ALGEBRA 1 - CHAPTER 7 NOTES
RULES OF EXPONENTS

PROPERTY	RULE	EXAMPLE
Zero Exponent		
Negative Exponent		
Product Rule		
Power to a Power		
Product to a Power		
Quotient Rule		
Quotient to a Power		

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ALGEBRA 1
7.1 Zero and Negative Exponents

Objectives:	To simplify expressions with zero and negative exponents

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Warm Up **Simplify each expression without using a calculator!**

1. 2^3

2. $(-2)^3$

3. -2^3

4. $\dfrac{1}{4^2}$

5. $4^2 \div 2^2$

6. $6^2 \div 12$

Evaluate each expression for a = 2, b = -1 and c = $\frac{1}{2}$

7. $\dfrac{a}{2b}$

8. $\dfrac{ab}{c}$

9. $\dfrac{ac}{b}$

Example 1: Fill in the chart with the value of the power in standard form.

x	2^x	5^x
4		
3		
2		
1		
0		
-1		
-2		

b) What pattern do you see as you go down each column?
The patterns that you found illustrate the definitions of zero and negative exponents.

PROPERTY	EXAMPLE 1	EXAMPLE 2	EXAMPLE 3
Zero Exponent	8^0	$(-5)^0$	$(1.043)^0$
Negative Exponent	7^{-2}	$(-2)^{-3}$	$(4)^{-1}$

RULES:

Zero Exponent Rule:_____

Negative Exponent Rule:_____

PRACTICE: Simplify each expression **<u>without</u>** negative exponents.

a) 9^{-2} b) $(-3.6)^0$ c) 3^{-3} d) -7^0 e) $(-4)^{-2}$

<u>Example 2</u>: Simplify each expression **<u>without</u>** negative exponents.

a) $4x^{-3}y$ b) $\dfrac{1}{w^{-4}}$ c) $-7s^{-4}t^2$ d) $\dfrac{n^{-5}}{v^2}$ e) s^0r^{-3}

<u>Example 3</u>: Simplify each expression **<u>without</u>** negative exponents.

a) $5a^3b^{-2}$ b) $\dfrac{y^0}{x^{-5}}$ c) $4^{-2}bc^{-3}$ d) $\dfrac{6}{2a^{-3}}$ e) $\dfrac{2n^{-5}}{3^{-1}m^2}$

Evaluating an Exponential Expression:
Always simplify the expression before substituting values in for the variables

Example 4:

Evaluate $3m^2t^{-2}$ for m = 2 and t = -3

Example 5:

Evaluate $\dfrac{n^{-1}}{w^2}$ for n = -2 and w = 5

PRACTICE: Evaluate each expression for n = -2 and w = 5

a) $n^{-3}w^0$

b) $\dfrac{n^{-3}}{w^2}$

c) $\dfrac{-w^0}{n^4}$

d) $\dfrac{-2}{nw^{-2}}$

Using an Exponential Expression:

Example 6: A population of marine bacteria doubles every hour under controlled laboratory conditions. The number of bacteria is modeled by the expression $1000 \cdot 2^h$, where h is the number of hours after a scientist measures the population size. Evaluate the expression for h=0 and h= -3. What does each value of the expression represent in the situation?

Example 7: A population of insects triples every week. The number of insects is modeled by the expression $5400 \cdot 3^w$, where w is the number of weeks after the population was measured. Evaluate the expression for w= -2, w= 0, and w = 1. What does the value of the expression mean in the situation?

ALGEBRA I NOTES
7.2 & 7.3 Multiplication Properties of Exponents

Objectives:	To multiply powers with the same base.
	To raise a power to a power.

Warm-Up:

Negative Exponent Rule:_____

Zero Exponent Rule:_____

Simpify _WITHOUT_ negative exponents.

1. $\dfrac{1}{x^{-2}y^5}$ 2. -9^0 3. $5m^{-3}n^{-1}$ 4. $\dfrac{a^{-4}}{b^2c^0}$

1. Expand x^7 (Write out what it means)

Expand and simplify.

2. $m^4 \cdot m^3$ 3. $(p^4)^3$

4. $(2x^3y^2)^2$

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RULES OF EXPONENTS

Multiplying Powers with the Same Base
    For every nonzero number a and integers m and n _____

Raising a Power to a Power
    For every nonzero number a and integers m and n _____

Raising a Product to a Power
    For every nonzero number a and b and integer n _____

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Multiplying Powers in Algebraic Expressions:
When variable factors have more than one base, combine powers with the same base.

Example 1: Simplify $4x^5 \cdot 9x^{-12}$ **Example 2:** Simplify $2a \cdot 9b^4 \cdot 3a^2$

Example 3: Simplify each expression *without* negative exponents.

a. $m^4 \cdot 2m^{-3}$ b. $-4c^3 \cdot 7d^2 \cdot 2c^{-2}$

c. $(2x^3y^{-3})(2x^{-1}y^3)$ d. $(4a^3b^2)(3a^{-4}b^{-5})$

Example 4: Simplify each expression **_without_** negative exponents.

a. $5x^4 \cdot x^9 \cdot 3x$

b. $(5m^5)(2mn^4)(8m^3)$

c. $j^2 \cdot 3k^{-2} \cdot -12j$

d. $(-7a^{-5}b)(-4a^8b^{-2})$

Example 5: Simplify each expression **_without_** negative exponents.

a. $(n^4)^7$

b. $(x^{-2})^3$

c. $(4xy^2)^3$

d. $(-5m^3n^{-4})^2$

Example 6: Simplify each expression *without* negative exponents.

a. $(3b^4)^{-2}$

b. $(5x^2y)^{-3}$

c. $(3m^{-2}n)^{-2}$

d. $(2a^{-3}b)^{-4}$

Example 7: Simplify each expression *without* negative exponents.

a. $(x^{-2})^2(3xy^2)^4$

b. $(2x^{-6})^4 \cdot 2^{-3}x^{14}$

c. $(2k^5)^3(2k^{-4})$

d. $(-4a^3b)^2(2a^{-2}b^{-3})$

Example 8: Determine the value of the missing exponent.

a. $9^5 \cdot 9^{\blacksquare} = 9^{-2}$

b. $(3x^2y^{\blacksquare})^3 = 27x^6y^{12}$

Algebra I
7.4 Division Properties of Exponents

Objectives:	To divide powers with the same base; to raise a quotient to a power

Warm-Up:

1. Complete the exponential rule for each:

Zero Exponent: $a^0 =$	Negative Exponent: $a^{-1} =$
Product Rule: $a^m \cdot a^n =$	Power to a Power: $(a^m)^n =$

Product to a Power: $(ab)^n =$	2 new rules today:
	    Quotient Rule
	    Quotient to a Power Rule

Simplify without negative exponents.

2. $-3m^4 \cdot 2m^3 \cdot m^0$

3. $(-3p\,q^3)(4\,p^{-2}q^5)$

4. $(-2a^3b^{-2})^2$

5. $(3x^{-1}y^2)^{-3}$

SCIENTIFIC NOTATION

$$a \times 10^{b} \leftarrow \text{integer}$$

$1 \leq |a| < 10$

A number greater
than or equal to 1
but less than 10.

A base of 10.

MathBits.com

Example 1 Complete the table.

Standard Notation	Scientific Notation
32,000	
0.0000157	
	1.25×10^4
	5.7×10^{-3}

Example 2 Simplify each expression in scientific notation.

a. $(8 \times 10^{-5})(2 \times 10^8)$

b. $(0.2 \times 10^{-7})(0.6 \times 10^{-1})$

c. $\dfrac{(8.5 \times 10^3)}{(5 \times 10^5)}$

d. $\dfrac{(4.8 \times 10^{-1})}{(8 \times 10^{-6})}$

Rules of Exponents Involving Division

Dividing Powers with the Same Base
    For every nonzero number a and integers m and n _____

Raising a Quotient to a Power Property
    For every nonzero number a and b and integer n _____

Example 3 Simplify without negative exponents.

a. $\dfrac{2^6}{2^4}$

b. $\dfrac{n^5 m^3}{n^4 m^6}$

c. $\dfrac{16\, x^{-4} y^3}{4\, x^{-7}\, y^5}$

Example 4 Simplify each expression.

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

b. $\left(\dfrac{x^4}{x}\right)^3$

c. $\left(\dfrac{4}{5}\right)^{-2}$

d. $(2\, x\,\ 10^{-4})^3$

Example 5 Simplify without negative exponents.

a. $\dfrac{-12\,k^6 j^2}{6\,k\,j^5}$

b. $\dfrac{18\,x^5\,y^{-1}\,z^{-8}}{9\,x^4\,y^{-5}\,z^{-3}}$

c. $\left(\dfrac{8\,x^6\,y^2}{2\,x^4\,y^4}\right)^{-3}$

d. $\left(\dfrac{-5xy^2}{5x^2y^{-3}}\right)^{-2}$

e. $\dfrac{(2x^2)}{(3y^4)} \cdot \dfrac{(3x)}{(-5y^3)}$

f. $\dfrac{(4ab)}{(-2a)} \cdot \dfrac{(9a^2)}{(6b^3)}$