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NOTES: Section 5.1 – Use Properties of Exponents

Goals: #1 - I can simplify an expression using the properties of exponents and explain my reasoning using these properties.

#2 - I use the properties of exponents to write an expression for a figure's area or volume in terms of x.

Homework: Lesson 5.1 Worksheet

Exploration #1: Work with a partner and answer the following questions.

1. What happens when you multiply two powers with the same base? Write the product using exponents.

   a. $(2^2)(2^3) = 2^5$
   $2 \cdot 2 \cdot 2 \cdot 2 \cdot 2$

   b. $(x^2)(x^6) = x^8$
   $x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x \cdot x$

   c. Write a general rule for finding the product of two powers with the same base.

$$a^m \cdot a^n = a^{\boxed{m+n}}$$

2. What happens when you divide two powers with the same base? Write the quotient using exponents.

   a. $\frac{2^5}{2^2} = 2^3$
   $\frac{2 \cdot 2 \cdot 2 \cdot 2 \cdot 2}{2 \cdot 2}$

   b. $\frac{x^6}{x^3} = x^3$
   $\frac{x \cdot x \cdot x \cdot x \cdot x \cdot x}{x \cdot x \cdot x}$

   c. Write a general rule for finding the quotient of two powers with the same base.

$$\frac{a^m}{a^n} = a^{\boxed{m-n}}$$

3. What happens when you find a power of a power? Write the expression using exponents.

   a. $(2^2)^4 = 2^8$
   $(2 \cdot 2)^4$
   $(2 \cdot 2)(2 \cdot 2)(2 \cdot 2)(2 \cdot 2)$

   b. $(x^3)^3 = x^9$
   $(x \cdot x \cdot x)^3$
   $(x \cdot x \cdot x)(x \cdot x \cdot x)(x \cdot x \cdot x)$

   c. Write a general rule for finding a power of a power.

$$(a^m)^n = a^{\boxed{m \cdot n}}$$

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4. What happens when you find a power of a product? Write the expression using exponents.

a. $(5 \cdot 4)^3 = 5^3 \cdot 4^3$

$(5 \cdot 4)(5 \cdot 4)(5 \cdot 4)$

b. $(3x)^2 = 3^2 x^2$

$(3x)(3x)$

c. Write a general rule for finding a power of a product.

$$(a \cdot b)^m = a^{\boxed{m}} \, b^{\boxed{m}}$$

5. What happens when you find a power of a quotient? Write the expression using exponents.

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

$\frac{2 \cdot 2}{3 \cdot 3}$

b. $\left(\frac{x}{2}\right)^2 = \frac{x^2}{4}$

$\frac{x \cdot x}{2 \cdot 2}$

c. Write a general rule for finding the quotient of two powers with the same base.

$$\left(\frac{a}{b}\right)^m = \frac{a^{\boxed{m}}}{b^{\boxed{m}}}$$

6. Evaluate the following exponents:

a. $10^1 = 10$ b. $10^2 = 100$ c. $10^3 = 1000$ d. $10^0 = 1$

Use your calculator to evaluate the following exponents and write your answer as FRACTIONS:

a. $10^{-1} = \frac{1}{10}$ b. $10^{-2} = \frac{1}{100}$ c. $10^{-3} = \frac{1}{1000}$

d. Write a general rule for finding negative powers.

$$a^{-m} = \frac{1}{a^{\boxed{m}}}$$

e. Write a general rule for finding powers of 0.

$$a^0 = \boxed{1}$$

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Properties of Exponents:

Property:	Algebraic Expression:	Example:
Product of Powers Property	$a^m \cdot a^n = a^{m+n}$	$3^2 \cdot 3^3 = 3^{2+3} = 3^5 = 243$
Power of a Power Property	$(a^m)^n = a^{m \cdot n}$	$(3^2)^3 = 3^{2 \cdot 3} = 3^6 = 729$
Power of a Product Property	$(a \cdot b)^m = a^m b^m$ *NOTE: $(a+b)^m \neq a^m + b^m$	$(3 \cdot 2)^3 = 3^3 \cdot 2^3$
Negative Exponent Property	$a^{-n} = \frac{1}{a^n}$	$3^{-3} = \frac{1}{3^3} = \frac{1}{27}$ $\frac{1}{3^{-2}} = 3^2 = 9$
Zero Exponent Property	$a^0 = 1$	$3^0 = 1$
Quotient of Powers Property	$\frac{a^m}{a^n} = a^{m-n}$	$\frac{3^3}{3^2} = 3^{3-2} = 3$
Power of a Quotient Property	$\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}$	$\left(\frac{3}{2}\right)^3 = \frac{3^3}{2^3} = \frac{27}{8}$

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Example #1: Evaluate the expression. Write your answer using exponents and as a simplified fraction. NO DECIMALS.

1. 3^{-4}

$\frac{1}{3^4}$

$\frac{1}{81}$

2. $(2^8)^2$

2^{16}

65536

3. $\left(\frac{1}{2}\right)^{-3}$

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

You practice: Evaluate the expression. Write your answer using exponents and as a simplified fraction. NO DECIMALS.

1. $(3^{-2})^3$

3^{-6}

$\frac{1}{3^6}$ $\frac{1}{729}$

2. $\frac{8^{-4}}{8^{-6}}$

8^2

64

3. $(-2)^3 \cdot (-2)^6$

$(-2)^9$

-512

4. $[(-4)^3]^2$

$(-4)^6$

4096

5. $\frac{5}{2^{-3}}$

$5 \cdot 2^3$

40

6. -100^0

-1

Example #2: Simplify the expression. Evaluate all integers to powers. NO DECIMALS.

1. $(2d^5e^{-2})^{-3}$

$2^{-3}d^{-15}e^6$

$\frac{e^6}{2^3d^{15}}$

$\frac{e^6}{8d^{15}}$

2. $\frac{(2e)^{-4}g^5}{e^5g^{-3}}$

$\frac{2^{-4}e^{-4}g^5}{e^5g^{-3}}$

$\frac{e^{-9}g^8}{2^4}$

$\frac{g^8}{16e^9}$

3. $\frac{x^{-4}y^3}{3y^{-2}} \cdot \frac{y^3}{x^4}$

$\frac{x^{-4}y^6}{3y^{-2}x^4}$

$\frac{x^{-8}y^8}{3}$

$\frac{y^8}{3x^8}$

You practice: Simplify the expression. Evaluate all integers to powers. NO DECIMALS.

1. $\left(\frac{s^3}{t^{-4}}\right)^{-2}$

$\frac{s^{-6}}{t^8}$

$\frac{1}{s^6t^8}$

2. $(7y^2z^5)(y^{-4}z^{-1})$

$7y^{-2}z^4$

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

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

$\frac{x^{-6}y^6}{x^5y^6}$

x^{-11}

$\frac{1}{x^{11}}$

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4. $\left(\frac{a^2b^{-1}}{2a^3b^2}\right)^3$

$\frac{a^6 b^{-3}}{2^3 a^9 b^6}$

$\frac{a^{-3} b^{-9}}{8}$

$\boxed{\frac{1}{8a^3b^9}}$

5. $\left(\frac{6x}{y^2}\right)^{-2} \cdot 12x^4y^{-10}$

$\frac{6^{-2}x^{-2}}{y^{-4}} \cdot 12x^4y^{-10}$

$\frac{12x^2y^{-10}}{6^2y^{-4}}$

$\frac{12x^2y^{-6}}{36}$

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

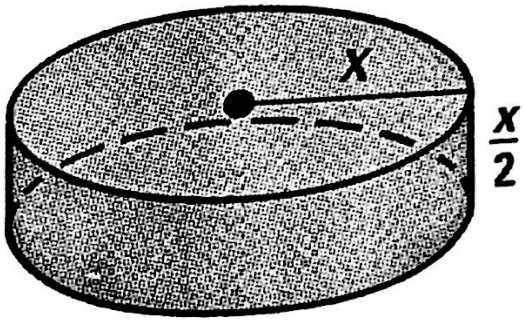
6. $\frac{2x^{-8}y^5z^{-7}}{4x^{-2}y^5z^{-8}}$

$\frac{x^{-6}z}{2}$

$\boxed{\frac{z}{2x^6}}$

Example #3: Write an expression for the figure's area of volume in terms of x.

1. $V = \pi r^2 h$



$V = \pi (x)^2 \left(\frac{x}{2}\right)$

$V = \pi x^2 \cdot \frac{x}{2}$

$\boxed{V = \frac{\pi x^3}{2}}$