Name ______________________________ Date ______________

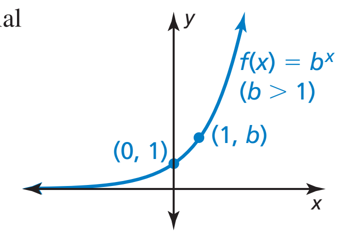
# Exponential Functions

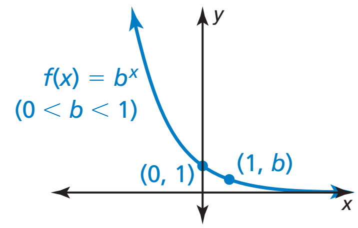
## Graphing Exponential Functions

An **exponential function** is a nonlinear function of the form $y = ab^x$, where $a \neq 0$, $b \neq 1$, and $b > 0$.

- When $a > 0$ and $b > 1$, the function is an exponential growth function.
- When $a > 0$ and $0 < b < 1$, the function is an exponential decay function.

The graphs of the parent exponential functions $y = b^x$ are shown.



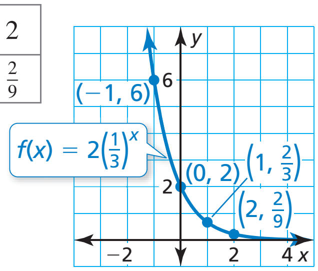




**Example 1** **Tell whether each function represents *exponential growth* or *exponential decay*. Then graph the function.**

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

Because $a = 2$ is positive and $b = \frac{1}{3}$ is greater than 0 and less than 1, the function is an exponential decay function. Use a table to graph the function.

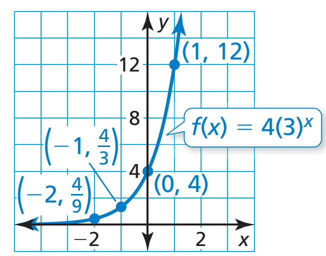
| **x** | −1 | 0 | 1 | 2 |
|---|---|---|---|---|
| **y** | 6 | 2 | $\frac{2}{3}$ | $\frac{2}{9}$ |




**b.** $f(x) = 4(3)^x$

Because $a = 4$ is positive and $b = 3$ is greater than 1, the function is an exponential growth function. Use a table to graph the function.

| **x** | −2 | −1 | 0 | 1 |
|---|---|---|---|---|
| **y** | $\frac{4}{9}$ | $\frac{4}{3}$ | 4 | 12 |

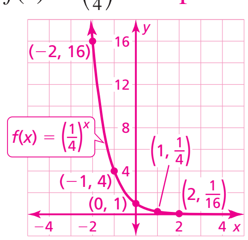



## Practice

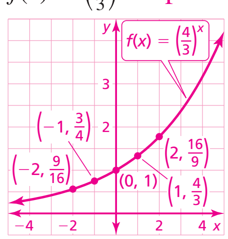
*Check your answers at BigIdeasMath.com.*

**Tell whether the function represents *exponential growth* or *exponential decay*. Then graph the function.**

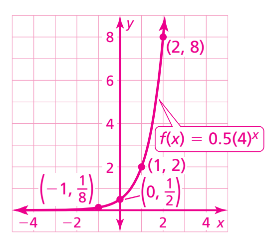
**1.** $f(x) = \left(\frac{1}{4}\right)^x$ exponential decay



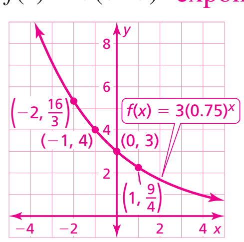

**2.** $f(x) = \left(\frac{4}{3}\right)^x$ exponential growth



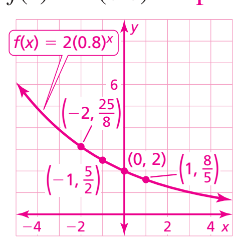

**3.** $f(x) = 0.5(4)^x$ exponential growth



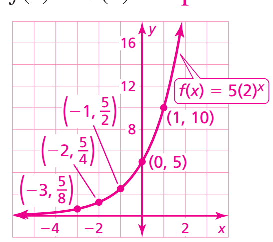

**4.** $f(x) = 3(0.75)^x$ exponential decay




**5.** $f(x) = 2(0.8)^x$ exponential decay




**6.** $f(x) = 5(2)^x$ exponential growth



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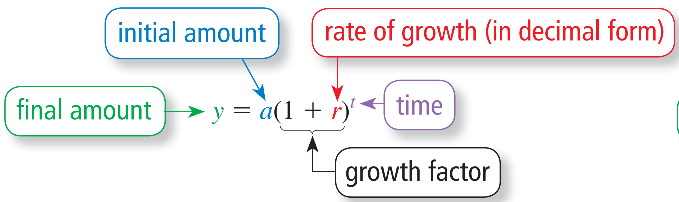
# Exponential Functions

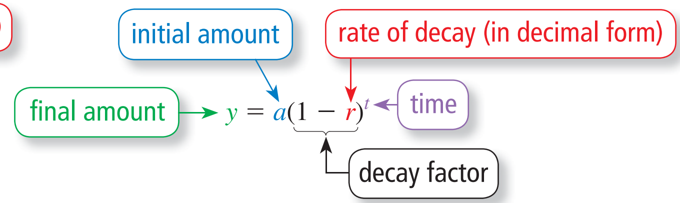
## Rewriting Exponential Functions

**Exponential growth** occurs when a quantity increases by the same factor over equal intervals of time, whereas **exponential decay** occurs when a quantity decreases by the same factor over equal intervals of time.

**Exponential Growth Model**




**Exponential Decay Model**




**Example 1** **Rewrite the function $y = 120(1.25)^{t/12}$ to determine whether it represents *exponential growth* or *exponential decay*. Then find the percent rate of change.**

$y = 120(1.25)^{t/12}$ — Write the function.

$= 120[(1.25)^{1/12}]^t$ — Power of a Power Property

$\approx 120(1.02)^t$ — Evaluate the power.

$= 120(1 + 0.02)^t$ — Rewrite in the form $y = a(1 + r)^t$.

▶ So, the function represents exponential growth and the growth rate is about 0.02, or 2%.

## Practice

*Check your answers at BigIdeasMath.com.*

**Rewrite the function to determine whether it represents *exponential growth* or *exponential decay*. Then find the percent rate of change.**

**1.** $y = 80(0.85)^{2t}$
$y = 80(1 - 0.28)^t$, exponential decay; 28%

**2.** $y = 67(1.13)^{t/4}$
$y = 67(1 + 0.03)^t$, exponential growth; 3%

**3.** $y = 5\left(\frac{3}{2}\right)^{-8t}$
$y = 5(1 - 0.96)^t$, exponential decay; 96%

**4.** $y = 17\left(\frac{2}{5}\right)^{0.65t}$
$y = 17(1 - 0.45)^t$, exponential decay; 45%

**5.** $y = 4(0.5)^{t/88}$
$y = 4(1 - 0.01)^t$, exponential decay; 1%

**6.** $y = 31(1.02)^{4t}$
$y = 31(1 + 0.08)^t$, exponential growth; 8%

**7.** $y = 9(1.12)^{0.3t}$
$y = 9(1 + 0.03)^t$, exponential growth; 3%

**8.** $y = 750(0.88)^{t/3}$
$y = 750(1 - 0.04)^t$, exponential decay; 4%

**9.** $y = (0.64)^{5t}$
$y = (1 - 0.89)^t$, exponential decay; 89%

**10.** $y = 6(0.82)^{-0.25t}$
$y = 6(1 + 0.05)^t$, exponential growth; 5%