

EXPONENTS: THE QUOTIENT RULE

LEARNING GOAL

1. I can divide exponential expressions using the quotient rule.

**appears
5 times**

exponent

$2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 = 2^5$

base

The diagram illustrates the relationship between repeated multiplication and exponential notation. It shows the expression $2 \cdot 2 \cdot 2 \cdot 2 \cdot 2$ where the number 2 is repeated five times. A bracket above the five 2s is labeled "appears 5 times". This expression is set equal to 2^5 . A blue arrow points from the word "exponent" to the superscript 5, and a red arrow points from the word "base" to the base 2.

Exponential Rules

Product Rule

$$a^x \times a^y = a^{x+y}$$

$$a^2 \times a^3 = a^5$$

Quotient Rule

$$a^x \div a^y = a^{x-y}$$

$$a^7 \div a^3 = a^4$$

Power Rule

$$(a^x)^y = a^{xy}$$

$$(a^7)^2 = a^{14}$$

Negative Rule

$$a^{-x} = \frac{1}{a^x}$$

$$a^{-4} = \frac{1}{a^4}$$

Zero Rule

$$a^0 = 1$$

Exponents Dividing Example One

$$2^3 \div 2^2 \quad \text{Rewrite as a Fraction}$$

$$= \frac{2^3}{2^2} \quad \text{Fully Expand the Powers out}$$

$$= \frac{2 \times \cancel{2} \times \cancel{2}}{\cancel{2} \times \cancel{2}} \quad \text{and then cancel all identical items in the top and bottom}$$

$$= 2 \quad \checkmark$$

Dividing Rule Example Two

$$k^5 \div k^3 \quad \text{Rewrite as a Fraction}$$

$$= \frac{k^5}{k^3} \quad \text{Use the Subtract Powers shortcut Rule}$$

$$= k^{5-3} \quad \text{If Bases are the same, then subtract the Powers, which is the Exponents Divide Rule.}$$

$$= k^2 \checkmark$$

Dividing Rule Example Four

$$12a^7b^5 \div 16a^2b^2 \quad \text{Rewrite as a Fraction}$$

$$= \frac{12a^7b^5}{16a^2b^2} \quad \text{Separate Numbers \& Letters}$$

$$= \frac{\overset{3}{\cancel{12}}}{\underset{4}{\cancel{16}}} \times \frac{a^{\overset{7}{\cancel{2}}}}{a^{\underset{2}{\cancel{2}}}} \times \frac{b^{\overset{5}{\cancel{2}}}}{b^{\underset{2}{\cancel{2}}}} \quad \begin{array}{l} \text{Reduce down number Fraction} \\ \text{and use Powers Subtract Rule} \end{array}$$

$$= \frac{3}{4} \times a^{7-2} \times b^{5-2} = \frac{3}{4} \times a^5 \times b^3 = \frac{3a^5b^3}{4} \quad \checkmark$$

Exponents
Worksheet 2

Directions: Complete the chart below.

		Expanded Form	Single Base and a Power
1.	$\frac{x^4}{x^3}$	$\frac{x \cdot x \cdot x \cdot x}{x \cdot x \cdot x} \leftarrow \begin{matrix} 4 \text{ times} \\ 3 \text{ times} \end{matrix}$	$x = x^1$
2.	$\frac{x^8}{x^5}$	$\frac{x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x}{x \cdot x \cdot x \cdot x \cdot x}$	$x \cdot x \cdot x = x^3$
3.	$\frac{x^5}{x}$	$\frac{x \cdot x \cdot x \cdot x \cdot x}{x}$	x^4
4.	$\frac{x^2}{x^8}$	$\frac{x \cdot x}{x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x}$	$\frac{1}{x^6}$
5.	$\frac{x}{x^5}$	$\frac{x}{x \cdot x \cdot x \cdot x \cdot x}$	$\frac{1}{x^4}$

6. Compare the 2nd and 4th columns in the table above. Describe, in words, what you notice about the relationship you see between them.

		Expanded Form	Single Base and a Power
7.	$\frac{x^3 y^3}{x^3 y}$	$\frac{x \cdot x \cdot x \cdot y \cdot y \cdot y}{x \cdot x \cdot x \cdot y}$	y^2
8.	$\frac{x^2 y^5}{x^3 y^2}$	$\frac{x \cdot x \cdot y \cdot y \cdot y \cdot y \cdot y}{x \cdot x \cdot x \cdot y \cdot y}$	$\frac{y^3}{x}$
9.	$\frac{6x^5}{8x^3}$	$\frac{2 \cdot 3 \cdot x \cdot x \cdot x \cdot x \cdot x}{2 \cdot 4 \cdot x \cdot x \cdot x}$	$\frac{3x^2}{4}$
10.	$\frac{12x^7 y}{6x^3 y^6}$	$\frac{2 \cdot 2 \cdot 3 \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot y}{2 \cdot 3 \cdot x \cdot x \cdot x \cdot y \cdot y \cdot y \cdot y \cdot y \cdot y}$	$\frac{2x^3}{y^5}$

Exponents
Worksheet 2

Name: _____

$$1) \frac{b^6}{b^4} = \boxed{b^2}$$

$$7) \frac{4k^3z^2}{3kz^4} = \frac{4\cancel{k^3}z^2}{3\cancel{k}z^4} = \boxed{\frac{4k^2}{3z^2}}$$

$$2) \frac{8n^6z^3}{2n^5z^2} = \boxed{4nz}$$

$$8) \frac{w}{w^3} = \frac{w^1}{w^3} = \boxed{\frac{1}{w^2}}$$

$$3) \frac{5dk^3}{9d^4k^6} = \boxed{\frac{5}{9d^1k^3}}$$

$$9) \frac{9g^4}{6g^6} = \frac{\cancel{3} \cdot 3g^4}{\cancel{3} \cdot 2g^6} = \boxed{\frac{3}{2g^2}}$$

$$4) \frac{kh}{7k^4h^5} = \frac{\cancel{k} \cdot \cancel{h}}{7\cancel{k} \cdot \cancel{k} \cdot \cancel{k} \cdot \cancel{k} \cdot \cancel{h} \cdot \cancel{h} \cdot \cancel{h} \cdot \cancel{h} \cdot \cancel{h}} = \boxed{\frac{1}{7k^3h^4}}$$

$$10) \frac{9^2}{9^4} = \boxed{\frac{1}{9^2}} \text{ or } \boxed{\frac{1}{81}}$$

$$5) \frac{3w}{7w^6} = \frac{3w^1}{7w^6} = \boxed{\frac{3}{7w^5}}$$

$$11) \frac{5h^4}{2h^3k^5} = \boxed{\frac{5h^1}{2k^5}}$$

$$6) \frac{6^3}{6} = \frac{6^3}{6^1} = \boxed{6^2} \text{ or } \boxed{36}$$

$$12) \frac{2d^2}{6d} = \frac{\cancel{2}d^2}{\cancel{2} \cdot 3\cancel{d}^1} = \boxed{\frac{d}{3}}$$