



Real-World Link

Aquariums The Marine Club at Westview Middle School purchased an aquarium. The aquarium is in the shape of a cube with a side length of 2^4 inches. Use the questions to find the amount of water the aquarium will hold.

- Write a multiplication expression to represent the volume of the aquarium. $2^4 \cdot 2^4 \cdot 2^4$

- Simplify the expression. Write as a single power of 2. 2^{12}

- Using 2^4 as the base, write the multiplication expression $2^4 \cdot 2^4 \cdot 2^4$ using an exponent. $(2^4)^3$

- Explain why $(2^4)^3 = 2^{12}$. **Sample answer: Both expressions represent the volume of the same cube.**

- Use a calculator to find the volume of the tank.

$4,096$ cubic inches

- One gallon of water is equal



Essential

WHY is it helpful to use powers of numbers in different contexts?



Common State Standards

Content Standards
8.EE.1

MP Mathematical Practices
1, 3, 4, 7



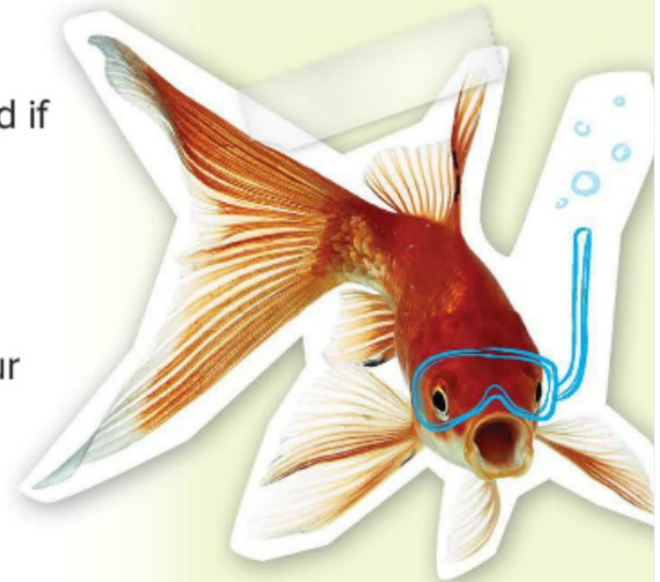
5. Use a calculator to find the volume of the tank.

4,096 cubic inches

6. One gallon of water is equal to 231 cubic inches. Write an expression to find how many gallons of water the tank will hold if

it is filled to the top. $\frac{4,096 \text{ cubic inches}}{231}$ ← converting!

7. How many gallons of water will the aquarium hold? Round your answer to the nearest gallon. **18** gallons



Which **MP** **Mathematical Practices** did you use?

Shade the circle(s) that applies.

① Persevere with Problems

⑤ Use Math Tools

② Reason Abstractly



Examples

Simplify using the Laws of Exponents.

1. $(8^4)^3 = 8^4 \cdot 8^4 \cdot 8^4$

$$(8^4)^3 = 8^{4 \cdot 3} \quad \text{Power of a Power}$$

$$= 8^{12} \quad \text{Simplify.}$$

2. $(k^7)^5$

$$(k^7)^5 = k^{7 \cdot 5} \quad \text{Power of a Power}$$

$$= k^{35} \quad \text{Simplify.}$$

Got it? Do these problems to find out.

a. $(2^5)^2$

b. $(w^4)^6$

c. $[(3^2)^3]^2$

a. 2^{10}

b. w^{24}

c. 3^{12}

Show
your
work.



3. $(4p^3)^4$

$$(4p^3)^4 = 4^4 \cdot p^{3 \cdot 4} \quad \text{Power of a Product}$$

$$= 256p^{12} \quad \text{Simplify.}$$

4. $(-2m^7n^6)^5$

$$(-2m^7n^6)^5 = (-2)^5 m^{7 \cdot 5} n^{6 \cdot 5} \quad \text{Power of a Product}$$

$$= -32m^{35}n^{30} \quad \text{Simplify.}$$

Got it? Do these problems to find out.

d. $(8b^9)^2$

e. $(6x^5y^{11})^4$

f. $(-5w^2z^8)^3$

$$(-5w^2z^8)(-5w^2z^8)(-5w^2z^8)$$

$$-125w^6z^{24}$$

Show your work.

d. $64b^{18}$

e. $1,296x^{20}y^{44}$

f. $-125w^6z^{24}$





Guided Practice



Simplify using the Laws of Exponents. (Examples 1–4)

1. $(3^2)^5 = \underline{3^{10} \text{ or } 59,049}$



2. $(h^6)^4 = \underline{h^{24}}$

3. $[(2^3)^2]^3 = \underline{2^{18} \text{ or } 262,144}$

4. $(7w^7)^3 = \underline{343w^{21}}$

5. $(5g^8k^{12})^4 = \underline{625g^{32}k^{48}}$

6. $(-6r^5s^9)^2 = \underline{36r^{10}s^{18}}$
 $(-6r^5s^9)(-6r^5s^9)$

7. The floor of the commons room at King Middle School



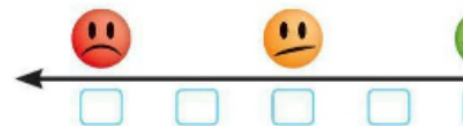
7. The floor of the commons room at King Middle School is in the shape of a square with side lengths of x^2y^3 feet. New tile is going to be put on the floor of the room. Find the area of the floor. (Example 5) $x^4y^6 \text{ ft}^2$

8.  **Building on the Essential Question** How does the Product of Powers law apply to finding the power of a power?

Sample answer: You can write out the power of a power as a multiplication problem with factors having the same base. Then you can apply the Product of Powers law to simplify.

Rate Yourself!

How confident are you about powers of monomials? Check the box that applies.



For more help, go online to access a Personal Tutor.

FOLDABLES Time to update your Foldables!

Simplify using the Laws of Exponents. (Examples 1–4)

1. $(4^2)^3 = 4^6$

2. $(5^3)^3 = 5^9$

4. $(h^4)^9 = h^{36}$

5. $[(3^2)^2]^2 = 3^8$

7. $(5j^6)^4 = 625j^{24}$

8. $(11c^4)^3 = 1,331c^{12}$

10. $(2m^5n^{11})^6 = 64m^{30}n^{66}$

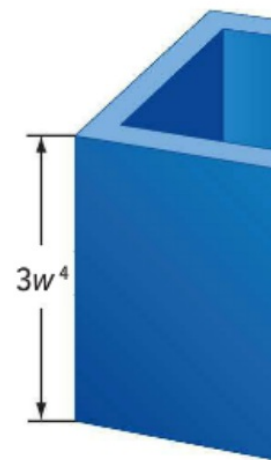
11. $(-3w^3z^8)^5 = -243w^{15}z^{40}$

- 13** A shipping box is in the shape of a cube. Each side measures $3c^6d^2$ inches. Express the volume of the cube as a monomial. (Example 5)

$$27c^{18}d^6 \text{ in}^3$$

- 14.** Tamara is decorating her patio with a planter in the shape of a cube like the one shown. Find the volume of the planter. (Example 5)

$$27w^{12} \text{ units}^3$$



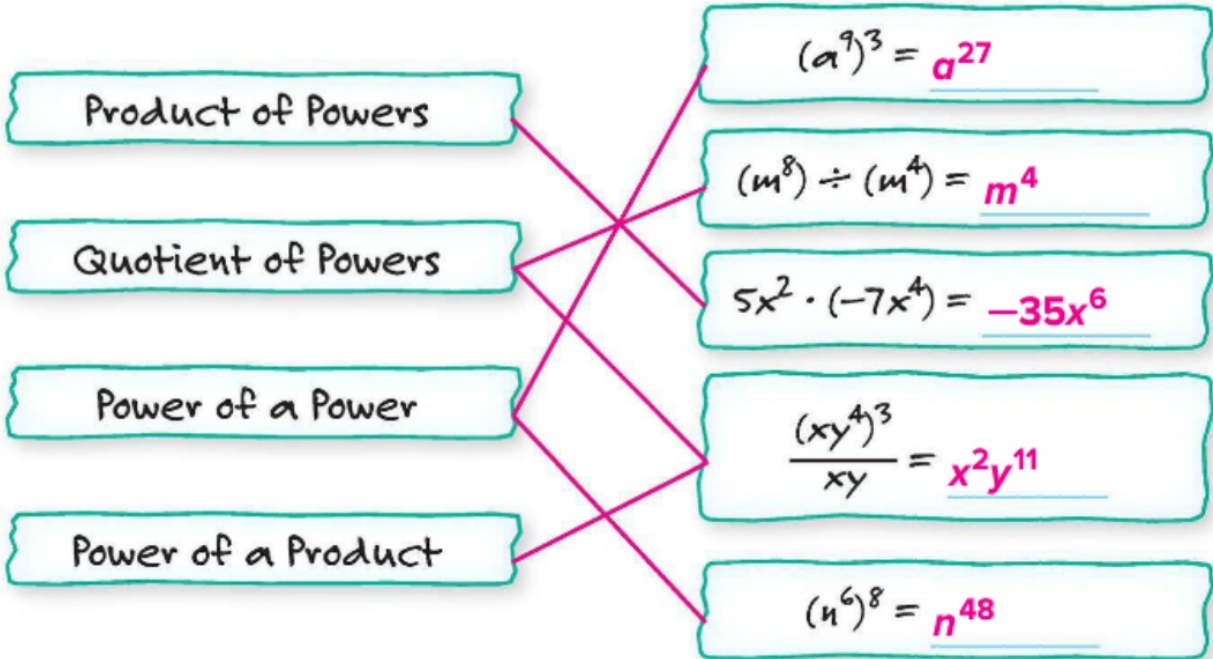
Copy and Solve Simplify. Show your work on a separate sheet of paper.

15. $[(3x^2y^3)^2]^3$ $729x^{12}y^{18}$

16. $\left(\frac{3}{5}a^6b^9\right)^2$ $\frac{9}{25}a^{12}b^{18}$

17 $(-2v^7)^3(-4v^2)^4$

3. **MP Identify Structure** Draw a line connecting the Law(s) of Exponents you would use to simplify each of the expressions. Then simplify each one.



H.O.T. Problems Higher Order Thinking



H.O.T. Problems Higher Order Thinking

19. **MP Reason Inductively** The table gives the area and volume of a square and cube, respectively, with side lengths shown.

- Complete the table.
- Describe how the area and volume are each affected if the side length is doubled. Then describe how they are each affected if the side length is tripled.

Side Length (units)	x	$2x$	$3x$
Area of Square (units ²)	x^2	$(2x)^2$ or $4x^2$	$(3x)^2$ or $9x^2$
Volume of Cube (units ³)	x^3	$(2x)^3$ or $8x^3$	$(3x)^3$ or $27x^3$

If the side length is doubled, the area is quadrupled and the volume is multiplied by 8. If the side length is tripled, the area is multiplied by 9 and the volume is multiplied by 27.

MP Persevere with Problems Solve each equation for x .

20. $(7^x)^3 = 7^{15}$ 5

21. $(-2m^3n^4)^x = -8m^9n^{12}$ 3

is multiplied by 8. If the side length is tripled, the area is multiplied by 9 and the volume is multiplied by 27.

MP Persevere with Problems Solve each equation for x .

20. $(7^x)^3 = 7^{15}$ 5

21. $(-2m^3n^4)^x = -8m^9n^{12}$ 3

22. **MP Reason Inductively** Compare how you would correctly simplify the expressions $(2a^3)(4a^6)$ and $(2a^3)^6$.

Sample answer: To simplify $(2a^3)(4a^6)$, multiply 2 by 4. Then add the exponents 3 and 6 and write this sum as the final exponent on a . To simplify $(2a^3)^6$, evaluate 2^6 . Then multiply the exponents 3 and 6 and write this product as the final exponent on a .

