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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 Powers	For any number a and all integers m and n, $a^m \cdot a^n = a^{m+n}$.

Example 1 **Simplify $(3x^6)(5x^2)$.**

$(3x^6)(5x^2) = (3)(5)(x^6 \cdot x^2)$ Associative Property

$= (3 \cdot 5)(x^{6+2})$ Product of Powers

$= 15x^8$ Simplify.

The product is $15x^8$.

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 $-12a^5b^6$.

Exercises

Simplify.

1. $y(y^5)$ y^6

2. $n^2 \cdot n^7$ n^9

3. $(-7x^2)(x^4)$ $-7x^6$

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

5. $m \cdot m^5$ m^6

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

7. $(2a^2)(8a)$ $16a^3$

8. $(rs)(rs^3)(s^2)$ r^2s^6

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

10. $\frac{1}{3}(2a^3b)(6b^3)$ $4a^3b^4$

11. $(-4x^3)(-5x^7)$ $20x^{10}$

12. $(-3j^2k^4)(2jk^6)$ $-6j^3k^{10}$

13. $(5a^2bc^3)\left(\frac{1}{5}abc^4\right)$ $a^3b^2c^7$

14. $(-5xy)(4x^2)(y^4)$ $-20x^3y^5$

15. $(10x^3yz^2)(-2xy^5z)$ $-20x^4y^6z^3$

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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. $(y^5)^2$ $= y^5 \cdot y^5$ y^{10}
2. $(n^7)^4$ n^{28}
3. $(x^2)^5(x^3)$ x^{13}
4. $-3(ab^4)^3$ $-3a^3b^{12}$
5. $(-3ab^4)^3$ $-27a^3b^{12}$
6. $(4x^2b)^3$ $64x^6b^3$
7. $(4a^2)^2(b^3)$ $16a^4b^3$
8. $(4x)^2(b^3)$ $16x^2b^3$
9. $(x^2y^4)^5$ $x^{10}y^{20}$
10. $(2a^3b^2)(b^3)^2$ $2a^3b^8$
11. $(-4xy)^3(-2x^2)^3$ $512x^9y^3$
12. $(-3j^2k^3)^2(2j^2k)^3$ $72j^{10}k^9$
13. $(25a^2b)^3\left(\frac{1}{5}abc\right)^2$ $625a^8b^5c^2$
14. $(2xy)^2(-3x^2)(4y^4)$ $-48x^4y^6$
15. $(2x^3y^2z^2)^3(x^2z)^4$ $8x^{17}y^6z^{10}$
16. $(-2n^6y^5)(-6n^3y^2)(ny)^3$ $12n^{12}y^{10}$
17. $(-3a^3n^4)(-3a^3n)^4$ $-243a^{15}n^8$
18. $-3(2x)^4(4x^5y)^2$ $-768x^{14}y^2$

11) $\frac{2n^2}{n} = 2n$

12) $\frac{8x^3}{10x^5} = \frac{4}{5x^2}$

13) $\frac{12x^3}{9y^8} = \frac{4x^3}{3y^8}$

14) $\frac{14x^4y^7}{6x^5y^4} = \frac{7y^3}{3x}$

15) $\frac{11u^4}{17u^7v^9} = \frac{11}{17u^3v^9}$

16) $\frac{4y^4}{14yx^8} = \frac{2y^3}{7x^8}$

17) $\frac{12yx^4}{10yx^8} = \frac{6}{5x^4}$

18) $\frac{18x^8y^8}{10x^3} = \frac{9x^5y^8}{5}$

19) $\frac{5n^8}{20n^8} = \frac{1}{4}$

20) $\frac{16yx^4}{9x^8y^2} = \frac{16}{9x^4y}$

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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.**

$\frac{a^4b^7}{ab^2} = \left(\frac{a^4}{a}\right)\left(\frac{b^7}{b^2}\right)$ Group powers with the same base.

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

$= a^3b^5$ Simplify.

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.**

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

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

$= \frac{8a^9b^{15}}{27b^6}$ Power of a Power

$= \frac{8a^9b^9}{27}$ Quotient of Powers

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

Exercises

Simplify. Assume that no denominator is equal to zero.

1. $\frac{5^5}{5^2}$ 5^3 or 125
2. $\frac{m^6}{m^4}$ m^2
3. $\frac{p^5n^4}{p^2n}$ p^3n^3
4. $\frac{a^2}{a}$ a
5. $\frac{x^5y^3}{x^5y^2}$ y
6. $\frac{-2y^7}{14y^5}$ $-\frac{1}{7}y^2$
7. $\frac{xy^6}{y^4x}$ y^2
8. $\left(\frac{2a^2b}{a}\right)^3$ $8a^3b^3$
9. $\left(\frac{4p^4q^4}{3p^2q^2}\right)^3$ $\frac{64}{27}p^6q^6$
10. $\left(\frac{2v^5w^3}{v^4w^3}\right)^4$ $16v^4$
11. $\left(\frac{3r^6s^3}{2r^5s}\right)^4$ $\frac{81}{16}r^4s^8$
12. $\frac{r^7s^7t^2}{s^3r^3t^2}$ r^4s^4

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8-2 Skills Practice

Dividing Monomials

Simplify. Assume that no denominator is equal to zero.

1. $\frac{6^5}{6^4}$ 6^1 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. $\frac{12n^5}{36n}$ $\frac{n^4}{3}$

8. $\frac{w^4u^3}{w^4u}$ u^2

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

10. $\frac{m^7n^2}{m^3n^2}$ m^4

11. $\frac{-21w^5u^2}{7w^4u^5}$ $-\frac{3w}{u^3}$

12. $\frac{32x^3y^2z^5}{-8xyz^2}$ $-4x^2yz^3$

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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.**

$\frac{4a^{-3}b^6}{16a^2b^6c^{-5}} = \left(\frac{4}{16}\right)\left(\frac{a^{-3}}{a^2}\right)\left(\frac{b^6}{b^6}\right)\left(\frac{1}{c^{-5}}\right)$ Group powers with the same base.

$= \frac{1}{4}(a^{-3-2})(b^{6-6})(c^5)$ Quotient of Powers and Negative Exponent Properties

$= \frac{1}{4}a^{-5}b^0c^5$ Simplify.

$= \frac{1}{4}\left(\frac{1}{a^5}\right)(1)c^5$ Negative Exponent and Zero Exponent Properties

$= \frac{c^5}{4a^5}$ Simplify.

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

Exercises

Simplify. Assume that no denominator is equal to zero.

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

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8-2 Skills Practice

Dividing Monomials

Simplify. Assume that no denominator is equal to zero.

1. $\frac{6^5}{6^4}$ 6^1 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. $\frac{12n^5}{36n}$ $\frac{n^4}{3}$
8. $\frac{w^4u^3}{w^4u}$ u^2
9. $\frac{a^3b^5}{ab^2}$ a^2b^3
10. $\frac{m^7n^2}{m^3n^2}$ m^4
11. $\frac{-21w^5u^2}{7w^4u^5}$ $-\frac{3w}{u^3}$
12. $\frac{32x^3y^2z^5}{-8xyz^2}$ $-4x^2yz^3$
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. $\frac{h^3}{h^{-6}}$ h^9
19. $k^0(k^4)(k^{-6})$ $\frac{1}{k^2}$
20. $k^{-1}(\ell^{-6})(m^3)$ $\frac{m^3}{k\ell^6}$
21. $\frac{f^{-7}}{f^4}$ $\frac{1}{f^{11}}$
22. $\left(\frac{16p^5q^2}{2p^3q^3}\right)^0$ 1
23. $\frac{f^{-5}g^4}{h^{-2}}$ $\frac{g^4h^2}{f^5}$
24. $\frac{15x^6y^{-9}}{5xy^{-11}}$ $3x^5y^2$
25. $\frac{-15w^0u^{-1}}{5u^3}$ $-\frac{3}{u^4}$
26. $\frac{48x^6y^7z^5}{-6xy^5z^6}$ $-\frac{8x^5y^2}{z}$