

6.1 Reteach**Key Ideas****Zero Exponent****Words** For any nonzero number a , $a^0 = 1$. The power 0^0 is undefined.**Numbers** $4^0 = 1$ **Algebra** $a^0 = 1$, where $a \neq 0$ **Negative Exponents****Words** For any integer n and any nonzero number a , a^{-n} is the reciprocal of a^n .**Numbers** $4^{-2} = \frac{1}{4^2}$ **Algebra** $a^{-n} = \frac{1}{a^n}$, where $a \neq 0$ **EXAMPLE Using Zero and Negative Exponents**Evaluate (a) 11^0 and (b) 4^{-3} .**SOLUTION**

$$\begin{array}{ll} \text{a. } 11^0 = 1 & \text{Definition of zero exponent} \\ \text{b. } 4^{-3} = \frac{1}{4^3} & \text{Definition of negative exponent} \\ & = \frac{1}{64} \quad \text{Simplify.} \end{array}$$

Key Ideas**Product of Powers Property**Let a be a real number, and let m and n be integers.**Words** To multiply powers with the same base, add their exponents.**Numbers** $4^6 \cdot 4^3 = 4^{6+3} = 4^9$ **Algebra** $a^m \cdot a^n = a^{m+n}$ **Quotient of Powers Property**Let a be a nonzero real number, and let m and n be integers.**Words** To divide powers with the same base, subtract their exponents.**Numbers** $\frac{4^6}{4^3} = 4^{6-3} = 4^3$ **Algebra** $\frac{a^m}{a^n} = a^{m-n}$, where $a \neq 0$ **Power of a Power Property**Let a be a real number, and let m and n be integers.**Words** To find a power of a power, multiply the exponents.**Numbers** $(4^6)^3 = 4^{6 \cdot 3} = 4^{18}$ **Algebra** $(a^m)^n = a^{mn}$

6.1**Reteach** (continued)**EXAMPLE** Using Properties of Exponents

Simplify (a) $9^2 \cdot 9^5$ and (b) $\frac{(5^6)^2}{5^3}$. Write your answer using only positive exponents.

SOLUTION

$$\begin{array}{ll} \text{a. } 9^2 \cdot 9^5 = 9^{2+5} & \text{Product of Powers Property} \\ = 9^7 & \text{Simplify.} \end{array} \quad \begin{array}{ll} \text{b. } \frac{(5^6)^2}{5^3} = \frac{5^{6 \cdot 2}}{5^3} & \text{Power of a Power Property} \\ = 5^{6 \cdot 2 - 3} & \text{Quotient of Powers Property} \\ = 5^9 & \text{Simplify.} \end{array}$$

Key Ideas**Power of a Product Property**

Let a and b be real numbers, and let m be an integer.

Words To find a power of a product, find the power of each factor and multiply.

Numbers $(3 \cdot 2)^5 = 3^5 \cdot 2^5$ **Algebra** $(ab)^m = a^m \cdot b^m$

Power of a Quotient Property

Let a and b be real numbers with $b \neq 0$, and let m be an integer.

Words To find the power of a quotient, find the power of the numerator and the power of the denominator and divide.

Numbers $\left(\frac{3}{2}\right)^5 = \frac{3^5}{2^5}$ **Algebra** $\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}$, where $b \neq 0$

EXAMPLE Using Properties of Exponents

Simplify (a) $(4x)^4$ and (b) $\left(\frac{c}{2}\right)^5$. Write your answer using only positive exponents.

SOLUTION

$$\begin{array}{ll} \text{a. } (4x)^4 = 4^4 x^4 & \text{Power of a Product Property} \\ = 256x^4 & \text{Simplify.} \end{array} \quad \begin{array}{ll} \text{b. } \left(\frac{c}{2}\right)^5 = \frac{c^5}{2^5} & \text{Power of a Quotient Property} \\ = \frac{c^5}{32} & \text{Simplify.} \end{array}$$

In Exercises 1–4, simplify the expression. Write your answer using only positive exponents.

1. $5^0 \cdot 2^{-3}$ 2. $\frac{8^5 \cdot 8^6}{8^7}$ 3. $(2y)^6$ 4. $\left(\frac{b}{5}\right)^3$

6.1 Extra Practice

In Exercises 1–6, evaluate the expression.

1. 5^{-4}

2. $(-5)^{-4}$

3. $\frac{7^{-1}}{-8^0}$

4. $\frac{8^{-1}}{(-4)^0}$

5. $\frac{-2^{-4}}{3^{-3}}$

6. $\frac{6^{-2}}{(-1)^{-4}}$

In Exercises 7–21, simplify the expression. Write your answer using only positive exponents.

7. $\frac{7^{-2}m^0}{n^{-4}}$

8. $\frac{(-9)^0 j^{-1} k^{-4}}{2^0}$

9. $\frac{5^{-2}w^0}{y^{-10}}$

10. $\frac{t^{-5}}{8^{-2}s^{-3}}$

11. $\frac{3^{-2}a^{-1}}{9^{-1}b^{-2}c^0}$

12. $\frac{17x^0y^{-8}}{4^{-2}z^{-6}}$

13. $(p^6)^3$

14. $(q^{-4})^5$

15. $5^3 \cdot 5^{-7}$

16. $-4 \cdot (-4)^{-2}$

17. $\frac{x^7}{x^4} \cdot x^2$

18. $\frac{v^5 \cdot v^3}{v^2}$

19. $(-8t^2)^3$

20. $\left(-\frac{q^4}{5}\right)^{-3}$

21. $\left(\frac{1}{3h^5}\right)^{-4}$

In Exercises 22–24, simplify the expression.

22. 5^{3t}

23. 3^{a+4}

24. 2^{3n+5}

In Exercises 25 and 26, simplify the expression. Write your answer using only positive exponents.

25. $\left(\frac{5x^{-4}y^3}{2x^2y^0}\right)^2 \cdot \left(\frac{4xy}{y^3}\right)^2$

26. $\left(\frac{2a^0b^{-4}}{b^3}\right)^4 \cdot \left(\frac{a^3b^{-2}}{3b^4a^{-4}}\right)^3$

In Exercises 27 and 28, evaluate the expression. Write your answer in scientific notation and in standard form.

27. $(4.3 \times 10^{-4})(6 \times 10^7)$

28. $\frac{(1.2 \times 10^{-3})}{(4.8 \times 10^{-10})}$

29. Without evaluating, rewrite $\frac{8^{21} \cdot 16^{18}}{4^{11}}$ as a single power with base 2.

6.1**Enrichment and Extension****Properties of Exponents**

In Exercises 1–8, simplify the expression. Write your answer using only positive exponents.

$$1. \frac{-3mn^2p^{-6}}{4mn} \cdot \left(\frac{9m^{-2}p^2}{16mn^4p^5} \right)^{-1}$$

$$2. xy^3z^{-4} \cdot x^{-5} \cdot xz^{-4}y^{-3} \cdot x^0z$$

$$3. \frac{-4(-3xy^{-3}z^4)^{-2}}{2x^{-5}yz^5}$$

$$4. \frac{\frac{-4mp^{-3}q^2}{25m^2p^4}}{\frac{16mpq^2}{15m^2p^{-2}}}$$

$$5. x^2y^3z^{-4} \cdot \frac{x^5yz^{-7}}{x^{-1}y^{-1}z^4}$$

$$6. \left((x^{-3}y)^{-2} \right)^3 \cdot (x^4y^{-2})^{-1}$$

$$7. \left(\left(\frac{-2ab^2c}{4a^{-5}b^{-3}c^6} \right)^3 \right)^{-2}$$

$$8. \left(\frac{\left(\frac{zx^2y^{-4}}{xy^5x^{-2}} \right)^{-2} \cdot \frac{-2}{x^{-6}y^7}}{\frac{4xyz^{-3}}{x^{-6}}} \right)^{-3}$$