Lesson 3

Powers of Monomials

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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. $(8^4)^3$

$(8^4)^3 = 8^{4 \cdot 3}$ 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.

Got It? Do these problems to find out.

a. $(2^5)^2$ b. $(w^4)^6$ c. $[(3^2)^3]^2$

2^{10} w^{24} 3^{12}

$(2^5)(2^5)$

Power of a Product

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

Examples

Numbers	Algebra
$(6x^2)^3 = (6)^3 \cdot (x^2)^3$ or $216x^6$	$(ab)^m = a^m b^m$

$(6x^2)(6x^2)(6x^2)$

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

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

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

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

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

Examples

Tutor

Simplify using the Laws of Exponents.

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

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

$= 256p^{12}$ Simplify.

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

$(-2m^7n^6)^5 = (-2)^5m^{7\cdot5}n^{6\cdot5}$ Power of a Product

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

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

$(-5)^3w^6z^{24}$

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

Got It? Do these problems to find out.

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

$(8^1b^9)^2$

8^2b^{18}

$64b^{18}$

OR $(8b^9)^2$

$(8b^9)(8b^9)$

$64b^{18}$

Same

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

e $(6^1x^5y^{11})^4$ multiply

$6^4x^{20}y^{44}$

$1296x^{20}y^{44}$

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

Real World **Example** Tutor

5. A magazine offers a special service to its subscribers. If they scan the square logo shown on a smartphone, they can receive special offers from the magazine. Find the area of the logo.

$A = s^2$ Area of a square

$A = (7a^4b)^2$ Replace s with $7a^4b$.

$A = 7^2(a^4)^2(b^1)^2$ Power of a Product

$A = 49a^8b^2$ Simplify.

The area of the logo is $49a^8b^2$ square units.

$7a^4b$

Area of Square:

$A = S^2$ or $A = S \times S$

$A = (7^1a^4b^1)^2$ OR $A = (7a^4b^1)(7a^4b^1)$

$A = 7^2a^8b^2$

$A = 49a^8b^2$

$A = 49a^8b^2$

Guided Practice

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

1. $(3^2)^5 =$ _____

show your work.

3^{10}

2. $(h^6)^4 =$ _____

h^{24}

3. $[(2^3)^2]^3 =$ _____

2^{18}

4. $(7w^7)^3 =$ _____

$(7^1w^7)^3$

7^3w^{21}

$343w^{21}$

5. $(5g^8k^{12})^4 =$ _____

$(5^1g^8k^{12})^4$

$5^4g^{32}k^{48}$

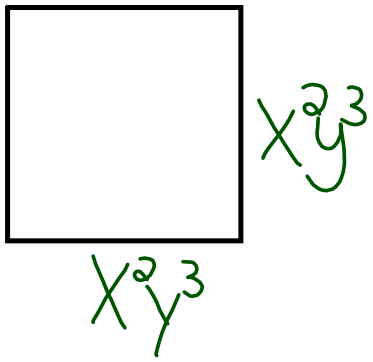
$625g^{32}k^{48}$

6. $(-6r^5s^9)^2 =$ _____

$(-6)^2r^{10}s^{18}$

$36r^{10}s^{18}$

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)



$A = S \times S$

$A = (x^2y^3)(x^2y^3)$

$A = x^4y^6$

Independent Practice

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

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

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

3. $(d^7)^6 =$ _____

4. $(h^4)^9 =$ _____

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

6. $[(5^2)^2]^2 =$ _____

7. $(5j^6)^4 =$ _____

8. $(11c^4)^3 =$ _____

9. $(6a^2b^6)^3 =$ _____

10. $(2m^5n^{11})^6 =$ _____

11. $(-3w^3z^8)^5 =$ _____

12. $(-5r^4s^{12})^4 =$ _____

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)

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)

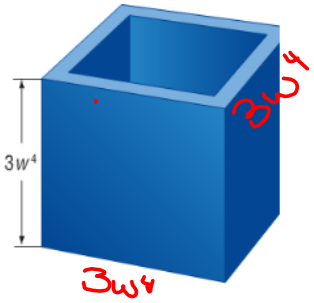
$V = s^3$ or $(3w^4)(3w^4)(3w^4)$

$V = (3w^4)^3$

$V = (3^1)^3 (w^4)^3$

$V = 3^3 w^{12}$

$V = 27w^{12}$



$V = \ell w h$

$V = s \cdot s \cdot s$

$V = s^3$

15. $[(3x^2y^3)^2]^3$

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

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

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

Product of Powers	$(a^9)^3 =$ _____
Quotient of Powers	$(m^8) \div (m^4) =$ _____
Power of a Power	$5x^2 \cdot (-7x^4) =$ _____
Power of a Product	$\frac{(xy^4)^3}{xy} =$ _____
	$(n^6)^8 =$ _____

Standardized Test Practice

22. Which expression is equivalent to $(10^4)^8$?

Ⓐ 10^2 Ⓒ 10^{12}

Ⓑ 10^4 Ⓓ 10^{32}

Practice

39. What is the volume of the cube shown below?

Ⓐ $8m^3$ Ⓒ $64m^9$

Ⓑ $16m^5$ Ⓓ $512m^9$

40. Which expression has the same value as $81h^8k^6$?

Ⓕ $(9h^6k^4)^2$ Ⓗ $(6h^5k^3)^3$

Ⓖ $(9h^4k^3)^2$ Ⓘ $(3h^2k)^6$

41. Which expression is equivalent to $(2x^2)^4(5x^6)$?

Ⓐ $10x^{12}$ Ⓒ $10x^{14}$

Ⓑ $80x^{12}$ Ⓓ $80x^{14}$

42. **Short Response** Manny has four pieces of carpet in the shape of a square like the one shown. He wants to use them together to carpet a portion of his basement. What is the area of the space he can cover with the carpet? _____