

**Objective:** To solve exponential equations with common bases

**Warm Up:** Fill in the blanks with the missing value to make the statement true.

$3^{\square} = 81$ $\square = 4$	$3^{\square} = 81$ 	$2^{\square} = 32$ $\square = 5$	$2^{\square} = 32$ 
$4^{\square} = 64$ $\square = 3$	$4^{\square} = 64$ 		

**Example 1:** Simplifying Exponential Expressions

\*The key is making all bases the same so that exponent properties hold\*

A.)  $\frac{8^{x-1}}{2^x}$   
 $= \frac{(2^3)^{x-1}}{2^x}$   
 $= \frac{2^{3x-3}}{2^x}$   
 $= 2^{3x-3-x}$   
 $= \boxed{2^{2x-3}}$

B.)  $7^{2x} * 49^{x-4}$   
 $= 7^{2x} * (7^2)^{x-4}$   
 $= 7^{2x} * 7^{2x-8}$   
 $= 7^{2x+2x-8}$   
 $= \boxed{7^{4x-8}}$

C.)  $3^x * 27 * 3^{x-1} * (\frac{1}{9})^{2x-1}$   
 $= 3^x * (3^3) * 3^{x-1} * (3^{-2})^{2x-1}$   
 $= 3^x * 3^3 * 3^{x-1} * 3^{-4x+2}$   
 $= 3^{x+3+x-1-4x+2}$   
 $= \boxed{3^{-2x+4}}$

**Example 2:** Solving Exponential Equations

\*The key is making the left side and right side have the same base. Once they look the same, then the exponents form their own equation\*

A.)  $4^x = 4^{2x+1}$   
 $x = 2x+1$   
 $\frac{-2x}{-2x} \quad \frac{-2x}{-2x}$   
 $\frac{-x}{-1} = \frac{1}{-1}$   
 $\boxed{x = -1}$

B.)  $3^{2x} = 3^{x-5}$   
 $2x = x-5$   
 $\frac{-x}{-x} \quad \frac{-5}{-x}$   
 $\boxed{x = -5}$

C.)  $7^{3x-3} = 7^{x+22}$

$$\begin{array}{r} 3x-3 = x+22 \\ -x \quad -x \\ \hline \end{array}$$

$$\begin{array}{r} 2x-3 = 22 \\ +3 \quad +3 \\ \hline \end{array}$$

$$\frac{2x}{2} = \frac{25}{2}$$

$$x = \frac{25}{2}$$

E.)  $2^{4x} = 32^{x-1}$

$$2^{4x} = (2^5)^{x-1}$$

$$2^{4x} = 2^{5x-5}$$

$$\begin{array}{r} 4x = 5x-5 \\ -5x \quad -5x \\ \hline \end{array}$$

$$\begin{array}{r} -x = -5 \\ -1 \quad -1 \\ \hline \end{array}$$

$$x = 5$$

G.)  $25^{x^2} = 5^{x+3}$

$$(5^2)^{x^2} = 5^{x+3}$$

$$5^{2x^2} = 5^{x+3}$$

$$2x^2 = x+3$$

$$2x^2 - x - 3 = 0$$

$$(2x-3)(x+1) = 0$$

$$\begin{array}{r} 2x-3=0 \\ +3 \quad +3 \\ \hline \end{array}$$

$$\frac{2x}{2} = \frac{3}{2}$$

$$x = \frac{3}{2}$$

$$\begin{array}{r} x+1=0 \\ -1 \quad -1 \\ \hline \end{array}$$

$$x = -1$$

	2x	-3
x	2x <sup>2</sup>	-3x
1	2x	-3

Mult:  $-6x^2$   
Add:  $-x$

D.)  $27^x = 9^{x-3}$

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

$$3^{3x} = 3^{2x-6}$$

$$\begin{array}{r} 3x = 2x-6 \\ -2x \quad -2x \\ \hline \end{array}$$

$$x = -6$$

F.)  $2^{x+1} = 8^{3x-2}$

$$2^{x+1} = (2^3)^{3x-2}$$

$$2^{x+1} = 2^{9x-6}$$

$$\begin{array}{r} x+1 = 9x-6 \\ -x \quad -x \\ \hline \end{array}$$

$$\begin{array}{r} 1 = 8x-6 \\ +6 \quad +6 \\ \hline \end{array}$$

$$\frac{7}{8} = \frac{8x}{8}$$

$$x = \frac{7}{8}$$

H.)  $125^{x^2} = 5^{-7x-2}$

$$(5^3)^{x^2} = 5^{-7x-2}$$

$$5^{3x^2} = 5^{-7x-2}$$

$$3x^2 = -7x-2$$

$$3x^2 + 7x + 2 = 0$$

$$(3x+1)(x+2) = 0$$

$$\begin{array}{r} 3x+1=0 \\ -1 \quad -1 \\ \hline \end{array}$$

$$\frac{3x}{3} = \frac{-1}{3}$$

$$x = -\frac{1}{3}$$

$$\begin{array}{r} x+2=0 \\ -2 \quad -2 \\ \hline \end{array}$$

$$x = -2$$

Mult:  $6x^2$   
Add:  $7x$

	x	2
3x	3x <sup>2</sup>	6x
1	x	2