Get out your homework and have it ready to check. Warm Up by simplifying the expressions below. TARGET CHECK WEDNESDAY

Classwork - Power of a Power Exponent Property

$-4x^3 \cdot 5x^2 \cdot y^5$

$-4 \cdot x^3 \cdot 5 \cdot x^2 \cdot y^5$

$-20x^5y^5$

$\frac{6g^8}{10g^1}$

$\frac{3}{5} \cdot \frac{g^7}{1}$

OR $\frac{3}{5} \cdot g^7$

OR $\frac{3g^7}{5}$

OR $0.6g^7$

$\frac{3a^2 \cdot 9a^5}{2a^3}$

$\frac{27a^7}{2a^3}$

$\frac{27}{2}a^4$

$13.5a^4$

OR

**Simplify. Express using exponents.**

**1.** $5^9 \cdot 5^3$

$5^{12}$

**2.** $3^8 \cdot 3$

$3^9$

**3.** $c \cdot c^6$

$c^7$

**4.** $m^5 \cdot m^2$

$m^7$

**5.** $3x \cdot 4x^4$

$12x^5$

**6.** $(2h^7)(7h)$

$14h^8$

**7.** $-5d^6(8d^6)$

$-40d^{12}$

$(-40d)^{12}$

**8.** $(6k^5)(-k^4)$

$-6k^9$

**9.** $(-w)(-10w^3)$

$10w^4$

**10.** $-7z^4(-3z^8)$

$21z^{12}$

**11.** $bc^3(b^2c)$

$b^3c^4$

**12.** $3a^4 \cdot 6a^2$

$18a^6$

**13.** $3m^3n^2(8mn^3)$

$24m^4n^5$

**14.** $7t^5(-6t^5)$

$-42t^{10}$

**15.** $(3ab^2)(a^2c^5)$

$3a^3b^2c^5$

**16.** $(9p^4)(-8p^2)$

$-72p^6$

17. $\frac{2^9}{2^3}$ **$2^6$**

18. $\frac{3^8}{3^4}$ **$3^4$**

19. $\frac{5^9}{5^2}$ **$5^7$**

20. $\frac{8^7}{8}$ **$8^6$**

21. $\frac{b^{12}}{b^5}$ **$b^7$**

22. $\frac{12n^5}{4n^2}$ **$3n^3$**

23. $\frac{14m^3}{7m^2}$ **$2m$**

24. $\frac{9r^8}{3r^4}$ **$3r^4$**

25. $\frac{24t^9}{6t^3}$ **$4t^6$**

26. $\frac{18y^6}{2y}$ **$9y^5$**

27. $\frac{a^4c^6}{a^2c}$ **$a^2c^5$**

28. $\frac{5^{10}}{5^2}$ **$5^8$**

**Simplify.**

29. $\frac{4^8 \cdot 5^3 \cdot 7^6}{4^6 \cdot 5^2 \cdot 7^5}$. **560** $4^2 \cdot 5 \cdot 7$

30. $\frac{(-2)^9 \cdot (-3)^7 \cdot 4^3}{(-2)^5 \cdot (-3)^5 \cdot 4^1}$. **2,304** $(-2)^4 \cdot (-3)^2 \cdot 4^2$

31. $\frac{3^{10} \cdot (-6)^5}{3^7 \cdot (-6)^2}$. **−5,832** $3^3 \cdot (-6)^3$

32. $\frac{9^8 \cdot 10^{12}}{9^6 \cdot 10^6}$. **81,000,000** $9^2 \cdot 10^6$

## 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 willl hold.

1. Write a multiplication expression to represent the volume of the aquarium. _____

2. Simplify the expression. Write as a single power of 2. ☐

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

4. Explain why $(2^4)^3 = 2^{12}$. _____

   _____

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

   ☐ 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. $\frac{\square}{\square}$

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

## Power of a Power

**Words** To find the power of a power, multiply the exponents.

**Examples**

| Numbers | Algebra |
| --- | --- |
| $(5^2)^3 = 5^{2 \cdot 3}$ or $5^6$ | $(a^m)^n = a^{m \cdot n}$ |

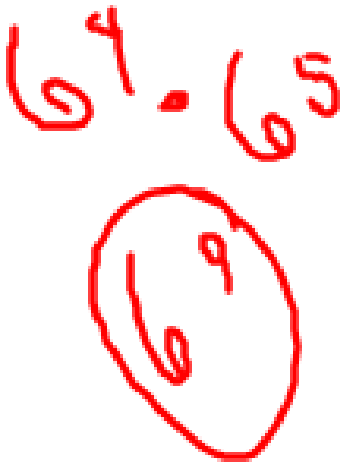
You can use the rule for finding the *product* of powers to discover another Law of Exponents for finding the *power* of a power.

$$(6^4)^5 = \overbrace{(6^4)(6^4)(6^4)(6^4)(6^4)}^{\text{5 factors}}$$

$$= 6^{4+4+4+4+4}$$ Apply the rule for the product of powers.

$$= 6^{20}$$

Notice that the product of the original exponents, 4 and 5, is the final power 20.



## Examples

Watch Tutor

**Simplify using the Laws of Exponents.**

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

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

$= 8^{12}$ Simplify.

**2.** $(k^7)^5$

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

$= k^{35}$ Simplify.

Ex: $[(h^3)^4)]^2$ $h^{24}$

**Got it?** Do these problems to find out.

a. $(2^5)^2$ $2^{10}$

b. $(w^4)^6$ $w^{24}$

c. $[(3^2)^3]^2$ $3^{12}$

# Power of a Product

**Words** To find the power of a product, find the power of each factor and multiply.

**Examples**

Numbers: $(6x^2)^3 = (6)^3 \cdot (x^2)^3$ or $216x^6$

Algebra: $(ab)^m = a^m b^m$

Extend the power of a *power* rule to find the Laws of Exponents for the power of a *product*.

$(3 \cdot a^2)^5$

$$(3a^2)^5 = \overbrace{(3a^2)(3a^2)(3a^2)(3a^2)(3a^2)}^{\text{5 factors}}$$

$$= 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot a^2 \cdot a^2 \cdot a^2 \cdot a^2 \cdot a^2$$

$$= 3^5 \cdot (a^2)^5 \quad \text{Write using powers.}$$

$$= 243 \cdot a^{10} \text{ or } 243a^{10} \quad \text{Power of a Power}$$

## Examples

**Simplify using the Laws of Exponents.**

**3.** $(4p^3)^4$ → $(4)^4 \cdot (p^3)^4$ → $256p^{12}$

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

$= 256p^{12}$ Simplify.

**4.** $(-2m^7n^6)^5$ → $(-2)^5 \cdot (m^7)^5 \cdot (n^6)^5$ → $-32m^{35}n^{30}$

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

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

**Got it?** Do these problems to find out.

d. $(8b^9)^2$ → $(8)^2 \cdot (b^9)^2$ → $64b^{18}$

e. $(6x^5y^{11})^4$ → $(6)^4 \cdot (x^5)^4 \cdot (y^{11})^4$ → $1296x^{20}y^{44}$

f. $(-5w^2z^8)^3$ → $(-5)^3 \cdot (w^2)^3 \cdot (z^8)^3$ → $-125w^6z^{24}$