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## Study Guide

## Exponential Functions

Functions of the form $y=b^{x}$, in which the base $b$ is a positive real number and the exponent is a variable, are known as exponential functions. Many real-world situations can be modeled by exponential functions. The equation $N=N_{0}(1+r)^{t}$, where $N$ is the final amount, $N_{0}$ is the initial amount, $r$ is the rate of growth or decay, and $t$ is time, is used for modeling exponential growth. The compound interest equation is $A=P\left(1+\frac{r}{n}\right)^{n t}$, where $P$ is the principal or initial investment, $A$ is the final amount of the investment, $r$ is the annual interest rate, $n$ is the number of times interest is compounded each year, and $t$ is the number of years.

## Example 1 Graph $\boldsymbol{y}<\mathbf{2}^{-x}$.

First, graph $y=2^{-x}$. This graph is a function, since there is a unique $y$-value for each $x$-value.

| $\boldsymbol{x}$ | -3 | -2 | -1 | 0 | 1 | 2 | 3 | 4 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\mathbf{2}^{-\boldsymbol{x}}$ | 8 | 4 | 2 | 1 | $\frac{1}{2}$ | $\frac{1}{4}$ | $\frac{1}{8}$ | $\frac{1}{16}$ |

Since the points on this curve are not in the solution of the inequality, the graph of $y=2^{-x}$
 is shown as a dashed curve.
Then, use $(0,0)$ as a test point to determine which area to shade.
$y<2^{-x}$
$0<2^{0}$
$0<1$
Since $(0,0)$ satisfies the inequality, the region that contains $(0,0)$ should be shaded.

Example 2 Biology Suppose a researcher estimates that the initial population of a colony of cells is 100 . If the cells reproduce at a rate of $25 \%$ per week, what is the expected population of the colony in six weeks?
$N=N_{0}(1+r)^{t}$
$N=100(1+0.25)^{6} \quad N_{0}=100, r=0.25, t=6$
$N \approx 381.4697266 \quad$ Use a calculator.
There will be about 381 cells in the colony in 6 weeks.

## Example 3 Finance Determine the amount of money in a

 money market account that provides an annual rate of $6.3 \%$ compounded quarterly if $\$ 1700$ is invested and left in the account for eight years.$A=P\left(1+\frac{r}{n}\right)^{n t}$
$A=1700\left(1+\frac{0.063}{4}\right)^{4 \cdot 8}$
$P=1700, r=0.063, n=4, t=8$
$A \approx 2803.028499 \quad$ Use a calculator.
After 8 years, the $\$ 1700$ investment will have a value of $\$ 2803.03$.
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## Practice

## Exponential Functions

## Graph each exponential function or inequality.

1. $y=2^{x-1}$

2. $y>-3^{x}+1$

3. $y=4^{-x+2}$

4. $y \geq 0.5^{x}$

5. Demographics An area in North Carolina known as The Triangle is principally composed of the cities of Durham, Raleigh, and Chapel Hill. The Triangle had a population of 700,000 in 1990. The average yearly rate of growth is $5.9 \%$. Find the projected population for 2010.
6. Finance Determine the amount of money in a savings account that provides an annual rate of $4 \%$ compounded monthly if the initial investment is $\$ 1000$ and the money is left in the account for 5 years.
7. Investments How much money must be invested by Mr. Kaufman if he wants to have $\$ 20,000$ in his account after 15 years? He can earn $5 \%$ compounded quarterly.
