

Unit 3: Powers & Exponents

3.2 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): $2^3 \times 2^2$

$$= 2 \times 2 \times 2 \times 2 \times 2$$

$$= 2^5$$

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) $\left(\frac{1}{2}\right)^4 \left(\frac{1}{2}\right)^2 \left(\frac{1}{2}\right)^1$

$$= \left(\frac{1}{2}\right)^7$$

** base same, add exponents*

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) $\frac{10^{20}}{10}$

$$= 10^{19}$$

3. Zero Exponent

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

$$2^{3-3}$$

$$2^0 = 1$$

← divide by itself

$$\frac{13^{25}}{13^{25}} = 1$$

$$13^{25-25} = 13^0 = 1$$

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: $(2 \times 3)^3$

$$= (2 \times 3) \times (2 \times 3) \times (2 \times 3)$$

$$= 2 \times 2 \times 2 \times 3 \times 3 \times 3$$

$$= 2^3 \times 3^3$$

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

Ex. Simplify:

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

$$= 5^6 \times 4^6$$

b) $(3 \cdot 5 \cdot 7)^4$

$$= 3^4 \times 5^4 \times 7^4$$

***NOTE: Not for adding or subtracting!**

$$(5+4)^6 \neq 5^6 + 4^6$$

5. Power of a Quotient

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

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

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

Ex. Simplify: $\left(\frac{5}{2}\right)^7 = \frac{5^7}{2^7}$

6. Power of a Power - one base with multiple exponents

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

$$= 2^6$$

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

Ex. Simplify:

a) $(3^4)^5$

$$= 3^{20}$$

b) $((6^2)^3)^4$

$$= 6^{24}$$

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

$$3^4 \cdot 3^5 = 3^9$$

$$6^2 \cdot 6^3 \cdot 6^4 = 6^9$$

Combinations:

Ex. Simplify, then evaluate:

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

$$= \frac{2^6 \times 2^5}{2^4 \times 2}$$

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

$$= \boxed{2^6}$$

$$= \boxed{64}$$

b) $(2^3 \times 3)^4$

$$= \boxed{2^{12} \times 3^4}$$

$$= 4096 \times 81$$

$$= \boxed{331,776}$$