

Unit 4: Radical Expressions & Equations

4.0 Review: Exponents

Part I: Exponent Laws

Exponent laws are used to **simplify** operations involving powers of the **same base**.

1. Multiplying Powers

Ex. Simplify:

a) $3^4 \cdot 3^8$
 3^{12}

b) $(-2)^9 \times (-2)^3$
 $(-2)^{12}$

Rule: $b^m \cdot b^n = b^{m+n}$

c) $(2x^1)(-3x^2)(x^3)$
 $-6x^6$

2. Dividing Powers

Ex. Simplify:

a) $5^{11} \div 5^7$
 5^4

b) $\frac{(-6)^{10}}{(-6)^5}$
 $(-6)^5$

Rule: $\frac{b^m}{b^n} = b^{m-n}$

c) $\frac{10x^{20}}{5x^1}$
 $2x^{19}$

3. Zero Exponent

Ex. Simplify:

a) $999,999,999^0$
 1

b) -3^0
 -1

Rule: $b^0 = 1$

c) $(-3)^0$
 1

4. Power of a Product

Ex. Simplify:

a) $(5 \times 4)^6$
 $5^6 \times 4^6$

b) $(xyz)^4$
 $x^4 y^4 z^4$
 $7(2xy)^3 = 8x^3 y^3$

Rule: $(ab)^n = a^n b^n$

5. Power of a Quotient

Ex. Simplify: $\left(\frac{c}{d}\right)^7 = \frac{c^7}{d^7}$

Rule: $\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$

6. Power of a Power

Ex. Simplify:

a) $(3^4)^5$
 3^{20}

b) $((q^2)^3)^4$
 q^{24}

Rule: $(b^m)^n = b^{mn}$

c) $(2x^5)^3$
 $8x^{15}$

Combinations:

Ex. Simplify, then evaluate:

a) $\frac{(2^3)^2 \times 2^5}{2^4 \times 2} = \frac{2^6 \times 2^5}{2^4 \times 2} = \frac{2^{11}}{2^5} = 2^6$

b) $\frac{(x^3 y)^4 (x^2)}{y} = \frac{x^{12} y^4 x^2}{y^1} = x^{14} y^3$

Part II: Negative Exponents

Continue the pattern:

$$\begin{array}{l} 2^4 = 16 \\ 2^3 = 8 \\ 2^2 = 4 \\ 2^1 = 2 \\ 2^0 = 1 \\ 2^{-1} = \frac{1}{2} \\ 2^{-2} = \frac{1}{4} \\ 2^{-3} = \frac{1}{8} \\ 2^{-4} = \frac{1}{16} = \frac{1}{2^4} \end{array} \quad \left. \begin{array}{c} \downarrow \div 2 \end{array} \right\}$$

Summary:

$$a^{-n} = \frac{1}{a^n} \quad \left(\frac{1}{a}\right)^n$$

$$\frac{1}{a^{-n}} = a^n$$

$$\left(\frac{a}{b}\right)^{-n} = \left(\frac{b}{a}\right)^n$$

Ex. Write each expression with positive exponents.

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

$$\frac{1}{6^{-3}} = 6^3$$

$$4y^{-3} = \frac{4}{y^3}$$

$$x^{-5} = \frac{1}{x^5}$$

$$\frac{1}{z^{-5}} = z^5$$

$$(xy)^{-2} = \frac{1}{(xy)^2}$$

$$\left(\frac{4}{5}\right)^{-3} = \left(\frac{5}{4}\right)^3$$

$$(4y)^{-3} = \frac{1}{(4y)^3}$$

$$x^3y^{-1}z^{-7} = \frac{x^3}{yz^7}$$

Practice: Worksheet (Exponent Laws I – answer using only positive exponents)