



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 , $a^m \cdot a^n = a^{m+n}$.
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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. $(10x^3yz^2)(-2xy^5z)$ |



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Product of Powers	For any number a and all integers m and n , $a^m \cdot a^n = a^{m+n}$.
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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. $y(y^5)$
 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. $(10x^3yz^2)(-2xy^5z)$
 $-20x^4y^6z^3$

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. $(10^2)^3$

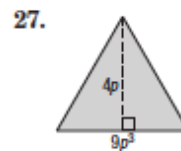
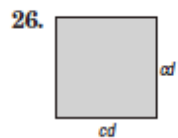
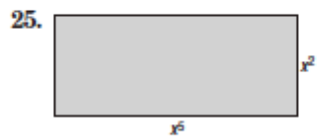
20. $(p^3)^{12}$

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.

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. $(\ell^2k^2)(\ell^3k)$ ℓ^5k^3

11. $(e^2f^4)(e^2f^2)$ e^4f^6

12. $(cd^2)(c^3d^2)$ c^4d^4

13. $(2x^2)(3x^5)$ $6x^7$

14. $(5a^7)(4a^2)$ $20a^9$

15. $(4xy^3)(3x^2y^5)$ $12x^4y^8$

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. $(10^2)^3$ 10^6 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.  x^7

26.  c^2d^2

27.  $18p^4$



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

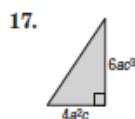
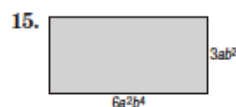
11. $\left(\frac{2}{3}p\right)^2$

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

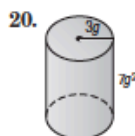
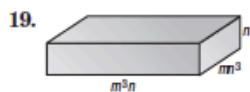
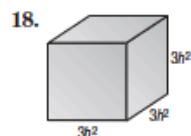
13. $(0.4k^3)^3$

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 be 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?



Multiplying Monomials

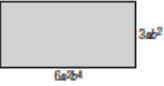


Determine whether each expression is a monomial. Write *yes* or *no*. Explain.

- $\frac{21a^2}{7b}$ **No; this involves the quotient, not the product, of variables.**
- $\frac{b^3c^2}{2}$ **Yes; this is the product of a number, $\frac{1}{2}$, and two variables.**

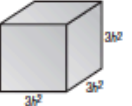
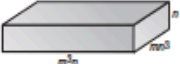
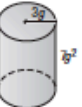
Simplify.

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

GEOMETRY Express the area of each figure as a monomial.

-  **$12a^4b^6$**
-  **$(25x^6)\pi$**
-  **$12a^3c^4$**

GEOMETRY Express the volume of each solid as a monomial.

-  **$27h^6$**
-  **m^4n^5**
-  **$(63g^4)\pi$**

- 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**

- 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**

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

Dividing Monomials

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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.

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

Dividing Monomials

Simplify. Assume that no denominator is equal to zero.

$$1. \frac{6^5}{8^4} \quad 6^1 \text{ or } 6$$

$$2. \frac{9^{12}}{9^8} \quad 9^4 \text{ or } 6561$$

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

$$4. \frac{r^3 s^2}{r^3 s^4} \quad \frac{1}{s^2}$$

$$5. \frac{m}{m^3} \quad \frac{1}{m^2}$$

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

$$7. \frac{12n^5}{36n} \quad \frac{n^4}{3}$$

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

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

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

$$11. \frac{-21w^6 u^2}{7w^4 u^5} \quad -\frac{3w}{u^3}$$

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

$$13. \left(\frac{4p^7}{7s^2} \right)^2 \quad \frac{16p^{14}}{49s^4}$$

$$14. 4^{-4} \quad \frac{1}{256}$$

$$15. 8^{-2} \quad \frac{1}{64}$$

$$16. \left(\frac{5}{3} \right)^{-2} \quad \frac{9}{25}$$

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

$$18. \frac{h^3}{h^{-6}} \quad h^9$$

$$19. k^0(k^4)(k^{-6}) \quad \frac{1}{k^2}$$

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

$$21. \frac{f^{-7}}{f^4} \quad \frac{1}{f^{11}}$$

$$22. \left(\frac{16p^5 q^2}{2p^3 q^3} \right)^0 \quad 1$$

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

$$24. \frac{15x^5 y^{-9}}{5xy^{11}} \quad 3x^5 y^2$$

$$25. \frac{-15w^6 u^{-1}}{5u^3} \quad -\frac{3}{u^4}$$

$$26. \frac{48x^6 y^7 z^5}{-6xy^5 z^6} \quad -\frac{8x^5 y^2}{z}$$



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. $\left(\frac{4f^2g}{3h^6}\right)^3$
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. $\frac{-12t^{-1}u^6v^{-4}}{2t^{-3}uv^5}$
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”?

Kuta Software - Infinite Algebra 1

Name _____

More Properties of Exponents

Date _____ Period _____

Simplify. Your answer should contain only positive exponents.

1) $(x^{-2}x^{-3})^4$

2) $(x^4)^{-3} \cdot 2x^4$

3) $(n^3)^3 \cdot 2n^{-1}$

4) $(2v)^2 \cdot 2v^2$

5) $\frac{2x^2y^4 \cdot 4x^2y^4 \cdot 3x}{3x^{-3}y^2}$

6) $\frac{2y^3 \cdot 3xy^3}{3x^2y^4}$

7) $\frac{x^3y^3 \cdot x^3}{4x^2}$

8) $\frac{3x^2y^2}{2x^{-1} \cdot 4yx^2}$

9) $\frac{x}{(2x^0)^2}$

10) $\frac{2m^{-4}}{(2m^{-4})^3}$

$$11) \frac{(2m^2)^{-1}}{m^2}$$

$$12) \frac{2x^3}{(x^{-1})^3}$$

$$13) (a^{-3}b^{-3})^0$$

$$14) x^4y^3 \cdot (2y^2)^0$$

$$15) ba^4 \cdot (2ba^4)^{-3}$$

$$16) (2x^0y^2)^{-3} \cdot 2yx^3$$

$$17) \frac{2k^3 \cdot k^2}{k^{-3}}$$

$$18) \frac{(x^{-3})^4 x^4}{2x^{-3}}$$

$$19) \frac{(2x)^{-4}}{x^{-1} \cdot x}$$

$$20) \frac{(2x^3z^2)^3}{x^3y^4z^2 \cdot x^{-4}z^3}$$

$$21) \frac{(2pm^{-1}q^0)^{-4} \cdot 2m^{-1}p^3}{2pq^2}$$

$$22) \frac{(2hj^2k^{-2} \cdot h^4j^{-1}k^4)^0}{2h^{-3}j^{-4}k^{-2}}$$

Kuta Software - Infinite Algebra 1

Name _____

More Properties of Exponents

Date _____ Period _____

Simplify. Your answer should contain only positive exponents.

1) $(x^{-2}x^{-3})^4$

$$\frac{1}{x^{20}}$$

2) $(x^4)^{-3} \cdot 2x^4$

$$\frac{2}{x^8}$$

3) $(n^3)^3 \cdot 2n^{-1}$

$$2n^8$$

4) $(2v)^2 \cdot 2v^2$

$$8v^4$$

5) $\frac{2x^2y^4 \cdot 4x^2y^4 \cdot 3x}{3x^{-3}y^2}$

$$8x^8y^6$$

6) $\frac{2y^3 \cdot 3xy^3}{3x^2y^4}$

$$\frac{2y^2}{x}$$

7) $\frac{x^3y^3 \cdot x^3}{4x^2}$

$$\frac{x^4y^3}{4}$$

8) $\frac{3x^2y^2}{2x^{-1} \cdot 4yx^2}$

$$\frac{3xy}{8}$$

9) $\frac{x}{(2x^0)^2}$

$$\frac{x}{4}$$

10) $\frac{2m^{-4}}{(2m^{-4})^3}$

$$\frac{m^8}{4}$$

$$11) \frac{(2m^2)^{-1}}{m^2}$$

$$\frac{1}{2m^4}$$

$$12) \frac{2x^3}{(x^{-1})^3}$$

$$2x^6$$

$$13) (a^{-3}b^{-3})^0$$

$$1$$

$$14) x^4y^3 \cdot (2y^2)^0$$

$$x^4y^3$$

$$15) ba^4 \cdot (2ba^4)^{-3}$$

$$\frac{1}{8b^2a^8}$$

$$16) (2x^0y^2)^{-3} \cdot 2yx^3$$

$$\frac{x^3}{4y^5}$$

$$17) \frac{2k^3 \cdot k^2}{k^{-3}}$$

$$2k^8$$

$$18) \frac{(x^{-3})^4 x^4}{2x^{-3}}$$

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

$$19) \frac{(2x)^{-4}}{x^{-1} \cdot x}$$

$$\frac{1}{16x^4}$$

$$20) \frac{(2x^3z^2)^3}{x^3y^4z^2 \cdot x^{-4}z^3}$$

$$\frac{8x^{10}z}{y^4}$$

$$21) \frac{(2pm^{-1}q^0)^{-4} \cdot 2m^{-1}p^3}{2pq^2}$$

$$\frac{m^3}{16p^2q^2}$$

$$22) \frac{(2hj^2k^{-2} \cdot h^4j^{-1}k^4)^0}{2h^{-3}j^{-4}k^{-2}}$$

$$\frac{h^3j^4k^2}{2}$$

