**Complete the table.**

1. $y = 3x$

| x | y |
|---|---|
| -1 | -3 |
| 0 | 0 |
| 1 | 3 |
| 2 | 6 |

2. $y = 2^x$

| x | y |
|---|---|
| -1 | .5 |
| 0 | 1 |
| 1 | 2 |
| 2 | 4 |

3. $y = 3^x$

| x | y |
|---|---|
| -1 | 1/3 |
| 0 | 1 |
| 1 | 3 |
| 2 | 9 |

Warm Up

· Use substitution to complete tables

· Can use calculator to complete tables

---

**Simplify the expression.**

1. $2^3 2^4$    $2^7$

2. $\dfrac{x^5 x^2}{x^3}$    $\dfrac{x^7}{x^3} = x^4$

3. $(2b^5)^3$    $2^3 b^{15}$

4. $3^x 3^5$    $3^{x+5}$

5. $\dfrac{y^{4x} y^x}{y^{2x}}$

$\dfrac{y^{4x+x}}{y^{2x}}$

$\dfrac{y^{5x}}{y^{2x}}$

$y^{3x}$

6. $(3a^x)^2$

$3^2 a^{2x}$

Cumulative Warm Up

· Review exponent property rules

---

## Essential Question

What are some of the characteristics of the
graph of an exponential function?

exponential function: $y = ab^x$

$a \neq 0$

Essential Question

What you will learn

· Graph exponential functions

· Use exponential models to solve real-life problems.

**Work with a partner.** Match each exponential function with its graph. Use a table of values to sketch the graph of the function, if necessary.
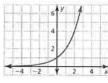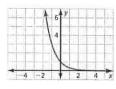
a. $f(x) = 2^x$          b. $f(x) = 3^x$          c. $f(x) = 4^x$

d. $f(x) = \left(\dfrac{1}{2}\right)^x$          e. $f(x) = \left(\dfrac{1}{3}\right)^x$          f. $f(x) = \left(\dfrac{1}{4}\right)^x$
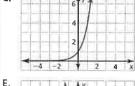
A.

B.

Exploration 1

· use graphing Calculator to see graphs.

C.

D.
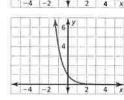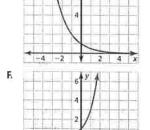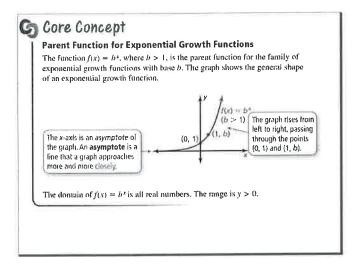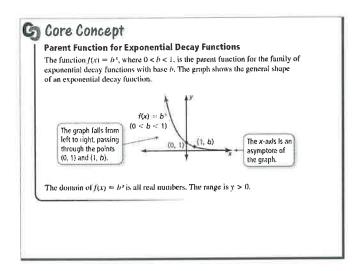
E.

F.

Exploration 1D-F

**Work with a partner.** Use the graphs in Exploration 1 to determine the domain, range, and $y$-intercept of the graph of $f(x) = b^x$, where $b$ is a positive real number other than 1. Explain your reasoning.

Exploration 2

## Core Concept

**Parent Function for Exponential Growth Functions**

The function $f(x) = b^x$, where $b > 1$, is the parent function for the family of exponential growth functions with base $b$. The graph shows the general shape of an exponential growth function.

The x-axis is an *asymptote* of the graph. An **asymptote** is a line that a graph approaches more and more closely.

$f(x) = b^x$
$(b > 1)$
The graph rises from left to right, passing through the points $(0, 1)$ and $(1, b)$.

$(0, 1)$  $(1, b)$

The domain of $f(x) = b^x$ is all real numbers. The range is $y > 0$.

Core Concept

*Handwritten:* $b > 1$ = growth

## Core Concept

**Parent Function for Exponential Decay Functions**

The function $f(x) = b^x$, where $0 < b < 1$, is the parent function for the family of exponential decay functions with base $b$. The graph shows the general shape of an exponential decay function.

The graph falls from left to right, passing through the points $(0, 1)$ and $(1, b)$.

$f(x) = b^x$
$(0 < b < 1)$

$(0, 1)$  $(1, b)$

The x-axis is an asymptote of the graph.

The domain of $f(x) = b^x$ is all real numbers. The range is $y > 0$.

Core Concept

*Handwritten:* $0 < b < 1 \Rightarrow$ decay

Tell whether each function represents *exponential growth* or *exponential decay*. Then graph the function.

**a.** $y = 2^x$

| x | y |
|----|-----|
| -2 | 1/4 |
| -1 | 1/2 |
| 0 | 1 |
| 1 | 2 |
| 2 | 4 |
| 3 | 8 |

**b.** $y = \left(\dfrac{1}{2}\right)^x$

| x | y |
|----|-----|
| -3 | 8 |
| -2 | 4 |
| -1 | 2 |
| 0 | 1 |
| 1 | 1/2 |
| 2 | 1/4 |

Example 1

Tell whether the function represents *exponential growth* or *exponential decay*. Then graph the function.

1. $y = 4^x$

2. $y = \left(\dfrac{2}{3}\right)^x$

3. $f(x) = (0.25)^x$

4. $f(x) = (1.5)^x$

Monitoring Progress 1-4

· Individual practice
· use tables to graph

---

The value of a car $y$ (in thousands of dollars) can be approximated by the model $y = 25(0.85)^t$, where $t$ is the number of years since the car was new.

a. Tell whether the model represents exponential growth or exponential decay.

base .85        $0 < .85 < 1$ — decay

b. Identify the annual percent increase or decrease in the value of the car.

$.85 = 1 - ?$   → .15 or 15%

c. Estimate when the value of the car will be $8000.

graph on Calculator to see where (estimate)

Example 2

---

In 2000, the world population was about 6.09 billion. During the next 13 years, the world population increased by about 1.18% each year.

a. Write an exponential growth model giving the population $y$ (in billions) $t$ years after 2000. Estimate the world population in 2005.

$y = a(1 + r)^t$
$= 6.09(1 + .0118)^t$

b. Estimate the year when the world population was 7 billion.

use equation
$y = 6.09(1.0118)^t$
put in graphing calculator to read.

a. Substitute 5 for t
$y = 6.09(1.0118)^5$
$y = 6.46$ billion

b. use table feature to determine when $y \approx 7$
7 billion in 2012

Example 3

You deposit $9000 in an account that pays 1.46% annual interest. Find the balance after 3 years when the interest is compounded quarterly.

$$A = P\left(1 + \frac{r}{n}\right)^{nt}$$

$$= 9000\left(1 + \frac{.0146}{4}\right)^{4 \cdot 3}$$

$$\approx 9402.21$$

balance after 3 years
$9402.21

Example 5

---

**7.** The amount $y$ (in grams) of the radioactive isotope iodine-123 remaining after $t$ hours is $y = a(0.5)^{t/13}$, where $a$ is the initial amount (in grams). What percent of the iodine-123 decays each hour?

about 5.19%

**8. WHAT IF?** In Example 5, find the balance after 3 years when the interest is compounded daily.

$9402.95

Monitoring Progress 7-8

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• **Response Logs:** Select from: "At first I thought ... but now I think ..." or "What confused me the most was ..." or "I was successful in ...."

Closure

**5. WHAT IF?** In Example 2, the value of the car can be approximated by the model $y = 25(0.9)^t$. Identify the annual percent decrease in the value of the car. Estimate when the value of the car will be $8000.

.1 or 10%   after 10.8 yrs

**6. WHAT IF?** In Example 3, assume the world population increased by 1.5% each year. Write an equation to model this situation. Estimate the year when the world population was 7 billion.

$$y = 6.09(1.015)^t$$

year 2009

Monitoring Progress 5-6

The amount $y$ (in grams) of the radioactive isotope chromium-51 remaining after $t$ days is $y = a(0.5)^{t/28}$, where $a$ is the initial amount (in grams). What percent of the chromium-51 decays each day?

$$y = a(0.5)^{t/28}$$
$$= a\left[(0.5)^{1/28}\right]^t$$
$$\approx a(0.9755)^t$$
$$= a(1 - 0.0245)^t$$

$1 - .9755 = .0245$

daily decay rate = 2.45%

Example 4

## ⊙ Core Concept

**Compound Interest**

Consider an initial principal $P$ deposited in an account that pays interest at an annual rate $r$ (expressed as a decimal), compounded $n$ times per year. The amount $A$ in the account after $t$ years is given by

$$A = P\left(1 + \frac{r}{n}\right)^{nt}.$$

· type of savings accounts

· no rounding decimal
    Values

Core Concept