**8-1 Study Guide and Intervention*****Multiplying Monomials***

Multiply Monomials A **monomial** is a number, a variable, or a product of a number and one or more variables. An expression of the form x^n is called a **power** and represents the product you obtain when x is used as a factor n times. To multiply two powers that have the same base, add the exponents.

Product of PowersFor any number a and all integers m and n , $a^m \cdot a^n = a^{m+n}$.**Example 1****Simplify $(3x^6)(5x^2)$.**

$$\begin{aligned}(3x^6)(5x^2) &= (3)(5)(x^6 \cdot x^2) && \text{Associative Property} \\ &= (3 \cdot 5)(x^{6+2}) && \text{Product of Powers} \\ &= 15x^8 && \text{Simplify.}\end{aligned}$$

The product is $15x^8$.**Example 2****Simplify $(-4a^3b)(3a^2b^5)$.**

$$\begin{aligned}(-4a^3b)(3a^2b^5) &= (-4)(3)(a^3 \cdot a^2)(b \cdot b^5) \\ &= -12(a^{3+2})(b^{1+5}) \\ &= -12a^5b^6\end{aligned}$$

The product is $-12a^5b^6$.**Exercises****Simplify.**

1. $y(y^5)$

2. $n^2 \cdot n^7$

3. $(-7x^2)(x^4)$

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

5. $m \cdot m^5$

6. $(-x^3)(-x^4)$

7. $(2a^2)(8a)$

8. $(rs)(rs^3)(s^2)$

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

10. $\frac{1}{3}(2a^3b)(6b^3)$

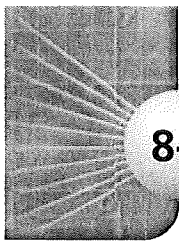
11. $(-4x^3)(-5x^7)$

12. $(-3j^2k^4)(2jk^6)$

13. $(5a^2bc^3)\left(\frac{1}{5}abc^4\right)$

14. $(-5xy)(4x^2)(y^4)$

15. $(10x^3yz^2)(-2xy^5z)$

**8-1 Study Guide and Intervention** *(continued)***Multiplying Monomials**

Powers of Monomials An expression of the form $(x^m)^n$ is called a **power of a power** and represents the product you obtain when x^m is used as a factor n times. To find the power of a power, multiply exponents.

Power of a Power	For any number a and all integers m and n , $(a^m)^n = a^{mn}$.
Power of a Product	For any number a and all integers m and n , $(ab)^m = a^m b^m$.

Example Simplify $(-2ab^2)^3(a^2)^4$.

$$\begin{aligned}
 (-2ab^2)^3(a^2)^4 &= (-2ab^2)^3(a^8) && \text{Power of a Power} \\
 &= (-2)^3(a^3)(b^2)^3(a^8) && \text{Power of a Product} \\
 &= (-2)^3(a^3)(a^8)(b^2)^3 && \text{Commutative Property} \\
 &= (-2)^3(a^{11})(b^2)^3 && \text{Product of Powers} \\
 &= -8a^{11}b^6 && \text{Power of a Power}
 \end{aligned}$$

The product is $-8a^{11}b^6$.

Exercises

Simplify.

1. $(y^5)^2$

2. $(n^7)^4$

3. $(x^2)^5(x^3)$

4. $-3(ab^4)^3$

5. $(-3ab^4)^3$

6. $(4x^2b)^3$

7. $(4a^2)^2(b^3)$

8. $(4x)^2(b^3)$

9. $(x^2y^4)^5$

10. $(2a^3b^2)(b^3)^2$

11. $(-4xy)^3(-2x^2)^3$

12. $(-3j^2k^3)^2(2j^2k)^3$

13. $(25a^2b)^3\left(\frac{1}{5}abc\right)^2$

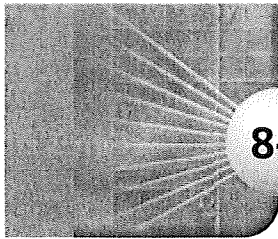
14. $(2xy)^2(-3x^2)(4y^4)$

15. $(2x^3y^2z^2)^3(x^2z)^4$

16. $(-2n^6y^5)(-6n^3y^2)(ny)^3$

17. $(-3a^3n^4)(-3a^3n)^4$

18. $-3(2x)^4(4x^5y)^2$



8-1 Skills Practice

Multiplying Monomials

Determine whether each expression is a monomial. Write *yes* or *no*. Explain.

1. 11

2. $a - b$

3. $\frac{p^2}{q^2}$

4. y

5. j^3k

6. $2a + 3b$

Simplify.

7. $a^2(a^3)(a^6)$

8. $x(x^2)(x^7)$

9. $(y^2z)(yz^2)$

10. $(\ell^2k^2)(\ell^3k)$

11. $(e^2f^4)(e^2f^2)$

12. $(cd^2)(c^3d^2)$

13. $(2x^2)(3x^5)$

14. $(5a^7)(4a^2)$

15. $(4xy^3)(3x^3y^5)$

16. $(7a^5b^2)(a^2b^3)$

17. $(-5m^3)(3m^8)$

18. $(-2c^4d)(-4cd)$

19. $(10^2)^3$

20. $(p^3)^{12}$

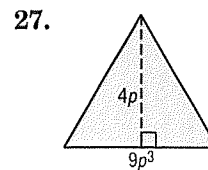
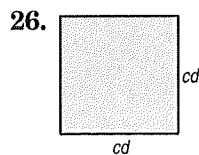
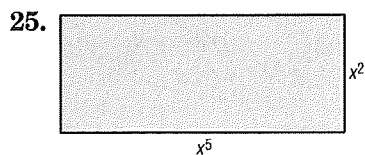
21. $(-6p)^2$

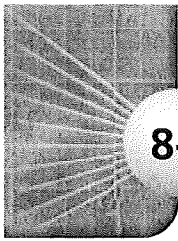
22. $(-3y)^3$

23. $(3pq^2)^2$

24. $(2b^3c^4)^2$

GEOMETRY Express the area of each figure as a monomial.



**8-1****Practice*****Multiplying Monomials***

Determine whether each expression is a monomial. Write *yes* or *no*. Explain.

1. $\frac{21a^2}{7b}$

2. $\frac{b^3c^2}{2}$

Simplify.

3. $(-5x^2y)(3x^4)$

4. $(2ab^2c^2)(4a^3b^2c^2)$

5. $(3cd^4)(-2c^2)$

6. $(4g^3h)(-2g^5)$

7. $(-15xy^4)\left(-\frac{1}{3}xy^3\right)$

8. $(-xy)^3(xz)$

9. $(-18m^2n)^2\left(-\frac{1}{6}mn^2\right)$

10. $(0.2a^2b^3)^2$

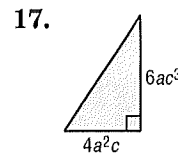
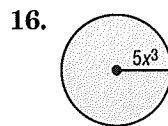
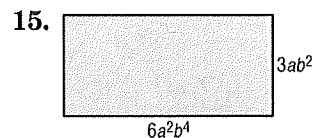
11. $\left(\frac{2}{3}p\right)^2$

12. $\left(\frac{1}{4}cd^3\right)^2$

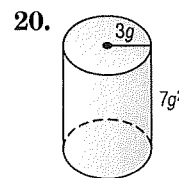
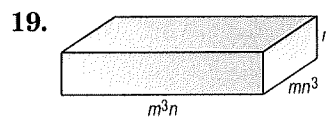
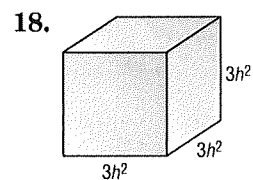
13. $(0.4k^3)^3$

14. $[(4^2)^2]^2$

GEOMETRY Express the area of each figure as a monomial.

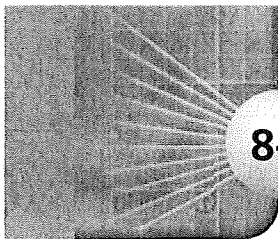


GEOMETRY Express the volume of each solid as a monomial.



21. COUNTING A panel of four light switches can be set in 2^4 ways. A panel of five light switches can set in twice this many ways. In how many ways can five light switches be set?

22. HOBBIES Tawa wants to increase her rock collection by a power of three this year and then increase it again by a power of two next year. If she has 2 rocks now, how many rocks will she have after the second year?



8-2 Study Guide and Intervention

Dividing Monomials

Quotients of Monomials To divide two powers with the same base, subtract the exponents.

Quotient of Powers	For all integers m and n and any nonzero number a , $\frac{a^m}{a^n} = a^{m-n}$.
Power of a Quotient	For any integer m and any real numbers a and b , $b \neq 0$, $\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}$.

Example 1 Simplify $\frac{a^4b^7}{ab^2}$. Assume neither a nor b is equal to zero.

$$\begin{aligned}\frac{a^4b^7}{ab^2} &= \left(\frac{a^4}{a}\right)\left(\frac{b^7}{b^2}\right) && \text{Group powers with the same base.} \\ &= (a^{4-1})(b^{7-2}) && \text{Quotient of Powers} \\ &= a^3b^5 && \text{Simplify.}\end{aligned}$$

The quotient is a^3b^5 .

Example 2 Simplify $\left(\frac{2a^3b^5}{3b^2}\right)^3$. Assume that b is not equal to zero.

$$\begin{aligned}\left(\frac{2a^3b^5}{3b^2}\right)^3 &= \frac{(2a^3b^5)^3}{(3b^2)^3} && \text{Power of a Quotient} \\ &= \frac{2^3(a^3)^3(b^5)^3}{(3)^3(b^2)^3} && \text{Power of a Product} \\ &= \frac{8a^9b^{15}}{27b^6} && \text{Power of a Power} \\ &= \frac{8a^9b^9}{27} && \text{Quotient of Powers}\end{aligned}$$

The quotient is $\frac{8a^9b^9}{27}$.

Exercises

Simplify. Assume that no denominator is equal to zero.

1. $\frac{5^5}{5^2}$

2. $\frac{m^6}{m^4}$

3. $\frac{p^5n^4}{p^2n}$

4. $\frac{a^2}{a}$

5. $\frac{x^5y^3}{x^5y^2}$

6. $\frac{-2y^7}{14y^5}$

7. $\frac{xy^6}{y^4x}$

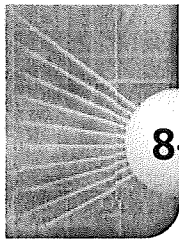
8. $\left(\frac{2a^2b}{a}\right)^3$

9. $\left(\frac{4p^4q^4}{3p^2q^2}\right)^3$

10. $\left(\frac{2v^5w^3}{v^4w^3}\right)^4$

11. $\left(\frac{3r^6s^3}{2r^5s}\right)^4$

12. $\frac{r^7s^7t^2}{s^3r^3t^2}$

**8-2 Study Guide and Intervention** *(continued)***Dividing Monomials**

Negative Exponents Any nonzero number raised to the zero power is 1; for example, $(-0.5)^0 = 1$. Any nonzero number raised to a negative power is equal to the reciprocal of the number raised to the opposite power; for example, $6^{-3} = \frac{1}{6^3}$. These definitions can be used to simplify expressions that have negative exponents.

Zero Exponent	For any nonzero number a , $a^0 = 1$.
Negative Exponent Property	For any nonzero number a and any integer n , $a^{-n} = \frac{1}{a^n}$ and $\frac{1}{a^{-n}} = a^n$.

The simplified form of an expression containing negative exponents must contain only positive exponents.

Example Simplify $\frac{4a^{-3}b^6}{16a^2b^6c^{-5}}$. Assume that the denominator is not equal to zero.

$$\begin{aligned}
 \frac{4a^{-3}b^6}{16a^2b^6c^{-5}} &= \left(\frac{4}{16}\right)\left(\frac{a^{-3}}{a^2}\right)\left(\frac{b^6}{b^6}\right)\left(\frac{1}{c^{-5}}\right) && \text{Group powers with the same base.} \\
 &= \frac{1}{4}(a^{-3-2})(b^{6-6})(c^5) && \text{Quotient of Powers and Negative Exponent Properties} \\
 &= \frac{1}{4}a^{-5}b^0c^5 && \text{Simplify.} \\
 &= \frac{1}{4}\left(\frac{1}{a^5}\right)(1)c^5 && \text{Negative Exponent and Zero Exponent Properties} \\
 &= \frac{c^5}{4a^5} && \text{Simplify.}
 \end{aligned}$$

The solution is $\frac{c^5}{4a^5}$.

Exercises

Simplify. Assume that no denominator is equal to zero.

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

2. $\frac{m}{m^{-4}}$

3. $\frac{p^{-8}}{p^3}$

4. $\frac{b^{-4}}{b^{-5}}$

5. $\frac{(-x^{-1}y)^0}{4w^{-1}y^2}$

6. $\frac{(a^2b^3)^2}{(ab)^{-2}}$

7. $\frac{x^4y^0}{x^{-2}}$

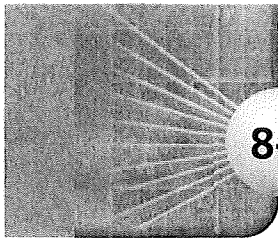
8. $\frac{(6a^{-1}b)^2}{(b^2)^4}$

9. $\frac{(3st)^2u^{-4}}{s^{-1}t^2u^7}$

10. $\frac{s^{-3}t^{-5}}{(s^2t^3)^{-1}}$

11. $\left(\frac{4m^2n^2}{8m^{-1}l}\right)^0$

12. $\frac{(-2mn^2)^{-3}}{4m^{-6}n^4}$



8-2 Skills Practice

Dividing Monomials

Simplify. Assume that no denominator is equal to zero.

1. $\frac{6^5}{6^4}$

2. $\frac{9^{12}}{9^8}$

3. $\frac{x^4}{x^2}$

4. $\frac{r^3s^2}{r^3s^4}$

5. $\frac{m}{m^3}$

6. $\frac{9d^7}{3d^6}$

7. $\frac{12n^5}{36n}$

8. $\frac{w^4u^3}{w^4u}$

9. $\frac{a^3b^5}{ab^2}$

10. $\frac{m^7n^2}{m^3n^2}$

11. $\frac{-21w^5u^2}{7w^4u^5}$

12. $\frac{32x^3y^2z^5}{-8xyz^2}$

13. $\left(\frac{4p^7}{7s^2}\right)^2$

14. 4^{-4}

15. 8^{-2}

16. $\left(\frac{5}{3}\right)^{-2}$

17. $\left(\frac{9}{11}\right)^{-1}$

18. $\frac{h^3}{h^{-6}}$

19. $k^0(k^4)(k^{-6})$

20. $k^{-1}(\ell^{-6})(m^3)$

21. $\frac{f^{-7}}{f^4}$

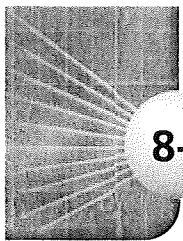
22. $\left(\frac{16p^5q^2}{2p^3q^3}\right)^0$

23. $\frac{f^{-5}g^4}{h^{-2}}$

24. $\frac{15x^6y^{-9}}{5xy^{-11}}$

25. $\frac{-15w^0u^{-1}}{5u^3}$

26. $\frac{48x^6y^7z^5}{-6xy^5z^6}$

**8-2 Practice*****Dividing Monomials***

Simplify. Assume that no denominator is equal to zero.

1. $\frac{8^8}{8^4}$

2. $\frac{a^4b^6}{ab^3}$

3. $\frac{xy^2}{xy}$

4. $\frac{m^5np}{m^4p}$

5. $\frac{5c^2d^3}{-4c^2d}$

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

7. $\left(\frac{4f^3g}{3h^6}\right)^3$

8. $\left(\frac{6w^5}{7p^6s^3}\right)^2$

9. $\frac{-4c^2}{24c^5}$

10. $x^3(y^{-5})(x^{-8})$

11. $p(q^{-2})(r^{-3})$

12. 12^{-2}

13. $\left(\frac{3}{7}\right)^{-2}$

14. $\left(\frac{4}{3}\right)^{-4}$

15. $\frac{22r^3s^2}{11r^2s^{-3}}$

16. $\frac{-15w^0u^{-1}}{5u^3}$

17. $\frac{8c^3d^2f^4}{4c^{-1}d^2f^{-3}}$

18. $\left(\frac{x^{-3}y^5}{4^{-3}}\right)^0$

19. $\frac{6f^{-2}g^3h^5}{54f^{-2}g^{-5}h^3}$

20. $\frac{-12t^{-1}u^5v^{-4}}{2t^{-3}uv^5}$

21. $\frac{r^4}{(3r)^3}$

22. $\frac{m^{-2}n^{-5}}{(m^4n^3)^{-1}}$

23. $\frac{(j^{-1}k^3)^{-4}}{j^3k^3}$

24. $\frac{(2a^{-2}b)^{-3}}{5a^2b^4}$

25. $\left(\frac{q^{-1}r^3}{qr^{-2}}\right)^{-5}$

26. $\left(\frac{7c^{-3}d^3}{c^5de^{-4}}\right)^{-1}$

27. $\left(\frac{2x^3y^2z}{3x^4yz^{-2}}\right)^{-2}$

28. BIOLOGY A lab technician draws a sample of blood. A cubic millimeter of the blood contains 22^3 white blood cells and 22^5 red blood cells. What is the ratio of white blood cells to red blood cells?

29. COUNTING The number of three-letter “words” that can be formed with the English alphabet is 26^3 . The number of five-letter “words” that can be formed is 26^5 . How many times more five-letter “words” can be formed than three-letter “words”?

NAME _____
DATE _____
PERIOD _____

8-1 Study Guide and Intervention

Multiplying Monomials

Powers of Monomials A monomial is a number, a variable, or a product of a number and one or more variables. An expression of the form x^n is called a **power** and represents the product you obtain when x is used as a factor n times. To multiply two powers that have the same base, add the exponents.

Product of Powers	For any number a and all integers m and n , $a^m \cdot a^n = a^{m+n}$.
Power of a Power	For any number a and all integers m and n , $(a^m)^n = a^{mn}$.

Example 1 Simplify $(3x^4)(5x^2)$.

$(3x^4)(5x^2) = (3)(5)(x^4 \cdot x^2)$ Associative Property

$= (3 \cdot 5)(x^4 + 2)$ Product of Powers

$= 15x^6$ Simplify

The product is $15x^6$.

Example 2 Simplify $(-4a^3b)(3a^2b^5)$.

$(-4a^3b)(3a^2b^5) = (-4)(3)(a^3 \cdot a^2)(b \cdot b^5)$

$= -12(a^3 + 2)(b^1 + 5)$

$= -12a^5b^6$

The product is $-12a^5b^6$.

NAME _____
DATE _____
PERIOD _____

8-1 Study Guide and Intervention

Multiplying Monomials

Powers of Monomials An expression of the form $(x^n)^m$ is called a **power of a power** and represents the product you obtain when x^n is used as a factor n times. To find the power of a power, multiply exponents.

Power of a Power	For any number a and all integers m and n , $(a^m)^n = a^{mn}$.
Power of a Product	For any number a and all integers m and n , $(ab)^m = a^m b^m$.

Example 3 Simplify $(-2ab^2)^3(a^2)^4$.

$(-2ab^2)^3(a^2)^4 = (-2ab^2)^3(a^8)$ Power of a Power

$= (-2)^3(a^3)(b^2)^3(a^8)$ Power of a Product

$= (-2)^3(a^3)(a^8)(b^2)^3$ Commutative Property

$= (-2)^3(a^{11})(b^2)^3$ Product of Powers

$= -8a^{11}b^6$ Power of a Power

The product is $-8a^{11}b^6$.

8-1 Study Guide and Intervention

Multiplying Monomials

Powers of Monomials A monomial is a number, a variable, or a product of a number and one or more variables. An expression of the form x^n is called a **power** and represents the product you obtain when x is used as a factor n times. To multiply two powers that have the same base, add the exponents.

Product of Powers	For any number a and all integers m and n , $a^m \cdot a^n = a^{m+n}$.
Power of a Power	For any number a and all integers m and n , $(a^m)^n = a^{mn}$.

Example 1 Simplify $(3x^4)(5x^2)$.

$(3x^4)(5x^2) = (3)(5)(x^4 \cdot x^2)$ Associative Property

$= (3 \cdot 5)(x^4 + 2)$ Product of Powers

$= 15x^6$ Simplify

The product is $15x^6$.

Example 2 Simplify $(-4a^3b)(3a^2b^5)$.

$(-4a^3b)(3a^2b^5) = (-4)(3)(a^3 \cdot a^2)(b \cdot b^5)$

$= -12(a^3 + 2)(b^1 + 5)$

$= -12a^5b^6$

The product is $-12a^5b^6$.

8-1 Study Guide and Intervention

Multiplying Monomials

Powers of Monomials An expression of the form $(x^n)^m$ is called a **power of a power** and represents the product you obtain when x^n is used as a factor n times. To find the power of a power, multiply exponents.

Power of a Power	For any number a and all integers m and n , $(a^m)^n = a^{mn}$.
Power of a Product	For any number a and all integers m and n , $(ab)^m = a^m b^m$.

Example 3 Simplify $(-2ab^2)^3(a^2)^4$.

$(-2ab^2)^3(a^2)^4 = (-2ab^2)^3(a^8)$ Power of a Power

$= (-2)^3(a^3)(b^2)^3(a^8)$ Power of a Product

$= (-2)^3(a^3)(a^8)(b^2)^3$ Commutative Property

$= (-2)^3(a^{11})(b^2)^3$ Product of Powers

$= -8a^{11}b^6$ Power of a Power

The product is $-8a^{11}b^6$.

8-1 Study Guide and Intervention

Multiplying Monomials

Powers of Monomials A monomial is a number, a variable, or a product of a number and one or more variables. An expression of the form x^n is called a **power** and represents the product you obtain when x is used as a factor n times. To multiply two powers that have the same base, add the exponents.

Product of Powers	For any number a and all integers m and n , $a^m \cdot a^n = a^{m+n}$.
Power of a Power	For any number a and all integers m and n , $(a^m)^n = a^{mn}$.

Example 1 Simplify $(3x^4)(5x^2)$.

$(3x^4)(5x^2) = (3)(5)(x^4 \cdot x^2)$ Associative Property

$= (3 \cdot 5)(x^4 + 2)$ Product of Powers

$= 15x^6$ Simplify

The product is $15x^6$.

Example 2 Simplify $(-4a^3b)(3a^2b^5)$.

$(-4a^3b)(3a^2b^5) = (-4)(3)(a^3 \cdot a^2)(b \cdot b^5)$

$= -12(a^3 + 2)(b^1 + 5)$

$= -12a^5b^6$

The product is $-12a^5b^6$.

8-1 Study Guide and Intervention

Multiplying Monomials

Powers of Monomials An expression of the form $(x^n)^m$ is called a **power of a power** and represents the product you obtain when x^n is used as a factor n times. To find the power of a power, multiply exponents.

Power of a Power	For any number a and all integers m and n , $(a^m)^n = a^{mn}$.
Power of a Product	For any number a and all integers m and n , $(ab)^m = a^m b^m$.

Example 3 Simplify $(-2ab^2)^3(a^2)^4$.

$(-2ab^2)^3(a^2)^4 = (-2ab^2)^3(a^8)$ Power of a Power

$= (-2)^3(a^3)(b^2)^3(a^8)$ Power of a Product

$= (-2)^3(a^3)(a^8)(b^2)^3$ Commutative Property

$= (-2)^3(a^{11})(b^2)^3$ Product of Powers

$= -8a^{11}b^6$ Power of a Power

The product is $-8a^{11}b^6$.

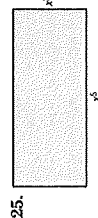
NAME _____ DATE _____ PERIOD _____

8-1 Skills Practice**Multiplying Monomials**Determine whether each expression is a monomial. Write *yes* or *no*. Explain.

1. 11 Yes: 11 is a real number and an example of a constant.
2. $a - b$ No: This is the difference, not the product, of two variables.
3. $\frac{p^2}{q^2}$ No: This is the quotient, not the product, of two variables.
4. y Yes: Single variables are monomials.
5. j^3k Yes: This is the product of two variables.
6. $2a + 3b$ No: This is the sum of two monomials.

Simplify.

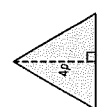
7. $a^2(a^3)(a^6)$ a^{11}
8. $x(x^2)(x^7)$ x^{10}
9. $(y^2z)(yz^2)$ y^3z^3
10. $(2k^2)(c^3k)$ $2c^3k^3$
11. $(e^2f^4)(e^2f^2)$ e^4f^6
12. $(c^2d^2)(c^3d^2)$ c^5d^4
13. $(2x^2)(3x^5)$ $6x^7$
14. $(5a^7)(4a^2)$ $20a^9$
15. $(4xy^3)(3x^2y^5)$ $12x^3y^8$
16. $(7a^5b^2)(a^2b^3)$ $7a^7b^5$
17. $(-5m^3)(3m^8)$ $-15m^{11}$
18. $(-2c^4d)(-4cd)$ $8c^5d^2$
19. $(10^3)^3$ 10^9 or 1,000,000
20. $(p^3)^{12}$ p^{36}
21. $(-6p)^2$ $36p^2$
22. $(-3y)^3$ $-27y^3$
23. $(3pq^2)^2$ $9p^2q^4$
24. $(2b^3c^4)^2$ $4b^6c^8$

GEOMETRY Express the area of each figure as a monomial.

25.



26.



27.

 x^7 c^2d^2 $18p^4$

© Glencoe/McGraw-Hill

457

Glencoe Algebra 1

NAME _____ DATE _____ PERIOD _____

8-1 Practice**(Average)****Multiplying Monomials**Determine whether each expression is a monomial. Write *yes* or *no*. Explain.

1. $\frac{21a^2}{7b}$ No: this involves the quotient, not the product, of variables.
2. $\frac{b^2c^2}{2}$ Yes: this is the product of a number, $\frac{1}{2}$, and two variables.

Simplify.

3. $(-5x^2y)(3x^4)$ $-15x^6y$
4. $(2ab^2c^2)(4a^3b^2c^2)$ $8a^4b^4c^4$
5. $(3cd^4)(-2c^2)$ $-6c^3d^4$
6. $(4g^3h)(-2g^5)$ $-8g^8h$
7. $(-15xy^4)(-\frac{1}{3}xy^3)$ $5x^2y^7$
8. $(-xy)^3(xz)$ $-x^4y^3z$
9. $(-18m^2n)^2(-\frac{1}{6}mn^2)$ $54m^5n^4$
10. $(0.2a^2b^3)^2$ $0.04a^4b^6$
11. $(\frac{2}{3p})^2 \cdot \frac{4}{9}p^2$ $\frac{1}{15}c^2d^6$
12. $(\frac{1}{4}cd^3)^2$ $\frac{1}{16}c^2d^6$
13. $(0.4k^3)^3$ $0.064k^9$
14. $((4^3)^2)^2$ 4^6 or 65,536

GEOMETRY Express the area of each figure as a monomial.

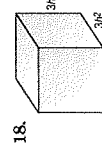
15.



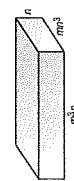
16.



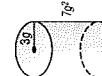
17.

 $18a^3b^6$ $(25x^3)^2\pi$ $12a^3c^4$ **GEOMETRY** Express the volume of each solid as a monomial.

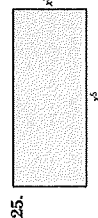
18.



19.



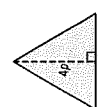
20.

 m^3n^5 $(63p^4)^2\pi$ **GEOMETRY** Express the area of each figure as a monomial.

25.



26.



27.

21. **COUNTING** A panel of four light switches can be set in 2^4 ways. A panel of five light switches can be set in twice this many ways. In how many ways can five light switches be set? 2^5 or 32
22. **HOBBIES** Tawa wants to increase her rock collection by a power of three this year and then increase it again by a power of two next year. If she has 2 rocks now, how many rocks will she have after the second year? 2^6 or 64

© Glencoe/McGraw-Hill

458

Glencoe Algebra 1

8-1 Reading to Learn Mathematics

Multiplying Monomials

NAME _____ DATE _____ PERIOD _____

Pre-Activity Why does doubling speed quadruple braking distance?

Read the introduction to Lesson 8-1 at the top of page 410 in your textbook. Find two examples in the table to verify the statement that when speed is doubled, the braking distance is quadrupled. Write your examples in the table.

Speed (miles per hour)	Braking Distance (feet)	Speed Doubled (miles per hour)	Braking Distance Quadrupled (feet)
20	20	40	80
30	45	60	180

Reading the Lesson

- Describe the expression $3xy$ using the terms *monomial*, *constant*, *variable*, and *product*. The monomial $3xy$ is the product of the constant 3 and the variables x and y .
- Complete the chart by choosing the property that can be used to simplify each expression. Then simplify the expression.

Expression	Property	Expression Simplified
$3^5 \cdot 3^2$	Product of Powers Power of a Power Power of a Product	3^7 or 2187
$(a^3)^4$	Product of Powers Power of a Power Power of a Product	a^{12}
$(-4xy)^5$	Product of Powers Power of a Power Power of a Product	$1024x^5y^5$

Helping You Remember

- Write an example of each of the three properties of powers discussed in this lesson. Then, using the examples, explain how the property is used to simplify them.

Sample answer: For $z^2 \cdot z^5$, since the bases are the same, use the Product of Powers Property and add the exponents to get z^7 . For $(a^3)^5$, use the Power of a Power Property. Multiply the exponents to get a^{15} . For $(3rs)^3$, use the Power of a Product Property. Raise the constant and each variable to the power to get $27r^3s^3$.

© Glencoe/McGraw-Hill

459

Glencoe Algebra 1

8-1 Enrichment

NAME _____ DATE _____ PERIOD _____

An Wang

An Wang (1920–1980) was an Asian-American who became one of the pioneers of the computer industry in the United States. He grew up in Shanghai, China, but came to the United States to further his studies in science. In 1948, he invented a magnetic pulse controlling device that vastly increased the storage capacity of computers. He later founded his own company, Wang Laboratories, and became a leader in the development of desktop calculators and word processing systems. In 1988, Wang was elected to the National Inventors Hall of Fame.

Digital computers store information as numbers. Because the electronic circuits of a computer can exist in only one of two states, open or closed, the numbers that are stored can consist of only two digits, 0 or 1. Numbers written using only these two digits are called **binary numbers**. To find the decimal value of a binary number, you use the digits to write a *polynomial in 2*. For instance, this is how to find the decimal value of the number 1001101_2 . (The subscript 2 indicates that this is a binary number.)

$$\begin{aligned}
 1001101_2 &= 1 \times 2^6 + 0 \times 2^5 + 0 \times 2^4 + 1 \times 2^3 + 1 \times 2^2 + 0 \times 2^1 + 1 \times 2^0 \\
 &= 1 \times 64 + 0 \times 32 + 0 \times 16 + 1 \times 8 + 1 \times 4 + 0 \times 2 + 1 \times 1 \\
 &= 64 + 0 + 0 + 8 + 4 + 0 + 1 \\
 &= 77
 \end{aligned}$$

Find the decimal value of each binary number.

$$1. 1111_2 \quad 15 \qquad 2. 10000_2 \quad 16 \qquad 3. 11000011_2 \quad 195 \qquad 4. 10111001_2 \quad 165$$

Write each decimal number as a binary number.

$$5. 8 \quad 1000 \qquad 6. 11 \quad 1011 \qquad 7. 29 \quad 11101 \qquad 8. 117 \quad 1110101$$

- The chart at the right shows a set of decimal code numbers that is used widely in storing letters of the alphabet in a computer's memory. Find the code numbers for the letters of your name. Then write the code for your name using binary numbers. *Answers will vary.*

The American Standard Guide for Information Interchange (ASCII)											
A 65	N 78	a 97	n 110								
B 66	O 79	b 98	o 111								
C 67	P 80	c 99	p 112								
D 68	Q 81	d 100	q 113								
E 69	R 82	e 101	r 114								
F 70	S 83	f 102	s 115								
G 71	T 84	g 103	t 116								
H 72	U 85	h 104	u 117								
I 73	V 86	i 105	v 118								
J 74	W 87	j 106	w 119								
K 75	X 88	k 107	x 120								
L 76	Y 89	l 108	y 121								
M 77	Z 90	m 109	z 122								

© Glencoe/McGraw-Hill

460

Glencoe Algebra 1

8-2 Study Guide and Intervention

Dividing Monomials

Quotients of Monomials To divide two powers with the same base, subtract the exponents.

Quotient of Powers For all integers m and n and any nonzero number a , $\frac{a^m}{a^n} = a^{m-n}$.	Zero Exponent For any nonzero number a , $a^0 = 1$.
Power of a Quotient For any integer m and any real numbers a and b , $b \neq 0$, $\left(\frac{a}{b}\right)^m = \frac{a^m}{b^m}$.	Negative Exponent Property For any nonzero number a and any integer n , $a^{-n} = \frac{1}{a^n}$ and $\frac{1}{a^{-n}} = a^n$.

Example 1 Simplify $\frac{a^4b^7}{ab^2}$. Assume neither a nor b is equal to zero.

Group powers with the same base.

$$\frac{a^4b^7}{ab^2} = \left(\frac{a^4}{a}\right)\left(\frac{b^7}{b^2}\right)$$

Quotient of Powers

$$= (a^{4-1})(b^{7-2})$$

Simplify.

$$= a^3b^5$$

The quotient is a^3b^5 .

Example 2 Simplify $\frac{2a^2b^5}{3b^2}$. Assume that b is not equal to zero.

Power of a Quotient

$$\left(\frac{2a^2b^5}{3b^2}\right)^3 = \frac{(2a^2b^5)^3}{(3b^2)^3}$$

Power of a Product

$$= \frac{2^3(a^2)^3(b^5)^3}{(3)^3(b^2)^3}$$

Power of a Power

$$= \frac{8a^6b^{15}}{27b^6}$$

Quotient of Powers

$$= \frac{8a^6b^9}{27}$$

The quotient is $\frac{8a^6b^9}{27}$.

Example 3 Simplify $\frac{m^6}{m^4}$. Assume that no denominator is equal to zero.

$$\frac{m^6}{m^4} = m^{6-4} = m^2$$

8-2 Study Guide and Intervention

Dividing Monomials

Negative Exponents Any nonzero number raised to the zero power is 1; for example, $(-0.5)^0 = 1$. Any nonzero number raised to a negative power is equal to the reciprocal of the number raised to the opposite power; for example, $6^{-3} = \frac{1}{6^3}$. These definitions can be used to simplify expressions that have negative exponents.

Example 1 Simplify $\frac{4a^{-3}b^6}{16a^2b^5c^{-3}}$. Assume that the denominator is not equal to zero.

Group powers with the same base.

$$\frac{4a^{-3}b^6}{16a^2b^5c^{-3}} = \left(\frac{4}{16}\right)\left(\frac{a^{-3}}{a^2}\right)\left(\frac{b^6}{b^5}\right)\left(\frac{1}{c^{-3}}\right)$$

Quotient of Powers and Negative Exponent Properties

$$= \frac{1}{4}(a^{-3-2})(b^{6-5})(c^3)$$

Simplify.

$$= \frac{1}{4}a^{-5}b^1c^3$$

Negative Exponent and Zero Exponent Properties

$$= \frac{1}{4}\left(\frac{1}{a^5}\right)(1)c^3$$

Simplify.

$$= \frac{c^3}{4a^5}$$

The solution is $\frac{c^3}{4a^5}$.

Example 2 Simplify. Assume that no denominator is equal to zero.

1. $\frac{2^2}{2^{-3}} = 2^5$ or 32
2. $\frac{m}{m^{-4}} = m^5$
3. $\frac{p^{-8}}{p^3} = \frac{1}{p^{11}}$
4. $\frac{b^{-4}}{b^{-5}} = b$
5. $\frac{(-x^{-1}y)^0}{4w^{-3}y^2} = \frac{1}{4w^{-3}y^2}$
6. $\frac{(a^2b^3)^2}{(ab)^{-3}} = a^6b^8$
7. $\frac{x^4y^0}{x^{-2}y^6} = x^6y^{-6}$
8. $\frac{(6a^{-1}b)^2}{(b^2)^4} = \frac{36}{b^6b^8} = \frac{36}{b^{14}}$
9. $\frac{(3st)^2u^{-4}}{s^{-1}t^2u^7} = \frac{9s^2t^2u^{-4}}{s^{-1}t^2u^7} = \frac{9s^3t^0u^{-8}}{u^7} = \frac{9s^3}{u^{15}}$
10. $\frac{s^{-3}y^{-5}}{(s^2t^3)^{-1}} = \frac{s^{-3}y^{-5}}{s^{-2}t^{-3}} = \frac{s^{-3-(-2)}y^{-5}t^3}{1} = \frac{s^{-1}y^{-5}t^3}{1} = \frac{t^3}{sy^5}$
11. $\left(\frac{4m^2n^2}{8m^{-1}t}\right)^0 = 1$
12. $\frac{(-2mn^2)^{-3}}{4m^{-6}n^4} = \frac{(-2)^{-3}m^{-6}n^{-4}}{4m^{-6}n^4} = \frac{-\frac{1}{8}m^{-6}n^{-4}}{4m^{-6}n^4} = \frac{-\frac{1}{8}n^{-4-4}}{4} = \frac{-\frac{1}{8}n^{-8}}{4} = \frac{-n^8}{32}$

© Glencoe/McGraw-Hill

A5

Glencoe Algebra 1

NAME _____	DATE _____	PERIOD _____
8-2 Skills Practice <i>Dividing Monomials</i>		
Simplify. Assume that no denominator is equal to zero.		
1. $\frac{6^5}{6^4}$ 6 or 6	2. $\frac{9^{12}}{9^8}$ 9^4 or 6561	
3. $\frac{x^4}{x^2}$ x^2	4. $\frac{r^3s^2}{r^3s^4}$ $\frac{1}{s^2}$	
5. $\frac{m}{m^3}$ $\frac{1}{m^2}$	6. $\frac{9d^7}{3d^6}$ $3d$	
7. $\frac{12p^5}{36n}$ $\frac{n^4}{3}$	8. $\frac{w^4u^3}{w^4u}$ u^2	
9. $\frac{a^3b^5}{ad^2}$ a^2b^5	10. $\frac{m^7n^2}{m^3n^2}$ m^4	
11. $\frac{-21u^5v^2}{7u^4v^5}$ $-\frac{3v}{u^3}$	12. $\frac{32x^3y^2z^5}{-8xy^2z}$ $-4x^2yz^4$	
13. $\left(\frac{4p^7}{7s^2}\right)^2$ $\frac{16p^{14}}{49s^4}$	14. 4^{-4} $\frac{1}{256}$	
15. 8^{-2} $\frac{1}{64}$	16. $\left(\frac{5}{3}\right)^{-2}$ $\frac{9}{25}$	
17. $\left(\frac{9}{11}\right)^{-1}$ $\frac{11}{9}$	18. $\frac{h^8}{h^{-6}}$ h^{14}	
19. $k^0(k^4)(k^{-6})$ $\frac{1}{k^2}$	20. $k^{-1}(l^{-5})(m^3)$ $\frac{m^3}{k^1l^5}$	
21. $\frac{f^{-7}}{f^4}$ $\frac{1}{f^{11}}$	22. $\left(\frac{16p^3q^2}{2p^3q^3}\right)^0$ 1	
23. $\frac{f^{-5}g^{-4}}{h^{-2}}$ $\frac{g^4h^2}{f^5}$	24. $\frac{15x^5y^{-9}}{5xy^{-11}}$ $3x^4y^2$	
25. $\frac{-15w^4u^{-1}}{5u^3}$ $-\frac{3}{u^3}$	26. $\frac{48x^5y^{15}}{-6xy^2z}$ $-\frac{8x^4y^{13}}{z}$	
© Glencoe/McGraw-Hill	463	Glencoe Algebra 1
8-2 Practice (Average) <i>Dividing Monomials</i>		
Simplify. Assume that no denominator is equal to zero.		
1. $\frac{8^8}{8^4}$ 8 ⁴ or 4096	2. $\frac{a^4b^8}{ab^3}$ a^3b^5	3. $\frac{x^2y}{xy}$ y
4. $\frac{m^5np}{m^4p}$ mn	5. $\frac{5c^2d^3}{-4c^2d}$ $-\frac{5d^2}{4}$	6. $\frac{8y^7z^6}{4y^6z^5}$ $2yz$
7. $\left(\frac{4r^3s}{3t^6}\right)^3$ $\frac{64r^9s^3}{27t^{18}}$	8. $\left(\frac{6w^5}{7p^6q^3}\right)^2$ $\frac{36w^{10}}{49p^{12}q^6}$	9. $\frac{-4c^2}{24c^5}$ $-\frac{1}{6c^3}$
10. $x^3(y^{-5})(x^{-6})$ $\frac{1}{x^3y^5}$	11. $p(q^{-2})(r^{-3})$ $\frac{p}{q^2r^3}$	12. 12^{-2} $\frac{1}{144}$
13. $\left(\frac{3}{7}\right)^{-2}$ $\frac{49}{9}$	14. $\left(\frac{4}{3}\right)^{-4}$ $\frac{81}{256}$	15. $\frac{22s^2}{11s^3}$ $\frac{2}{s}$
16. $\frac{-15w^6u^{-1}}{5u^3}$ $-\frac{3}{u^2}$	17. $\frac{8c^3d^2f^4}{4c^{-1}d^2f^{-3}}$ $2c^4f^7$	18. $\left(\frac{x^{-3}y^5}{4^{-3}}\right)^0$ 1
19. $\frac{6f^{-2}g^3h^5}{54f^{-2}g^{-3}h^3}$ $\frac{g^6h^2}{5}$	20. $\frac{-12t^{-1}u^5v^{-4}}{2t^{-3}uv^5}$ $-\frac{6t^2u^4}{v^9}$	21. $\frac{r^4}{(3r)^3}$ $\frac{r}{27}$
22. $\frac{m^{-2}n^{-5}}{(m^4n^3)^{-1}}$ $\frac{m^2}{n^2}$	23. $\frac{(j^{-1}k^3)^{-4}}{j^3k^3}$ $\frac{1}{k^3}$	24. $\frac{(2a^{-2}b^{-3})^{-3}}{5a^2b^4}$ $\frac{a^6}{40b^5}$
25. $\left(\frac{q^{-1}r^4}{qr^2}\right)^{-5}$ $\frac{q^{10}}{r^25}$	26. $\left(\frac{7c^{-3}d^3}{c^5de^{-4}}\right)^{-1}$ $\frac{c^3}{7d^3e^4}$	27. $\left(\frac{2a^3y^2z}{3x^2yz}\right)^{-2}$ $\frac{9x^2}{4y^2z}$
28. BIOLOGY A lab technician draws a sample of blood. A cubic millimeter of the blood contains 22 ³ white blood cells and 22 ⁵ red blood cells. What is the ratio of white blood cells to red blood cells? $\frac{1}{484}$		
29. COUNTING The number of three-letter "words" that can be formed with the English alphabet is 26 ³ . The number of five-letter "words" that can be formed is 26 ⁵ . How many times more five-letter "words" can be formed than three-letter "words"? 676		
© Glencoe/McGraw-Hill	464	Glencoe Algebra 1