Unit 1:
Exponents!

b^n

Exponent

The value that specifies how many times the base will be multiplied by itself

Base

The number or variable that is being multiplied repeatedly in the expanded form

Name: _____

Teacher: Ms. Moser Period: ____


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Introduction to Exponents

Aim: *How can I use exponents to represent repeated multiplication?*

- **Factors** are the numbers that you are _____.

$6 \cdot 3 = 18$ (factors)

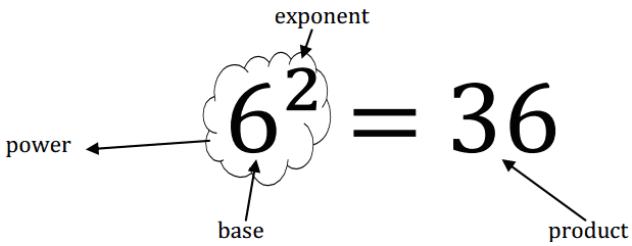
$2 \cdot 3 \cdot 4 = 24$ (factors)

- When **factors** are the _____, you can simplify it by using an _____.

$6 \cdot 6 = 36$ → $6^2 = 36$

$2 \cdot 2 \cdot 2 \cdot 2 = 16$ → $2^4 = 16$

- Numbers written with **exponents** are called _____.



Powers	***In words...***

Exponential Form			
Expanded Form			
Standard Form			

1. Write in exponential form: a) $\underbrace{4 \times \cdots \times 4}_{7\ times} =$ b) $\underbrace{\frac{7}{2} \times \cdots \times \frac{7}{2}}_{21\ times} =$ c) $\underbrace{x \cdot x \cdots x}_{\text{n } times} =$

2. Tim wrote 16 as $(-2)^4$. Is he correct? *Justify* your answer.

HW # _____ *Date:_____*

Aim: How can I use exponents to represent repeated multiplication?

Write each expression using exponents.

1. $4 \cdot 4 \cdot 4 \cdot 4 =$	**2.** $\frac{3}{4} \cdot \frac{3}{4} \cdot \frac{3}{4} \cdot \frac{3}{4} \cdot \frac{3}{4} \cdot \frac{3}{4} =$	**3.** $b \cdot b \cdot b \cdot b \cdot c \cdot c \cdot c \cdot c \cdot c \cdot c =$
4. Evaluate 7^3.	**5.** Evaluate $(-2)^4$.	**6.** Evaluate $2 \cdot 3^2 \cdot 4^2$.

Lesson 1-2 Multiplying Exponents Date _____

Multiplying and Dividing Exponents

Aim: *What conclusions can be drawn when multiplying or dividing exponents with like bases?*

Warm Up: What is another way you can abbreviate each expression?

(a) $3 + 3 + 3 + 3 + 3$ (b) $3 \cdot 3 \cdot 3 \cdot 3 \cdot 3$

Exercise 1- For the following expressions, name the constant, coefficient, base, variable, & exponent:

Expression	Constant	Coefficient	Base	Variable	Exponent
$6x^2 - 5$					
4^2					
$10x^3 + 1$					
y^2					

Multiplying Exponents Discovery

Exercise 2- For the following expressions, simplify by expanding & re-write in exponential form

Expression	Expanded Form	Exponential Form
$\mathbf{3^2 \cdot 3^4}$	$(3 \cdot 3) \cdot (3 \cdot 3 \cdot 3 \cdot 3)$	3^6
$\boldsymbol{x^5 \cdot x^3}$	$(x \cdot x \cdot x \cdot x \cdot x) \cdot (x \cdot x \cdot x)$	
$\mathbf{5^6 \cdot 5^4}$		

RULE: When multiplying terms with like _____, you **keep** the base and _____ the exponents.

Problem Set: Simplify the following expressions completely.

(1) $x^4 \cdot x^3$	(2) $k^5 \cdot k$	(3) $(\frac{1}{7})^6 \cdot (\frac{1}{7})^2$
(4) $4y^3 \cdot 8y^2$	(5) $4^2 \cdot 4^{10} \cdot 4^{-3}$	(6) $x^3(x^{13} + y^2)$

Lesson 1-3 Dividing Exponents

Dividing Exponents Discovery

Exercise 2- For the following expressions, simplify by expanding then re-write in exponential form

Expression	Expanded Form	Exponential Form
$\frac{5^6}{5^2}$	$\frac{5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 \cdot 5}{5 \cdot 5}$	5^4
$\frac{x^5}{x^2}$	$\frac{x \cdot x \cdot x \cdot x \cdot x}{x \cdot x}$	
$\frac{x^7y^{10}}{x^4y^6}$		

RULE: When dividing terms with like _____, you **keep** the base and _____ the exponents.

Problem Set: Simplify the following expressions completely.

(7) $\frac{6^8}{6}$	(8) $\frac{5^{10}}{5^2}$	(9) $\frac{3x^9}{3x^6}$
(10) $\frac{x^5y^4}{x^2y}$	(11) $\frac{a^6b}{a^4b}$	(12) $\frac{6m^5n^4}{2m^2n^4}$

Putting it all together: Simplify the following expressions completely.

(13) $2^7 \cdot 2 \cdot 2^{-3}$	(14) $\frac{a^4bc^6}{a^4bc^5}$	(15) $y^4(x^8 + y^3)$
(16) $2r^4n^3 \cdot 3rn^2$	(17) $\frac{8a^9b^5}{12a^3b^4}$	(18) $\frac{8^{16} \cdot 8^5}{8^{12}}$

(19) Jack and Jill simplify the following expression $\frac{m^3}{m^7}$, below are their responses:

Jack: m^4 ***Jill:*** m^{-4}

Determine which student got the correct answer & *explain* the mistake made by the other student.

_____

_____

HW # _____ *Date:_____*

Aim: What conclusions can be drawn when multiplying or dividing exponents with like bases?

Simplify each exponential expression using the laws of exponents. Show all work.

1. $f^{10} \cdot f^{13} =$	**2.** $5x^{94} \times 5x^{78} =$	**3.** $\frac{(-5)^{16}}{(-5)^7} =$
4. $\frac{12x^5}{3x^4} =$	**5.** $(2x^2)(4x^3y^2) =$	**6.** $(-3a^2b)(6ab^4c) =$
7. $(-2x^2z)(-4y^2z)(-3xyz) =$	**8.** $\frac{21d^{18}e^5}{7d^{11}e^3} =$	**9.** $\frac{-16w^7r^2}{-4wr} =$

Zero and Negative Exponent Rules

Aim: *How can we create a rule when we have exponents that are zero and negative?*

Warm Up: Simplify the following expressions.

(a) $\frac{9y^{16}}{3y^7}$ (b) $\frac{5x^3y^6}{xy}$

Discovery to the Zero Exponent Rule

What happens when you raise a number to a zero power? Look for a pattern as you fill in the table below. Then, evaluate each expression using what you know about dividing a number by itself.

Expression	***Expanded Form***	***Exponential Form***	***Evaluate***
$\frac{\mathbf{5^6}}{\mathbf{5^6}}$			
$\frac{\boldsymbol{x^5}}{\boldsymbol{x^5}}$			
$\frac{\mathbf{(-4)^3}}{\mathbf{(-4)^3}}$			

RULE: Any number raised to the _____ power will ALWAYS be _____.

Note this works when $x \neq 0$

Exercise 1- Evaluate the following

(1) $(-9821)^0$ (2) $(4x)^0$ (3) $4x^0$

Discovery to the Negative Exponent Rule

What happens when you raise a number to a negative power? Look for a pattern in the table below.

Expression	***Expanded Form***	***Exponential Form***	***As a Fraction***
$\frac{\mathbf{2^2}}{\mathbf{2^5}}$	$\frac{\cancel{2}\cdot\cancel{2}}{\cancel{2}\cdot\cancel{2}\cdot 2\cdot 2\cdot 2}$		
$\frac{\mathbf{4^4}}{\mathbf{4^{10}}}$			
$\frac{\mathbf{(-9)^2}}{\mathbf{(-9)^7}}$			
$\frac{\boldsymbol{a^6b^5}}{\boldsymbol{a^9b^{12}}}$			

RULE:

Exercise 2- Write each expression using a positive exponent

(4) 8^{-5} (5) 3^{-9} (6) z^{-2} (7) p^{-4}

Problem Set: Putting it all together.

Simplify each expression and re-write with a *positive* exponent. Show ALL work!

(8) $7a^0b^3$	(9) $\frac{6^8}{6^9}$	(10) $8x^{-2}$
(11) $10x^{-4}y^5$	(12) $\frac{8x^9}{2x}$	(13) $(\frac{3}{4})^{-1}$
(14) $(4x^{-2}y^5z^{-3})(5x^3y^{-5}z^{-2})$	(15) $2^2(2^4 + 2^{-8})$	(16) $-x^3y^{-6}$

Determine the missing (?) value in each:

(17) $\frac{x^6}{x^?} = x^4$ (18) $\frac{2^8}{2^?} = 2^9$

Lesson Summary:

- Anything raised to the zero power is always _____.
- When you have negative exponents, in order to make them positive you:

HW # _____ *Date:_____*

Aim: How can we create a rule for exponents that are zero and negative?

Simplify each expression. Write solution without zero or negative exponents.

1. -3^0	**2.** $8k^0$	**3.** $(-5)^{-2}$
4. 2^{-4}	**5.** $5x^{-4}$	**6.** $\frac{x^5}{y^{-3}}$
7. $\frac{a^{-4}}{b^{-3}}$	**8.** $2x^{-1}y^{-4}$	**9.** $\frac{x^2}{2y^{-3}}$

10. Which of the following is correct? *Explain* why the other choice is incorrect.

a. $2x^{-3} = \frac{1}{2x^3}$ b. $2x^{-3} = \frac{2}{x^3}$

Power to a Power Exponents Rules

Aim: *What conclusions can be made when you raise a power to another power?*

Warm Up: Simplify the following. Express with positive exponents.

$$\frac{6x^4y^2z^7}{8x^5y^2z^{-1}}$$

Discovering the Laws of Exponents: Power to a Power Rule

What happens when you raise a power to a power? Look for a pattern as you fill in the table below.

Example	***Write in Expanded Form***	***Exponential Form***
$(2^3)^2$		
$(3^2)^4$		
$(5^4)^3$		
$[\,(\frac{1}{2})^2\,]^5$		

RULE: When you raise a **power to a power**, keep the _____ and _____ the exponents.

Practice: Simplify the following expressions.

(1) $(5^2)^3$	(2) $(x^5)^4$	(3) $(y^4)^{-3}$	(4) $(6^2)^2 \cdot 6^{-5}$

Discovering the Laws of Exponents: Product to a Power Rule

What happens when you raise a product to a power? Look for a pattern in the table below.

Example	***Write in Expanded Form***	***Exponential Form***
$(2 \cdot 3)^3$	$(2 \cdot 3) \cdot (2 \cdot 3) \cdot (2 \cdot 3)$ $2 \cdot 2 \cdot 2 \cdot 3 \cdot 3 \cdot 3$	$2^3 3^3$
$(4 \cdot 6)^5$		
$(6a)^4$		
$(7 \cdot 4 \cdot 11)^2$		

R U L E: When finding a **product raised to a power,**

you find the power of each factor and then _____

Problem Set: Simplify the following expressions. Use only positive exponents.

(5) $(7^3)^4$	(6) $(2^{-1})^0$	(7) $(-2^7)^2 \cdot (-2)^{-1}$	(8) $(-3y^5)^2$
(9) $(2x^3y^{-2}z^4)^3$	(10) $(6^{-2})^3$	(11) $(x^4 \cdot x^2)^2$	(12) $(2a^3b^{-2})^3$

(13) The formula for the volume of a rectangular prism is $V = LWH$. If the length is 8^4, the width is 8^{-2}, and the height is 8^0. Express the volume, *in exponential form.*

More Practice with the Power Rule…

Simplify. Your answer should contain only positive exponents.

1) $(3a^2)^3$	2) $(2n^4)^4$	3) $(3x^4)^4$
4) $(6b^2)^2$	5) $(7y^4)^2$	6) $(3ab^4)^2$
7) $(2x^4y^4)^3$	8) $(x^2y^2)^2$	9) $(3x \cdot 2x)^2$
10) $(4n^2 \cdot n^2)^2$	11) $(2p^3 \cdot 2p)^2$	12) $(u^4v^3)^2$
13) $(h \cdot 4h^2 \cdot h^3)^2$	14) $(4g \cdot 2g^2)^3$	15) $(3k^3 \cdot 4k \cdot k^2)^2$

Lesson 1-6 Mixed Practice with Exponent Laws Date _____

PRODUCT RULE	_____ THE COEFFICIENTS, KEEP THE _____, _____ THE EXPONENTS

1) $10^{12} \bullet 10^{35} =$ 2) $a^7 \bullet a^{12} =$ 3) $x^2 \bullet z^2 =$

4) $(3x^8)(5x) =$ 5) $-5y^3(-8y^6) =$

QUOTIENT RULE	_____ THE COEFFICIENTS, KEEP THE _____, SUBTRACT THE _____.

1) $\frac{10^6}{10^2} =$ 2) $\frac{9^{210}}{9^{207}} =$ 3) $\frac{6r^3}{2r} =$

4) $\frac{-40s^6}{20s^3} =$ 5) $\frac{-16w^7r^2}{-4wr} =$ 6) $\frac{x^3y}{xy^3} =$

NEGATIVE EXPONENTS	

1) $\frac{1}{g^{-3}} =$ 2) $\frac{x^{-7}}{x^5} =$ 3) $\frac{p}{p^{-4}} =$

4) $\frac{11^{-2}}{11^8} =$ 5) $\frac{b^{-4}}{b^{-7}} =$ 6) $\frac{y^6}{y^{10}} =$

POWER TO A POWER	To raise a power to a power, keep the base and _____ the exponents.

1) $\left(x^2\right)^3 =$ 2) $\left(5^2\right)^3 =$ 3) $\left(k^9\right)^5\left(k^3\right)^2 =$

4) $\left(-y^5\right)^4 =$ 5) $\left(w^{-21}\right)^{-15} =$

PRODUCT TO A POWER	To raise a product to a power, raise each factor to the power, then _____.

1) $\left(8c^5\right)^2 =$ 2) $\left(4y^3\right)^2 =$ 3) $\left(-c^5h^6\right)^4 =$

4) $\left(y^4d^6\right)^8 =$ 5) $\left(-15h^9k^7\right)^3 =$

ZERO EXPONENT	Any number raised to the zero power is equal to ___.

1) $b^0 =$ 2) $5x^0 =$ 3) $\frac{y^4}{y^4} =$

Exponents and Their Properties - Multiplying and Dividing Monomials
Algebra 1 Homework

Skill

Express the product with exponents.

1. $a \cdot a \cdot a \cdot b \cdot b =$

2. $(2x)(2x)(2x) =$

3. $(2x)(2x)\,y \cdot y =$

Express the product in simplest form.

4. $b^3 \cdot b =$

5. $y^4 \cdot y^9 =$

6. $x^2 \cdot x^3 \cdot x^4 =$

7. $n^4 \cdot n =$

8. $y \cdot y =$

9. $a^4 \cdot a^2 =$

10. $x^3 \cdot x^7 =$

11. $z^4 \cdot z^4 =$

Express the quotient in simplest form.

13. $\dfrac{x^5}{x^4} =$

14. $\dfrac{a^{10}}{a^4} =$

15. $\dfrac{x^5}{x^8} =$

16. $\dfrac{y^6}{y^{12}} =$

17. $\dfrac{x^{13}y^5}{x^2y^9} =$

18. $\dfrac{8x^5y^3}{4x^8y^{10}} =$

19. $\dfrac{y^4}{y^4} =$

Reasoning

Simplify.

20. $\dfrac{x^c}{x^d} =$ $\quad c > d$

21. $z(2z)^3(2z) =$

22. $x^{4a} \cdot x^{2a} =$

23. $\dfrac{x^3 \cdot x^6 \cdot x^4}{x^5 \cdot x^2} =$

24. $\dfrac{y^{2a} \cdot y^{3a}}{y^a} =$

25. $\dfrac{x^3 \cdot x^4}{(x^2)^2} =$

26. $x^4 \cdot y^5 =$

Determine True or False for each.
State the reason for your answer.

27. $\dfrac{x^4}{x^2} = 1^2$

28. $\dfrac{4^5}{2^3} = 2^2$

HW # _____ *Date:_____*

Laws of Exponents Mixed Practice

Simplify each expression. Express your answer using positive exponents. Show all work.

1. $xy^{-3} \cdot x^{-6}y^4$	**2.** $3x^3y \cdot 8x^5y^4$	**3.** $\frac{ab^{-5}}{ab^8}$
4. $\frac{a^5b^{10}}{a^8y^3}$	**5.** $5m^6 \cdot m^5n$	**6.** $(-5x^3y^{12}z^6)(-6x^3y^5z^{-6})$

Determine if the sentence is true or false by simplifying the exponential expression. Show your work and clearly write your answer.

7. $3^2 \cdot 2^2 = 6^5$	**8.** $3^2 \cdot 2^2 = 6^6$	**9.** $6^2 \cdot 6^2 = 6^4$

Multiple Choice Practice

1. Which is equivalent to $(6^2)^0$?

a. 0
b. 1
c. 6
d. 36

2. Simplify: $5^{-8} \times 5^4$

a. $\frac{1}{5^4}$
b. $\frac{1}{5^{32}}$
c. -5^2
d. -5^{12}

3. Which exponential expression is equal to $2^{-5} \times 2^8$?

a. $\frac{2^2}{2^{-1}}$
b. $(2^3)^{-1}$
c. $\frac{2^{-2}}{2^{-1}}$
d. $(2^{-1})^3$

4. What is the correct value of the expression $\left(-\frac{1}{4}\right)^{-2}$?

a. -16
b. $-\frac{1}{16}$
c. $\frac{1}{16}$
d. 16

5. Which number goes in the numerator to make this equation true?

$$\frac{\quad}{2^{-6}} = 2^3$$

a. 2^{-2}
b. 2^{-3}
c. 2^{-9}
d. 2^{-18}

6. Which expression is equivalent to $4^7 \times 4^{-5}$?

a. 4^{12}
b. 4^2
c. 4^{-2}
d. 4^{-35}

7. Which number is equivalent to $\frac{3^4}{3^2}$?

a. 2
b. 9
c. 81
d. 729

8. Which expression is equivalent to $(5^{-2})^5 \times 5^4$?

a. 5^{12}
b. 5^7
c. $\frac{1}{5^6}$
d. $\frac{1}{5^{40}}$