

Content and Language Objective:

Students will learn define what a logarithm is and solve logarithm equations with base 10 and with bases other than 10.

Warm - Up

Without using a calculator, solve for x

1. $9^x = 2187$

$$3^{2x} = 3^7$$

$$\frac{2x=7}{2}$$

$$x = 7/2 \text{ or } 3.5$$

$$\begin{array}{c} 2187 \\ \wedge \\ 3 \quad 729 \\ \wedge \\ 3 \quad 243 \\ \wedge \\ 3 \quad 81 \\ \wedge \\ 3 \quad 27 \\ \wedge \\ 3 \quad 9 \\ \wedge \\ 3 \quad 3 \end{array}$$

2. $36^x = \frac{1}{1296}$

$$6^{2x} = 6^{-4}$$

$$6^{2x} = 6^{-4}$$

$$2x = -4$$

$$x = -2$$

$$\begin{array}{c} 1296 \\ \wedge \\ 6 \quad 216 \\ \wedge \\ 6 \quad 36 \\ \wedge \\ 6 \quad 6 \end{array}$$

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Vocabulary

LOGARITHM: Is the inverse operation of exponentiation. This means that the **logarithm** of a number is the exponent to which another fixed number, the base, must be raised to produce the number.

In other words the logarithm allows us to find the unknown exponent of a base value.



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We have been looking at how to model many different concepts with exponential functions. We have been using several different methods to solve for x when it is represented in the exponent form. We have also learned that in special occasions that are often rare we can solve these problems by finding a common base (a^n ; a is the base, n is the exponent.) For example, finding the value of x to make the following equations true is easy because of the properties of exponents.

$$10^x = 1000$$

$$10^x = 10^3$$

$$x = 3$$

$$3^x = 81$$

$$3^x = 3^4$$

$$x = 4$$

$$\begin{array}{c} 81 \\ \wedge \\ 3^{27} \\ \wedge \\ 3^9 \\ \wedge \\ 3^3 \end{array}$$

$$4^x = \frac{1}{16}$$

$$4^x = \frac{1}{4^2}$$

$$x = -2$$

To solve these equations we can substitute in values for x until we find the correct answer.

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Solving the equation $10^x = 47$ isn't as easy because finding a whole exponent won't work. We can solve this equation by graphing $y = 10^x$ and $y = 47$ and then find the intersection point of the two graphs. Try graphing the two equations and find the intersection point.

The two graphs intersect at _____.

Now substitute the value you just found in for x in your original equation.

$$10^x = 47$$

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Is your x value true??

By graphing, the two equations and finding the intersection point it can be time-consuming. Therefore, we are going to learn an algebraic strategy to help us solve for x in an exponential equation. We are going to use a new function called a **logarithm**.

Let's find the **log** key on our calculator.

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INVESTIGATION

In this investigation we are going to explore the connection between exponents with a base of 10, and logarithms.

Step 1

Enter the equation $Y_1 = 10^x$ into your calculator.

Step 2

Make a table of values for Y_1 . Push the blue **2nd** button and the gray **graph** button

Step 3

Enter the equation $Y_2 = \log(10^x)$ and compare the table values for Y_1 and Y_2 . What observations can you make? Try starting your table at different values (including negative values) and using different decimal increment values.

Step 4

Based on your observations in Step 3, what are the values of the following expressions?

- a. $\log(10^{2.5})$ b. $\log(10^{-3.2})$ c. $\log(10^0)$ d. $\log(10^x)$