Objective: Identify and Graph Exponential Growth and Decay Functions

Concept

To identify an exponential function, $f(x) = a(b)^{c(x-h)} + k$, as growth or decay you should consider the function when it is in the form where the coefficient of x is positive. Then, if the base, b, is greater than 1, the function is exponential growth, and if the base, b, is between 0 and 1, the function is exponential decay.

In some exponential functions, especially those that model real-world situations, looking at the base alone can lead to a misinterpretation of the model.

For example: $r(h) = 3(2.4)^{-h}$ **is exponential decay** because the negative exponent means the base value is really $\frac{1}{2.4}$, which is $\frac{5}{12}$, a value between 0 and 1. The model can be rewritten as $r(h) = 3\left(\frac{5}{12}\right)^{h}$, and from this form the true base value is shown.

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Ex) Identify each function as exponential growth or exponential decay. Identify the base.

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

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

$f(x) = 4(3)^{x-4} - 2$

$3 > 1$

base = 3
exponential growth

$g(x) = 7\left(\frac{1}{2}\right)^{x} - 6$

$0 < \frac{1}{2} < 1$

base = $\frac{1}{2}$
exponential decay

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

$h(x) = 4^{-1x} + 5$

$h(x) = \left(\frac{1}{4}\right)^{x} + 5$

$0 < \frac{1}{4} < 1$

base = $\frac{1}{4}$
exponential decay

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Practice) A) Identify the function as exponential growth or decay. B) Graph the function. C) State the y-intercept and zero, if they exist.

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

$0 < \frac{1}{2} < 1$

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

$a = 1$ none
$h = 3$ right 3
$k = 2$ up 2

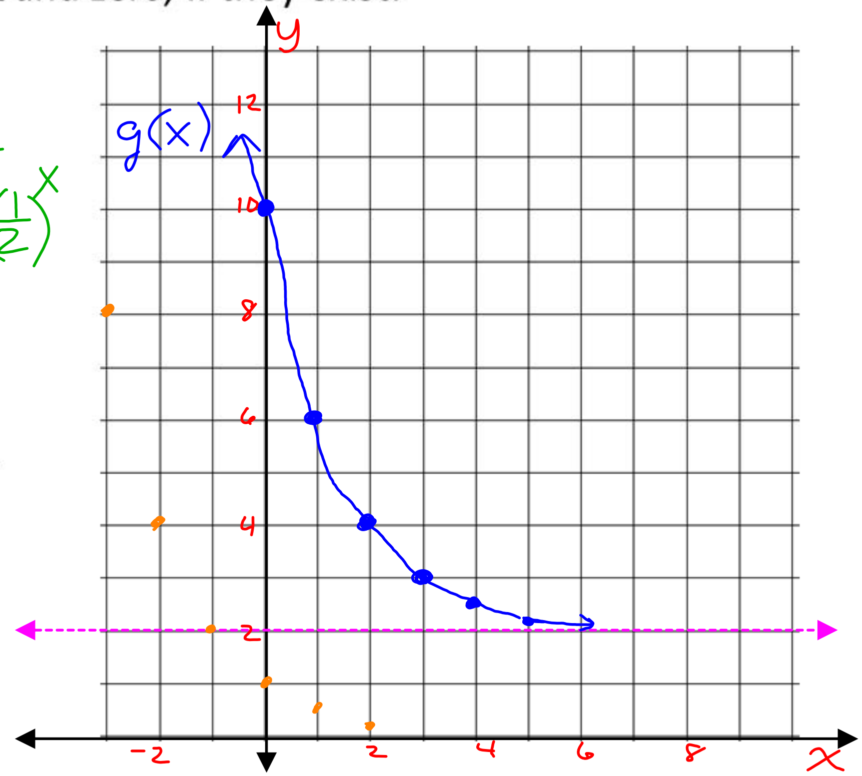
A) exponential decay

C) y-intercept (0, 10)
zero none

$g(0) = \left(\frac{1}{2}\right)^{0-3} + 2$

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

$= 2^3 + 2 = 8 + 2 = 10$



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Practice) A) Identify the function as exponential growth or decay. B) Graph the function. C) State the y-intercept and zero, if they exist.

$$g(x) = 2^{-x-4} - 1$$

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

A) Exponential Decay

C) y-intercept $(0, -\frac{15}{16})$

zero -4

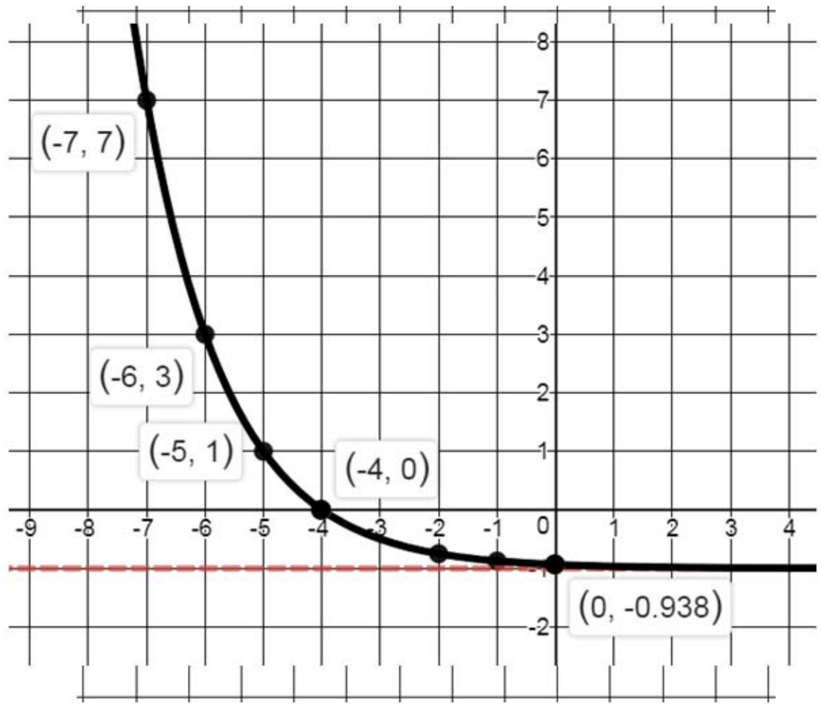
$C)$ y-intercept

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

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

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

$$= \frac{1}{16} + -1 = \frac{1}{16} + \frac{-16}{16} = \frac{-15}{16}$$



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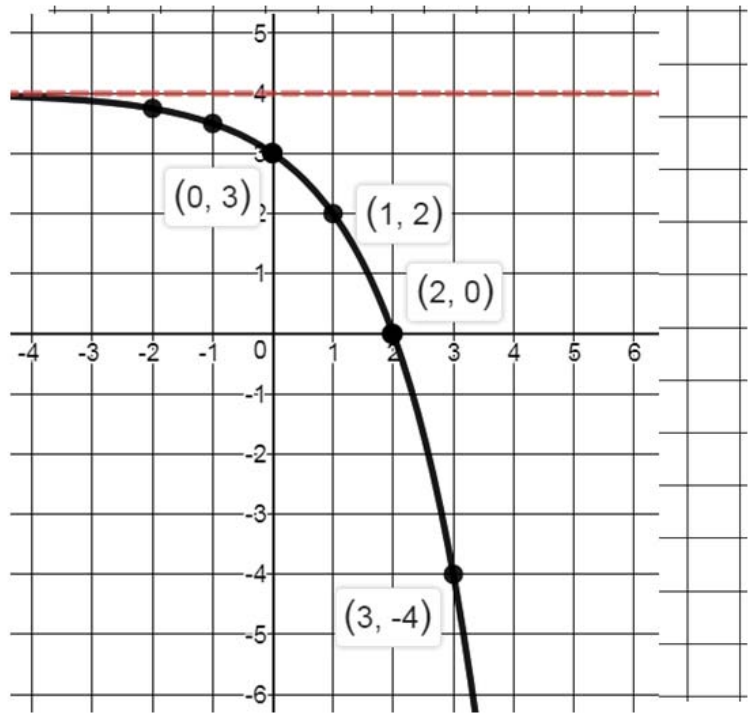
Practice) A) Identify the function as exponential growth or decay. B) Graph the function. C) State the y-intercept and zero, if they exist.

$g(x) = -2^x + 4$

$g(x) = -1(2)^x + 4$



A) Exponential Growth

C) y-intercept (0,3)

zero 2

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Practice) A) Identify the function as exponential growth or decay. B) Graph the function. C) State the y-intercept and zero, if they exist.

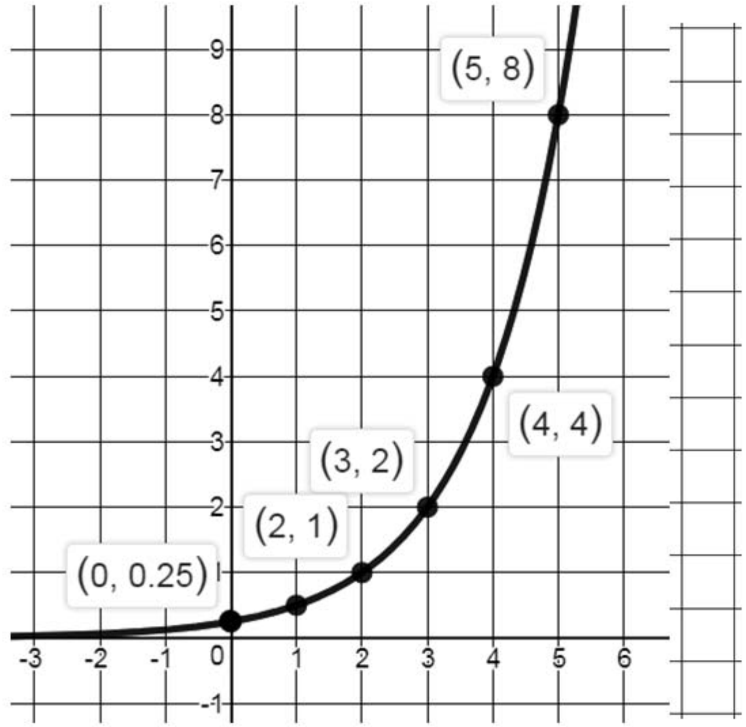
$$g(x) = 0.5^{-(x-2)}$$

$$g(x) = (2)^{x-2}$$

A) Exponential Growth

C) y-intercept $(0, \frac{1}{4})$

zero $none$



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Closure

Will an exponential function always have a y-intercept? Explain.

Yes, since the domain of an exponential function is the set of all real numbers, the x value of 0 will always produce a y-intercept.

Explain when an exponential function will not have a zero. Give an example of a function without a zero as part of your explanation.

An exponential function will not have a zero when the horizontal asymptote prevents it from intersecting the x-axis. An example of such a function is $f(x) = 2^x + 5$.