Some Rules Involving Exponents

1. $b^0 = 1 \quad (b \neq 0)$
2. $b^{-n} = \frac{1}{b^n} \quad (b \neq 0)$
3. $\frac{1}{b^{-n}} = b^n \quad (b \neq 0)$
4. $b^{\frac{m}{n}} = (\sqrt[n]{b})^m$

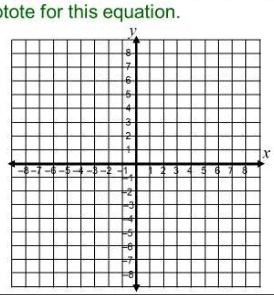
Examples: Simplify each of the following: (a) 85^0, (b) 7^{-2}, (c) $\left(\frac{4}{5}\right)^{-3}$, (d) $8^{4/3}$, and (e) $36^{-1/2}$.

Graphing Exponential Functions

An exponential function has the form $f(x) = b(a^x)$, where $a > 0$ and $a \neq 1$.

Example: Graph $f(x) = \left(\frac{1}{3}\right)^x$. Then find the domain, range, and equation of the asymptote for this equation.

x	$y = f(x)$
–2	
–1	
0	
1	
2	
3	
6	

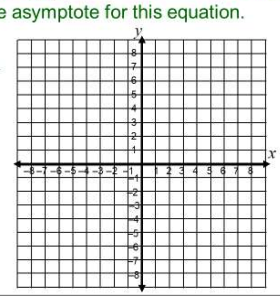


Graphing Exponential Functions

An exponential function has the form $f(x) = b(a^x)$, where $a > 0$ and $a \neq 1$.

Example: Graph $g(x) = 2^x$. Then find the domain, range, and equation of the asymptote for this equation.

x	$y = g(x)$
–5	
–2	
–1	
0	
1	
2	
3	

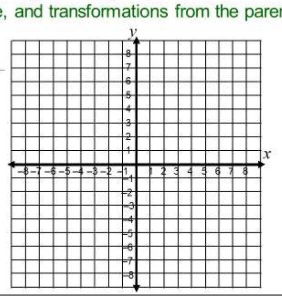


Graphing Exponential Functions

An exponential function has the form $f(x) = b(a^x)$, where $a > 0$ and $a \neq 1$.

Example: Graph $h(x) = 3 - 5(2^{x+1})$. Then find the domain, range, equation of the asymptote, and transformations from the parent graph for this function.

x	$y = h(x)$
–7	
–4	
–3	
–2	
–1	
0	
1	



Graphing Exponential Functions

Transformations of Parent Graphs

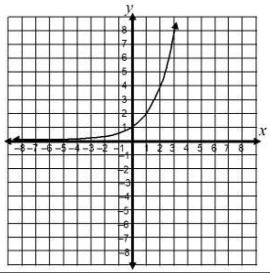
	Inside (Horizontal) Transformations	Outside (Vertical) Transformations
Adding a number	Shift the graph left.	Shift the graph up.
Subtracting a number	Shift the graph right.	Shift the graph down.
Multiplying by a positive number	Horizontal stretch if the number is between 0 and 1; horizontal shrink if the number is larger than 1 **If there is a number added to or subtracted from the x, you must factor the number out before you worry about any of the other transformations.**	Vertical shrink if the number is between 0 and 1; vertical stretch if the number is larger than 1
Multiplying by –1	Reflect the graph over the y-axis. **If there is a number added to or subtracted from the x, you must factor the –1 out before you worry about any of the other transformations.**	Reflect the graph over the x-axis.

Graphing Exponential Functions

An exponential function has the form $f(x) = b(a^x)$, where $a > 0$ and $a \neq 1$.

Example: Graph $h(x) = 3 - 5(2^{x+1})$. Then find the domain, range, equation of the asymptote, and transformations from the parent graph for this function.

x	y
−8	≈0.004
−3	0.125
0	1
1	2
2	4



Transformations:

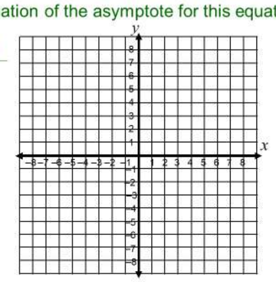
1. Parent graph: $g(x) = 2^x$

Graphing Exponential Functions

The number e is approximately equal to 2.718. Because this is only an approximation, you should always use the e button on your calculator (and not the approximation).

Example: Graph $k(x) = \frac{1}{2}e^{x-3} - 1$. Also write an equation that describes the parent graph, state the transformations that lead to the new graph, and find the domain, range, and equation of the asymptote for this equation.

x	$y = k(x)$
−3	
0	
1	
2	
3	
4	
5	
6	



Interest in a Savings Account

When you invest money in a bank account, the bank will usually add a small amount of money to your account each month to say "thank you" for leaving your money with them. This money is called interest.

Example: Suppose that you are going to invest $2000 in a savings account today. If you don't make any withdrawals and the account will have an annual percentage yield of 3%, how much money will you have in the account (a) one year from today, (b) two years from today, and (c) three years from today?

Applications of Exponential Functions

If you don't make any withdrawals or deposits after your initial investment, you can use one of the formulas below to calculate the balance in a bank account.

$A = P\left(1 + \frac{r}{n}\right)^{nt}$ (for interest compounded daily, monthly, etc.)

$A = Pe^{rt}$ (for interest compounded continuously)

A = amount of money in the account after t years

P = principal (or amount of money originally invested)

n = number of times per year interest is compounded

r = annual interest rate expressed as a decimal

t = time in years

e is an irrational number (like π) and approximately equal to 2.718

Interest in a Savings Account

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$A = P\left(1 + \frac{r}{n}\right)^{nt}$ (for interest compounded daily, monthly, etc.)

$A = Pe^{rt}$ (for interest compounded continuously)

Example: Suppose that you are going to invest $2000 in a savings account today. If the account will have an annual percentage yield of 3%, how much money will you have in the account twenty years from today? How much money will you have earned in interest?

Applications of Exponential Functions

If you don't make any withdrawals or deposits after your initial investment, you can use one of the formulas below to calculate the balance in a bank account.

$A = P\left(1 + \frac{r}{n}\right)^{nt}$ (for interest compounded daily, monthly, etc.)

$A = Pe^{rt}$ (for interest compounded continuously)

Example: Suppose that Matthew will invest $11,000 in an account that will pay 1.3% annual interest, compounded daily. (a) How much money will be in the account after 5 years? (b) How much money will Matthew have earned in interest after 5 years?

Applications of Exponential Functions

If you don't make any withdrawals or deposits after your initial investment, you can use one of the formulas below to calculate the balance in a bank account.

$A = P\left(1 + \frac{r}{n}\right)^{nt}$ (for interest compounded daily, monthly, etc.)

$A = Pe^{rt}$ (for interest compounded continuously)

Example: Suppose that James will invest $900 in an account that will pay 1% annual interest, compounded continuously. (a) How much money will be in the account after 4 years? (b) How much money will James have earned in interest after 4 years?

More Applications of Exponential Functions

If an amount is growing (or decaying) exponentially, you can use the formula $y = C\left(1 + \frac{r}{100}\right)^{t}$ to describe the amount at time t. In this formula, C stands for the initial amount, and r stands for the growth or decay rate written as a percent. (Make sure your units for r agree with those of t.)

Example: Suppose that a certain company made $25,000 in sales during the month of April 2010. If the company's revenue increased by approximately 0.2% every month over the course over of the next 5 years, (a) what was the company's approximate revenue during the month of July 2010, and (b) what was the company's approximate revenue during the month of April 2014? Round your answers to the nearest dollar.

More Applications of Exponential Functions

If an amount is growing (or decaying) exponentially, you can use the formula $y = C\left(1 + \frac{r}{100}\right)^{t}$ to describe the amount at time t. In this formula, C stands for the initial amount, and r stands for the growth or decay rate written as a percent. (Make sure your units for r agree with those of t.)

Example: Suppose that Madison will buy a car today for $15,000. If the car will lose approximately 12% of its value every year over the course over of the next 5 years, what will the car be worth (a) one year from today and (b) five years from today?

More Applications of Exponential Functions

If an amount is growing exponentially and you know the length of time it takes for an amount to double, you can use the formula $n(t) = n_0(2)^{t/a}$ to describe the amount at time t. In this formula, n_0 stands for the initial amount, and a stands for the amount of time it takes for the amount to double. (Make sure your units for a agree with those of t.)

Example: Suppose that the price of a stock was $15.35 on January 1, 2017. If the price doubled over the course over of the next 3 years, (a) write a formula that approximates the price t years after January 1, 2017, and (b) if the trend continues, estimate what the price will be on January 1, 2021.