Algebra 1 7.2

Use the properties of exponents to divide monomials

Simplify expressions containing negative exponents

Simplify expressions containing zero exponer

Compare measurements using order of magnitude

exponent

base

quotient

factors

negative exponent

order of magnitude

$\frac{2^7}{2^4}$

$\frac{t^4}{t^3}$

$\frac{x}{x} = 1$

$\frac{5a}{5a}$

$a \cdot a \cdot a \cdot a \cdot a = a^5$

$\frac{3}{3} = 1 \quad 1 \cdot 1 = 1$

Triangle puzzle

Old school or shortcut?

KeyConcept Quotient of Powers

Words	To divide two powers with the same base, subtract the exponents.
Symbols	For any nonzero number a, and any integers m and p, $\frac{a^m}{a^p} = a^{m-p}$.
Examples	$\frac{c^{11}}{c^8} = c^{11-8}$ or c^3 $\qquad \frac{r^5}{r^2} = r^{5-2} = r^3$

$\frac{c\,c\,c\,c\,c\,c\,c\,c\,c\,c\,c}{c\,c\,c\,c\,c\,c\,c\,c} = c^3$

Example 1 Quotient of Powers

Simplify $\frac{g^3h^5}{gh^2}$. Assume that no denominator equals zero.

$\frac{g\,g\,g\,h\,h\,h\,h\,h}{g\,h\,h}$ $\quad 1 \cdot g^2h^3$

why?

Simplify each expression. Assume that no denominator equals zero.

1A. $\frac{x^3y^4}{x^2y}$ $3 = \frac{3}{1}$ **1B.** $\frac{k^7m^{10}p}{k^5m^3p}$

$\frac{xxxyyyy}{xxy}$

$\frac{xy^3}{1}$

$\frac{kkkkkkk(kmmmmmmmmmmm)p}{kkkkkmmmp}$

k^2m^7

$\left(\frac{r}{t}\right)^5 = \left(\frac{r}{t}\right)\left(\frac{r}{t}\right)\left(\frac{r}{t}\right)\left(\frac{r}{t}\right)\left(\frac{r}{t}\right)$ "Power rule" $\frac{r^5}{t^5}$

KeyConcept Power of a Quotient

Words	To find the power of a quotient, find the power of the numerator and the power of the denominator.
Symbols	For any real numbers a and $b \neq 0$, and any integer m, $\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}$.
Examples	$\left(\frac{3}{5}\right)^4 = \frac{3^4}{5^4}$ $\left(\frac{r}{t}\right)^5 = \frac{r^5}{t^5}$

$\left(\frac{3}{5}\right)^2 = \frac{3}{5} \cdot \frac{3}{5} = \frac{9}{25}$

StudyTip

Power Rules with Variables

The power rules apply to variables as well as numbers. For example,

$\left(\frac{3a}{4b}\right)^3 = \frac{(3a)^3}{(4b)^3}$ or $\frac{27a^3}{64b^3}$.

$\frac{4}{12} \qquad \frac{1}{3}$

$$\left(\frac{3a}{4b}\right)^3 = \left(\frac{3a}{4b}\right)\left(\frac{3a}{4b}\right)\left(\frac{3a}{4b}\right) = \frac{27a^3}{64b^3}$$

numerator/denominator

Example 2 Power of a Quotient

Simplify $\left(\frac{3p^3}{7}\right)^2$.

$\left(\frac{3ppp}{7}\right)\left(\frac{3ppp}{7}\right)\ \frac{9p^6}{49}$

$\frac{7p^6}{49} = \frac{1}{7}p^6$

$= \frac{p^6}{7}$

whiteboards

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Simplify each expression.

2A. $\left(\frac{3x^4}{4}\right)^3$ **2B.** $\left(\frac{5x^5y}{6}\right)^2$ **2C.** $\left(\frac{2y^2}{3z^3}\right)^2$ **2D.** $\left(\frac{4x^3}{5y^4}\right)^3$

$\left(\frac{3xxxx}{4}\right)\left(\frac{5xxxx}{4}\right)\left(\frac{3xxxx}{4}\right) = \frac{27x^{12}}{64}$

Patterns: $(\text{anything})^0 = 1$

$25 = 5^2$

$\frac{25}{25} = \frac{5^2}{5^2}$

$= \frac{5 \cdot 5}{5 \cdot 5} = 1$

1×10^6	1,000,000
10^5	100,000
10^4	10,000
10^3	1000
10^2	100
10^1	10
$10^0 =$	1

$3^0 = 1$

$19^0 = 1$

$x^0 = 1$

$y^0 = 1$

$$\left(\frac{-5r^2p^4}{-5r^8p^6}\right)^0$$

KeyConcept Zero Exponent Property

Words	Any nonzero number raised to the zero power is equal to 1.
Symbols	For any nonzero number a, $a^0 = 1$.
Examples	$15^0 = 1$ $\left(\frac{b}{c}\right)^0 = 1$ $\left(\frac{2}{7}\right)^0 = 1$

why?

replace zero powers with something =
what would that be?

Example 3 Zero Exponent

Simplify each expression. Assume that no denominator equals zero.

a. $\left(-\frac{4n^2q^5r^2}{9n^3q^2r}\right)^0$ $= 1$

$\frac{x^5y^0}{x^3} = \frac{xxxxx \cdot 1}{xxx} = x^2$

b. $\frac{x^5y^0}{x^3}$

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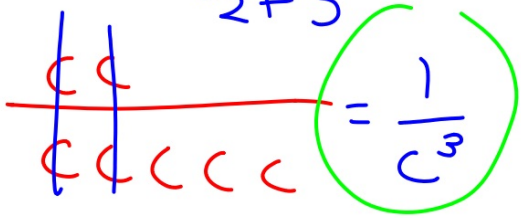
3A. $\dfrac{b^4c^2d^0}{b^2c}$

$\dfrac{bbbbcc \cdot 1}{bbc} \quad \Big| \; b^2c$

b^2c

3B. $\left(\dfrac{2f^4g^7h^3}{15f^3g^9h^6}\right)^0 = 1$

Method 1

$\frac{c^2}{c^5} =$ 

$= \frac{1}{c^3}$

Method 2

$\frac{c^2}{c^5} = c^{-3}$

An expression can only have one answer...

$2^3 = 2 \cdot 2 \cdot 2 = 8$

2^{-3} $\frac{1}{2^3} = \frac{1}{8}$

What do you think - might stand for (in this context)?

KeyConcept Negative Exponent Property

Words For any nonzero number a and any integer n, a^{-n} is the reciprocal of a^n. Also, the reciprocal of a^{-n} is a^n.

Symbols For any nonzero number a and any integer n, $a^{-n} = \frac{1}{a^n}$.

Examples $2^{-4} = \frac{1}{2^4} = \frac{1}{16}$ $\frac{1}{j^{-4}} = j^4$

negative exponent = code for reciprocal

Example 4 Negative Exponents

Simplify each expression. Assume that no denominator equals zero.

a. $\dfrac{n^{-5}p^4}{r^{-2}}$

$\dfrac{p^4 r^{-2} t^{-1} x}{n^5 \, t^1 t^1} = \dfrac{1x}{t^2}$

$\dfrac{x}{t^2}$

final answer: exponents positive, no zero exponents

b. $\dfrac{5r^{-3}t^{4}}{-20r^{2}t^{7}u^{-5}}$

$\dfrac{5t^{4}u^{5}}{-20r^{3}r^{2}t^{7}}$

$= \dfrac{\$\,ttttuuuuu}{-20\,rrrrrttttttt}$

$= \dfrac{1\,u^{5}}{-4r^{5}t^{3}}$

final answer: exponents positive
no zero exponents

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final answer: exponents positive
no zero exponents

Simplify each expression. Assume that no denominator equals zero.

4A. $\frac{x^3wx^2y^6}{wy^6}$

4B. $\frac{32a^{-8}b^3c^{-4}}{4a^3b^5c^{-2}}$

4C. $\frac{5j^{-3}k^2m^{-6}}{25k^{-4}m^{-2}}$

$\frac{4 \cdot x \cdot x \cdot y \cdot y \cdot y \cdot y \cdot y \cdot y}{4 \cdot v \cdot v \cdot v}$

$\frac{x^2 y^6}{v^3}$

7.2 19-55.