Math 3

3.4 Solving Exponential Equations

Unit 3

SWBAT solve equations initially without logarithms by using either similar bases or the properties of logs.

Solving equations with NO logs!

Method 1: SWOOSH!

(Note: Does not work for every problem)

Step 1: Make sure the piece with the unknown exponent is isolated on one side.

Step 2: SWOOSH into logarithmic form.

Step 3: Evaluate using your calculator and then solve for x!

Example 1: Solve for x: $5^{3x} = \frac{1}{125}$

$\log_5\left(\frac{1}{125}\right) = 3x$

$-3 = 3x$

$x = -1$

You Try! Solve for x: $2^{5x+1} = 32$

$\log_2(32) = 5x+1$

$5 = 5x+1$

$4 = 5x$

$x = 4/5$

Example 2: Solve for x: $3^x + 5 = 40$

$3^x = 35$

$\log_3 35 = x$

$x = 3.24$

You Try! Solve for x: $2(6^{2x}) = 20$

$6^{2x} = 10$

$\log_6 10 = 2x$

$1.29 = 2x$

$x = 0.6425$

Why would you need to use a log? Because the variables are in the exponent and logs bring them down!

Method 2: Properties of Logs

(Note: This works for every problem)

Step 1: Make sure the piece with the unknown exponent is isolated on one side.

Step 2: Add the logarithm to each side of the equation.

Step 3: Use the exponent prop. to bring down the exponent and solve!

Example 3: Solve for x: $2^{3x} = 12^x$

$\frac{(3x)\log 2}{\log 2} = \frac{(x)\log 12}{\log 2}$

$3x = 3.6x$

$-0.6x = 0$

$x = 0$

You Try! Solve for x: $6^{2x} = 25^{4x}$

$\frac{(2x)\log 6}{\log 6} = \frac{(4x)\log 25}{\log 6}$

$2x = 4x(1.8)$

$2x = 7.2x$

$0 = 5.2x$

$x = 0$

Example 4: $3^{x-7} = 2^{x+4}$

$\frac{(x-7)\log 3}{\log 3} = \frac{(x+4)\log 2}{\log 3}$

$x-7 = 0.63(x+4)$

$x-7 = 0.63x + 2.52$

$0.37x = 9.52$

$x = 25.7$

You Try! $7^{3x+2} = 11^{x-1}$

$(3x+2)\log 7 = (x-1)\log 11$

$3x+2 = (x-1)(1.23)$

$3x+2 = 1.23x - 1.23$

$1.77x = -3.23$

$x = -1.82$

The Many Ways to Solve a Logarithmic Equation

One Log	**SWOOSH!** Use when a variable is attached to the logarithm.	Solve for x: $\log_4(4x-2)=3$ $4^3=4x-2$ $64=4x-2$ $66=4x$ $x=16.5$
	Evaluate in your Calculator Use when the variable is <u>not</u> attached to the logarithm.	Solve for x: $\log_2 45=x$ $x=5.49$
Two Logs	**Cancel the logs!** Do this if and only if there is <u>one</u> log per side.	Solve for x: $\log_6 x=\log_6(2x-2)$ $x=2x-2$ $-x=-2$ $x=2$
	Condense the logs So that only one log appears per side. Then, decide whether to cancel, swoosh, or use change of base.	Solve for x: $3\log_2 x+\log_2 5=7$ $\log_2 5x^3=7$ $2^7=5x^3$ $128=5x^3$ $x^3=25.6$ $x=2.94$
No Logs	**SWOOSH!** Use this if there is only one variable located in the exponent.	Solve for x: $7^{x-3}+5=30$ $7^{x-3}=25$ $\log_7 25=x-3$ $1.65=x-3$ $4.65=x$
	Add logs! Add a log to each side of the equation if there are variables located in both exponents!	Solve for x: $25^{2x}=125^{x+1}$ $2x\log 25=(x+1)\log 125$ $2x=1.5(x+1)$ $2x=1.5x+1.5$ $0.5x=1.5$ $x=3$

Practice: Complete the following problems for extra practice using the above rules for solving logarithms.

1. $2\log_4 x=12$

$\log_4 x=6$

$4^6=x$

$x=4096$

2. $\log 5x-\log 7=2$

$\log\frac{5x}{7}=2$

$10^2=\frac{5x}{7}$

$700=5x$

$x=140$

3. $\log_5 15=3x$

$1.68=3x$

$x=0.56$

4. $4^{3x}\cdot 4^{2x}=1048576$

$4^{5x}=1048576$

$\log_4 1048576=5x$

$10=5x$

$x=2$