Think

Why must like variables be grouped together?

To simplify by adding exponents, the bases must be the same.



Problem 6 Simplifying Expressions With Rational Exponents

Simplify the expression $\left(2a^{\frac{2}{3}} \cdot 3b^{\frac{1}{4}}\right)\left(a^{\frac{1}{3}} \cdot 5b^{\frac{1}{2}}\right)$.

=
$$(2 \cdot 3 \cdot 5) \left(a^{\frac{2}{3}} \cdot a^{\frac{1}{3}} \right) \left(b^{\frac{1}{4}} \cdot b^{\frac{1}{2}} \right)$$

= $(2 \cdot 3 \cdot 5) \left(a^{\frac{2}{3}} \cdot a^{\frac{1}{3}}\right) \left(b^{\frac{1}{4}} \cdot b^{\frac{1}{2}}\right)$ Commutative and associative properties of multiplication

$$=30\left(a^{\frac{2}{3}}\cdot a^{\frac{1}{3}}\right)\left(b^{\frac{1}{4}}\cdot b^{\frac{1}{2}}\right)$$

Simplify.

$$=30\left(a^{\frac{3}{3}}\right)\left(b^{\frac{3}{4}}\right)$$

Add exponents that have the same base.

$$=30ab^{\frac{3}{4}}$$

Simplify.



Got It? 6. Simplify each expression.

a.
$$2c^{\frac{3}{5}} \cdot 2c^{\frac{1}{5}}$$

c.
$$\left(b^{\frac{2}{3}} \cdot c^{\frac{2}{5}}\right) \left(b^{\frac{4}{9}} \cdot c^{\frac{9}{10}}\right)$$

b.
$$n^{\frac{1}{3}} \cdot n^{\frac{4}{3}}$$

d.
$$(3j^{\frac{2}{3}} \cdot 7m^{\frac{1}{4}})(3j^{\frac{1}{6}} \cdot 7m^{\frac{3}{2}})$$



Lesson Check

Do you know HOW?

- **1.** What is $8^4 \cdot 8^8$ written using each base only once?
- **2.** What is the simplified form of $2n^{\frac{2}{3}} \cdot 3n^{\frac{3}{4}}$?
- 3. What is $(3 \times 10^5)(8 \times 10^4)$ written in scientific notation?
- 4. Measurement The diameter of a penny is about 1.9×10^{-5} km. It would take about 2.1×10^{9} pennies placed end to end to circle the equator once. What is the approximate length of the equator?

Do you UNDERSTAND? (MATHEMATICAL PRACTICES



- **6 5. Writing** Can $x^8 \cdot y^3$ be written as a single power? Explain your reasoning.
- **6. Reasoning** Suppose $a \times 10^m$ and $b \times 10^n$ are two numbers in scientific notation. Is their product $ab \times 10^{m+n}$ always, sometimes, or never a number in scientific notation? Justify your answer.
- **(a)** 7. Error Analysis Your friend says $4a^{\frac{1}{2}} \cdot 3a^{\frac{1}{5}} = 7a^{\frac{1}{7}}$. Explain your friend's error. What is the correct answer?



Practice and Problem-Solving Exercises





Rewrite each expression using each base only once.



8 73 . 74

14. m^3m^4

- 9. $(-6)^{12} \cdot (-6)^5 \cdot (-6)^2$
- 10. $9^6 \cdot 9^{-4} \cdot 9^{-2}$

11. $2^2 \cdot 2^7 \cdot 2^0$

- 12. $5^{-2} \cdot 5^{-4} \cdot 5^{8}$
- 13. $(-8)^5 \cdot (-8)^{-5}$

Simplify each expression.

15. $5c^4 \cdot c^6$

16. $4t^{-5} \cdot 2t^{-3}$

- 17. $(x^5y^2)(x^{-6}y)$
- **18.** $(5x^5)(3y^6)(3x^2)$
- 19. $-m^2 \cdot 4r^3 \cdot 12r^{-4} \cdot 5m$

Write each answer in scientific notation.

PowerAlgebra.com,

See Problem 3.

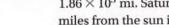
See Problem 1.

See Problem 2.



STEM 20. Biology A human body contains about 2.7×10^4 microliters (μ L) of blood for each pound of body weight. Each microliter of blood contains about 7×10^4 white blood cells. About how many white blood cells are in the body of a 140-lb person?

429



STEM 21. Astronomy The distance light travels in one second (one light-second) is about 1.86×10^5 mi. Saturn is about 475 light-seconds from the sun. About how many miles from the sun is Saturn?

See Problem 4.

See Problem 5.

22. 83

23. 6254

24. 1000¹/₃

Simplify each expression.

Simplify each expression.

25. 16³

26. 92

27. 643

Simplify each expression.

28. $\left(8b^{\frac{2}{3}} \cdot 9t^{\frac{1}{5}}\right) \left(8b^{\frac{5}{3}} \cdot 9t^{\frac{3}{5}}\right)$

29. $(7d^{\frac{3}{2}} \cdot 2g^{\frac{5}{6}})(2g^{\frac{3}{2}} \cdot 7d^{\frac{5}{6}})$ **30.** $(4r^{\frac{2}{5}} \cdot 5s^{\frac{2}{7}})(5s^{\frac{5}{7}} \cdot 4r^{\frac{3}{5}})$

See Problem 6.



Complete each equation.

31.
$$5^2 \cdot 5^{11} = 5^{11}$$

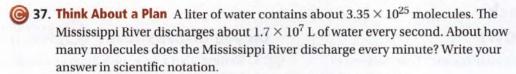
32.
$$m^{\blacksquare} \cdot m^{-4} = m^{-9}$$

33.
$$2^{1} \cdot 2^{\frac{1}{2}} = 2^{1}$$

34.
$$a^{11} \cdot a^4 = 1$$

35.
$$a^{\frac{2}{3}} \cdot a^{11} = a^{\frac{5}{6}}$$

36.
$$x^3y^{-1} \cdot x^{-1} = y^2$$



- · How can you use unit analysis to help you find the answer?
- · What properties can you use to make the calculation easier?

38. When you simplify an algebraic expression like $c^{\frac{3}{5}} \cdot c^{\frac{1}{2}}$, you know that the bases of the expressions must be the same. You also need to rewrite the exponents so that they have a common denominator.

- a. Explain why you need to find the common denominator to simplify.
- **b.** Simplify the expression $c^{\frac{3}{5}} \cdot c^{\frac{1}{2}}$.

Simplify each expression. Write each answer in scientific notation.

39.
$$(9 \times 10^7)(3 \times 10^{-16})$$

40.
$$(0.5 \times 10^{-6})(0.3 \times 10^{-2})$$
 41. $(0.2 \times 10^{5})(4 \times 10^{-12})$

41.
$$(0.2 \times 10^5)(4 \times 10^{-12})$$



SIEM 42. Chemistry In chemistry, a mole is a unit of measure equal to 6.02×10^{23} atoms of a substance. The mass of a single neon atom is about 3.35×10^{-23} g. What is the mass of 2 moles of neon atoms? Write your answer in scientific notation.

Simplify each expression.

43.
$$\frac{1}{a^4 \cdot a^{-3}}$$

44.
$$8m^{\frac{1}{3}}(m^{\frac{1}{3}}+2)$$

45.
$$-4x^3(3x^3-10x)$$



6 46. a. Open-Ended Write y^6 as a product of two powers with the same base in four different ways. Use only positive exponents.

b. Write y^6 as a product of two powers with the same base in four different ways, using negative or zero exponents in each product.

c. Reasoning How many ways can you write y^6 as the product of two powers? Explain your reasoning.