of Exponential Growth Functions, $f(x) = b^x$, $b > 1$	**1.** The function is continuous, one-to-one, and increasing. **2.** The domain is the set of all real numbers. **3.** The x-axis is the asymptote of the graph. **4.** The range is the set of all non-zero real numbers. **5.** The graph contains the point (0, 1).

Example: Graph $y = 4^x + 2$. State the domain and range.

Make a table of values. Connect the points to form a smooth curve.

x	−1	0	1	2	3
y	2.25	3	6	18	66

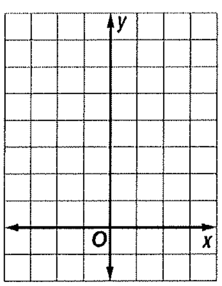
The domain of the function is all real numbers, while the range is the set of all positive real numbers greater than 2.



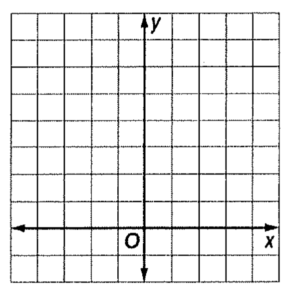
Exercises

Graph each function. State the domain and range.

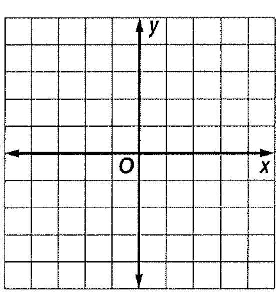
1. $y = 3(2)^x$



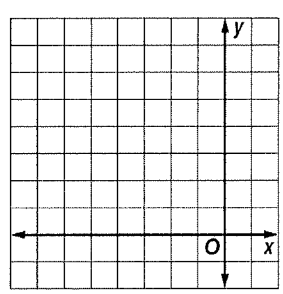
2. $y = \frac{1}{3}(3)^x$



3. $y = 4^x - 2$



4. $y = 2^{x+5}$



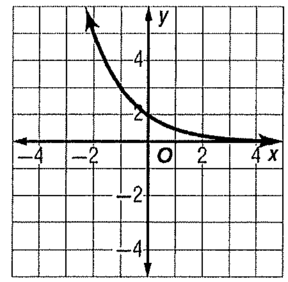
Exponential Decay The following table summarizes the characteristics of **exponential decay** functions.

Parent Function of Exponential Growth Functions, $f(x) = b^x$, $0 < b < 1$	**1.** The function is continuous, one-to-one, and decreasing. **2.** The domain is the set of all real numbers. **3.** The x-axis is the asymptote of the graph. **4.** The range is the set of all non-zero real numbers. **5.** The graph contains the point (0, 1).

Example: Graph $y = \left(\frac{1}{2}\right)^x$. State the domain and range.

Make a table of values. Connect the points to form a smooth curve. The domain is all real numbers and the range is the set of all positive real numbers.

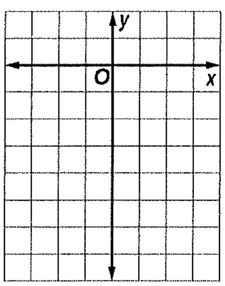
x	−2	−1	0	1	2
y	4	2	1	0.5	0.25



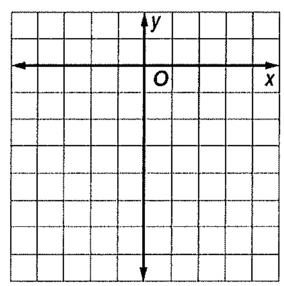
Exercises

Graph each function. State the domain and range.

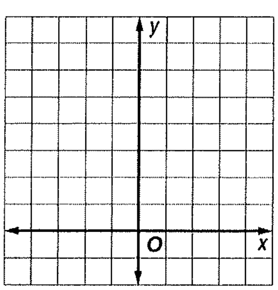
1. $y = -2\left(\frac{1}{4}\right)^x$



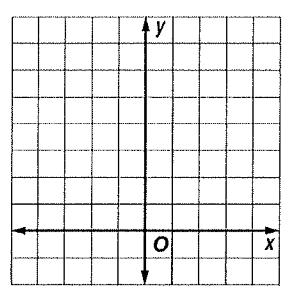
2. $y = -0.4(0.2)^x$



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



4. $y = 4\left(\frac{1}{5}\right)^{x+3} - 1$



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6-2 Practice

Solving Exponential Equations and Inequalities

Solve each equation.

1. $4^{x + 35} = 64^{x - 3}$

2. $\left(\frac{1}{64}\right)^{0.5x - 3} = 8^{9x - 2}$

Write an exponential function for the graph that passes through the given points.

3. (0, 5) and (4, 3125)

4. (0, 8) and (4, 2048)

Solve each inequality.

5. $10^{2x + 7} \geq 1000^{x}$

6. $\left(\frac{1}{16}\right)^{3x - 4} \leq 64^{x - 1}$

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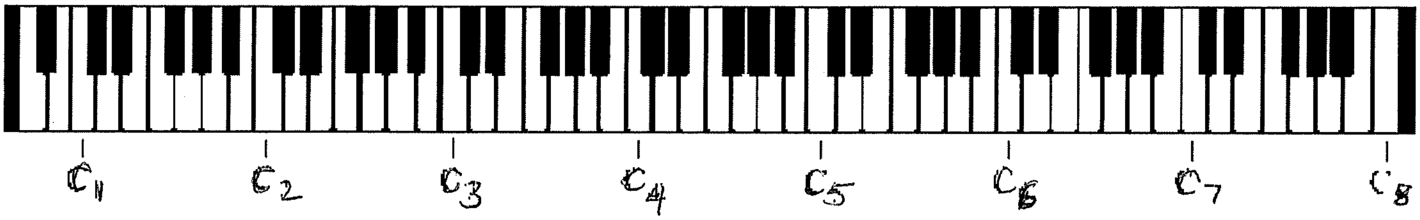
Musical Relationships

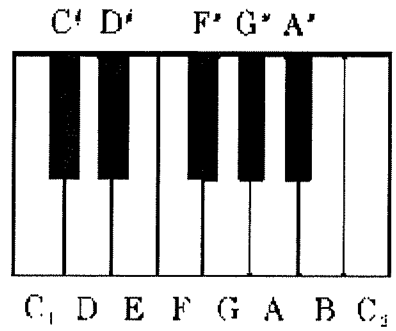
The frequencies of notes that are one octave apart in a musical scale are related by an exponential equation. For the eight C notes on a piano, the equation is $C_n = C_1 2^{n-1}$, where C_n represents the frequency of the nth C note.



1. Find the relationship between C_1 and C_2.

2. Find the relationship between C_1 and C_4.

The frequencies of consecutive notes are related by a common ratio r. The general equation is $f_n = f_1 r^{n-1}$.



3. If the frequency of middle C is 261.6 cycles per second and the frequency of the next higher C is 523.2 cycles per second, find the common ratio r. (*Hint:* The two C's are 12 notes apart.) Write the answer as a radical expression.

4. Substitute decimal values for r and f_1 to find a specific equation for f_n.

5. Find the frequency of $F^{\#}$ above middle C.

6. Frets are a series of ridges placed across the fingerboard of a guitar. They are spaced so that the distance d from the nut to the *nth* fret is $d = s - \frac{s}{2^{n \div 12}}$, where s is the length of the guitar's scale. Are the frets equally spaced on the fingerboard? Explain.