Happy National Battery Day!

- Park your phones
- NEW SEATS!
- Grab your calculators
- Start warm up on circle table

No calc. on warmup!

Warm-up - Exponents and Exponentials

Evaluate:

1. 8^2

$= 64$

2. 4^{-3}

$= \frac{1}{4^3}$

$= \boxed{\frac{1}{64}}$

3. 2^{-5}

$= \frac{1}{2^5}$

$= \boxed{\frac{1}{32}}$

4. $\left(\frac{2}{3}\right)^{-2}$

$= \frac{2^{-2}}{3^{-2}}$

$= \frac{3^2}{2^2} = \boxed{\frac{9}{4}}$

5. $64^{\frac{1}{2}}$

$= \sqrt{64}$

$= \boxed{8}$

6. $16^{\frac{1}{4}}$

$= \sqrt[4]{16}$

$= \boxed{2}$

7. $16^{\frac{3}{2}}$ ← power ← root

$= \left(16^{\frac{1}{2}}\right)^3$

$= (4)^3$

$= \boxed{64}$

8. $225^{\frac{1}{2}}$

$= \boxed{15}$

Give the initial value, growth/decay FACTOR, and the growth/decay RATE:

9. $y = 25(1.46)^t$

growth

I.V. = 25

G. Factor = 1.46

Rate = 46%

10. $y = 40(0.72)^x$

Decay

IV = 40

D. Factor = .72

D Rate = -28%

$\begin{array}{r} 72 \\ -100 \\ \hline 28 \end{array}$

11. $y = 3^x \Rightarrow y = 1(3)^x$

Growth

IV = 1

G Factor = 3

$\begin{array}{r} 300 \\ -100 \\ \hline 200\% \end{array}$

G Rate 200%

12. $y = 15(0.35)^t$

Decay

I.V. = 15

D. Factor .35

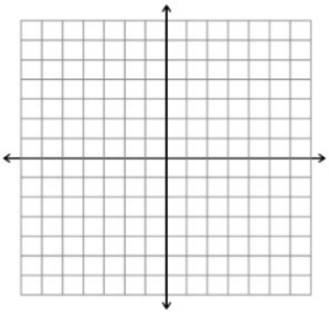
D Rate -65%

$\begin{array}{r} 35 \\ -100 \\ \hline \end{array}$

Graphing Exponential Functions

$$f(x) = ab^x$$

Decay: $0 < b < 1$

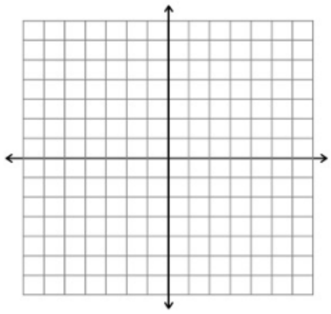


Domain:

Range:

Asymptote:

Growth: $b > 1$

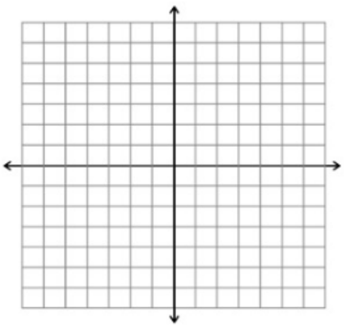


Domain:

Range:

Asymptote:

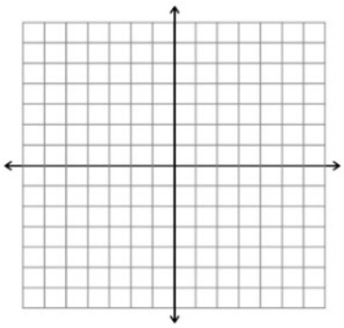
$$f(x) = 2^X$$



Initial Value: (,)

Asymptote:

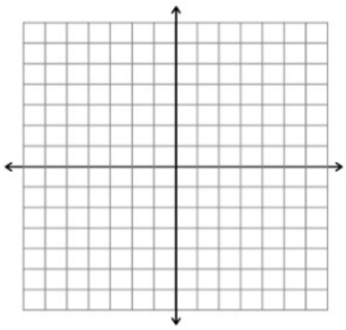
$$f(x) = 2^{X+3}$$



Initial Value: (,)

Asymptote:

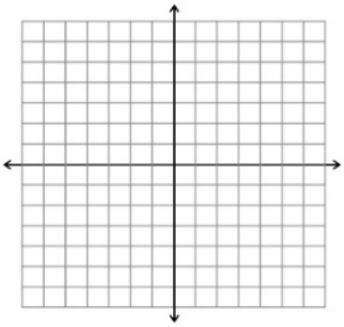
$$f(x) = -2^X + 3$$

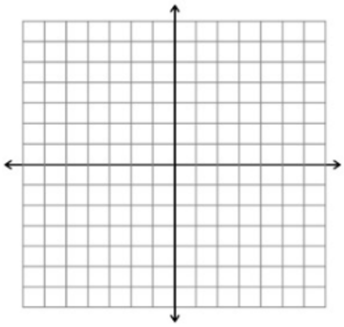


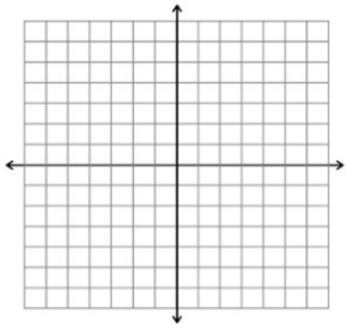
Initial Value: (,)

Asymptote:

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







Initial Value: (,) Initial Value: (,) Initial Value: (,)

Asymptote: Asymptote: Asymptote:

1. Population of Concord, NC is 80,975 and grows at a rate of 1.2% per year. Write an exponential function to model this situation.

2. Your savings account has an initial deposit of $1,000 and earns 15% interest each year. Write an exponential function to model the situation. What will be your total balance after 15 year?

3. A new truck is sold for $32,000 and depreciates at a rate of 7% yearly. Write a function that models the value of the truck after *t* years. What is the value of the truck after 5 years?

4. The initial population of bacteria is 3 and grows at a rate of 80% per hour. Write a function that models the population after *h* hours. What is the population after 24 hours?

Exponential Growth/Decay HW

Determine if the function represents a growth/decay. Identify the initial value, growth factor and rate. (Do not graph)

1. $y = 2(3.5)^x$ 2. $y = 4.2(.09)^x$ 3. $y = 5\left(\frac{1}{3}\right)^x$ 4. $y = 21\left(\frac{5}{2}\right)^x$ 5. $y = 12\left(\frac{1}{4}\right)^x$

6. The mice population is 25,000 and is decreasing by 20% each year. Write a model for this situation.

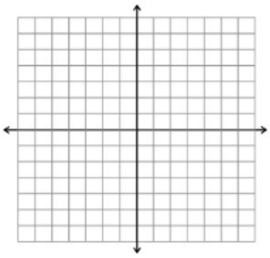
   a. Given the model for #6, what will be the mice population after 3 years?

7. A house that costs $200,000 will appreciate in value by 2% each year. Write a function to model the cost of the over time.

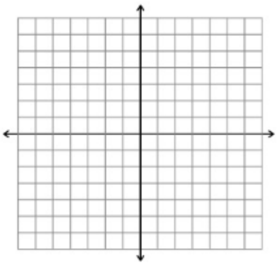
   a. Find the value of the house at the end of 10 years.

Graph the following functions. State the initial value, domain, range and asymptote.

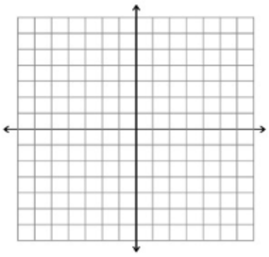
8. $f(x) = -3^x$



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



10. $h(x) = 10^{x+3}$



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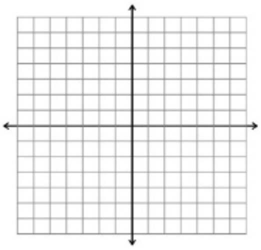
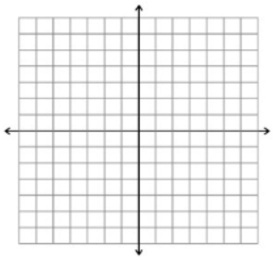
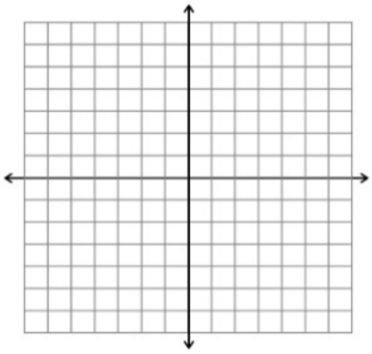


12. $y = 1 + 2^{x+1}$



13. The consumption of soda has increased each year since 2000. The function $C(t) = 179(1.029)^t$ models the amount of soda consumed in the world, where *C* is the amount consumed in billions of liters and *t* is the number of years since 2000. **Graph and sketch the function. How much soda was consumed in 2005?**



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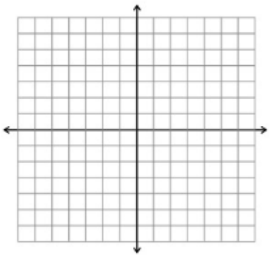

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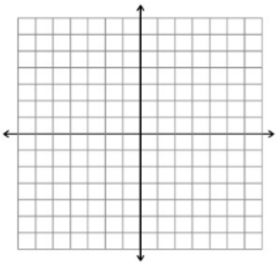

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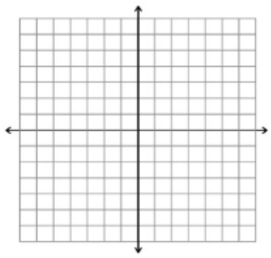

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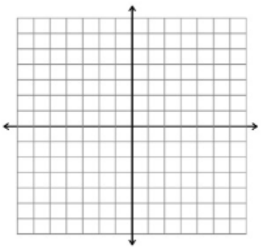

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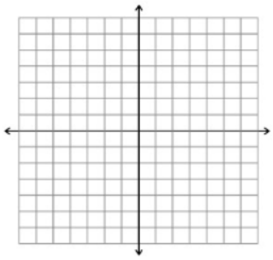

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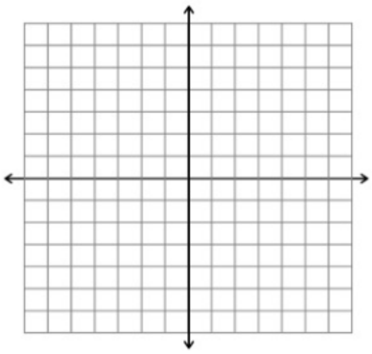

Log Functions Notes

Logarithmic Functions positive

Definition: For all $\boxed{x > 0 \text{ and } a > 0}$ with $a \neq 1$, $\boxed{\boldsymbol{y = \log_a x} \textbf{ if and only if } \boldsymbol{x = a^y}}$

The function given by $\boxed{f(x) = \log_a x}$ is called **logarithmic function with base a.**

When evaluating logarithms, remember that a $\boxed{\text{logarithm is an exponent}}$. This means that $\log_a x$ is the exponent to which a must be raised to get x.
Example: $\log_2 8 = 3$ because 2 must be raised to the third power to get 8.

the answer to a log is the exponent!

Logarithmic Form		Exponential Form
Exponent		Exponent
$\log_a x = y$	$\Leftrightarrow$	$a^y = x$
Base		Base

Examples. Rewrite the logarithmic functions as exponential functions.

1. $\log_2 32 = 5$

$2^5 = 32$

2. $\log_4 2 = \frac{1}{2}$

$4^{1/2} = 2$

3. $\log_3 1 = 0$

$3^0 = 1$

4. $\log \frac{1}{100} = -2$

$10^{-2} = \frac{1}{100}$

*no base => implied base 10

5. $\log_r s = t$

$r^t = s$

6. $\log(a + b) = y$

$10^y = a+b$

Examples. Rewrite the exponential functions as logarithmic functions.

1. $10^3 = 1000$

$\log_{10} 1000 = 3$

2. $2^1 = 2$

$\log_2 2 = 1$

3. $2^{-3} = \frac{1}{8}$

$\log_2 \frac{1}{8} = -3$

4. $10^{-3} = \frac{1}{1000}$

$\log \frac{1}{1000} = -3$

5. $3^m = n$

$\log_3 n = m$

6. $16^{\frac{1}{2}} = 4$

$\log_{16} 4 = \frac{1}{2}$

Log Functions Notes

The Natural Logarithmic Function

The most widely used base for logarithmic function is the number e,

$\boxed{e \approx 2.718281828 \ldots}$

The function is called the **natural logarithmic function** and is defined by ln

$$f(x) = \boxed{\log_e x = \ln x,} \quad x > 0$$

Rewrite in Exponential Form:

$\ln x = y + 2$ ($\log_e x$)

$\boxed{e^{y+2} = x}$

$\ln(x + 5) = t - 2$

$\boxed{e^{t-2} = x+5}$

Rewrite as a Natural Log:

$e^3 = 20.085$

$\boxed{\ln 20.085 = 3}$

$e^{x+2} = 7$

$\boxed{\ln 7 = x+2}$

Evaluate the Expressions:

1. $\log_2 16 = x$

$2^x = 16$

$\boxed{x = 4}$

2. $\ln e^2 = x$

$e^x = e^2$

$\boxed{x = 2}$

3. $\log_4 64 = x$

$4^x = 64$

$\boxed{x = 3}$

4. $\log_3 \frac{1}{27}$

$3^x = \frac{1}{27}$

$\boxed{x = -3}$

5. $\log_2 \frac{1}{16} = x$

$2^x = \frac{1}{16}$

$\boxed{x = -4}$

7. $\log \sqrt{10} = x$

$10^x = \sqrt{10}$

$10^x = 10^{\frac{1}{2}}$

$\boxed{x = \frac{1}{2}}$

8. $\ln \frac{1}{e} = x$

$e^x = \frac{1}{e^1}$

$\boxed{x = -1}$

9. $\ln \sqrt{e^3} = x$

$e^x = e^{3/2}$

$\boxed{x = 3/2}$

Identities of Logarithms

Equality Property

If $\log_a(x) = \log_a(y)$ then $\boxed{x = y}$

same base

Example:

same base

$$\log_4(-2x + 7) = \log_4(5x - 14)$$

$$-2x + 7 = 5x - 14$$
$$+2x + 14 \quad +2x + 14$$
$$21 = 7x$$
$$\boxed{3 = x}$$

Logarithmic Functions HW

Write the logarithmic equation in exponential form

1. $\log_4 64 = 3$ 2. $\log_7 \frac{1}{49} = -2$ 3. $\log_{32} 4 = \frac{2}{5}$

Write the exponential equation in logarithmic form

4. $5^3 = 125$ 5. $6^{-2} = \frac{1}{36}$ 6. $81^{\frac{1}{4}} = 3$

Use the definition of the logarithmic function to find *x*.

7. $\log_2 x = 5$ 8. $\log_2 16 = x$ 9. $\log_{10} x = 2$

Use the properties of the logarithmic function to solve for *x*

10. $\log_4(3x - 2) = \log_4(x + 4)$ 11. $\log_5 1 = x$

12. $\log_3 3 = x$ 13. $\log_5 5^2 = x$

Evaluate the expression

14. $\log_4 64$ 15. $\log_3 \frac{1}{27}$ 16. $\log_{16} 4$

17. $\ln(\sqrt[5]{e^3})$ 18. $\log(\sqrt[3]{100}) = x$ 19. $\log_5\left(\frac{1}{25}\right)$

$10^x = 100^{1/3}$

$10^x = (10^2)^{1/3}$

$10^x = 10^{2/3}$

$x = 2/3$