[1-6A] Use Properties of Integer Exponents Name: _____

Multiplication Property of Exponents

Complete the table below and answer the questions that follow.

Product	Expanded Form	Exponential Form
$3^2 \cdot 3^3$	$(3 \cdot 3) \cdot (3 \cdot 3 \cdot 3)$	3^5
$2^3 \cdot 2^3$		
$2^5 \cdot 2^4$		
$4^7 \cdot 4^1$		
$x^4 \cdot x^2$		

Compare the original product in the first column to the exponential form you found in the third column. What pattern do you see?

Use the pattern to create a general rule for the multiplication property of exponents.

$$x^a \cdot x^b = \_\_\_\_\_$$

Test your rule on the following expressions to check that it works:

a) $4^3 \cdot 4^2$

b) $5^2 \cdot 5^4$

2

Division Property of Exponents

Complete the table below and answer the questions that follow.

Division	Expanded Form	Exponential Form
$\frac{3^5}{3^2}$	$\frac{3\cdot3\cdot3\cdot3\cdot3}{3\cdot3}=3\cdot3\cdot3$	3^3
$\frac{2^4}{2^1}$		
$\frac{5^{12}}{5^8}$		
$\frac{4^7}{4^5}$		
$\frac{x^3}{x^1}$		

Compare the original division in the first column to the exponential form you found in the third column. What patterns do you see?

Use the pattern to create a general rule for the power properties of exponents.

$$\frac{x^a}{x^b}=\_\_\_\_\_$$

Test your rule on the following expressions to check that it works:

a) $\frac{x^6}{x^3}$ b) $\frac{2^9}{2^7}$

Find each product or quotient. Express your answer using exponents.

1. $4^7\cdot4^6$ **2.** $v^5\cdot v^4$ **3.** $(f^3)(f^9)$

4. $22^5\cdot22^5$ **5.** $7h(5h^3)$ **6.** $-10x^2(7x^3)$

7. $\frac{7^5}{7^2}$ **8.** $\frac{1^8}{1^6}$ **9.** $\frac{(-12)^3}{(-12)^3}$

10. $3^8\cdot3^3$ **11.** $\frac{c^{20}}{c^{13}}$ **12.** $\frac{(-p)^{18}}{(-p)^{12}}$

13. $-7u^6(-6u^5)$ **14.** $\frac{2w^3}{2w}$ **15.** $-5m^3(4m^6)$

16. the product of two cubed and two squared

17. the quotient of six to the eighth power and six squared

Multiplying and Dividing Monomials

Find each product or quotient. Express your answer using exponents.

1. $2^3 \cdot 2^5$
2. $10^2 \cdot 10^7$
3. $1^4 \cdot 1$
4. $6^3 \cdot 6^3$
5. $(-3)^2(-3)^3$
6. $(-9)^2(-9)^2$
7. $a^2 \cdot a^3$
8. $n^8 \cdot n^3$
9. $(p^4)(p^4)$
10. $(z^6)(z^7)$
11. $(6b^3)(3b^4)$
12. $(-v)^3(-v)^7$
13. $11a^2 \cdot 3a^6$
14. $10t^2 \cdot 4t^{10}$
15. $(8c^2)(9c)$
16. $(4f^8)(5f^6)$
17. $\frac{5^{10}}{5^2}$
18. $\frac{10^6}{10^2}$
19. $\frac{7^9}{7^6}$
20. $\frac{12^8}{12^3}$
21. $\frac{100^9}{100^8}$
22. $\frac{(-2)^3}{-2}$
23. $\frac{r^8}{r^7}$
24. $\frac{z^{10}}{z^8}$
25. $\frac{q^8}{q^4}$
26. $\frac{g^{12}}{g^8}$
27. $\frac{(-y)^7}{(-y)^2}$
28. $\frac{(-z)^{12}}{(-z)^5}$

For #29-32, write the numerical or variable expression, and then simplify.

29. the product of two squared and two to the sixth power — 29. _____ = _____
30. the quotient of ten to the seventh power and ten cubed — 30. _____ = _____
31. the product of y squared and y cubed — 31. _____ = _____
32. the quotient of a to the twentieth power and a to the tenth power — 32. _____ = _____

[1-6B] Use Properties of Integer Exponents Name: _____

Power of a Power Property

Complete the table and answer the questions that follow.

Power	Expanded Form	Exponential Form
$(3^2)^3$	$3^2 \cdot 3^2 \cdot 3^2 =$ $(3 \cdot 3) \cdot (3 \cdot 3) \cdot (3 \cdot 3)$	3^6
$(2^3)^4$		
$(4^5)^2$		
$(x^7)^3$		

Compare the original power in the first column to the exponential form you found in the third column. What patterns do you see?

Use the pattern to create a general rule for the power of a power property

$$(x^a)^b = \_\_\_\_\_$$

Power of a Product Property

Complete the table and answer the questions that follow.

Power	Expanded Form	Exponential Form
$(3^2)^3$	$3^2 \cdot 3^2 \cdot 3^2 =$ $(3 \cdot 3) \cdot (3 \cdot 3) \cdot (3 \cdot 3)$	3^6
$(2^3)^4$		
$(4^5)^2$		
$(x^7)^3$		

Compare the original power in the first column to the exponential form you found in the third column. What patterns do you see?

Use the pattern to create a general rule for the power of a product property

$$(xy)^b = \_\_\_\_\_$$

PRODUCT RULE: To multiply when two bases are the same, write the base and ADD the exponents.

$$x^m \cdot x^n = x^{m+n}$$

Examples:

A. $x^3 \cdot x^8 = x^{11}$ B. $2^4 \cdot 2^2 = 2^6$ C. $(x^2y)(x^3y^4) = x^5y^5$

QUOTIENT RULE: To divide when two bases are the same, write the base and SUBTRACT the exponents.

$$\frac{x^m}{x^n} = x^{m-n}$$

Examples:

A. $\frac{x^5}{x^2} = x^3$ B. $\frac{3^5}{3^3} = 3^2$ C. $\frac{x^2y^5}{xy^3} = xy^2$

POWER RULE: To raise a power to another power, write the base and MULTIPLY the exponents.

$$(x^m)^n = x^{m \cdot n}$$

Examples:

A. $(x^3)^2 = x^6$ B. $(3^2)^4 = 3^8$ C. $(z^5)^2 = z^{10}$

EXPANDED POWER RULE:

$$(xy)^m = x^m y^n$$

Examples:

A. $(2a)^3 = 2^3a^3 = 8a^3$ B. $(6x^3)^2 = 6^2(x^3)^2 = 36x^6$

Practice writing equivalent expressions using the exponent properties.

1. $3 \cdot 4^3$
2. $4x^3 \cdot 2x^3$
3. $x^5 \cdot x^3$
4. $2x^3 \cdot 2x^2$
5. $\frac{6^5}{6^3}$
6. $\frac{x^4}{x^7}$
7. $(y^4)^3$
8. $(x^2y)^4$
9. $\frac{6x^7}{2x^4}$
10. $\frac{8x^5}{4x^2}$
11. $(2cd^4)^2(cd)^5$
12. $(2fg^4)^4(fg)^6$

1) $4 \cdot 4^4 \cdot 4^4$
2) $4 \cdot 4^4 \cdot 4^2$
3) $4 \cdot 2^2$
4) $3 \cdot 3^3 \cdot 3^2$
5) $3m \cdot 4mn$
6) $3x \cdot 4x^2$
7) $2m^4n^2 \cdot 4nm^2$
8) $x^2y^4 \cdot xy^2$
9) $(3^3)^4$
10) $(4^3)^4$
11) $(4^4)^2$
12) $(3^2)^3$
13) $(2u^3v^2)^2$
14) $(xy)^3$
15) $(2a^4)^4$
16) $(2xy)^4$
17) $\frac{4^5}{4^3}$
18) $\frac{3^7}{3^3}$
19) $\frac{3^2}{3}$
20) $\frac{3^4}{3}$

[1-7] Use Properties of Integer Exponents Name: _____

Negative Exponents

Complete the following tables. Leave all answers as integers or fractions.

2^5	32
2^4	16
2^3	
2^2	
2^1	
2^0	
2^{-1}	
2^{-2}	
2^{-3}	

3^5	243
3^4	81
3^3	
3^2	
3^1	
3^0	
3^{-1}	
3^{-2}	
3^{-3}	

10^5	100,000
10^4	10,000
10^3	
10^2	
10^1	
10^0	
10^{-1}	
10^{-2}	
10^{-3}	

Solving Negative Exponents

You already know that an exponent represents the number of times you have to multiply a number by itself. For example, 2^4 means 2*2*2*2. But what if your variable is being raised to a negative exponent? If you were given 2^{-4}, how would you multiply two by itself negative four times?

A negative exponent is equivalent to the inverse of the same number with a positive exponent. In other words:

$$x^{-7} = \frac{1}{x^7}$$

There is nothing special about solving a problem that includes negative exponentials. It's just an intermediate step that you may or may not want to complete to make things simpler. The best way to get comfortable with negative exponents is to work a few example problems that use them. Here are some samples:

Examples:

$3^{-2} = \frac{1}{3^2} = \frac{1}{9}$ $\quad -4^{-2} = -\frac{1}{4^2} = -\frac{1}{16}$ $\quad 6^0 = 1$

$4^{-3} = \frac{1}{4^3} = \frac{1}{64}$ $\quad (-5)^{-2} = \frac{1}{(-5)^2} = \frac{1}{25}$ $\quad -4^0 = -1$

Practice:

7^{-2} $\quad (-1)^2$ $\quad -2^{-4}$ $\quad -6^2$ $\quad 8^0$ $\quad 10^{-3}$

Homework: Leave all answers as fractions if applicable.

Simplify.

1. 9^2 $\quad$ 2. -3^{-2} $\quad$ 3. 4^3 $\quad$ 4. $(-2)^{-2}$

5. $(-6)^0$ $\quad$ 6. -8^2 $\quad$ 7. -1^4 $\quad$ 8. -9^0

9. $(-3)^{-2}$ $\quad$ 10. -5^{-2} $\quad$ 11. $(-4)^{-2}$ $\quad$ 12. 7^{-2}

13. -10^5 $\quad$ 14. $(-2)^3$ $\quad$ 15. 6^{-2} $\quad$ 16. $(-3)^{-4}$

More practice on just multiplying and dividing…..

Find each product or quotient. Express your answer using exponents.

1. $4^2 \cdot 4^3$
2. $9^8 \cdot 9^6$
3. $7^4 \cdot 7^2$
4. $13^2 \cdot 13^4$
5. $(-8)^5(-8)^3$
6. $(-21)^9(-21)^5$
7. $t^9 \cdot t^3$
8. $h^4 \cdot h^{13}$
9. $(m^6)(m^6)$
10. $(u^{11})(u^{10})$
11. $(-r)^7(-r)^{20}$
12. $(-w)(-w)^9$
13. $4d^5 \cdot 8d^6$
14. $7j^{50} \cdot 6j^{50}$
15. $-5b^9 \cdot 6b^2$
16. $12^1 \cdot 12^2$
17. $\frac{6^{11}}{6^3}$
18. $\frac{15^3}{15^2}$
19. $\frac{9^9}{9^7}$
20. $\frac{18^4}{18^4}$
21. $\frac{(-7)^6}{(-7)^5}$
22. $\frac{95^{21}}{95^{18}}$
23. $\frac{v^{30}}{v^{20}}$
24. $\frac{n^{19}}{n^{11}}$
25. the product of five cubed and five to the fourth power
26. the quotient of eighteen to the ninth power and eighteen squared
27. the product of z cubed and z cubed
28. the quotient of x to the fifth power and x cubed