Algebra 1 7.2

- Use the properties of exponents to divide monomials
- Simplify expressions containing negative exponents
- Simplify expressions containing zero exponents
- Compare measurements using order of magnitude

exponent
base
quotient
factors
negative exponent
order of magnitude
Triangle puzzle

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

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

$X = x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x$

$(-3x^4)(-x^3)$

$(-3x^4)(-1x^3)$

$3x^7$

$\frac{3}{3}$ = Old school or shortcut? $\frac{c \cdot c \cdot c \cdot c \cdot c \cdot c \cdot c \cdot c \cdot c}{c \cdot c \cdot c \cdot c \cdot c \cdot c \cdot c \cdot c} = 1 \cdot c^3$

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 $\qquad \frac{r^5}{r^2} = r^{5-2} = r^3$

$\frac{r \cdot r \cdot r \cdot r \cdot r}{r \cdot r} = 1r^3$

Example 1 Quotient of Powers

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

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

why?

Simplify each expression. Assume that no denominator equals zero.

1A. $\frac{x^3y^4}{x^2y}$ $1 \cdot xy^3$

xy^3

1B. $\frac{k^7m^{10}p}{k^5m^3p}$ $1 \cdot k^2m^7$

$(x^3)^2 = (x\,x\,x)(x\,x\,x)$ "Power rule"

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	$\left(\frac{3}{5}\right)^4 = \frac{3^4}{5^4}$ $\left(\frac{r}{t}\right)^5 = \frac{r^5}{t^5}$ $\left(\frac{r}{t}\right)\left(\frac{r}{t}\right)\left(\frac{r}{t}\right)\left(\frac{r}{t}\right)\left(\frac{r}{t}\right) \frac{r^5}{t^5}$

$\left(\frac{3}{5}\right)^4 = \left(\frac{3}{5}\right)\left(\frac{3}{5}\right)\left(\frac{3}{5}\right)\left(\frac{3}{5}\right) = \frac{81}{625} =$

StudyTip

Power Rules with Variables

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

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

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

numerator/denominator

Example 2 Power of a Quotient

Simplify $\left(\frac{3p^3}{7}\right)^2$. $= \left(\frac{3ppp}{7}\right)\left(\frac{3ppp}{7}\right) = \frac{9p^6}{49}$

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.** $\left(\frac{4x^3}{5y^4}\right)^3$

$= \frac{27x^{12}}{64}$ $\frac{25x^{10}y^2}{36}$

$(\quad)^0 = 1$

Patterns:

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

$\frac{36}{36} = 1 = \frac{6 \cdot 6}{6 \cdot 6} = 1$

$\frac{X^3}{X^3} = \frac{xxx}{xxx} = 1$

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?

$(\quad)^0 = 1$

replace zero powers with something =
what would that be?

Example 3 Zero Exponent

Simplify each expression. Assume that no denominator equals zero.

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

b. $\frac{x^5y^0}{x^3}$ $= x^2$

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

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

$\dfrac{b\,b\,b\,b\,c\,c\,d^0}{b\,b\,c}$

b^2c

Method 1

$\frac{c^2}{c^5} = \frac{cc}{ccccc} = \frac{1}{c^3}$

Method 2

$\frac{c^2}{c^5} = c^{2-5} = c^{-3} = \frac{1}{c^3}$

neg expon → recip.

An expression can only have one answer...

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

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

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

negative exponent = code for reciprocal

Example 4 Negative Exponents

Simplify each expression. Assume that no denominator equals zero.

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

final answer: exponents positive, no zero exponents

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

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

final answer: exponents positive
no zero exponents

$\dfrac{5\,t\,t\,t\,t\,u\,u\,u\,u\,u}{-20\,r\,r\,t\,t\,t\,t\,t\,t\,t\,r\,r\,r}$

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

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final answer: exponents positive
no zero exponents

Simplify each expression. Assume that no denominator equals zero.

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

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

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

$\frac{w\,x\times y\,y\,y\,y\,y\,y}{w\,v\,v\,v}$

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

$8\,\frac{b\,b\,b\,a\,a}{a\,a\,a\,b\,b\,b\,b\,b\,a\,a\,a\,a\,a\,a\,a\,a\,a\,a\,c\,c}$

$8\cdot\frac{1}{a^{11}b^2c^2}=\frac{8}{a^{11}b^2c^2}$

p. 403
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