

Unit 2: Exponents & Roots

2.0 Review – Exponent Laws

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

1. Multiplying Powers

Ex. Simplify (express as a single power): $2^3 \times 2^2$

$$(2 \times 2 \times 2) \times (2 \times 2) \\ 2^5$$

Recall

$$\begin{array}{r} (-3)^2 \quad - 3^2 \\ -3 \cdot -3 \quad - 3 \cdot 3 \\ \hline 9 \quad - 9 \\ (-2)^3 \quad - 2^3 \\ -8 \quad -8 \end{array}$$

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

Ex. Simplify:

a) $3^6 \cdot 3^5$
 $= 3^{11}$

b) $(-5)^7 \times (-5)^3$
 $= (-5)^{10}$

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

2. Dividing Powers

Ex. Simplify (express as a single power): $2^5 \div 2^3$

$$\frac{2 \cdot 2 \cdot 2 \cdot 2 \cdot 2}{2 \cdot 2 \cdot 2} \\ = 2^2$$

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

Ex. Simplify:

a) $5^6 \div 5^2$
 $= 5^4$

b) $\frac{(-6)^8}{(-6)^4}$
 $= (-6)^4$

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

3. Zero Exponent

Ex. $\frac{2^3}{2^3} = 1$
 $2^{3-3} = 2^0 = 1$

$$\begin{array}{l} 2^3 = 8 \downarrow \div 2 \\ 2^2 = 4 \downarrow \div 2 \\ 2^1 = 2 \downarrow \div 2 \\ 2^0 = 1 \downarrow \div 2 \end{array}$$

Rule: $b^0 = 1$

Ex. Simplify:

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

b) -3^0
 $= -1$

c) $(-3)^0$
 $= 1$

4. Power of a Product

Ex. Simplify: $(2 \times 3)^3$
 $= (2 \times 3) \cdot (2 \times 3) \cdot (2 \times 3)$
 $= 2 \cdot 2 \cdot 2 \cdot 3 \cdot 3 \cdot 3$
 $= 2^3 \times 3^3$

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

Ex. Simplify:

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

b) $(xyz)^4$
 $= x^4 y^4 z^4$

*NOTE: Not for adding or subtracting!

$$(5+4)^2 \neq 5^2 + 4^2$$

$$9^2 \neq 25 + 16$$

$$81 \neq 41$$

5. Power of a Quotient

Ex. Simplify: $\left(\frac{2}{3}\right)^4 = \left(\frac{2}{3}\right)\left(\frac{2}{3}\right)\left(\frac{2}{3}\right)\left(\frac{2}{3}\right)$

$$= \frac{2 \cdot 2 \cdot 2 \cdot 2}{3 \cdot 3 \cdot 3 \cdot 3} = \frac{2^4}{3^4}$$

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

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

6. Power of a Power

Ex. Simplify: $(2^2)^3 = (2^2)(2^2)(2^2)$

$$= 2^6$$

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

Ex. Simplify:

a) $(3^4)^5$

$$3^{20}$$

b) $((q^2)^3)^4$

$$q^{24}$$

c) $(2x^5)^3$

$$2^3 x^{15}$$

*NOTE: Be careful not to confuse rule # 1 and rule #6!

#1 $(3^4)(3^5)$ vs #6 $(3^4)^5$

$$3^9 \quad 3^{20}$$

Combinations:

Ex. Simplify, then evaluate:

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

$$\frac{2^6 \times 2^5}{2^5} = \frac{2^{11}}{2^5} = 2^6$$

b) $\frac{(x^3y)^4(x^2)}{y}$

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