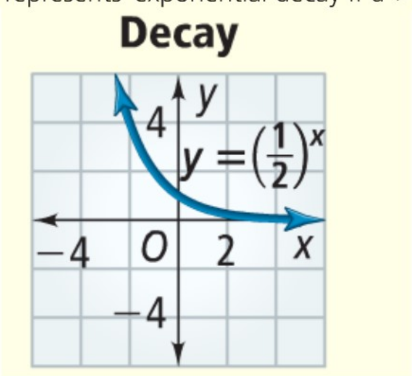
Exponential Decay

The function $y = ab^x$, represents exponential decay if $a > 0$ and $0 < b < 1$



For exponential decay, $0 < b < 1$ and b is the **decay factor**. The quantity decreases by a constant percentage each time period. The percentage decrease, r, is the *rate of decay*. Usually a rate of decay is expressed as a negative quantity, so $b = 1 + r$.

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take note

Key Concept Exponential Growth and Decay

You can model exponential growth or decay with this function.

Amount after t time periods

Rate of growth ($r > 0$) or decay ($r < 0$)

$$A(t) = a(1 + r)^t$$

Initial amount

Number of time periods

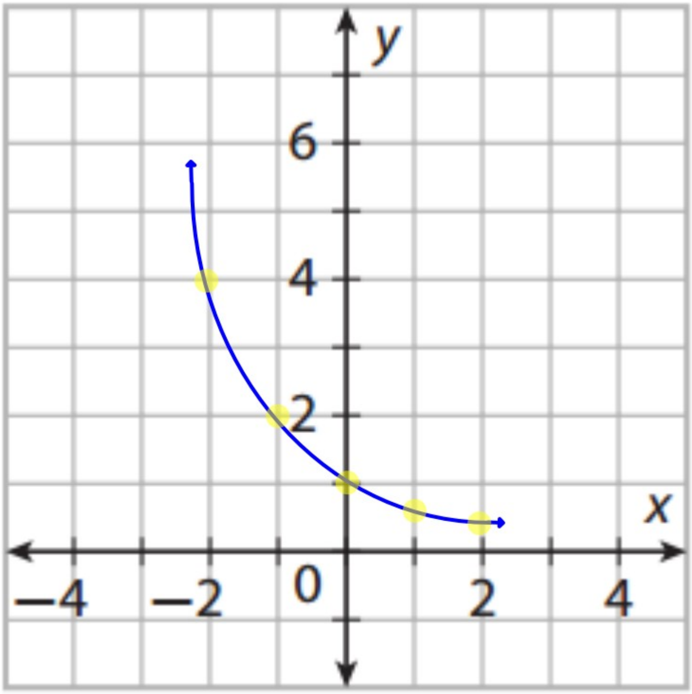
For growth or decay to be exponential, a quantity changes by a fixed percentage each time period.

Exponential Decay

Graphing and Analyzing *f*(*x*) =

x	*f(x)*
-2	*4*
-1	*2*
0	*1*
1	*1/2*
2	*1/4*

Domain	*All Real #s*
Range	*y > 0*
y-intercept	*(0, 1)*

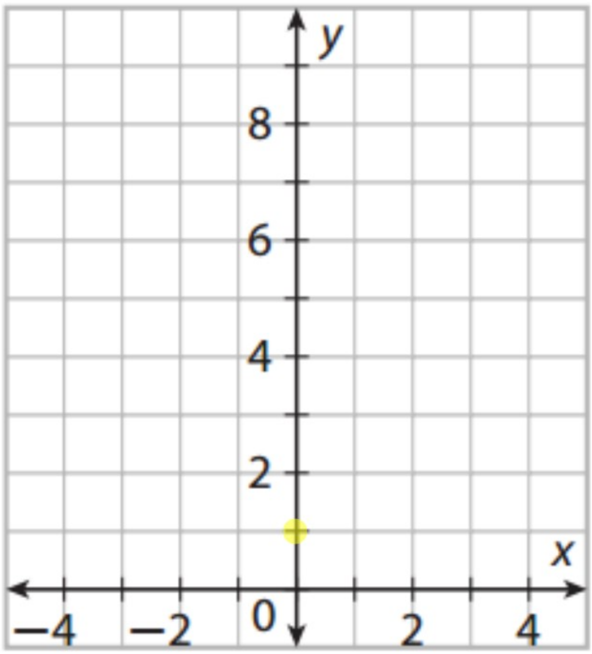


Exponential Decay

Graphing and Analyzing $f(x) = \left(\frac{1}{3}\right)^x$

x	f(x)
-2	?
-1	?
0	1
1	?
2	?

Domain ?
Range ?
y-intercept ?



Exponential Decay

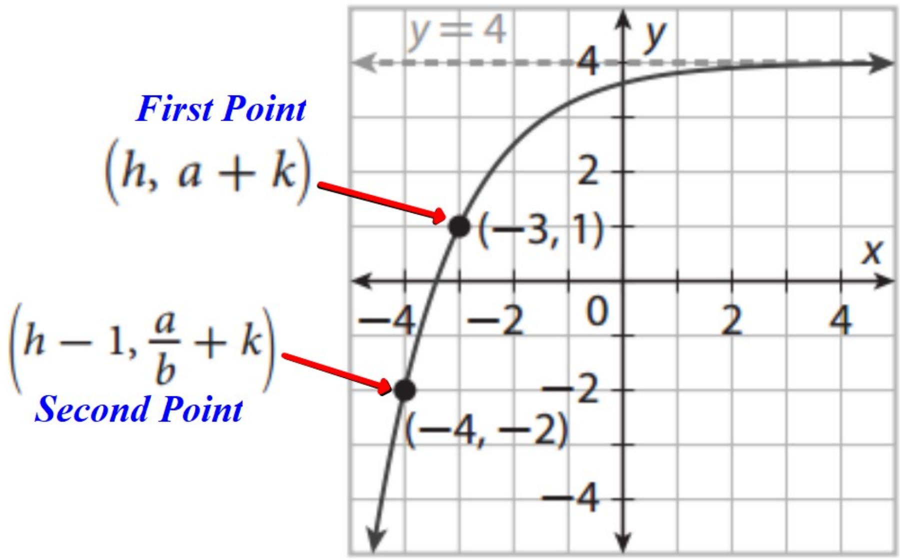
When graphing transformations of $f(x) = b^x$ where $0 < b < 1$, it is helpful to consider the effect of the transformation on two reference points, $(0, 1)$ and $\left(-1, \frac{1}{b}\right)$, as well as the effect on the asymptote, $y = 0$. The table shows these reference points and the asymptote $y = 0$ for $f(x) = b^x$ and the corresponding points and asymptote for the transformed function, $g(x) = ab^{x-h} + k$.

	$f(x) = b^x$	$g(x) = ab^{x-h} + k$
First reference point	$(0, 1)$	$(h, a + k)$
Second reference point	$\left(-1, \frac{1}{b}\right)$	$\left(h - 1, \frac{a}{b} + k\right)$
Asymptote	$y = 0$	$y = k$

First reference point is closer to the asymptote!

Exponential Decay

Writing Equations for Combined Transformations of $f(x) = b^x$ where $0 < b < 1$



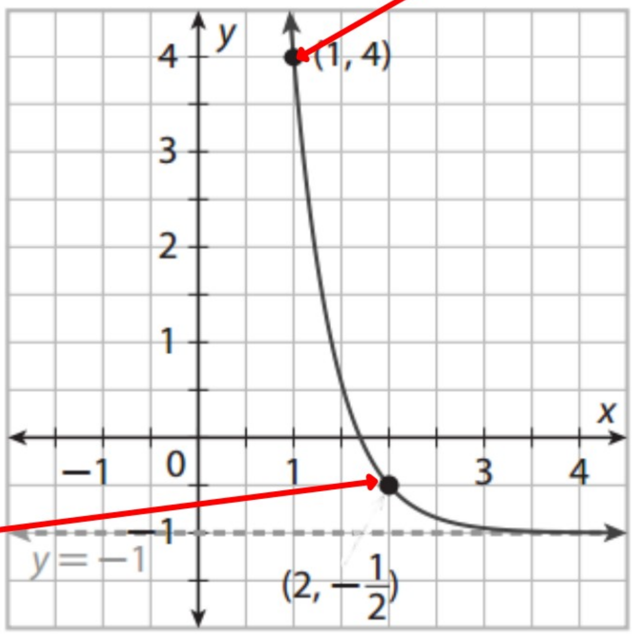
$$g(x) = -3\left(\frac{1}{2}\right)^{x+3} + 4$$

Exponential Decay

Second Point

$\left(h-1, \frac{a}{b}+k\right)$

Writing Equations for Combined Transformations of $f(x) = b^x$ where $0 < b < 1$



First Point

$(h, \ a+k)$

$g(x) = \boxed{\frac{1}{2}} \left(\frac{1}{10}\right)^{x-\boxed{2}} - \boxed{1}$

Exponential Decay

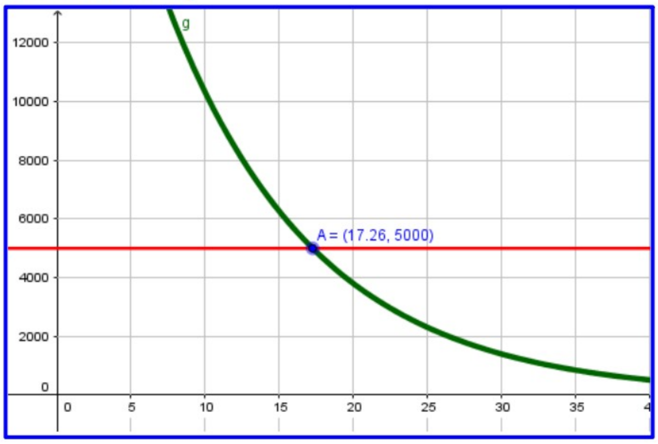
Modeling with Exponential Decay Functions

The value of a truck purchased new for $28,000 decreases by 9.5% each year. Write an exponential function for this situation and graph it using a calculator. Use the graph to predict after how many years the value of the truck will be $5000.

Given the description of the decay terms, write the exponential decay function in the form $f(t) = a(1 - r)^t$

Substitute parameter values. $V_T(t) = 28{,}000(1 - 0.095)^t$

after 17.26 years, the truck will have a value of $5000.

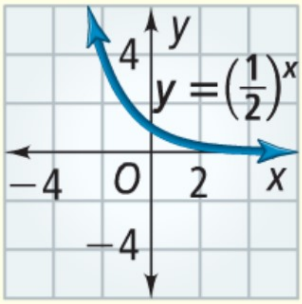


Exponential Decay

Any Questions ?

Exponential Decay

The function $y = ab^x$, represents exponential decay if $a > 0$ and $0 < b < 1$



Classwork

Worksheet 13.2

For exponential decay, $0 < b < 1$ and b is the **decay factor**. The quantity decreases by a constant percentage each time period. The percentage decrease, r, is the *rate of decay*. Usually a rate of decay is expressed as a negative quantity, so $b = 1 + r$.