

Independent Practice

In Exercises 9–41, simplify, if possible.

9. $4^2 \cdot 4^3$ 4^5 or 1024

12. $10^2 \cdot 10^9$ 10^{11}

15. $[(2x + 3)^3]^2$ $(2x + 3)^6$

18. $[(5 + x)^3]^6$ $(5 + x)^{18}$

21. $(4a)^2 \cdot a$ $16a^3$

24. $(x \cdot x^2)^3 \cdot 3x$ $3x^{10}$

27. $2x^3 \cdot (3x)^2$ $18x^5$

30. $(-rs)(rs^3)^2$ $-r^3s^7$

33. $(4a^2)^3(\frac{1}{2}a^3)^2$ $16a^{12}$

36. $(-y)^4(-y)^3(-y)^2$ $-y^9$

39. $(abc^2)^3(a^2b)^2$ $a^7b^5c^6$

10. $6^5 \cdot 6^4$ 6^9 or 10,077,696

13. $x \cdot x^5$ x^6

16. $(2x)^3$ $8x^3$

19. $(-5a)^2$ $25a^2$

22. $6^2 \cdot (6x^3)^2$ 6^4x^6 or $1296x^6$

25. $(3a)^2 \cdot (-4a)^4$

28. $3y^2 \cdot (2y)^3$ $24y^5$

31. $(-2xy)^3(-x^2)$ $8x^5y^3$

34. $(8b^3)^2(\frac{1}{4}b^2)^2$ $4b^{10}$

37. $(2t)^3(-t^2)$ $-8t^5$

40. $(r^2st^3)^2(s^4t)^3$ $r^4s^{14}t^9$

25. $3^2(-4)^4a^6$ or $2304a^6$

$(-9)^8$ or 43,046,721

11. $[(-9)^2]^4$

14. $(5^5)^4$ 5^{20}

17. $(3 \cdot 7)^4$ 21^4 or 194,481

20. $(16 \cdot 2)^2$ 32^2 or 1024

23. $[(-3xy)^2]^3$

26. $(9a^3)^2 \cdot (2a)^3$

29. $(-ab)(a^2b)^2$ $-a^5b^3$

32. $(-3cd)^3(-d^2)$ $27c^3d^5$

35. $(-x)^5(-x)^2(-x)^3$ x^{10}

38. $(-w^3)(3w^2)^2$ $-9w^7$

41. $(-3xy^2)^3(-2x^2y)^2$
 $-108x^7y^8$

26. $2^{39}9^2a^9$ or $648a^9$

44. $(a^2 \cdot b)^3$ 8

47. $[(a + 4)^2]^3 \cdot (a + 4)$
78,125

In Exercises 42–47, evaluate the expression when $a = 1$ and $b = 2$.

42. $(a^4)^3$ 1

43. $b^3 \cdot b^4$ 128

45. $(a^2b)^5$ 32

46. $(b^2 \cdot b^3) \cdot (b^2)^4$ 8192

In Exercises 48–50, say which number is larger.

48. $(5 \cdot 7)^3$ or $5 \cdot 7^3$ $(5 \cdot 7)^3$

49. $5^4 \cdot 2^5$ or $(5 \cdot 2)^5$ $(5 \cdot 2)^5$

50. $(4^5 \cdot 4^{10})$ or 4^{50} 4^{50}



Pushed to the max by the algebra test, Tim's brain spontaneously combusted.

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

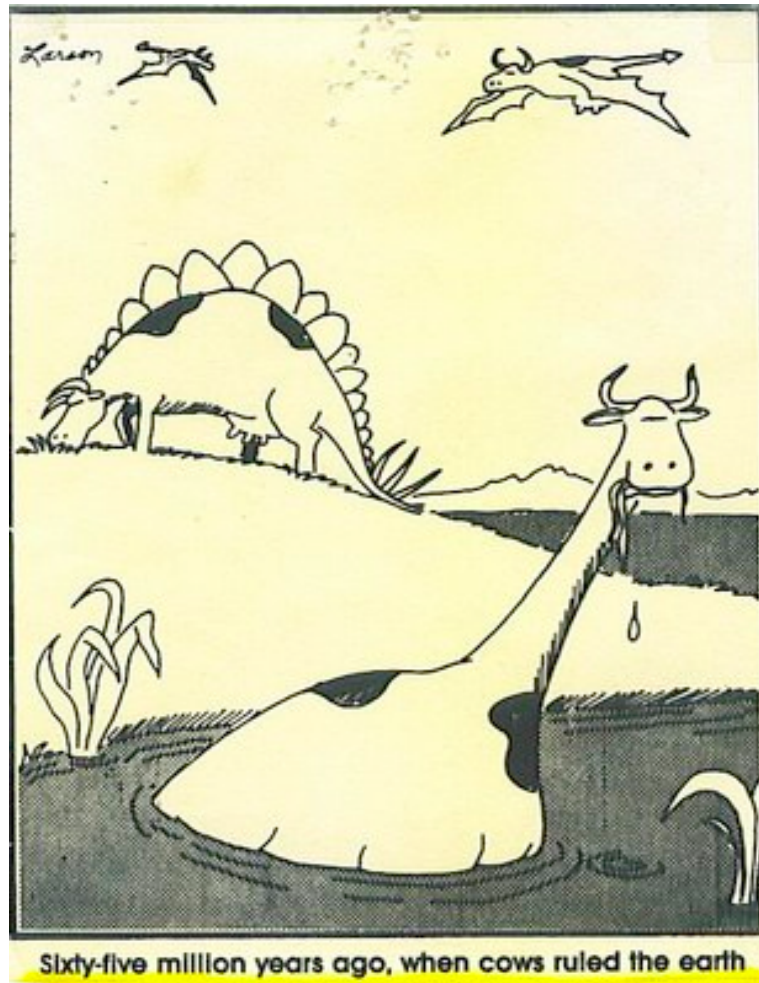
11. $(-4x^3)(-5x^7)$
 $20x^{10}$

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



Exercises**Simplify.**

1. $(y^5)^2$
 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. $(25a^2b)^3\left(\frac{1}{5}abc\right)^2$
 $625a^8b^5c^2$

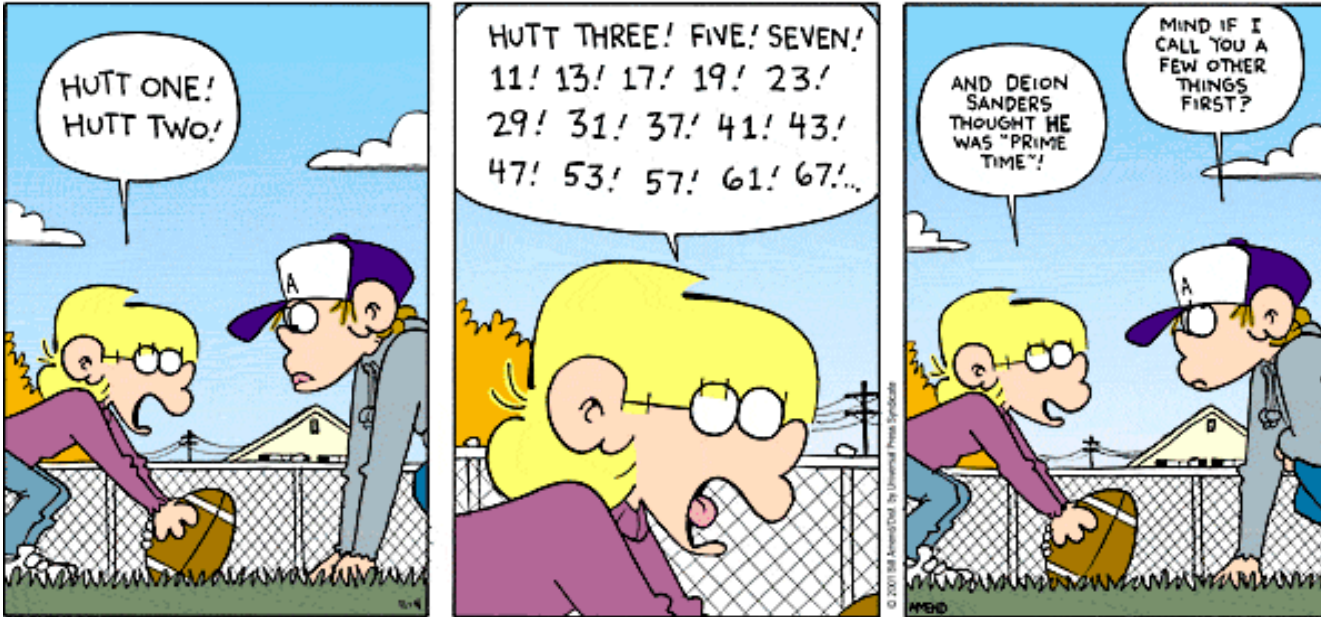
14. $(2xy)^2(-3x^2)(4y^4)$
 $-48x^4y^6$

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. $-3(2x)^4(4x^5y)^2$
 $-768x^{14}y^2$



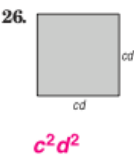
Determine whether each expression is a monomial. Write *yes* or *no*. Explain.

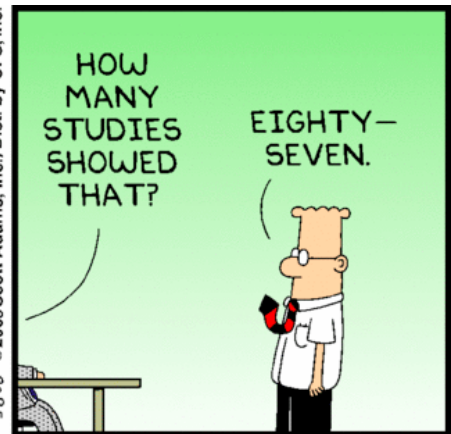
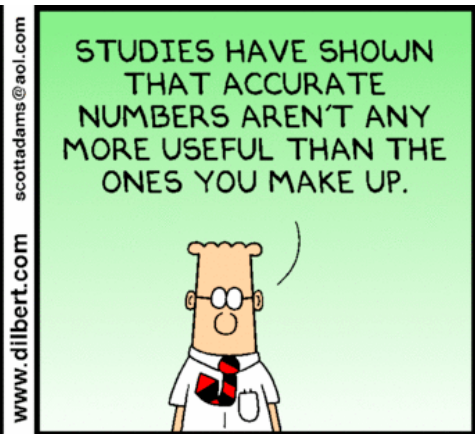
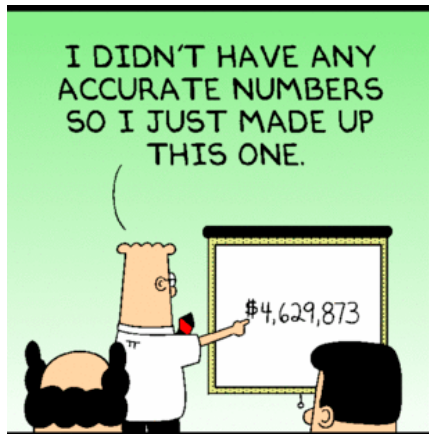
- 1. 11 **Yes; 11 is a real number and an example of a constant.**
- 2. $a - b$ **No; This is the difference, not the product, of two variables.**
- 3. $\frac{p^2}{q^2}$ **No; This is the quotient, not the product, of two variables.**
- 4. y **Yes; Single variables are monomials.**
- 5. j^3k **Yes; This 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. $(\ell^2k^2)(\ell^3k)$ 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. $(4xy^3)(3x^3y^5)$ $12x^4y^8$ | 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.





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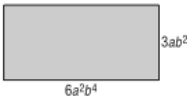


Determine whether each expression is a monomial. Write yes or no. Explain.

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

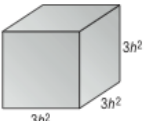
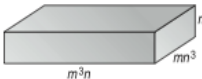
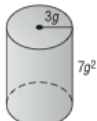
Simplify.

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

GEOMETRY Express the area of each figure as a monomial.

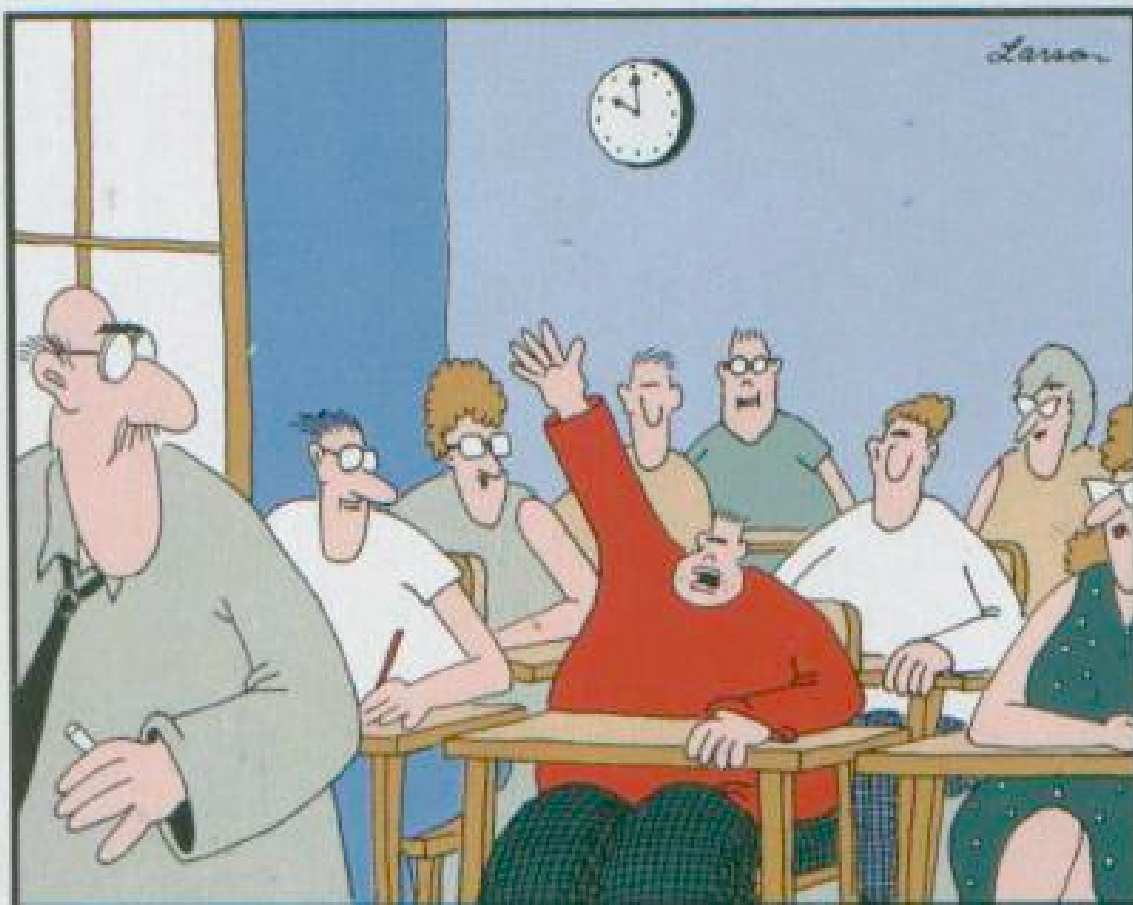
15.  **$18a^3b^6$**
16.  **$(25x^6)\pi$**
17.  **$12a^3c^4$**

GEOMETRY Express the volume of each solid as a monomial.

18.  **$27h^6$**
19.  **m^4n^5**
20.  **$(63g^4)\pi$**

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? **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**



**"Mr. Osborne, may I be excused?
My brain is full."**

Independent Practice

In Exercises 6–17, rewrite the expression using positive exponents.

6. $x^{-7} \frac{1}{x^7}$

7. $x^{-9} \frac{1}{x^9}$

8. $5x^{-4} \frac{5}{x^4}$

13. $\frac{x^6}{y^7}$

9. $3x^{-2}$

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

11. $\frac{1}{4x^{-5}} \frac{x^5}{4}$

12. $x^{-2}y^3 \frac{y^3}{x^2}$

13. x^6y^{-7}

14. $3x^{-3}y^{-8} \frac{3}{x^3y^8}$

15. $6x^{-2}y^{-4} \frac{6}{x^2y^4}$

16. $\frac{1}{7x^{-4}y^{-1}} \frac{x^4y}{7}$

17. $\frac{1}{2x^{-10}y^{12}}$

In Exercises 18–29, evaluate the expression.

18. $3^{-2} \frac{1}{9}$

19. $2^{-4} \frac{1}{16}$

20. $-4^0 \cdot \frac{1}{2^{-3}} - 4$

21. $4^{-3} \cdot 4^2$

22. $6^3 \cdot 6^{-1} 36$

23. $8^4 \cdot 8^{-4} 1$

24. $7^{-9} \cdot 7^9 1$

25. $(5^{-3})^2$

26. $(-4^{-2})^{-1} - 16$

27. $-6 \cdot (-6)^{-1} 1$

28. $5 \cdot 5^{-1} 1$

29. $2^0 \cdot 3^{-3}$

In Exercises 30–41, rewrite the expression using positive exponents.

30. $(-3)^0x x$

31. $(5y)^{-2} \frac{1}{25y^2}$

32. $(-2x)^{-3} - \frac{1}{8x^3}$

33. $(-4a)^0 1$

34. $(-3x)^{-1} \cdot 2y - \frac{2y}{3x}$

35. $(4xy)^{-2} \frac{1}{16x^2y^2}$

36. $(3x)^{-1} \frac{1}{3x}$

37. $(2a^{-3})^3$

38. $\frac{4}{b^{-2}} 4b^2$

39. $\frac{5}{a^{-4}} 5a^4$

40. $\frac{1}{(4x)^{-3}} 64x^3$

41. $\frac{1}{(2y)^{-5}} 32y^5$

In Exercises 42–45, say if the graph of the function contains the point (0, 1).

42. $y = -3^x$ No

43. $y = 4^x$ Yes

44. $y = 3 \cdot 1^x$ No

45. $y = 50^x$ Yes

46. **Population of Missouri** Between 1970 and 1990, Missouri's population increased at the rate of 0.47% per year. The population, P , in year t is given by

$$P = 4,903,000 \cdot 1.0047^t$$

where $t = 0$ corresponds to 1980. Find the population in 1970, 1980, and 1990.

$$4,678,406; 4,903,000; 5,138,376$$

47. **Population of Buffalo** Between 1970 and 1990, the population of Buffalo, New York, decreased at the rate of 0.82% per year. The population, P , in year t is given by

$$P = 1,025,000 \cdot 0.9918^t$$

where $t = 0$ corresponds to 1980. Find the population in 1970, 1980, and 1990.



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**

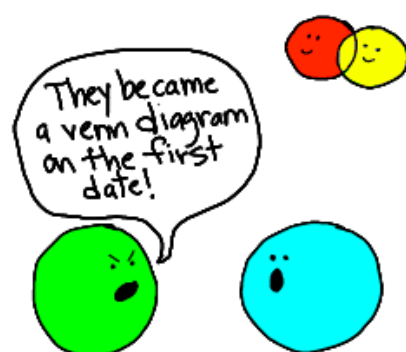
8. $\frac{(6a^{-1}b)^2}{(b^2)^4}$ **$\frac{36}{a^2b^6}$**

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. $\frac{(-2mn^2)^{-3}}{4m^{-6}n^4}$ **$-\frac{m^3}{32n^{10}}$**



Simplify. Assume that no denominator is equal to zero.

$$1. \frac{8^8}{8^4} \quad \mathbf{8^4 \text{ or } 4096}$$

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

$$3. \frac{xy^2}{xy} \quad \mathbf{y}$$

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

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

$$6. \frac{8y^7z^6}{4y^6z^5} \quad \mathbf{2yz}$$

$$7. \left(\frac{4f^3g}{3h^6}\right)^3 \quad \mathbf{\frac{64f^9g^3}{27h^{18}}}$$

$$8. \left(\frac{6w^5}{7p^6s^3}\right)^2 \quad \mathbf{\frac{36w^{10}}{49p^{12}s^6}}$$

$$9. \frac{-4c^2}{24c^5} \quad \mathbf{-\frac{1}{6c^3}}$$

$$10. x^3(y^{-5})(x^{-8}) \quad \mathbf{\frac{1}{x^5y^5}}$$

$$11. p(q^{-2})(r^{-3}) \quad \mathbf{\frac{p}{q^2r^3}}$$

$$12. 12^{-2} \quad \mathbf{\frac{1}{144}}$$

$$13. \left(\frac{3}{7}\right)^{-2} \quad \mathbf{\frac{49}{9}}$$

$$14. \left(\frac{4}{3}\right)^{-4} \quad \mathbf{\frac{81}{256}}$$

$$15. \frac{22r^3s^2}{11r^2s^{-3}} \quad \mathbf{2rs^5}$$

$$16. \frac{-15u^6u^{-1}}{5u^3} \quad \mathbf{-\frac{3}{u^4}}$$

$$17. \frac{8c^3d^2f^4}{4c^{-1}d^2f^{-3}} \quad \mathbf{2c^4d^4f^7}$$

$$18. \left(\frac{x^{-3}y^5}{4^{-3}}\right)^0 \quad \mathbf{1}$$

$$19. \frac{6f^{-2}g^3h^5}{54f^{-2}g^{-5}h^3} \quad \mathbf{\frac{g^8h^2}{9}}$$

$$20. \frac{-12t^{-1}u^5v^{-4}}{2t^{-3}uv^5} \quad \mathbf{-\frac{6t^2u^4}{v^9}}$$

$$21. \frac{r^4}{(3r)^3} \quad \mathbf{\frac{r}{27}}$$

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

$$23. \frac{(j^{-1}k^3)^{-4}}{j^3k^3} \quad \mathbf{\frac{j}{k^{15}}}$$

$$24. \frac{(2a^{-2}b)^{-3}}{5a^2b^4} \quad \mathbf{\frac{a^4}{40b^7}}$$

$$25. \left(\frac{q^{-1}r^3}{qr^{-2}}\right)^{-5} \quad \mathbf{\frac{q^{10}}{r^{25}}}$$

$$26. \left(\frac{7c^{-3}d^3}{c^5de^{-4}}\right)^{-1} \quad \mathbf{\frac{c^8}{7d^2e^4}}$$

$$27. \left(\frac{2x^3y^2z}{3x^4yz^{-2}}\right)^{-2} \quad \mathbf{\frac{9x^2}{4y^2z^6}}$$

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? $\mathbf{\frac{1}{484}}$

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”? $\mathbf{676}$

