Get out your homework for last night and have it ready to check. Start checking your answers with the key below.

Classwork - Multiplying and Dividing Monomials

Write each expression using exponents.

1. $3 \cdot 3 \cdot m$

   $3^2 \cdot m$

2. $\left(\frac{1}{4}\right)\left(\frac{1}{4}\right)\left(\frac{1}{4}\right)$

   $\left(\frac{1}{4}\right)^3$

3. $2 \cdot d \cdot 5 \cdot d \cdot d \cdot 5$

   $2 \cdot 5^2 \cdot d^3$

4. $p \cdot (-9) \cdot p \cdot (-9) \cdot p \cdot q \cdot q$

   $(-9)^2 \cdot p^3 \cdot q^2$

5. $g \cdot (-7) \cdot (-7) \cdot g \cdot h \cdot (-7) \cdot h$

   $(-7)^3 \cdot g^2 \cdot h^2$

6. $x \cdot \frac{1}{8} \cdot x \cdot x \cdot y \cdot \frac{1}{8} \cdot y \cdot x$

   $\left(\frac{1}{8}\right)^2 \cdot x^4 \cdot y^2$

Evaluate each expression.

7. $(-8)^4$

4,096

8. $\left(\frac{1}{5}\right)^3$

$\frac{1}{125}$

9. $\left(-\frac{3}{5}\right)^5$

$-\frac{243}{3,125}$ $\left(-\frac{3^5}{5^5}\right)$

10. $(-2)^3 + 5^2$

17

11. $3^4 - 5^2$

56

12. $(-2)^5 - (-2)^4$

−48

13. $4^3 \div 2^3$

8

14. $5^3 \cdot 2^3$

1,000

15. $1^7 + (-3)^4$

82

ALGEBRA Evaluate each expression.

16. $r^3 - s$, if $r = 5$ and $s = 4$ **121**

17. $m^2 - n^3$, if $m = 6$ and $n = 2$ **28**

18. $f - g^4$, if $f = 3$ and $g = -5$ **−622**

19. $(x^5 - y^2)^2 + x^3$, if $x = 2$ and $y = 8$ **1,032**

20. Replace ☐ with <, >, or = to make a true statement: 2^4 ☐ 4^2. **=**

21. **ISLANDS** Florida has about $2^2 \cdot 3^2 \cdot 5^3$ islands (over 10 acres). About how many islands is this? **about 4,500 islands**

Arachnids Spiders in North America can range in size from 1 millimeter in length to 7.6 centimeters in length. Use the table to see how other metric measurements of length are related to the millimeter.

Unit of Length	Times Longer than a Millimeter	Written Using Powers
Millimeter	1	10^0
Centimeter	$1 \times 10 = \boxed{}$	10^1
Decimeter	$10 \times 10 = \boxed{}$	$10^1 \times 10^1 = 10^2$
Meter	$100 \times 10 = 1{,}000$	$10^2 \times 10^1 = 10^{\boxed{}}$
Dekameter	$1{,}000 \times 10 = 10{,}000$	$10^3 \times 10^1 = 10^{\boxed{}}$
Hectometer	$10{,}000 \times 10 = \boxed{}$	$10^4 \times 10^1 = 10^5$
Kilometer	$100{,}000 \times 10 = \boxed{}$	$10^5 \times 10^1 = 10^{\boxed{}}$

1. Look at the entries in the last column. What do you observe about the exponents of the factors and the exponent of the product for each entry? _____

_____

2. A *megameter* is 100,000,000 × 10 or 1,000,000,000 times longer than a millimeter. Extend the pattern to write this number using powers. _____

Product of Powers

Words   To multiply powers with the same base, add their exponents.

Examples   Numbers

$2^4 \cdot 2^3 = 2^{4+3}$ or 2^7

Algebra

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

A **monomial** is a number, a variable, or a product of a number and one or more variables. You can use the Laws of Exponents to simplify monomials.

$$\overset{\text{2 factors}}{3^2} \cdot \overset{\text{4 factors}}{3^4} = \underbrace{(3 \cdot 3) \cdot (3 \cdot 3 \cdot 3 \cdot 3)}_{\text{6 factors}} \text{ or } 3^6$$

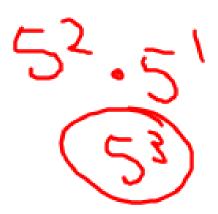Notice that the sum of the original exponents is the exponent in the final product.

Examples

Tutor

Simplify using the Laws of Exponents.

1. $5^2 \cdot 5$

$5^2 \cdot 5 = 5^2 \cdot 5^1$ $5 = 5^1$

$= 5^{2+1}$ The common base is 5.

$= 5^3$ or 125 Add the exponents. Simplify.

Check $5^2 \cdot 5 = (5 \cdot 5) \cdot 5$

$= 5 \cdot 5 \cdot 5$

$= 5^3$ ✓

2. $c^3 \cdot c^5$

$c^3 \cdot c^5 = c^{3+5}$ The common base is c.

$\qquad = c^8$ Add the exponents.

(handwritten) $c^3 \cdot c^5 \cdot d^4$

$c^8 \cdot d^4$

---

3. $-3x^2 \cdot 4x^5$ *(handwritten)* $-3 \cdot x^2 \cdot 4 \cdot x^5$

$-3x^2 \cdot 4x^5 = (-3 \cdot 4)(x^2 \cdot x^5)$ Commutative and Associative Properties

$\qquad = (-12)(x^{2+5})$ The common base is x.

(handwritten) $-12 \cdot x^7 = -12x^7$ $(-12)x^7$ Add the exponents.

Got it? Do these problems to find out.

a. $9^3 \cdot 9^2$

(handwritten) 9^5

b. $a^3 \cdot a^2$

(handwritten) 9^5

c. $-2m(-8m^5)$

(handwritten) $16m^6$

(handwritten, crossed out) $(-12x)^7$

$(-)(2)^7 \cdot (x)^7$

Quotient of Powers

Words   To divide powers with the same base, subtract their exponents.

Examples   Numbers

$\dfrac{3^7}{3^3} = 3^{7-3}$ or 3^4

Algebra

$\dfrac{a^m}{a^n} = a^{m-n}$, where $a \neq 0$

$$\dfrac{4x^3}{2x}$$

There is also a Law of Exponents for dividing powers with the same base.

$$\dfrac{5^7}{5^4} = \dfrac{\overbrace{5 \cdot 5 \cdot 5 \cdot \cancel{5} \cdot \cancel{5} \cdot \cancel{5} \cdot \cancel{5}}^{7 \text{ factors}}}{\underbrace{\cancel{5} \cdot \cancel{5} \cdot \cancel{5} \cdot \cancel{5}}_{4 \text{ factors}}} \text{ or } 5^3$$

Notice that the difference of the original exponents is the exponent in the final quotient.

Examples

Tutor

Simplify using the Laws of Exponents.

4. $\dfrac{4^8}{4^2}$

$\dfrac{4^8}{4^2} = 4^{8-2}$ The common base is 4.

$= 4^6$ or 4,096   Simplify.

5. $\dfrac{n^9}{n^4}$

$\dfrac{n^9}{n^4} = n^{9-4}$ The common base is n.

$= n^5$ Simplify.

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

$\dfrac{2^5 \cdot 3^5 \cdot 5^2}{2^2 \cdot 3^4 \cdot 5} = \left(\dfrac{2^5}{2^2}\right)\left(\dfrac{3^5}{3^4}\right)\left(\dfrac{5^2}{5}\right)$ Group by common base.

$= 2^3 \cdot 3^1 \cdot 5^1$ Subtract the exponents. $\longrightarrow 2^3 \cdot 3 \cdot 5$

$= 8 \cdot 3 \cdot 5$ $2^3 = 8$

$= 120$ Simplify.

$\dfrac{5^4}{5^7} = 5^{-3}$

Got it?   Do these problems to find out.

d. $\dfrac{5^7}{5^4} = 5^3$

e. $\dfrac{x^{10}}{x^3}$ x^7

f. $\dfrac{12w^5}{2w^?} = 6w^4$

g. $\dfrac{3^4 \cdot 5^2 \cdot 7^5}{3^2 \cdot 5 \cdot 7^3}$

h. $\dfrac{5^6 \cdot 7^4 \cdot 8^3}{5^4 \cdot 7^2 \cdot 8^2}$

i. $\dfrac{(-2)^5 \cdot 3^4 \cdot 5^7}{(-2)^2 \cdot 3 \cdot 5^4}$

$3^2 \cdot 5 \cdot 7^2$ $5^2 \cdot 7^2 \cdot 8$ $(-2)^3 \cdot 3^3 \cdot 5^3$