48, ~~36~~, 68, 56, 8 4^{16} $4 = 2 \cdot 2$, $16 = 2 \cdot 2 \cdot 2 \cdot 2$

(8) $\frac{2^{-1}}{2^5} = \frac{2^5}{2^1} = \frac{32}{2} = 16$

(36) $(3ab)^{-2} = \frac{1}{(3ab)^2} = \frac{1}{9a^2b^2}$

(48) $-7p^{-5}q^3r^2 = \frac{-7r^2}{p^5q^3}$

(56) $\frac{1}{1{,}000{,}000{,}000} = \frac{1}{10^9} = 10^{-9}$

(68) $mn^p = 4 \cdot 5^{-2} = \frac{4}{5^2} = \frac{4}{25}$

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Multiplication Properties of Exponents

Lesson Objectives	NAEP 2005 Strand: Number Properties and Operations
▼ Multiply powers ▼ Work with scientific notation	Topics: Number Sense: Estimation Local Standards:

Key Concepts

Multiplying Powers With the Same Base

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

Example $3^5 \cdot 3^4 = 3^{5+4} = 3^9$

When multiplying powers with the same base add the exponents, the base stays the same.

$3^5 \cdot 3^4 = 3^{5+4} = 3^9$

$(3 \cdot 3 \cdot 3 \cdot 3 \cdot 3)(3333)\ x^2 \cdot x^5 = x^7$

Example

1 Multiplying Powers Rewrite each expression using each base only once.

a. $7^3 \cdot 7^2 = 7^{[+]2}$ [ ] exponents of powers with the same base.

$= 7^5$ Simplify the sum of the exponents.

$6^8 \cdot 6^{-8}$

b. $6^8 \cdot 6^{-8} = 6^{8[+](-8)}$ [ ] exponents of powers with the same base.

$= 6^0$ Simplify the sum of the exponents.

$= 1$ Use the definition of zero as an exponent.

Quick Check

1. Rewrite each expression using each base only once.

a. $5 \cdot 5^6$ b. $2^4 \cdot 2^{-3}$ $4+3$

5^9 $2^1=2$

exponential form

c. $6^{-3} \cdot 6^2 \cdot 6^6$ $-3+2+6$ $-1+6$

7^5

Example

❷ **Multiplying Powers in an Algebraic Expression** Simplify each expression.

a. $4x^6 \cdot 5x^{-4}$ $6+-4$ $6-4$ 2

$4 \cdot 5$ $x \cdot x$

$20x^2$

b. $2q^1 \cdot 3p^3 \cdot 4q^4$

$6 \cdot 4$

$24p^3q^5$

Quick Check

2. Simplify each expression.

a. $n^1 \cdot n^2 \cdot n^4$

$1 \cdot 1 \cdot 7 = 7$

$n^2 \cdot n^3 \cdot n^1 = n^6$

$7n^6$

b. $2x^3 \cdot 7x^2 \cdot 2x^1$

$2 \cdot 7 \cdot 2 = 28$

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

$28x^3y^7$

c. $7m^2 \cdot n^{-3} \cdot 7m^1$

$1 \cdot 1 \cdot 7 = 7$

$m^2 \cdot m^1 = m^3$

$\frac{7m^3}{n^3}$

$7.2 \times 10^3 = 7.200. = 7200$

$3.65 \times 10^{-2} = .0365 = .0365$

$59,700,000. = 5.97 \times 10^7$

$.0000942 = 9.42 \times 10^{-5}$

Example

❸ **Multiplying Numbers in Scientific Notation** Simplify $(3 \times 10^{-3})(7 \times 10^{-5})$. Write the answer in scientific notation.

$(3 \times 10^{-3})(7 \times 10^{-5}) = (3 \cdot 7)(10^{-3} \cdot 10^{-5})$ Commutative and Associative Properties of Multiplication

$= 21 \times 10^{-8}$ Simplify.

$= 2.1 \times 10 \cdot 10$ Write 21 in scientific notation.

$= 2.1 \times 10^{+}$ Add exponents of powers with the same base.

$= 2.1 \times 10^{-7}$ Simplify.

21×10^{-8}

(a) $(2.5\times10^{8})(6\times10^{3})$

$2.5(6)\quad 10^{8}\cdot10^{3}$

15×10^{11} 1500000000000

1.5×10^{12}

(b) $(1.5\times10^{-2})(3\times10^{4})$

$1.5(3)\quad 10^{-2}\cdot10^{4}$

4.5×10^{2}

(c) $(9\times10^{-6})(7\times10^{-9})$

$9\cdot7\quad 10^{-6}\cdot10^{-9}$

63×10^{-15}

6.3×10^{-14}

13 zeros 63

15

(1) $2^{6}\cdot2^{4}\ 2^{10}$

(2) $5^{-13}\cdot5^{5}\cdot2^{5}=5^{-8}\cdot2^{5}=\frac{2^{5}}{5^{8}}$

(3) $10^{-6}\cdot10^{5}\cdot10^{1}=10^{0}$

$10^{0}=1$

(4) $(.99)^{3}\div(.99)^{0}\cdot.99^{3}$

$.99^{3}\cdot1$

(5) $c^{-2}c^{7}\ c^{5}$

(6) $3r^{1}\cdot r^{4}\cdot3r^{5}$

(7) $5x^{-2}\cdot2x^{-5}=10x^{-7}=\frac{10}{x^{7}}$

(8) $(7x^{5})(8x^{1})\div56$

(9) $3x^{2}\cdot x^{2}\ 3x^{4}$

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(2-36 even)

(10) $b^{-2} \cdot b^4 \cdot b$