# Algebra 2 Unit 5: Logarithms and Exponential Expressions

I CAN:

- Rewrite expressions from exponential to logarithmic form, and vice versa
- Evaluate logarithms
- Apply properties of logarithms to expand or condense expressions
- Solve equations involving logarithmic expressions
- Solve equations involving exponential expressions
- Apply logarithms to real-world scenarios and solve application problems

April

SHOWERS...

BRING

May

FLOWERS

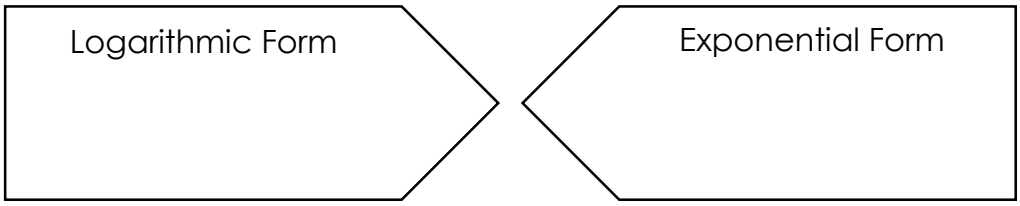
| Monday | Tuesday | Wednesday | Thursday | Friday |
|---|---|---|---|---|
| 26 DAY 1<br><br>Intro to Logarithms | 27 DAY 2<br><br>Properties of Logarithms<br><br>**Logs Quiz** | 28<br><br>Help Sessions | 29 DAY 3<br><br>Solving Log Equations<br><br>**Logs Quiz Due 8 am** | 30 DAY 4<br><br>More Solving Log Equations |
| 3 DAY 5<br><br>Solving Exponential Equations | 4 DAY 6<br><br>More Practice with Logarithmic and Exponential Equations | 5<br><br>Help Sessions | 6 DAY 7<br><br>Applications of Logarithms | 7 DAY 8<br><br>More Applications of Logs |
| 10 DAY 9<br><br>Review | 11 DAY 10<br><br>**Unit 5 Test** | 12<br><br>Help Sessions | | |

*THIS PLAN IS SUBJECT TO CHANGE. PLEASE REFER TO CTLS DIGITAL CLASSROOM FOR UPDATES.*

# Logarithms

Let $\boldsymbol{b}$ **and** $\boldsymbol{a}$ **be positive numbers**, $b \neq 1$.
The **logarithm** of $a$ with base $b$ is denoted $\log_b a$
and is defined as the **exponent** $x$ that makes the equation $b^x = a$ true.

- $b$ is called the _____
- $a$ is called the _____
- $x$ is called the _____




ex: If $\log_3 9 = 2$, then $3^2 = 9$

"log base 3 of 9 equals 2"

Ex 1: Rewrite each logarithmic equation in exponential form.

a. $\log_2 8 = 3$

b. $\log_3 729 = 6$

c. $\log_5 \frac{1}{25} = -2$

Use B.O.B.
B_____
O_____
B_____

Ex 2: Rewrite each exponential equation in logarithmic form.

a. $3^3 = 27$

b. $15^3 = 3375$

c. $4^{\frac{1}{2}} = 2$

## Special Logarithms

A logarithm with **base 10** is called a _____ logarithm and can be written without a base. When no base is shown, it is understood base ____.

ex: $\log 1000 = 3$ because $10^3 = 1000$

A logarithm with **base** $\boldsymbol{e}$ is called a _____ logarithm and can be written using the notation _____. You may choose to write it with base ___.

- $e$ represents Euler's number, an irrational constant, similar to $\pi$
- the decimal approximation of $e$ is 2.718

Ex 3: Evaluate each logarithm without using a calculator.

*THINK IT THROUGH: "2 to **what power** gives me 4?"

*WORK IT OUT: **Rewrite in exponential form** with $x$ as the exponent.

| | | | |
|---|---|---|---|
| a. $\log_2 4$ | b. $\log_3 81$ | c. $\log 100$ | d. $\log_8 8$ |
| e. $\log_7 1$ | f. $\log_2 \frac{1}{2}$ | g. $\log_9 3$ | h. $\log_8 2$ |
| i. $\log_x x$ | j. $\log_{64} 2$ | k. $\log_5 5^3$ | l. $\log .001$ |
| m. $\ln e^4$ | n. $\log_{\frac{1}{3}} 3$ | o. $\log 10$ | p. $\log_5 125$ |

You Try:

1. Rewrite in exponential form: $\log_4 1024 = 5$

2. Write a true logarithmic equation (not shown above) using a base of 2.

3. Fill in the blank to make the equation true.

   a. $\log\_\_\_ 625 = 4$

   b. $\log_3 9 = \_\_\_\_$

   c. $\log_6 \_\_\_\_ = 2$

   d. $\log \_\_\_\_ = -1$ *this is a common log

Algebra 2 Name_____ ID: 1



# Intro to Logarithms HW

Date_____ Period____

**Rewrite each equation in exponential form.**

1) $\log_3 81 = 4$

2) $\log_{13} 169 = 2$

3) $\log_8 8 = 1$

4) $\log_{49} \frac{1}{7} = -\frac{1}{2}$

5) $\log_{18} 324 = 2$

6) $\log_4 64 = 3$

7) $\log_{17} 289 = 2$

8) $\log_{16} 256 = 2$

9) $\log_7 \frac{1}{49} = -2$

10) $\log_{169} \frac{1}{13} = -\frac{1}{2}$

**Rewrite each equation in logarithmic form.**

11) $18^2 = 324$

12) $18^{-2} = \frac{1}{324}$

13) $20^{-2} = \frac{1}{400}$

14) $5^3 = 125$

15) $19^{-1} = \frac{1}{19}$

16) $5^4 = 625$

17) $14^2 = 196$

18) $4^{-3} = \frac{1}{64}$

19) $15^2 = 225$

20) $3^3 = 27$

**Evaluate each expression.**

21) $\log_2 64$

22) $\log_4 64$

23) $\log_4 16$

24) $\log_5 \frac{1}{25}$

25) $\log_2 32$

26) $\log_7 \frac{1}{343}$

27) $\log_3 243$

28) $\log_7 1$

29) $\log_5 25$

30) $\log_2 16$



| Name: | Date: |
|---|---|
| Topic: | Class: |

| Main Ideas/Questions | Notes/Examples | | |
|---|---|---|---|
| **Product Property**<br>$\log_b(m \cdot n) =$ | **Condense into a single logarithm. Simplify if possible.** | | |
| | **1.** $\log_2 7 + \log_2 4$ | **2.** $\log 25 + \log 4$ | **3.** $\log_4 2x + \log_4 4x^2$ |
| | **Expand using the product property.** | | |
| | **4.** $\log 6$ | **5.** $\log_7 45$ | **6.** $\log_2(5x)$ |
| **Quotient Property**<br>$\log_b\left(\frac{m}{n}\right) =$ | **Condense into a single logarithm. Simplify if possible.** | | |
| | **7.** $\log_3 24 - \log_3 8$ | **8.** $\log_2 15 - \log_2 15$ | **9.** $\log_4 x^9 - \log_4 x^2$ |
| | **Expand using the quotient property.** | | |
| | **10.** $\log_8 4$ | **11.** $\log_5 \frac{1}{3}$ | **12.** $\log\left(\frac{m}{7}\right)$ |
| **Power Property**<br>$\log_b m^n =$ | **Condense into a single logarithm. Simplify if possible.** | | |
| | **13.** $5 \cdot \log_4 2$ | **14.** $7 \cdot \log_2 x$ | **15.** $\frac{1}{3} \cdot \log 8$ |
| | **Expand using the power property. Simplify if possible.** | | |
| | **16.** $\log_2 8^7$ | **17.** $3 \cdot \log 4^{x-1}$ | **18.** $\log_7 \sqrt{w}$ |

# Putting it All Together!

## CONDENSING LOGS

**Directions:** Rewrite as a single logarithm. Simplify if possible.

**19.** $2 \cdot \log 6 - \log 9$

**20.** $4 \cdot \log_4 a + 2 \cdot \log_4 b$

**21.** $7 \cdot \log_4 u - 3 \cdot \log_4 v^2$

**22.** $\log_2 15 + \log_2 4 - \log_2 6$

**23.** $\log_3 4 + \log_3 y + \frac{1}{2} \cdot \log_3 49$

**24.** $\frac{1}{3}(\log_5 8 + \log_5 27) - \log_5 3$

**25.** $3 \cdot \log_2 4 - \log_2 32$

**26.** $2 \cdot \log 6 - \frac{1}{4} \cdot \log 16 + \log 3$

## EXPANDING LOGS

**Directions:** Expand each logarithm.

**27.** $\log_6 \left(xyz^4\right)$

**28.** $\log_4 \left(\frac{a^9}{b}\right)$

**29.** $\log_7 \left(q^4 r^2\right)^2$

**30.** $\log_2 \left(\frac{y}{z^5}\right)^2$

**31.** $\log \sqrt{7x^3}$

**32.** $\log_3 \sqrt[4]{m^5 n^2}$

# Properties of Logarithms

Date_____ Period____

**Expand each logarithm.**

1) $\log_9 (x^6 \cdot y)^5$

2) $\log_9 \left(c^6 \sqrt[3]{a}\right)$

3) $\log_4 \left(x \cdot y \cdot z^3\right)$

4) $\log_5 \left(3^2 \sqrt[3]{10}\right)$

5) $\log_9 \left(11^6 \sqrt{2}\right)$

6) $\log_5 (uv^2)^4$

7) $\log_6 \left(x^3 y^6\right)$

8) $\log_8 \dfrac{5^3}{7^6}$

9) $\log_9 \left(x \cdot y \cdot z^3\right)$

10) $\log_4 \left(\dfrac{7}{10^3}\right)^6$

11) $\log_4 \left(11^4 \sqrt[3]{3}\right)$

12) $\log_9 \left(\dfrac{3}{2^5}\right)^5$

13) $\log_5 (u^6 \cdot v)^5$

14) $\log_3 \left(\dfrac{8}{7^5}\right)^3$

15) $\log_6 \sqrt[3]{u \cdot v \cdot w}$

16) $\log_3 \left(5 \cdot 6^2\right)^3$



**Condense each expression to a single logarithm.**

17) $6\log_6 a + 2\log_6 b$

18) $\frac{\log_5 7}{2} + \frac{\log_5 10}{2} + \frac{\log_5 3}{2}$

19) $12\log_3 x + 4\log_3 y$

20) $4\log_7 a + 24\log_7 b$

21) $5\log_5 7 + \frac{\log_5 12}{3}$

22) $4\log_3 z + \frac{\log_3 x}{2}$

23) $15\log_5 8 + 5\log_5 7$

24) $\log_8 11 + \frac{\log_8 7}{2} + \frac{\log_8 12}{2}$

25) $\log_5 x + \log_5 y + 5\log_5 z$

26) $\frac{\log_6 7}{2} + \frac{\log_6 8}{2} + \frac{\log_6 3}{2}$

27) $\log_6 x + \log_6 y + 4\log_6 z$

28) $3\log_7 10 - 18\log_7 11$

29) $\log_7 5 + \log_7 8 + 6\log_7 3$

30) $\ln a + \ln b + 4\ln c$

31) $3\log_4 12 + 15\log_4 5$

32) $4\log_4 w + \frac{\log_4 u}{2}$

Solving Logarithmic Equations

*Recall that in $\log_b a = x$, both $\boldsymbol{a}$ **and** $\boldsymbol{b}$ **must be positive numbers**, and $b \neq 1$.

If a solution to a log equation causes a negative base or argument, it is **extraneous**!

| **LOG = LOG**<br>Each term in the equation is a logarithmic expression.<br><br>One-to-One Property:<br>If $\log_b m = \log_b n$, then ____= ____<br><br>Step 1: Condense each side into a single log<br>Step 2: Set the arguments equal<br>Step 3: Solve<br>Step 4: Check for extraneous solutions. | **LOG = NUMBER**<br>The equation has both logarithmic expressions and constants.<br><br>BOB it!<br>Rewrite in exponential form…<br>B_____, O_____, B_____!<br><br>Step 1: Condense and isolate the log<br>Step 2: BOB it!<br>Step 3: Solve<br>Step 4: Check for extraneous solutions. |
|---|---|
| a. $\log_5(5x + 9) = \log_5(6x)$ | b. $\log_2(x - 4) = 6$ |
| c. $\log_9(6 - 3w) = \log_9(-2w)$ | d. $\log_4(4x + 8) - 7 = -5$ |

| | |
|---|---|
| e. $\log_3(2p-5) = \log_3 6 - \log_3 2$ | f. $2 = \log_6(x+9) + \log_6 x$ |
| g. $\log(y+5) + \log 4 = \log 72$ | h. $\log(2x) + \log(x-5) = 2$ |
| i. $2\log x = \log(18-7x)$ | j. $2\log x = 2 + \log 4$ |

Algebra 2 Name_____



# Solving Log Equations Practice

Date_____ Block____

**Solve each equation.**

1) $\log_4 (5a + 4) = \log_4 (3a + 8)$

2) $\log_{15} (5a + 8) = \log_{15} -3a$

3) $\log_6 (4 - k) = \log_6 (k + 3)$

4) $\log_{19} 5k = \log_{19} (3k + 10)$

5) $\log_6 k = 4$

6) $\log_2 n = 0$

7) $\log_8 (x + 2) = -2$

8) $\log_8 -6x = 1$

9) $\log_5 -9r + 5 = 9$

10) $5 \log_8 (m - 6) = -5$

11) $4 \log_9 (-9v - 5) = 12$

12) $\log_{12} (8n + 10) - 9 = -7$

13) $3 + \log_3 (-10n + 8) = 1$

14) $-9 \log_{12} (9k - 2) = -36$

15) $-2 \log_2 (-2n - 4) - 6 = -8$

16) $1 + 5 \log_{12} (9 - 3p) = 16$

17) $\log_8 4 + \log_8 (x - 9) = 2$

18) $\log_9 (x - 5) - \log_9 x = 2$

19) $\log_6 2x^2 + \log_6 8 = 4$

20) $\ln (x + 5) - \ln x = 1$

21) $\log_4 (-5x - 8) - \log_4 3 = 3$

22) $\log_8 (4x^2 - 4) - \log_8 5 = 2$

23) $\log_9 6 - \log_9 (4x - 2) = 1$

24) $\ln (5x + 5) - \ln 8 = 3$

25) $\ln 3 + \ln (3x^2 + 5) = \ln 15$

26) $\log (x - 3) - \log (x - 5) = 1$

Solving Exponential Equations

Any logarithm can be rewritten or evaluated using the **Change of Base Formula**: $\log_b a = \frac{\log a}{\log}$

ex: $\log_3 7$

| Strategy 1:<br>Make the bases match… | Strategy 2:<br>The bases cannot match… |
|---|---|
| Property of Equality of Exponential Functions<br>If $b^x = b^y$, then ____ = ____<br><br>Step 1: Rewrite each exponential expression as a power with a **common base**.<br>Step 2: Set the exponents equal<br>Step 3: Solve<br>Step 4: Check | BOB it!<br>Rewrite in logarithmic form:<br>B_____, O_____, B_____!<br><br>Step 1: Isolate the exponential expression<br>Step 2: **BOB it!**<br>Step 3: Solve<br>Step 4 Check |
| a. $2^{x+1} = 2^9$ | b. $7^x = 20$ |
| c. $6^{2x-10} = 36$ | d. $3^{x+1} = 18$ |

| | |
|---|---|
| e. $7^{4x+11} = \frac{1}{7}$ | f. $4^{3w} - 5 = 3$ |
| g. $16^{3x} = 8^{x+2}$ | h. $7 - 4^{x+1} = 18$ |
| i. $9^{a+2} = 27^{4a-2}$ | j. $5 \cdot 9^{x-1} + 1 = 181$ |

Algebra 2 Name_____



# Solving Exponential Equations Practice

Date_____ Block____

**Solve each equation.**

1) $6^{-3p-1} = 6^{-p}$

2) $4^{-x} = 4^{x+2}$

3) $8^{-r-3} = 1$

4) $\left(\frac{1}{6}\right)^{v+2} = 36$

5) $36^{2-2n} = 216^{2n+1}$

6) $6^{-2p} = 6^{-2p}$

7) $5^{2-2n} = 125$

8) $6^{-3m+1} \cdot 6^{3m} = 6^2$

9) $16 \cdot 4^{-3a} = 4$

10) $\frac{4^3}{64^{2b}} = 4^2$

11) $\left(\frac{1}{6}\right)^{2k+3} \cdot 36^{3k} = 36$

12) $\frac{1}{81} \cdot 81^{-k} = \frac{1}{3}$

13) $15^{a} = 8$

14) $6^{n} = 79$

15) $3^{n-3} = 56$

16) $8^{x+6} = 32$

17) $13^{2x} = 56$

18) $-4 \cdot 10^{x+2} = -3$

19) $5 \cdot 10^{a+3} = 65$

20) $20^{r+3} - 3 = 46$

21) $e^{-2b-5} - 9 = 74$

22) $-6^{10b-3} = 0$

23) $10^{5p+7} - 2 = 34$

24) $2 \cdot 4^{2n-2} = 8$

25) $-7e^{6-7a} + 7 = -68$

26) $7 \cdot 12^{6x-9} - 2 = 56$

27) $-7 \cdot 10^{4n+8} - 8 = -8$

**Name:** _____ **Unit 7:** Exponential & Logarithmic Functions

**Date:** _____ **Bell:** _____ **Homework 8:** Logarithmic & Exponential Equations

**** This is a 2-page document! ****

**Directions:** Solve each equation. Check all answers for extraneous solutions.

**1.** $\log_4(25-2x)=\log_4(6x+1)$

**2.** $\log_9(8y-9)=\log_9 108-\log_9 4$

**3.** $6\cdot\log_2 2=\log_2 8+\log_2(a-2)$

**4.** $\log_6(5w+14)=2\cdot\log_6 w$

**5.** $\log_7(3x+5)=2$

**6.** $\log_{27}(11-2k)=\frac{1}{3}$

**7.** $\log(24x+64)=3$

**8.** $5=\log_3 8+\log_3(r+6)$

**9.** $5^{x-4} = 25^{x-6}$

**10.** $36^{5v+2} = \left(\frac{1}{6}\right)^{11-v}$

**11.** $5^{m} = 220$

**12.** $14^{p-8} = 62$

**13.** $3 \cdot 4^{n+2} = 78$

**14.** $5^{8-2y} - 10 = 45$

**15.** $2 \cdot 10^{6c} + 9 = 17$

**16.** $9 \cdot 14^{5a+9} + 8 = 107$

| Name: | Date: |
|---|---|
| Topic: | Class: |

| Main Ideas/Questions | Notes/Examples | |
|---|---|---|
| **Exponential Growth** | Occurs when a **quantity exponentially increases** over time. | |
| | **Formula:** | $a =$ _____<br>$r =$ _____<br>$t =$ _____ |
| Examples | **1.** The original value of an investment is $1,800. If the value has increased by 7% each year, write an exponential function to model the situation. Then, find the value of the investment after 15 years. | |
| | **2.** In 2002, there were 972 students enrolled at Oakview High School. Since then, the number of students has increased by 1.5% each year. Write an exponential function to model the situation, then find the number of students enrolled in 2014. | |
| **Exponential Decay** | Occurs when a **quantity exponentially decreases** over time. | |
| | **Formula:** | $a =$ _____<br>$r =$ _____<br>$t =$ _____ |
| Examples | **3.** An investment of $12,000 is losing value at a rate of 4% each year. Write an exponential function to model the situation, then find the value of the investment after 9 years. | |
| | **4.** Mark bought a brand new car for $35,000 in 2008. If the car depreciates in value approximately 8% each year, write an exponential function to model the situation. Then, find the value of the car in 2015. | |

## Compound Interest

Occurs when interest is calculated on both the **principal amount AND the accrued interest** thus far.

**Formula:**

$P =$ _____

$r =$ _____

$n =$ _____

$t =$ _____

## Examples

**5.** Laura deposited $12,000 into an account that earns 8% interest. How much money will she have in 5 years if the interest is compounded quarterly?

**6.** Jack took out a 6-year loan for $25,000 to purchase a boat at a 4.5% interest rate. If the interest is compounded monthly, what wil he have paid total over the course of the loan?

**7.** An investment account pays 3.9% interest compounded semi-annually. If $4,000 is invested in this account, what will be the balance after 12 years?

**8.** A savings account offers 0.8% interest compounded bimonthly. If Bob deposited $300 into this account, how much interest will he earn after 10 years?

**9.** Suppose you invest $750 into an account that pays 3% interest compounded weekly. How much interest will you have earned after 20 years?

**Name:** _____ **Unit 7:** Exponential & Logarithmic Functions

**Date:** _____ **Bell:** _____ **Homework 10:** Applications of Exponential Functions

**** This is a 2-page document! ****

**Exponential Growth & Decay**

**1.** Vanessa invested $2,500 into an account that will increase in value by 3.5% each year. Write an exponential function to model this situation, then find the value of the investment after 20 years.

**2.** The average price of a movie ticket in 1990 was $4.22. Since then, the price has increased by approximately 3.1% each year. Write an exponential function to model this situation, then find the price of a ticket in 2016.

**3.** A virus has infected 400 people in the town and is spreading to 25% more people each day. Write an exponential function to model this situation, then find the number of people that will be infected in 10 days.

**4.** The population of a small town was 10,800 in 2002. Since then, the population has decreased at a rate of 2.5% each year. Write an exponential function to model the situation, then find the population of the town in 2020.

**5.** Manny bought a brand new car in 2012 for $28,750. If the car depreciates by 12% each year, write an exponential function to model the situation, then find the value of the car in 2018.

Applications of Logarithms

In 1956, scientists B. Gutenberg and C. F. Richter developed a formula to estimate the amount of energy released in an earthquake. $E$ represents the amount of energy, in ergs, released from an earthquake. The **magnitude** of an earthquake is given by the formula:

$$M = \frac{\log E - 11.4}{1.5}$$

where $E$ is ergs, the energy released from an earthquake.

Richter Scale

| | |
|---|---|
| 1 | only detectable by seismograph |
| 2 | hanging lamps sway |
| 3 | can be felt |
| 4 | glass breaks, buildings shiver |
| 5 | furniture falls |
| 6 | wooden houses damaged |
| 7 | buildings fall |
| 8 | catastrophic damage |

Analyze:

a. The base of the logarithm in the formula is _____.
b. Because it is a _____ logarithm, an earthquake with a rating of 7 is how much stronger than one with a rating of 4?
c. How much stronger is an earthquake with a rating of 8 than one with a rating of 2?

Ex 1: On April 13, 1985, the energy released by the earthquake in Indonesia was 3.981 x $19^{21}$ ergs. What did it measure on the Richter Scale?

Ex 2: On September 19, 1985, the energy released by the earthquake in Mexico was 1.259 x $10^{23}$ ergs. What did it measure on the Richter Scale?

Ex 3: How much more powerful was the earthquake in Mexico than the one in Indonesia?

Ex 4: The relationship between a telescope's limiting magnitude (the apparent magnitude of the dimmest star that can be seen with the telescope) and the diameter of the telescope's objective lens or mirror can be modeled by

$$M = 5 \log D + 2$$

where $M$ is the limiting magnitude and $D$ is the diameter (in millimeters) of the lens mirror. If a telescope can reveal stars with a magnitude of 12, what is the diameter of its objective lens?

Ex 5: An altimeter is an instrument that finds the height above sea level by measuring air pressure. The height and the air pressure are related by the model

$$h = -8005 \ln \frac{P}{101{,}300}$$

where $h$ is the height (in meters) above sea level and $P$ is the air pressure (in pascals). What is the air pressure when the height is 4000 meters above sea level?

Ex 6: The loudness $L$ of a sound (in decibels) is related to the intensity $I$ of the sound (in watts per square meter) by the equation

$$L = 10 \log \frac{I}{I_0}$$

where $I_0$ is and intensity of $10^{-1}$ watt per square meter, corresponding roughly to the faintest sound that can be heard by humans.

a. What is the intensity of the sound of fans cheering in Arrowhead Stadium if the noise level measures 142.2 decibels?

b. If the decibel level of the sound of a soft whisper is 30, what is the intensity of the sound?

# PROPERTIES OF LOGS

| Name | Rule(s) | Example 1 | Example 2 |
|---|---|---|---|
| BASIC LOGARITHMS | $\log_b b =$ ____: $\log_b 1 =$ ____ | Simplify<br>$\log_5 5$ | Simplify<br>$\log_8 1$ |
| PRODUCT RULE | $\log_b m \cdot n =$ _____ | Expand<br>$\log_2 10$ | Condense<br>$\log_5 6 + \log_5 7$ |
| QUOTIENT RULE | $\log_b \left(\frac{m}{n}\right) =$ _____ | Expand<br>$\log\left(\frac{3}{10}\right)$ | Condense<br>$\log_4 48 - \log_4 12$ |
| POWER RULE | $\log_b m^n =$ _____ | Expand<br>$\log_3 5^2$ | Condense<br>$(x-1)\log_5 7$ |
| CHANGE OF BASE FORMULA | $\log_b a =$ _____ | Use a common base to evaluate<br>$\log_7 3$ | |
| Remember: | **Common Logs** are **base10** and are often written with no base shown.<br>**Natural Logs** are **base *e*** and are denoted using ln | | |

# Unit 5 Practice Test

**Rewrite each equation in exponential form.**

1) $\log_9 81 = 2$

2) $\log_{256} 16 = \frac{1}{2}$

**Rewrite each equation in logarithmic form.**

3) $18^2 = 324$

4) $125^{\frac{1}{3}} = 5$

**Evaluate each expression.**

5) $\log_{16} 4$

6) $\log_3 \frac{1}{27}$

**Condense each expression to a single logarithm.**

7) $8\log_6 x - 2\log_6 y$

8) $\log_7 a + \log_7 b + 5\log_7 c$

**Expand each logarithm.**

9) $\log_2 \left(z^2\sqrt{x}\right)$

10) $\log_7 \left(\frac{x}{y^4}\right)^5$

**Solve each equation.**

11) $\log_3 (x+5) - \log_3 7 = \log_3 18$

12) $\log_9 x + \log_9 (x+24) = 2$

13) $625^{-3x} = 25$

14) $2^{2v} = 2^{3v-2}$

**Solve each equation. Round your answers to the nearest ten-thousandth.**

15) $7^{x-10} = 80.9$

16) $10 \cdot 9^{5.8p+5} - 2 = 48$

The wind speed $s$ (in miles per hour) near the center of a tornado can be modeled by

$$s = 93 \log d + 65$$

where $d$ is the distance (in miles) that the tornado travels.

A. In April 1947, a tornado traveled over 125 miles, from Texas to Oklahoma. Estimate the wind speed of the tornado.

B. In May 2011, a tornado stuck Joplin, Missouri, with wind speeds up to200 miles per hour. Determine the distance that the tornado traveled.

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

In 1998, Jana invested $1500 in an account with a 4.5% interest rate compounded monthly. What will be her account balance in 2022?

Exponential Growth: $y = a(1 + r)^t$ Exponential Decay: $y = a(1 - r)^t$

A. Jorge purchased an investment property for $55,000. Its value is expected to increase by 1.7% each year. What will be the value of the property in 10 years?

B. Julie bought a car for $29,500 in 2019. It depreciates at a rate of 15% per year. What will be the value of the car in 2025?

C. When will the depreciated value of Julie's car be $9,000?