Name: _____ Date: _____

Learning Goal 8.1	Solving exponential and logarithmic equations with same base and with different bases, including base e.

Example Write each expression without brackets and with positive exponents.

a. $\dfrac{24m^5p^{-3}q^4}{-4m^4p^2q^{-2}}$

$= \dfrac{6m^5p^{-3}q^4}{-m^4p^2q^{-2}}$

$= \dfrac{6mp^{-3}q^4}{-p^2q^{-2}}$

$= \dfrac{6mq^4}{-p^5q^{-2}}$

$= \dfrac{6mq^6}{-p^5}$

$= -\dfrac{6mq^6}{p^5}$

$\frac{m^5}{m^4} = m^{5-4} = m$

$\frac{p^{-3}}{p^2} = p^{-3-2} = p^{-5} = \frac{1}{p^5}$

$q^{4-(-2)} = q^6$

b. $\left(\dfrac{18x^{-2}y^3}{54x^{-6}y^{-1}}\right)^3 \div \dfrac{(6x^2y^{-3})^{-2}}{(x^{-4}y^2)^3}$

$= \left(\dfrac{x^6y^3y}{3x^2}\right)^3 \div \dfrac{1}{(x^{-4}y^2)^3(6x^2y^{-3})^2}$

$= \left(\dfrac{x^4y^4}{3}\right)^3 \times (x^{-4}y^2)^3(6x^2y^{-3})^2$

$= \dfrac{x^{12}y^{12}}{3^3} \times x^{-12}y^6 \times 6^2x^4y^{-6}$

$= \dfrac{6^2x^4y^{12}}{3^3} = \dfrac{4x^4y^{12}}{3}$

BEDMAS

Example Convert each of the following to the base indicated.

a. 32^x to base 2

$= (2^5)^x$

$= 2^{5x}$

b. 81^{x-2} to base 3

$= (3^4)^{x-2}$

$= 3^{4(x-2)}$

$= 3^{4x-8}$

c. $\dfrac{1}{64^{2x}}$ to base 4

$= (4^{-3})^{2x}$

$= 4^{-6x}$

Example Simplify the following by converting each term to a common base.

a. $\dfrac{8^{3x-4} \cdot 16^{4-x}}{64^{1-2x}}$

$= \dfrac{(2^3)^{3x-4}(2^4)^{4-x}}{(2^6)^{1-2x}}$

$= \dfrac{2^{9x-12}2^{16-4x}}{2^{6-12x}}$

$= \dfrac{2^{5x+4}}{2^{6-12x}} = 2^{17x-2}$

b. $(9^{2x+3} \div 27^{3x-1}) \cdot 81^{x-1}$

$= ((3^2)^{2x+3} \div (3^3)^{3x-1}) \times (3^4)^{x-1}$

$= (3^{4x+6} \div 3^{9x-3}) \times 3^{4x-4}$

$= 3^{-5x+9} \times 3^{4x-4}$

$= 3^{-x+5}$

$= 3^{5-x}$

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Definition An exponential equation is an equation where the variable appears in the exponent.

$y = b^x$

(For now, we are only solving **exponential equations with the same base** using algebraic methods)

Example Solve and check.

a. $2^{(4x-1)} = 8^{2x}$

$2^{4x-1} = (2^3)^{2x}$

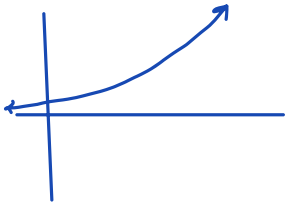
$2^{4x-1} = 2^{6x}$

$4x - 1 = 6x$

$-4x \quad -4x$

$\frac{-1}{2} = \frac{2x}{2}$

$x = -\frac{1}{2}$



b. $27^{x-4} = \left(\frac{1}{9}\right)^{2x-8}$

$(3^3)^{x-4} = \left(\frac{1}{3^2}\right)^{2x-8}$

$3^{3x-12} = \left(\frac{1}{3}\right)^{4x-16}$

$3^{3x-12} = 3^{-4x+16}$

$3x - 12 = -4x + 16$

$7x - 12 = 16$

$7x = 28$

$x = 4$

Steps

- Make the Bases Match
- Cancel Bases / equate the exponents.
- Solve.

Example A population of ants starts with 4000. After 4 weeks the estimated count is 128000 ants in the colony. What is the doubling period for this population?

$I = I_0 (g)^{t/d}$

- I: end conditions
- I_0: initial conditions
- g: growth rate
- t: elapsed time
- d: growth rate time span

$128\,000 = 4000(2)^{4/d}$

$32 = (2)^{4/d}$

$2^5 = 2^{4/d}$

$5 = \frac{4}{d} \Rightarrow d = \frac{4}{5}$

THE DOUBLING PERIOD OF THE COLONY IS $\frac{4}{5}$ OF A WEEK.

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