

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

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

$$= 2^5$$

* base same, add exponents

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

Ex. Simplify:

a) $3^6 \cdot 3^5$

$$= 3^{11}$$

b) $(-5)^7 \times (-5)^3$

$$= (-5)^{10}$$

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

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

2. Dividing Powers

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

$$\frac{2 \cdot 2 \cdot 2 \cdot 2 \cdot 2}{2 \cdot 2 \cdot 2}$$

$$= 2^2$$

* base same, subtract exponents

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

Ex. Simplify:

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

$$= 5^4$$

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

$$= (-6)^4$$

c) $\frac{10^{20}}{10^1}$

$$= 10^{19}$$

3. Zero Exponent

Ex. $\frac{2^3}{2^3} = 1$ ← divide by itself

$$2^{3-3}$$

$$2^0 = 1$$

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

$$13^{25-25}$$

$$13^0 = 1$$

$$\text{Rule: } b^0 = 1$$

Ex. Simplify:

a) $999,999,999^0$

$$= 1$$

b) -3^0
 $= -1 \times 3^0$
 $= -1$

c) $(-3)^0$

$$= 1$$

$$\frac{(-3)^5}{(-3)^5} = 1$$

$$\frac{(-3)^{5-5}}{(-3)^{5-5}} = 1$$

4. Power of a Product

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

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

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

$$\text{Rule: } (ab)^n = a^n b^n$$

Ex. Simplify:

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

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

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

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

*NOTE: Not for adding or subtracting!

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

$$\text{ex. } (1+2)^3 = 27$$
$$1^3 + 2^3 = 9$$

5. Power of a Quotient

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

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

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

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

$$= \frac{2^6 \times 2^5}{2^4 \times 2^1}$$

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

$$= 2^6 \leftarrow (2^3)^2$$
$$= 64$$
$$8^2$$

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

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

$$= 2^{12} \times 3^4$$
$$4096 \times 81$$
$$= 331776$$