

Warm Up Simplify.

- 1. $(x^2)^3$
- 2. 2^{-3}
- 3. $3^2 \cdot x^{-1}$
- 4. $(v^{-2}w^3)^{-3}$
- 5. $3^8 \cdot 3^{-2}$
- 6. $(\frac{y}{z})^3$

Write in Scientific Notation.

- 7. 30×10^{-3}
- 8. 0.16×10^7

Objective

Use division properties of exponents to evaluate and simplify expressions.

Quotient of Powers Property

$$\frac{x^5}{x^3} = \frac{\cancel{x} \cdot \cancel{x} \cdot \cancel{x} \cdot \cancel{x} \cdot \cancel{x}}{\cancel{x} \cdot \cancel{x} \cdot \cancel{x}}$$

$$\frac{x^3}{x^5} = \frac{\cancel{x} \cdot \cancel{x} \cdot \cancel{x}}{\cancel{x} \cdot \cancel{x} \cdot \cancel{x} \cdot \cancel{x} \cdot \cancel{x}} = \frac{1}{x^2}$$

A quotient of powers with the same base can be found by writing the powers in a factored form and dividing out common factors.

$$\frac{2^5}{2^3} = \frac{\cancel{2} \cdot \cancel{2} \cdot \cancel{2} \cdot 2 \cdot 2}{\cancel{2} \cdot \cancel{2} \cdot \cancel{2}} = 2 \cdot 2 = 2^2$$

Notice the relationship between the exponents in the original quotient and the exponent in the final answer: $5 - 3 = 2$.

Quotient of Powers Property

WORDS	NUMBERS	ALGEBRA
The quotient of two nonzero powers with the same base equals the base raised to the difference of the exponents.	$\frac{6^7}{6^4} = 6^{7-4} = 6^3$	If a is a nonzero real number and m and n are integers, then $\frac{a^m}{a^n} = a^{m-n}$.

* When dividing powers w/ same base take larger exp. minus smaller exp. — where the larger exp. was is where your leftovers will stay.

Example 1: Finding Quotients of Powers

Simplify.

A. $\frac{2^7}{2^2}$
 2^5

B. $\frac{x^4}{x^3}$
 x

C. $\frac{d^4e^3}{(de)^2}$
 d^2e

D. $\frac{3 \cdot 4^3 \cdot 5^5}{3^2 \cdot 4^4 \cdot 5^3}$
 $\frac{5^2}{3 \cdot 4} \cdot \frac{25}{12}$

Check It Out! Example 1

Simplify.

a. $\frac{2^9}{2^7}$
 2^2

b. $\frac{y}{y^4}$
 $\frac{1}{y^3}$

c. $\frac{m^5n^4}{(m^5)^2n}$
 $\frac{n^3}{m^5}$

d. $\frac{3^5 \cdot 2^4 \cdot 4^3}{3^4 \cdot 2^2 \cdot 4^6}$
 $\frac{3 \cdot 2^2}{4^3} \cdot \frac{12}{64} = \frac{3}{16}$

A power of a quotient can be found by first writing the numerator and denominator as powers.

$$\left(\frac{2}{3}\right)^3 = \frac{2 \cdot 2 \cdot 2}{3 \cdot 3 \cdot 3} = \frac{2 \cdot 2 \cdot 2}{3 \cdot 3 \cdot 3} = \frac{2^3}{3^3}$$

Notice that the exponents in the final answer are the same as the exponent in the original expression.

$$\left(\frac{x}{y}\right)^3 = \frac{x^3}{y^3}$$

$$\left(\frac{3d^2}{d^5ef^3}\right)^4 = \left(\frac{3^4 d^8}{d^{20} e^4 f^{12}}\right)$$

2 options.
 - simplify inside () first then distribute the exp outside to each exp. inside
 or
 Vice versa (the other way around)

$$\frac{3^4 d^8}{d^{20} e^4 f^{12}} = \frac{81}{d^{12} e^4 f^{12}}$$

Positive Power of a Quotient Property		
WORDS	NUMBERS	ALGEBRA
A quotient raised to a positive power equals the quotient of each base raised to that power.	$\left(\frac{2}{3}\right)^3 = \frac{2}{3} \cdot \frac{2}{3} \cdot \frac{2}{3} = \frac{2 \cdot 2 \cdot 2}{3 \cdot 3 \cdot 3} = \frac{2^3}{3^3}$	If a and b are nonzero real numbers and n is a positive integer, then $\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$.

Example 4A: Finding Positive Powers of Quotient

Simplify.

$$\left(\frac{4}{7}\right)^2$$

$$\left(\frac{3d^2}{ef}\right)^4$$

Simplify.

$$\left(\frac{2^3}{3^2}\right)^2$$

$$\left(\frac{ab^4}{c^2d^3}\right)^5$$

$$\left(\frac{2x^3}{xy^3}\right)^2 = \frac{2^2 x^6}{x^2 y^6} = \frac{4x^4}{y^6}$$

$$\left(\frac{a^3b}{a^2b^2}\right)^3 = \frac{a^9 b^3}{a^6 b^6} = \frac{a^3}{b^3}$$

Daily Practice

Pg. 472 #30 - 37, 51 - 53

Simplify.

- 26. $\left(\frac{2}{3}\right)^4$
- 27. $\left(\frac{a^3}{b^2}\right)^5$
- 28. $\left(\frac{a^2b^3}{ab^2}\right)^4$
- 29. $\left(\frac{3x^2}{2y}\right)^3$
- 30. $\left(\frac{1}{2}\right)^{-3}$
- 31. $\left(\frac{x^2}{y^3}\right)^{-5}$
- 32. $\left(\frac{8m^2}{16}\right)^{-3}$
- 33. $\left(\frac{1}{3}\right)^{-2} \left(\frac{9}{4}\right)^{-1}$

Simplify, if possible.

- 34. $\frac{x^5}{x^3}$
- 35. $\frac{8d^4}{4d^3}$
- 36. $\frac{x^4 \cdot x^3}{x^2 \cdot x^5}$
- 37. $\frac{(3x^2)^4}{(6x^2)^4}$
- 38. $\frac{(5x^2)^3}{3x^2}$
- 39. $\left(\frac{c^3d^4}{d^2}\right)^7$
- 40. $\left(\frac{3p}{a^2 \cdot a^3}\right)^3$
- 41. $\left(\frac{-p^4}{-3p^2}\right)^{-2}$
- 42. $\left(\frac{h^{-2}j^3}{h^5}\right)^2$
- 43. $\left(\frac{10^2 \cdot 10^3}{10^5 \cdot 10^2}\right)^{-1}$
- 44. $\left(\frac{x^2y^3}{x^3y}\right)^{-2}$
- 45. $\frac{(-x^2)^4}{-(x^2)^4}$

Find the missing exponent(s).

- 50. $\frac{x^5}{x^3} = x^2$
- 51. $\frac{x^2}{x^5} = x^{-3}$
- 52. $\left(\frac{a^2}{b^3}\right)^4 = \frac{a^8}{b^{12}}$
- 53. $\left(\frac{x^3}{y^2}\right)^{-2} = \frac{y^4}{x^6}$

Warm - Up

Simplify each.

- 1. x^3y^{-2}
- 2. $(2x^4y^2z^{-1})^2$
- 3. $(x^{-1}y^2)^{-3} \cdot x^2y^2$
- 4. $\frac{x^5y^{-3}}{x^2y^{-6}}$