

# ALG I - §7-2 & §7-3 NOTES

## ALGEBRA I NOTES

### 7.2 & 7.3 Multiplication Properties of Exponents

**Objectives:** To multiply powers with the same base.  
To raise a power to a power.

#### Warm-Up:

Negative Exponent Rule:  $a^{-n} = \frac{1}{a^n}$  ;  $a \neq 0$

Zero Exponent Rule:  $a^0 = 1$  ;  $a \neq 0$

Simplify WITHOUT negative exponents.

1.  $\frac{1}{x^{-2}y^5}$

$$= \frac{x^2}{y^5}$$

2.  $-9^0$

$$= -1$$

3.  $5m^{-3}n^{-1}$

$$= \frac{5}{m^3n}$$

4.  $\frac{a^{-4}}{b^2c^0}$

$$= \frac{1}{a^4b^2}$$

1. Expand  $x^7$  (Write out what it means)

$$x^7 = x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x$$

Expand and simplify.

2.  $m^4 \cdot m^3$

$$= (m \cdot m \cdot m \cdot m)(m \cdot m \cdot m)$$
$$= m^7$$

3.  $(p^4)^3 = (p^4)(p^4)(p^4)$

$$= (p \cdot p \cdot p \cdot p)(p \cdot p \cdot p \cdot p)(p \cdot p \cdot p \cdot p)$$
$$= p^{12}$$

4.  $(2x^3y^2)^2 = (2x^3y^2)(2x^3y^2)$

$$= (2 \cdot x \cdot x \cdot x \cdot y \cdot y)(2 \cdot x \cdot x \cdot x \cdot y \cdot y)$$
$$= 4x^6y^4$$

## RULES OF EXPONENTS

### **Multiplying Powers with the Same Base**

For every nonzero number  $a$  and integers  $m$  and  $n$   $a^m \cdot a^n = a^{m+n}$

### **Raising a Power to a Power**

For every nonzero number  $a$  and integers  $m$  and  $n$   $(a^m)^n = a^{mn}$

### **Raising a Product to a Power**

For every nonzero number  $a$  and  $b$  and integer  $n$   $(ab)^n = a^n b^n$

### **Multiplying Powers in Algebraic Expressions:**

When variable factors have more than one base, combine powers with the same base.

**Example 1:** Simplify  $4x^5 \cdot 9x^{-12}$

$$\begin{aligned} &= (4 \cdot 9)(x^5 \cdot x^{-12}) \\ &= 36x^{-7} \\ &= \frac{36}{x^7} \end{aligned}$$

**Example 2:** Simplify  $2a \cdot 9b^4 \cdot 3a^2$

$$\begin{aligned} &= (2 \cdot 9 \cdot 3)(a \cdot a^2)(b^4) \\ &= 54a^3b^4 \end{aligned}$$

**Example 3:** Simplify each expression without negative exponents.

a.  $m^4 \cdot 2m^{-3} = 2(m^4 \cdot m^{-3})$

$$= 2m^1$$

b.  $-4c^3 \cdot 7d^2 \cdot 2c^{-2} = (-4 \cdot 7 \cdot 2)(c^3 \cdot c^{-2})(d^2)$

$$= -56cd^2$$

c.  $(2x^3y^{-3})(2x^{-1}y^3)$

$$\begin{aligned} &= (2 \cdot 2)(x^3 \cdot x^{-1})(y^{-3} \cdot y^3) \\ &= 4x^2y^0 \\ &= 4x^2 \end{aligned}$$

d.  $(4a^3b^2)(3a^{-4}b^{-5})$

$$\begin{aligned} &= (4 \cdot 3)(a^3 \cdot a^{-4})(b^2 \cdot b^{-5}) \\ &= 12a^{-1}b^{-3} \\ &= \frac{12}{ab^3} \end{aligned}$$

**Example 4:** Simplify each expression without negative exponents.

a.  $5x^4 \cdot x^9 \cdot 3x$

$$= (5 \cdot 3)(x^4 \cdot x^9 \cdot x)$$

$$= 15x^{14}$$

b.  $(5m^5)(2mn^4)(8m^3)$

$$= (5 \cdot 2 \cdot 8)(m^5 \cdot m \cdot m^3)(n^4)$$

$$= 80m^9n^4$$

c.  $j^2 \cdot 3k^{-2} \cdot -12j$

$$= (3 \cdot -12)(j^2 \cdot j)(k^{-2})$$

$$= -36j^3k^{-2}$$

$$= \frac{-36j^3}{k^2}$$

d.  $(-7a^{-5}b)(-4a^8b^{-2})$

$$= (-7 \cdot -4)(a^{-5} \cdot a^8)(b \cdot b^{-2})$$

$$= 28a^3b^{-1}$$

$$= \frac{28a^3}{b}$$

**Example 5:** Simplify each expression without negative exponents.

a.  $(n^4)^7$

$$= n^{28}$$

b.  $(x^{-2})^3$

$$= x^{-6}$$

$$= \frac{1}{x^6}$$

$$\text{OR } = (x^{-2})^3$$
$$= \left(\frac{1}{x^2}\right)^3$$
$$= \frac{1}{x^6}$$

c.  $(4xy^2)^3$

$$= (4)^3(x)^3(y^2)^3$$

$$= 64x^3y^6$$

d.  $(-5m^3n^{-4})^2$

$$= (-5)^2(m^3)^2(n^{-4})^2$$

$$= 25m^6n^{-8}$$

$$= \frac{25m^6}{n^8}$$

**Example 6:** Simplify each expression without negative exponents.

$$\begin{aligned} \text{a. } (3b^4)^{-2} \\ &= \frac{1}{(3b^4)^2} \\ &= \frac{1}{9b^8} \end{aligned}$$

$$\begin{aligned} \text{b. } (5x^2y)^{-3} &= \frac{1}{(5x^2y)^3} \\ &= \frac{1}{125x^6y^3} \end{aligned}$$

$$\begin{aligned} \text{c. } (3m^{-2}n)^{-2} &= \left(\frac{3n}{m^2}\right)^{-2} \\ &= \left(\frac{m^2}{3n}\right)^2 \\ &= \frac{m^4}{9n^2} \end{aligned}$$

$$\begin{aligned} \text{d. } (2a^{-3}b)^{-4} &= \left(\frac{2b}{a^3}\right)^{-4} \\ &= \left(\frac{a^3}{2b}\right)^4 \\ &= \frac{a^{12}}{16b^4} \end{aligned}$$

**Example 7:** Simplify each expression without negative exponents.

$$\begin{aligned} \text{a. } (x^{-2})^2(3xy^2)^4 \\ &= (x^{-4})(81x^4y^8) \\ &= 81x^0y^8 \\ &= 81y^8 \end{aligned}$$

$$\begin{aligned} \text{b. } (2x^{-6})^4 \cdot 2^{-3}x^{14} \\ &= (2^4x^{-24})(2^{-3}x^{14}) \\ &= (2^4 \cdot 2^{-3})(x^{-24} \cdot x^{14}) \\ &= 2x^{-10} \\ &= \frac{2}{x^{10}} \end{aligned}$$

$$\begin{aligned} \text{c. } (2k^5)^3(2k^{-4}) \\ &= (8k^{15})(2k^{-4}) \\ &= (8 \cdot 2)(k^{15} \cdot k^{-4}) \\ &= 16k^{11} \end{aligned}$$

$$\begin{aligned} \text{d. } (-4a^3b)^2(2a^2b^{-\frac{2}{3}})^{-3} \\ &= (-4a^3b)^2(2a^{-2}b^{-3}) \\ &= (16a^6b^2)(2a^{-2}b^{-3}) \\ &= (16 \cdot 2)(a^6 \cdot a^{-2})(b^2 \cdot b^{-3}) \\ &= 32a^4b^{-1} \\ &= \frac{32a^4}{b} \end{aligned}$$

**Example 8:** Determine the value of the missing exponent.

$$\text{a. } 9^5 \cdot 9^{\square} = 9^{-2}$$

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$$\text{b. } (3x^2y^{\square})^3 = 27x^6y^{12}$$

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