

7.1 Exponential Expression

GOAL Use properties of exponents involving products.

Vocabulary

The **order of magnitude** of a quantity can be defined as the power of 10 nearest the quantity.

Common Student Errors

- Incorrectly simplifying powers with negative signs

Tip Reinforce to students that when a negative sign is part of the base, the exponent applies to the negative sign. When a negative sign is not part of the base, the exponent does not apply to the negative sign.

- Using properties of exponents when there are different bases

Tip Stress that the properties of exponents can only be used on powers with the same base.

Student equation: $(-2^4) = -16$

Student equation: $-2^4 = 16$

Student equation: $x^2 \cdot y^3 = xy^5$

Suggest students check their answers by substituting values into the variables and evaluating both sides of the equation to verify they are equivalent.

EXAMPLE 1 Use the product of powers property

Simplify the expression.

a. $2^6 \cdot 2^8 = 2^{6+8}$
 $= 2^{14}$

b. $(-3)^7 \cdot (-3) = (-3)^7 \cdot (-3)^1$
 $= (-3)^{7+1}$
 $= (-3)^8$

c. $(-7)^3 \cdot (-7) \cdot (-7)^4 = (-7)^3 \cdot (-7)^1 \cdot (-7)^4$
 $= (-7)^{3+1+4}$
 $= (-7)^8$

d. $m \cdot m^5 \cdot m^6 = m^{1+5+6}$
 $= m^{12}$

Exercises for Example 1

Simplify the expression.

1. $8^3 \cdot 8^{11}$

2. $6 \cdot 6^3$

3. $y^3 \cdot y^6 \cdot y^2$

4. $(-10)^2 \cdot (-10) \cdot (-10)^5$

EXAMPLE 3 Use the power of a product property

Simplify the expression.

a. $(16 \cdot 21)^4 = 16^4 \cdot 21^4$

b. $(6mn)^3 = (6 \cdot m \cdot n)^3$
 $= 6^3 m^3 n^3$
 $= 216m^3 n^3$

c. $(-5p)^3 = (-5 \cdot p)^3$
 $= (-5)^3 \cdot p^3$
 $= -125p^3$

d. $-(2q)^4 = -(2 \cdot q)^4$
 $= -(2^4 \cdot q^4)$
 $= -16q^4$

EXAMPLE 4 Use all three properties

Simplify $(-3y^5)^3 \cdot 2y^2$.**Solution**

$$\begin{aligned}(-3y^5)^3 \cdot 2y^2 &= (-3)^3 \cdot (y^5)^3 \cdot 2y^2 && \text{Power of a product property} \\ &= -27 \cdot y^{15} \cdot 2y^2 && \text{Power of a power property} \\ &= -54y^{17} && \text{Product of powers property}\end{aligned}$$

Exercises for Examples 3 and 4

Simplify the expression.

9. $(5 \cdot 18)^6$

10. $-(11p)^3$

11. $(-3x^2y^5)^2$

12. $(2m)^3 \cdot (m^4)^5$

EXAMPLE 2 Use the power of a power property

Simplify the expression.

a. $(3^3)^6 = 3^{3 \cdot 6}$
 $= 3^{18}$

b. $[(-12)^7]^6 = (-12)^{7 \cdot 6}$
 $= (-12)^{42}$

c. $(d^5)^2 = d^{5 \cdot 2}$
 $= d^{10}$

d. $[(x-3)^3]^4 = (x-3)^{3 \cdot 4}$
 $= (x-3)^{12}$

