Chapter 7 Exponential Logarithmic Functions

7.0 Pre-assessment

Match each of the vocabulary terms on the left with the appropriate letter and definition on the right.

1. exponent.
2. function.
3. relation.
4. variable.

A. a symbol used to represent one or more numbers.

B. the set of counting numbers and their opposites

C. a relation with at most one y-value for each x-value.

D. the number of times the base of a power is used as a factor.

E. a set of ordered pairs.

Simplify each expression.

5. $x^2(x^3)(x)$

6. $3y^{-1}(5x^2y^2)$

7. $\dfrac{a^{-2}b^3}{a^4b^{-1}}$.

8. $(3x)^2(4x^3)$

Use the simple interest formula, $I = Prt$, where I is the interest, P is the initial amount (principal), and r is the interest rate..

9. Find the simple interest on an investment of \$3000 at 3% for 2 years..

10. A savings account of \$2000 earned \$90 simple interest in 3 years. Find the interest rate.

Solve each equation for x.

11. $\dfrac{x}{2} = 3y - 4$

12. $y = \dfrac{3}{4}x - \dfrac{1}{2}$

1. D 2. C 3. E 4. A 5. x^6 6. $15x^2y$ 7. b^4/a^6 8. $36x^5$ 9. \$180

10. 1.5% 11. $6y - 8$ 12. $(4y + 2)/3$

7.1 Exponential Functions, growth and Decay

Objective: Write and evaluate exponential expressions to model growth and decay situations.

Moore's law, a rule used in the computer industry, states that the number of transistors per integrated circuit (the processing power) doubles every year. Beginning in the early days of integrated circuits, the growth in capacity may be approximated by this table.

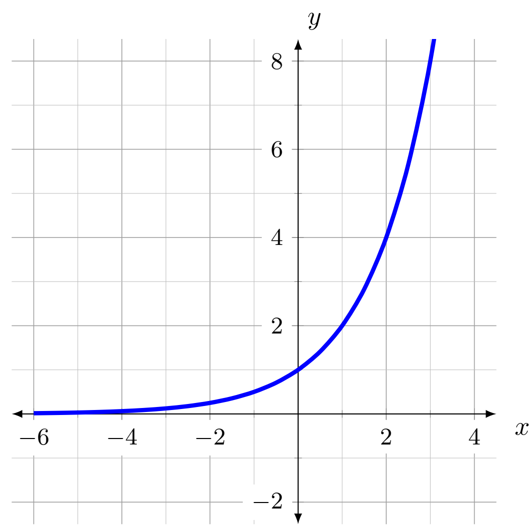
Transistors per Integrated Chip							
Year	1965	1966	1967	1968	1969	1970	1971
Transistors	60	120	240	480	960	1920	3840

$\times 2$ $\times 2$ $\times 2$ $\times 2$ $\times 2$ $\times 2$

Definition 7.1.1. Functions with a variable exponent are known as **exponential functions**. The parent exponential function is $f(x) = b^x$, where the **base** b is a constant and the exponent x is the independent variable.

$$f(x) = b^x, \text{ where } b > 0, b \neq 1.$$

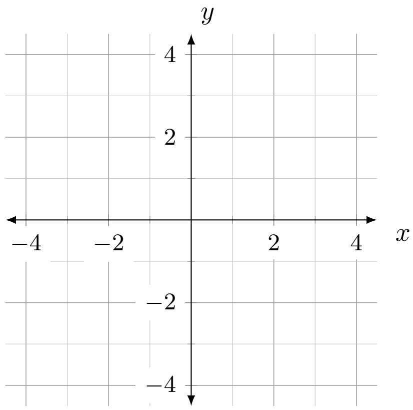
x	-2	-1	0	1	2	3
$\mathbf{f(x) = 2^x}$						



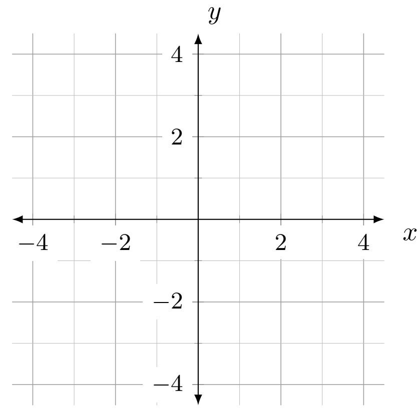
Definition 7.1.2. An **asymptote** is a line that a graphed function approaches as the value of x gets very large or very small. A function of the form $f(x) = ab^x$, with $a > 0$ and $b > 1$, is an **exponential growth** function, which increases as x increases. When $0 < b < 1$, the function is called an **exponential decay** function, which decreases as x increases.

Example 1. Tell whether the function shows growth or decay. Then graph.

(a) $f(x) = 3^x$

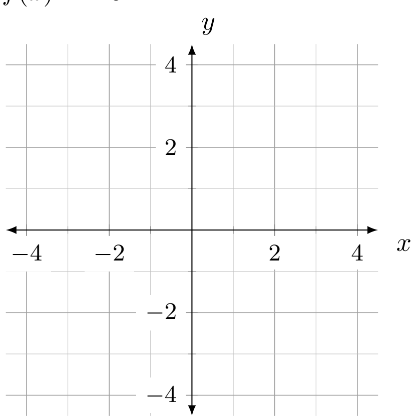


(b) $g(x) = 2\left(\frac{1}{2}\right)^x$

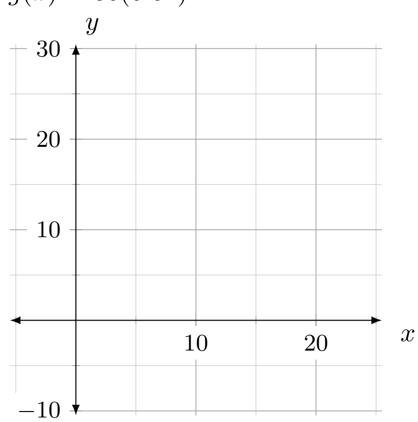


Example 2. Use a table and graphing calculator to sketch the exponential functions. Tell whether the function shows growth or decay.

(a) $f(x) = 1.5^x$



(b) $g(x) = 30(0.8^x)$



Exponential Growth Model

$$A(x) = P(1 \pm r)^t$$

Where A is the final amount, P is the principal (initial amount), r is the rate of increase or decrease, and t is time in compounding periods.

Example 3. (Calculator) Tyler purchased a rare 1959 Gibson Les Paul guitar in 2000 for \$12,000. Experts estimate that its value will increase by 14% per year. Use a calculator to graph to find when the value of the guitar will be \$60,000.

7.1 (day 1) Homework: page 493 2-5, 7-10

7.1 Exponential Functions (day 2)

Objective: Write and evaluate exponential expressions to model growth and decay situations.

Often we have a need to find when two equations are equal or when a function reaches a specific value. This is where we will use the `INTERSECT` function in the calculate menu.

Step 1: Press $\boxed{Y=}$ and use `Y1` for one side of the equation to solve and `Y2` for the other side of the equation.

Step 2: Press $\boxed{\text{GRAPH}}$ and use $\boxed{\text{WINDOW}}$ to set the `Xmin` and `Xmax` as well as the `Ymin` and `Ymax` to fit the interestion within the window.

Step 3: Use $\boxed{\text{2nd}}$ $\boxed{\text{Trace}}$ (the calculate menu) and select option 5. `insersect`. Press $\boxed{\text{ENTER}}$ on `Y1` and use the up arrow to select `Y2`. Use the arrow keys to guess the approximate intersection of the two curves.

Example 4. In 1081, the Australian humpback whale population was 350 and has increased at a rate of about 14% each year since then. Write a function to model population growth. Use a graph to predict when the population will reach $20,000$.

Example 5. The value of a truck bought new for \$28,000 decreases 9.5% each year. Write an exponential function, and graph the function. Use the graph to predict when the value will fall to \$5,000.

You Try It! 1. A motor scooter purchased for \$1,000 depreciates at an annual rate of 15%. Write an exponential function, and graph the function. Use the graph to predict when the value will fall below \$100.

Example 6. The amount of freight transported by rail in the United States was about 580 billion *ton-miles* in 1960 and has been increasing at a rate of 2.32% per year since then.

a. Write a function representing the amount of freight, in billions of ton-miles, transported annually (let 1960 = year 0).

b. Graph the function.

c. In what year would you predict that the number of ton-miles woud have exceeded or would exceed 1 trillion (1000 billion)?

You Try It! 2. A quantity of insulin used to regulate sugar in the bloodstream breaks down by about 5% each minute. A body-weight adjusted does is generally 10 units.

a. Write a function representing the amount of the dose that remains after t minutes.

b. Graph the function.

c. About how much insulin remains after 10 minutes?

d. About how long does it take for half the dose to remain?

7.1 (day 2) Homework: page 494   15, 17, 21, 22, 27

7.2 Inverse of Relations and Functions

Objective: Graph and recognize inverses of relations and functions. Find Inverses of functions

Definition 7.2.1. An **inverse relation** is a relation that swaps x and y in every ordered pair of a given relation. This is the same as reflecting a graph over the line $y = x$.

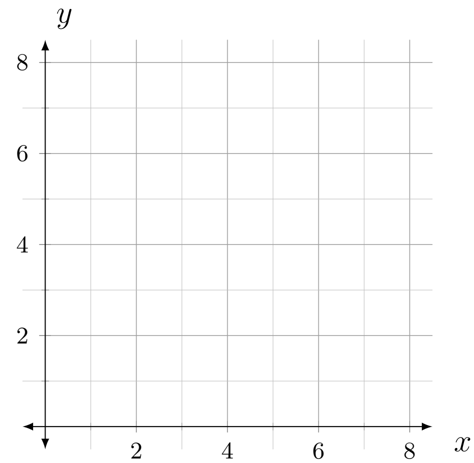
Example 1. Graph the relation and connect the points. Then graph the inverse relation, identify the domain and range of each relation.

Relation

Domain:

Range:

x	0	1	2	4	8
y	2	4	5	6	7



Inverse Relation

Domain:

Range:

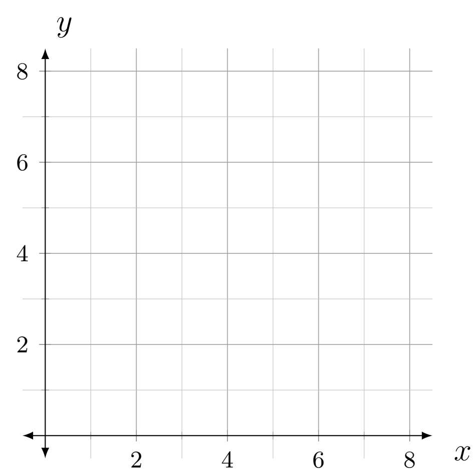
You Try It! 3. Graph the relation and connect the points. Then graph the inverse relation, identify the domain and range of each relation.

Relation

Domain:

Range:

x	1	3	4	5	6
y	0	1	2	3	5



Inverse Relation

Domain:

Range:

Definition 7.2.2. When a relation is also a function, you can write the inverse of the function $f(x)$ as $\mathbf{f^{-1}(x)}$. This notation does not indicate a reciprocal. Functions that *undo* each other are **inverse functions**.

Input	$\longrightarrow$	Function	$\longrightarrow$	**Output**
3		$\mathbf{f(x) = x + 6}$		**9**
Input	$\longrightarrow$	Inverse Function	$\longrightarrow$	**Output**
9		$\mathbf{f^{-1}(x) = x - 6}$		**3**

Example 2. Use inverse operations to write the inverse of the following functions.

(a) $f(x) = \dfrac{x}{3}$

(b) $g(x) = x - \dfrac{2}{3}$

You Try It! 4. Use inverse operations to write the inverse of the following functions.

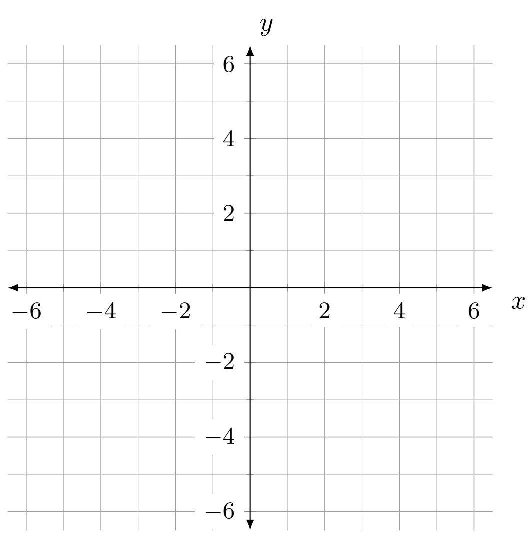
(a) $f(x) = -5x$

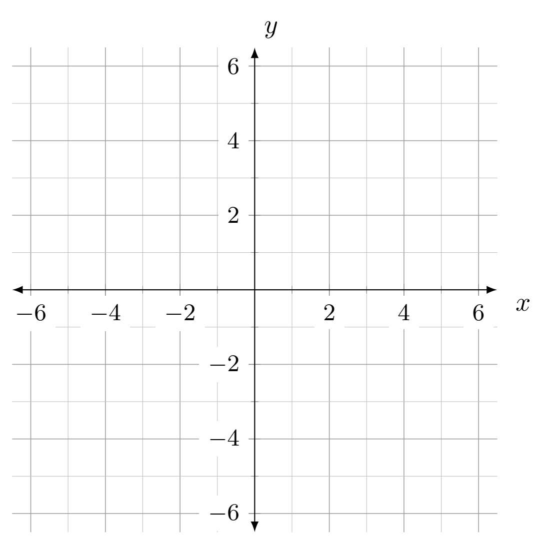
(b) $g(x) = x + 5$

Example 3. Write and graph the inverse of each function.

(a) $f(x) = 3x + 6$

(b) $g(x) = \dfrac{2}{3}x + 2$





7.2 Homework (day 1): page 501 2-16 all

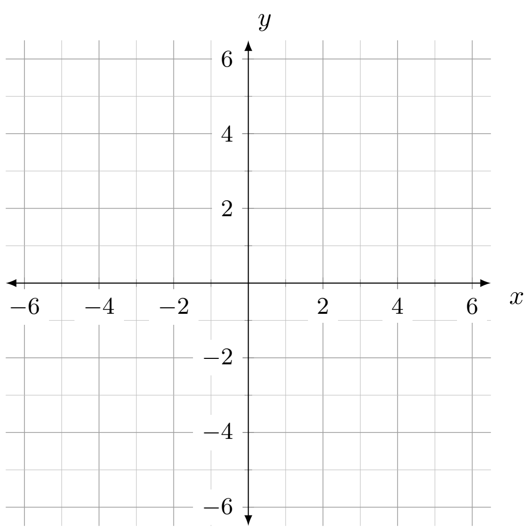
7.2 Inverses of Relations and Functions (day 2)

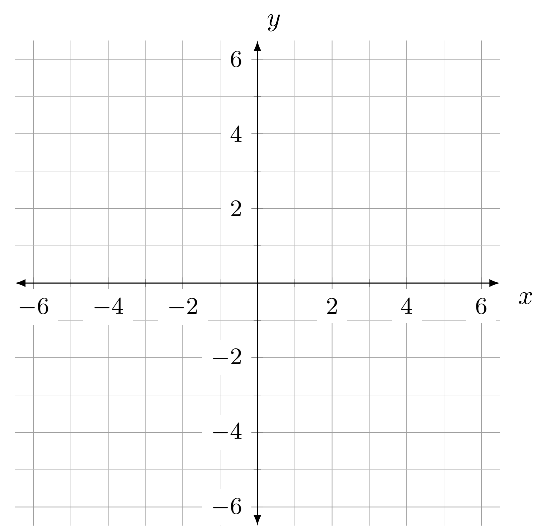
Objective: Find the inverses of functions.

Example 4. Write and graph the inverse of each function.

(a) $f(x) = \frac{3}{5}x - 4$

(b) $g(x) = \frac{3}{4}x + 3$





Example 5. A clerk needs to price a digital camera returned by a customer. The customer paid a total of \$103.14, which included a gift-wrapping charge of \$3 and 8% sales tax. What price should the clerk mark on the tag?

Example 6. To make tea, use $\frac{1}{6}$ teaspoon of tea per ounce of water plus a teaspoon for the pot. Use the inverse to find the number of ounces of water needed if 7 teaspoons of tea are used.

Example 7. Tell whether each statement is sometimes, always, or never true.

The inverse of an ordered pair on a graph is its reflection over the line $y = x$

The inverse of a linear function is a linear function.

The inverse of a line with positive slope is a line with negative slope.

The inverse of a line with slope greater than 1 is a line with slope less than one.

The inverse of the inverse of a point (x, y) is the original point.

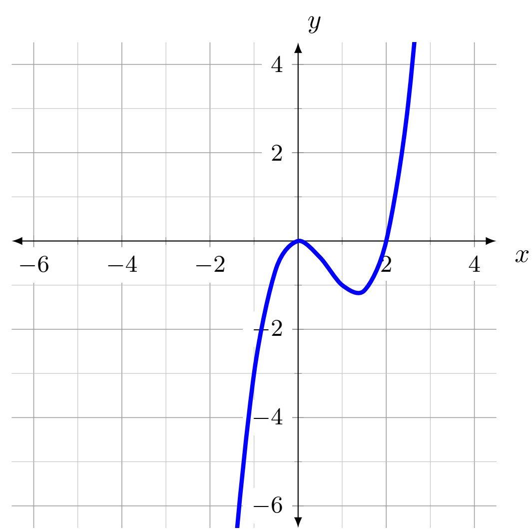
Example 8. What is the inverse of $f(x) = 3$ (Hint: Write this function as $y = 0x + 3$.) Is the inverse a function? Explain.

Example 9. State whether the inverse is a function.

(a)

x	1	3	4	5	6
y	5	1	5	10	17

(b)



(c) $(1, 2), (2, 5), (3, 8), (4, 11)$

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

7.2 Homework (day 2): page 501 17-28 all

7.3 Logarithmic Functions

Objective: Write equivalent forms for exponential and logarithmic functions.

Definition 7.3.1. A **logarithim** is the exponent to which a specified base is raised to obtain a given value.

$$\mathbf{b^x} = \qquad \log_{\mathbf{b}} \mathbf{a} = \mathbf{x}$$

Example 1. Write each exponential equation in logarithmic form.

	Exponential Equation	Logarithmic Form
(a)	$2^6 = 64$	$\log_2 64 =$ ______
(b)	$4^1 = 4$	$\log_4 4 =$ ______
(c)	$5^0 = 1$	$\log_5 1 =$ ______
(d)	$5^{-2} = 0.04$	$\log_5 0.04 =$ ______
(e)	$3^x = 81$	$\log_3 81 =$ ______

(f) $9^2 = 81$

(g) $3^3 = 27$

(h) $x^0 = 1$ $(x \neq 0)$

Example 2. Write each logarithmic equation in exponential form.

	Logarithmic Form	Exponential Equation
(a)	$\log_1 0100 = 2$	$10^2 =$ ______
(b)	$\log_7 49 = 2$	$7^2 =$ ______
(c)	$\log_8 0.125 = -1$	$8^{-1} =$ ______
(d)	$\log_5 5 = 1$	$5^1 =$ ______
(e)	$\log_1 21 = 0$	$12^0 =$ ______

(f) $\log_{10} 10 = 1$

(g) $\log_{12} 144 = 2$

(h) $\log_{\frac{1}{2}} 8 = -3$

Special Properties of Logarithms for any base b such that $b > 0$ and $b \neq 1$		
Logarithmic Form	**Exponential Form**	**example**
$\log_b b = 1$	$b^1 = b$	$\log_{10} 10 = 1$ and $10^1 = 10$
$\log_b 1 = 0$	$b^0 = 1$	$\log_{10} 1 = 0$ and $10^0 = 1$

Definition 7.3.2. A logarithm with base 10 is called a **common logarithm**. If no base is written the base is assumed to be 10, $\log 5 = \log_{10} 5$.

Example 3. Use mental math to evaluate the following logarithms.

(a) $\log 1000$ (b) $\log_4 \frac{1}{4}$ (c) $\log 0.00001$ (d) $\log_{25} 0.04$ (e) $\log_2 8$

You Try It! 5. Rewrite each equation in exponential form.

(a) $\log_6 36 = 2$

(b) $\log_{289} 17 = -2$

(c) $\log_{14} \frac{1}{196} = -2$

(d) $\log_3 81 = 4$

You Try It! 6. Rewrite each equation in logarithmic form.

(a) $64^{\frac{1}{2}} = 8$

(b) $12^2 = 144$

(c) $9^{-2} = \frac{1}{81}$

(d) $\left(\frac{1}{12}\right)^2 = \frac{1}{144}$

$\boxed{\textbf{7.3 (day 1) Homework}\text{: page 509 1-13 all, 17-27 odds Adv. 40, 41, 45}}$

7.3 (day 2)

Objective: Write, evaluate, and graph logarithmic functions.

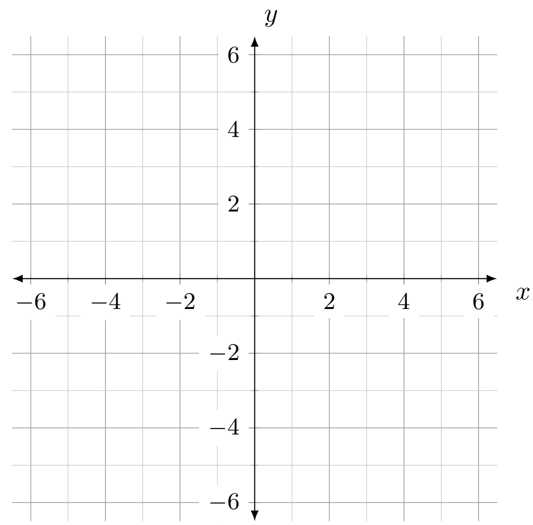
Definition 7.3.3. Logarithms are inverses of exponentials, the inverse of an exponential is a function and is called a **logarithmic function**.

Example 4. Use the given x-values to graph each function. Then graph its inverse. Describe the domain and range for each function.

(a)

$\mathbf{x}$	-2	-1	0	1	2
$\mathbf{f(x) = 2^x}$					

$\mathbf{x}$					
$\mathbf{f^{-1}(x) = \log_2 x}$					



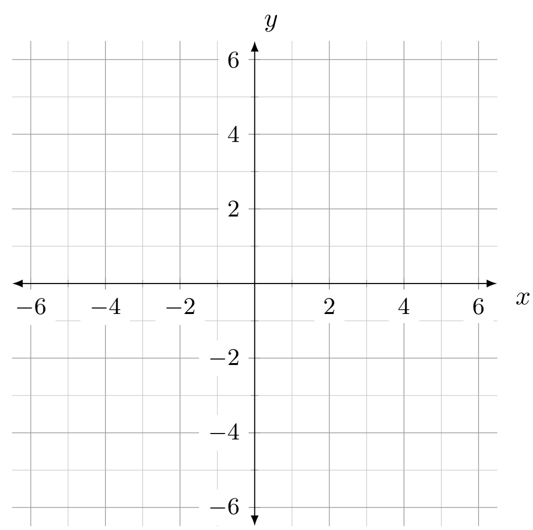
Domain:

Range:

(b)

$\mathbf{x}$	-2	-1	0	1	2
$\mathbf{f(x) = \left(\frac{1}{2}\right)^x}$					

$\mathbf{x}$					
$\mathbf{f^{-1}(x) = \log_{\frac{1}{2}} x}$					



Domain:

Range:

Example 5. The **pH scale** is a logarithmic scale. When given the number of hydrogen ions (H^+) pH is measured as

$$\text{pH} = -\log\left(H^+\right)$$

The hydrogen ion concentration of rain water in each state is given in the table below. Calculate the pH of the rain water for each state.

State	H^+ **(mol/L)**	**pH**
North Dakota	0.0000009	
California	0.0000032	
Ohio	0.0000629	
New Jersey	0.0000316	
Texas	0.0000192	

Example 6. Use the given x-values to graph each function. Then graph its inverse. Describe the domain and range for each function.

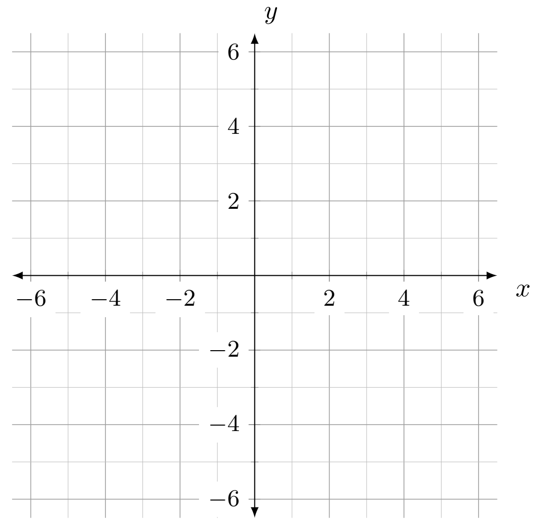
(a)

$\mathbf{x}$	-2	-1	0	1	2
$\mathbf{f(x) = 3^x}$					

$\mathbf{x}$					
$\mathbf{f^{-1}(x) = \log_3 x}$					

Domain:

Range:



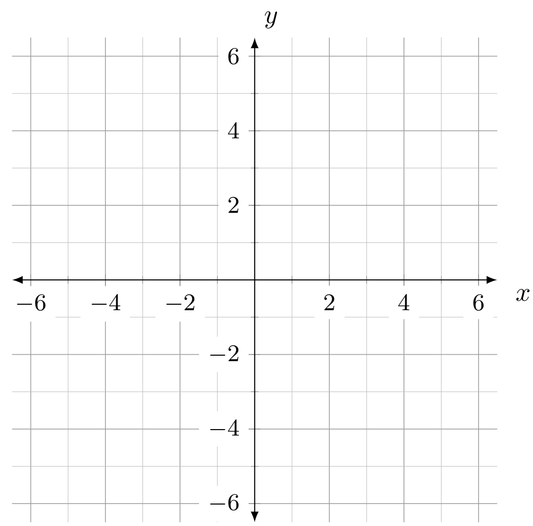
(b)

$\mathbf{x}$	-2	-1	0	1	2
$\mathbf{f(x) = \left(\frac{1}{3}\right)^x}$					

$\mathbf{x}$					
$\mathbf{f^{-1}(x) = \log_{\frac{1}{3}} x}$					

Domain:

Range:



Example 7. The **Richter scale** is a logarithmic scale used to measure the "size" of an earthquake. The relative magnitude of an earthquake can be calculated using,

$$M_B - M_A = \log\left(\frac{I_B}{I_A}\right),$$

where M is the **magnitude** of the earthquake, I is the **intensity**, and A and B are two measured earthquakes.

Suppose the magnitue, M_A, of earthquake A is measured as a 7 on the Richter scale. We also know that earthquake B is three times more intense, $I_B = 3I_A$. Find the value of earthquake B on the Richter scale.

7.3 (day 2) Homework: page 509 14-16, 34, Adv. 39-42

7.4 Properties of Logarithms

Objective: Use properties to simplify logarithmic expressions.

Remember that multiplying powers with the same base, you add the exponents.

$$b^m b^n = b^{m+n}$$

Product Property of Logarithms		
Words	**Numbers**	**Algebra**
The logarithm of a product is equal to the sum of the logarithms of its factors.	$\log_3 1000 = \log_3(10 \cdot 100) = \log_3 10 + \log_3 100$	$\log_b mn = \log_b m + \log_b n$

Example 1. Express as a single logarithm. Simplify if possible.

(a) $\log_4 2 + \log_4 32$

(b) $\log_5 625 + \log_5 25$

You Try It! 7. Express as a single logarithm. Simplify if possible.

(a) $\log_3 27 + \log_3 \dfrac{1}{9}$

(b) $\log_2 16 + \log_2 4$

Quotient Property of Logarithms		
Words	**Numbers**	**Algebra**
The logarithm of a quotient is the logarithm of the dividend minus the logarithm of the divisor.	$\log_5 \left(\dfrac{16}{2}\right) = \log_5 16 - \log_5 2$	$\log_b \frac{m}{n} = \log_b m - \log_b n$

Example 2. Express as a single logarithm and simplify if possible.

(a) $\log_2 32 - \log_2 4$

(b) $\log_7 49 - \log_7 7$

Power Property of Logarithms		
Words	**Numbers**	**Algebra**
The logarithm of a power is the product of the exponent and the logarithm of the base.	$\log 10^3$ $\log(10 \cdot 10 \cdot 10)$ $\log 10 + \log 10 + \log 10$ $3 \log 10$	$\log_b a^n = n \cdot \log_b a$

Example 3. Express as a single logarithm. Simplify if possible.

(a) $\log_3 81^2$

(b) $\log_5 \left(\frac{1}{5}\right)^3$

You Try It! 8. Express as a single logarithm. Simplify if possible.

(a) $\log 10^4$

(b) $\log_5 25^2$

(c) $\log_2 \left(\frac{1}{2}\right)^5$

Properties of Logarithm Summary	
Product Property	$\log_b n \cdot m = \log_b n + \log_b m$
Quotient Property	$\log_b \left(\frac{m}{n}\right) = \log_b m - \log_b n$
Power Property	$\log_b a^n = n \cdot \log_b a$

7.4 (day 1) Homework: page 516 1-10,21-27 odds, Adv. 37-41 odd

7.4 (day 2) Properties of Logarithms

Objective: Use properties to simplify logarithms.

You Try It! 9. Express as a single logarithm. Simplify, if possible.

(a) $\log_3 81 + \log_3 9$

(b) $\log_{\frac{1}{5}} 25 + \log_{\frac{1}{5}} 5$

(c) $\log_4 256^2$

(d) $\log_7 343$

(e) $\log_{27} 243$

(f) $\log_{10} 0.01$

Inverse Properties of Logarithms and Exponents	
Algebra	**Example**
$\log_b b^x = x$	$\log_{10} 10^7 = 7$
$b^{\log_b x} = x$	$10^{\log_{10} 2} = 2$

Example 4. Simplify each expression

(a) $\log_8 8^{3x+1}$

(b) $\log_5 125$

(c) $2^{\log_2 27}$

You Try It! 10. Simplify each expression

(a) $\log 10^{0.9}$

(b) $2^{\log_2(8x)}$

Change of Base Formula	
Algebra	**Example**
$\log_{\mathbf{b}} x = \dfrac{\log_{\mathbf{a}} x}{\log_{\mathbf{a}} \mathbf{b}}$	$\log_{\mathbf{4}} 8 = \dfrac{\log_{\mathbf{2}} 8}{\log_{\mathbf{2}} \mathbf{4}}$

Example 5. Evaluate. (Use a calculator)

(a) $\log_4 8$ (b) $\log_9 27$ (c) $\log_8 16$

Example 6. Seismologists use the Richter scale to express the energy, or magnitude of an earthquake. The Richter magnitude of an earthquake, M, is related to the energy released in ergs E shown by the formula

$$M = \frac{2}{3}\log\left(\frac{E}{10^{11.8}}\right)$$

in 1964, an earthquake centered at Prince William Sound, Alaska, registered a magnitude of 9.2 on the Richter scale. Find the energy, E, released by the earthquake.

7.4 (day 2) Homework: page 516 11-19, Adv. 46, 47

7.6 The Natural Base, e

Objective: Use the number e to write and graph exponential functions representing real-world.

Recall the compounded interest formula:

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

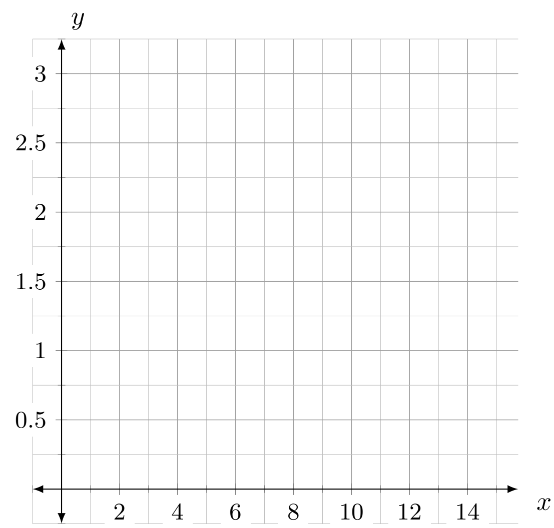
Where A is the total or final amount, P is the principal, r is the annual interest rate, n is the number of times the interest is compounded per year, and t is the time in years.

Exploration to discover the Euler Number, e

$r = 100\%$

$P = \$1$

$n \to \infty$

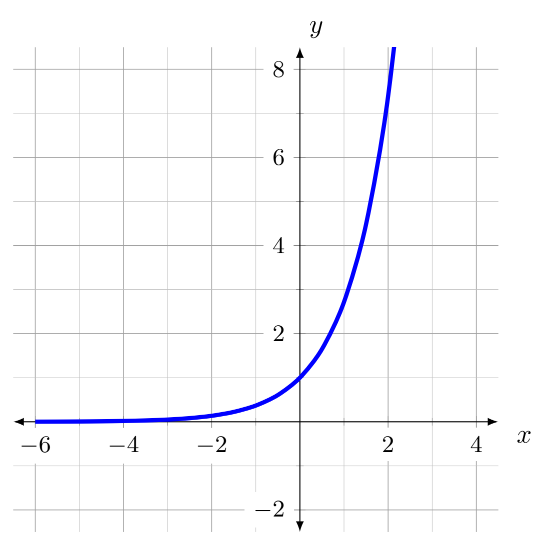


The Graph of the Exponential Function, e^x

$\mathbf{x}$	$\mathbf{f(x) = e^x}$
-2	$e^{-2} = 0.1353$
-1	$e^{-1} = 0.3679$
$e^0 = 0$	$e^0 = 1$
1	$e^1 = 2.7182$
2	$e^2 = 7.3891$

Domain of $f(x)$: $(-\infty, \infty)$

Range of $f(x)$: $(0, \infty)$



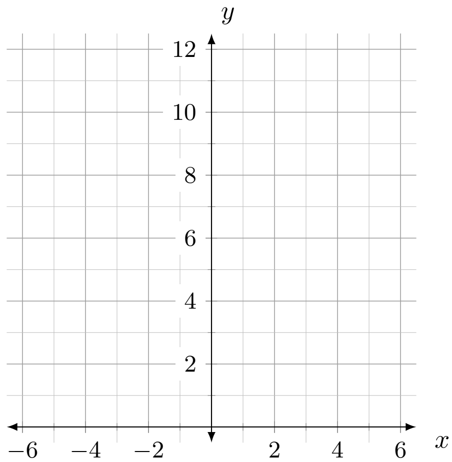
Definition 7.6.1. The formula for continuously compunded interest is $A = Pe^{rt}$, where A is the total amount, P is the principal, r is the annual interest rate, and t is the time in years.

Example 1. What is the total amount for an inestment of \$1000 invested at 5% for 10 years compounded continuously.

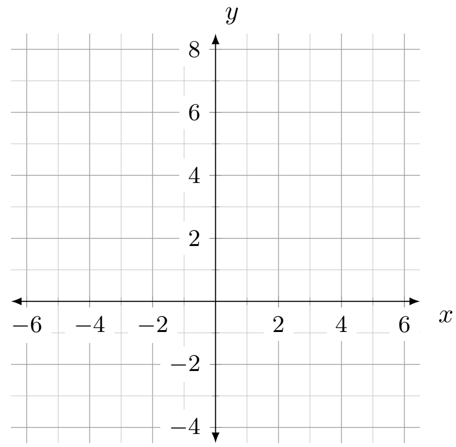
Example 2. What is the total amount for an inestment of \$100 invested at 3.5% for 8 years compounded continuously.

Example 3. Graph the following.

(a) $f(x) = e^x + 2$

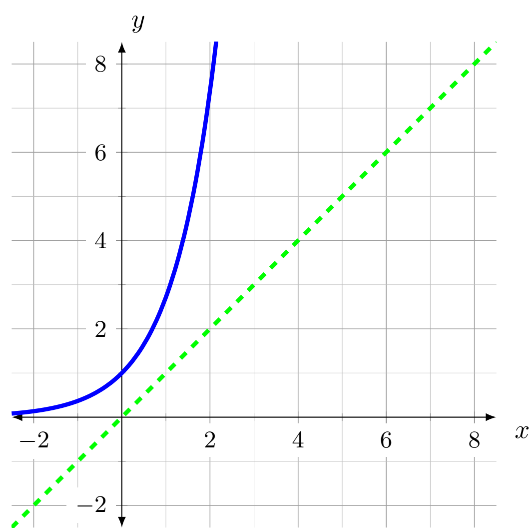


(b) $g(x) = e^x - 3$



Definition 7.6.2. A logarithm with a base of e is called a **natural logarithm** and is abbreviated as ln rather than $\log_e$. The natural logarithm, $f(x) = \ln x$ is the inverse of the exponential function, $g(x) = e^x$.

$\mathbf{x}$	$\mathbf{f(x) = \ln x}$
-2	undefined
-1	undefined
0	undefined
1	0
$e^1 = 2.7182$	1
$e^2 = 7.3891$	2



7.6 Homework (day 1): page 534 3-11 odds, Adv. 21, 23

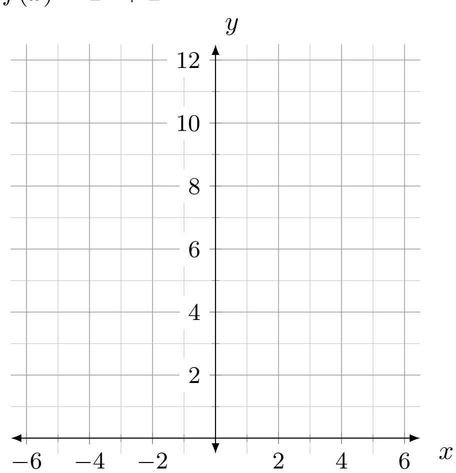
7.7 Transforming Exponential and Logarithmic Functions

Objective: Transform exponential and logarithmic functions by changing parameters..

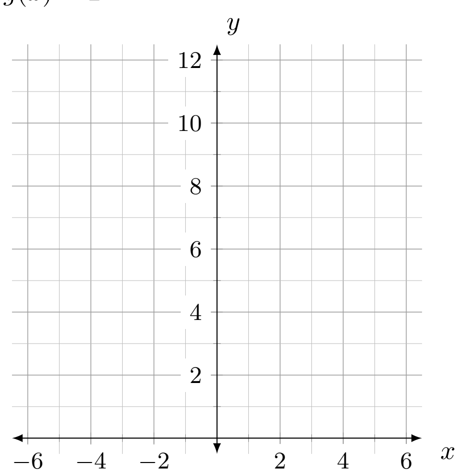
Transformations of Exponential Functions		
Transformation	$f(x)$ **Notation**	**Examples**
Vertical Translation	$f(x) + k$	$y = 2^x + 3$ 3 units up $y = 2^x - 6$ 6 units down
Horizontal Translation	$f(x - h)$	$y = 2^{x-2}$ 2 units right $y = 2^{x+1}$ 1 unit left
Vertical stretch or compression	$af(x)$	$y = 6(2^x)$ stretch by 6 $y = \frac{1}{2}(2^x)$ compression by $\frac{1}{2}$
Horizontal stretch or compression	$f\left(\frac{1}{b}x\right)$	$y = 2^{\left(1/5x\right)}$ stretch by 5 $y = 2^{3x}$ compression by $1/3$
Reflection	$-f(x)$ $f(-x)$	$y = -2^x$ across x-axis $y = 2^{-x}$ across y-axis

Example 1. Graph the following.

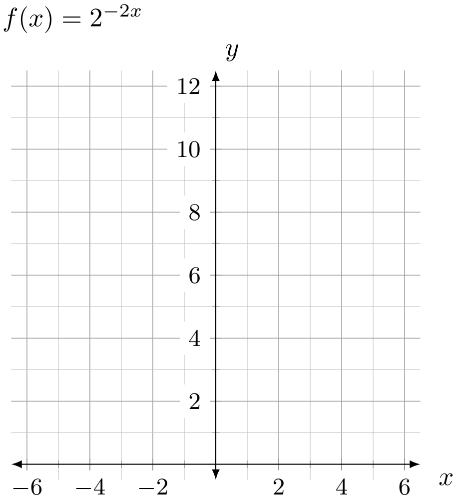
(a) $f(x) = 2^x + 2$



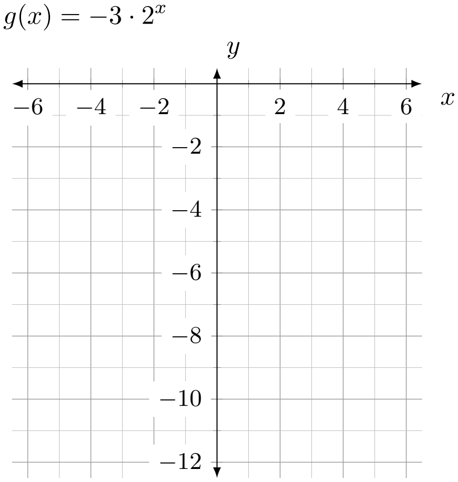
(b) $g(x) = 2^{x-3}$



(c) $f(x) = 2^{-2x}$



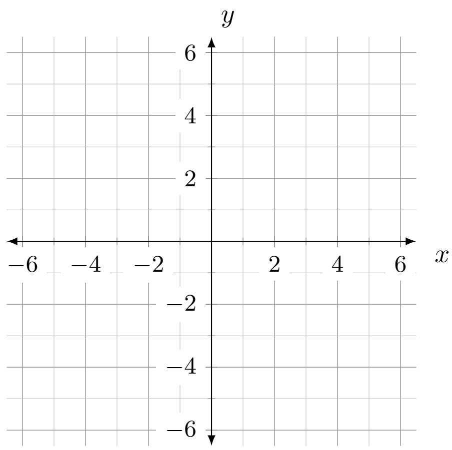
(d) $g(x) = -3 \cdot 2^x$



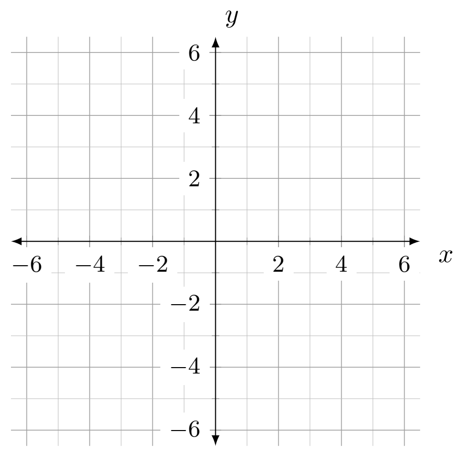
Transformations of Logarithmic Functions		
Transformation	**$f(x)$ Notation**	**Examples**
Vertical Translation	$f(x)+k$	$y=\log x+3$ 3 units up $y=\log x-4$ 4 units down
Horizontal Translation	$f(x-h)$	$y=\log(x-2)$ 2 units right $y=\log(x+1)$ 1 unit left
Vertical stretch or compression	$af(x)$	$y=6\log x$ stretch by 6 $y=\frac{1}{2}(\log x)$ compression by $\frac{1}{2}$
Horizontal stretch or compression	$f\left(\frac{1}{b}x\right)$	$y=\log\left(1/5\cdot x\right)$ stretch by 5 $y=\log 3x$ compression by 1/3
Reflection	$-f(x)$ $f(-x)$	$y=-\log x$ across x-axis $y=\log(-x)$ across y-axis

Example 2. Graph the following.

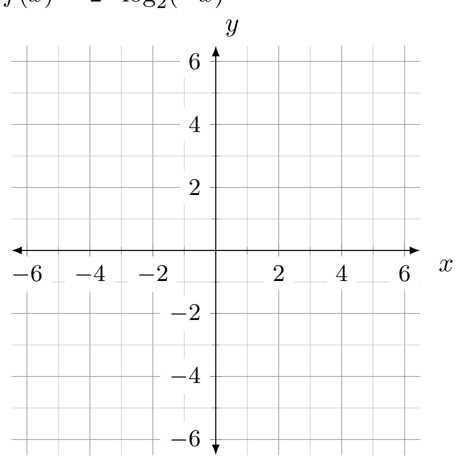
(a) $f(x)=\log_2 x-1$



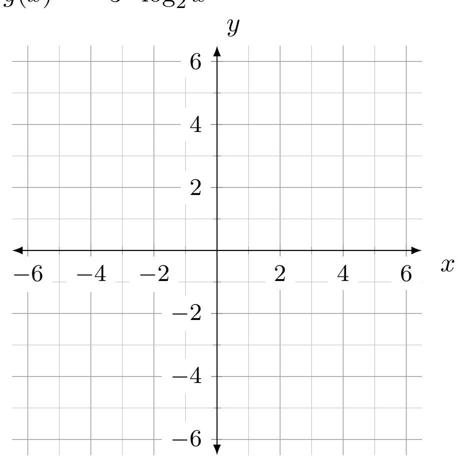
(b) $g(x)=\log_2(x+4)$



(c) $f(x)=2\cdot\log_2(-x)$



(d) $g(x)=-3\cdot\log_2 x$



7.7 Homework (day 1): page 541 2, 3, 4, 5, 7, 10, 11

Chapter 7 Review (day 1) Sections 7.4, 7.6, 7.7

Express as a single logarithm and simplify.

1. $\log_2 8 + \log_2 16$
2. $\log 100 + \log 10,000$
3. $\log_2 128 - \log_2 2$
4. $\log 10 - \log 0.1$
5. $\log_5 25^2$
6. $\log 10^5 + \log 10^4$
7. $\log 25 + \log 40$
8. $\log_5 125 - \log_5 25$
9. $\log_3 9^2$
10. $\log_5 16$ (Hint: Use change of base)

Simplify.

11. $e^{\ln(2x+1)}$

12. $\ln e^{5y-8}$

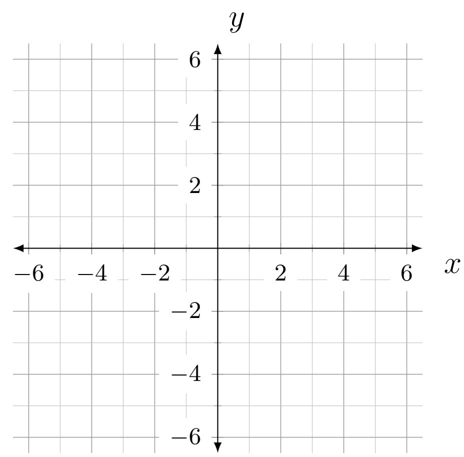
13. Carbon-14 is a useful dating tool for specimens between 500 and 25,000 years old, such as ancient manuscripts and artifacts. Carbon-14s half-life is 5730 years.

a. Use the formula $\frac{1}{2} = e^{-kt}$ to find the value of the decay constant for carbon-14. (Hint: change to a natural logarthimic equation)

b. Use the decay function $N_t = N_0 e^{-kt}$ to determine how much of 10 grams of carbon-14 will remain after 1000 years.

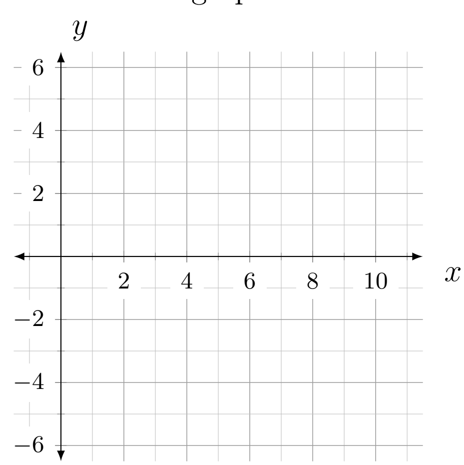
Graph the function. Find the y-intercept and asymptote. Describe how the graph is transformed from the graph of the parent function.

14. $g(x) = 2 \cdot (3^x)$



Graph the function. Find the x-intercept and asymptote. Describe how the graph is transformed from the graph of the parent function.

15. $k(x) = 3\log_{10}(x+1)$



Ch 7 Review (day 2)