7.1 Product of Powers Property

Learning Target: Generate equivalent expressions involving

Success Criteria:
- I can write products using exponents an
involving powers.
- I can find products of powers that have
- I can find powers of powers and powers

then go to
497

try 7, 8, 9
10, 11, 12

Number Sense and Operations
MA.8.NSO.1.3 Extend previous understanding of the Laws of Exponent
Exponents to evaluate numerical expressions and generate equivalent nu
rational number bases, with procedural fluency.
Algebraic Reasoning
MA.8.AR.1.1 Apply the Laws of Exponents to generate equivalent algeb
monomial bases.

Exploration 1 Finding Products of Powers

Work with a partner.

a. Complete the table. Use your results to write a *general rule* for finding $a^m \cdot a^n$, a product of two powers with the same base.

Product	Repeated Multiplication Form	Power
$(-3)^2 \cdot (-3)^4$	$(-3) \cdot (-3) \cdot (-3) \cdot (-3) \cdot (-3) \cdot (-3)$	-3^6
$5.1^1 \cdot 5.1^6$	$5.1 \cdot 5.1 \cdot 5.1 \cdot 5.1 \cdot 5.1 \cdot 5.1 \cdot 5.1$	5.1^7
$\left(\frac{1}{2}\right)^5 \cdot \left(\frac{1}{2}\right)^5$	$\frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2} \cdot \frac{1}{2}$	$\left(\frac{1}{2}\right)^{10}$
$m^2 \cdot m^2$	$m \cdot m \cdot m \cdot m$	m^4
$p^3 \cdot p^4$	$p \cdot p \cdot p \cdot p \cdot p \cdot p \cdot p$	p^7

dot in the middle w/ same base, add exponents

b. Show how to use your rule in part (a) to write each expression below as a single power. Then write a *general rule* for finding $(a^m)^n$, a power of a power.

$\rightarrow 0.5 \cdot 0.5 \cdot 0.5 \cdot 0.5 \cdot 0.5 \cdot 0.5$

$\left(\left(\frac{1}{4}\right)^2\right)^2$ $\quad (0.5^3)^2$ $\quad (r^2)^3$ $\quad (s^3)^3$

$\left(\frac{1}{4}\right)^4$ $\quad 0.5^6$ $\quad r^6$ $\quad s^9$

parenthesis in between exponents multiply

GO DIGITAL

Example 3 Multiplying Powers with the Same Base

a. $(-3)^2 \cdot (-3)^4 = (-3)^{2+4}$ Product of Powers Property

$= (-3)^6$ Simplify.

b. $x^3 \cdot x^7 = x^{3+7}$ Product of Powers Property

$= x^{10}$ Simplify.

When a number is written without an exponent, its exponent is 1.

c. $y \cdot y^6 = y^1 \cdot y^6$ Rewrite y as y^1.

$= y^{1+6}$ Product of Powers Property

$= y^7$ Simplify.

dot in middle → add exponents

Try It Simplify the expression. Write your answer as a power.

7. $7^3 \cdot 7^5$

7^8

8. $\left(-\frac{1}{2}\right)^3 \cdot \left(-\frac{1}{2}\right)^6$

$\left(-\frac{1}{2}\right)^9$

9. $z^1 \cdot z^{12}$ ← imaginary 1 exponent

z^{13}

Example 4 Finding a Power of a Power

a. $(2^5)^2 = 2^{5 \cdot 2}$ Power of a Power Property

$= 2^{10}$ Simplify.

b. $(w^5)^4 = w^{5 \cdot 4}$ Power of a Power Property

$= w^{20}$ Simplify.

parenthesis in between → multiply

Try It Simplify the expression. Write your answer as a power.

10. $(6^2)^4$

6^8

11. $(y^2)^4$

y^8

12. $((-4)^3)^2$

$(-4)^6$

GO DIGITAL

5 MTR **USE STRUCTURE**

How are the expressions in part (b) similar to the expressions in part (a)?

Exploration 2 Finding Powers of Products

Work with a partner. Copy and complete the table. Use your results to write a *general rule* for finding $(ab)^m$, a power of a product.

Power	Repeated Multiplication Form	Product of Powers
$(2 \cdot w)^3$	$2 \cdot 2 \cdot 2 \cdot w \cdot w \cdot w$	$2^3 \cdot w^3$
$(5 \cdot x)^2$	$5 \cdot 5 \cdot x \cdot x$	$5^2 \cdot x^2$
$(yz)^3$	$y \cdot y \cdot y \cdot z \cdot z \cdot z$	$y^3 \cdot z^3$

rewrite each base with the exponent

7.1 Lesson

Recall that a *power* is a product of repeated factors. The *base* of a power is the repeated factor. The *exponent* of a power indicates the number of times the base is used as a factor.

base exponent

$$\underbrace{a^4}_{\text{power}} = \underbrace{a \cdot a \cdot a \cdot a}_{a \text{ is used as a factor 4 times.}}$$

Example 1 Writing Expressions Using Exponents

1 MTR HELP A CLASSMATE

Remind a classmate why you need to use parentheses to write powers when the base is negative.

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____

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Write each product using exponents.

a. $(-2) \cdot (-2) \cdot (-2) \cdot b \cdot b$ $(-2)^3 \cdot b^2$

Because -2 is used as a factor 3 times, its exponent is 3. Because b is used as a factor 2 times, its exponent is 2.

▶ So, $(-2) \cdot (-2) \cdot (-2) \cdot b \cdot b = (-2)^3 \cdot b^2$.

b. $\pi \cdot \pi \cdot r \cdot r \cdot r$ $\pi^2 \cdot r^3$

Because π is used as a factor 2 times, its exponent is 2. Because r is used as a factor 3 times, its exponent is 3.

▶ So, $\pi \cdot \pi \cdot r \cdot r \cdot r = \pi^2 r^3$.

Try It **Write the product <u>using exponents</u>.** answer should have exponents

1. $5 \cdot 5 \cdot 5 \cdot m \cdot m \cdot m \cdot m$

$5^3 \cdot m^4$

2. $0.3 \cdot 0.3 \cdot 0.3 \cdot 0.3 \cdot x \cdot x$

$(0.3)^4 \cdot x^2$

flip then come back

Example 2 Evaluating Expressions

negative in parenthesis without exponen. is nega

Try It Evaluate the expression.

3. 0.1^5

0.00001

4. $(-0.3)^4$

0.0081

5. $-\left(\frac{1}{2}\right)^6$

$-\frac{1}{64}$

6. $\left(-\frac{1}{5}\right)^3$

$-\frac{1}{125}$

on calculator

3 0.1 y^x button 5 =

5 1 y^x 6 = 1 → $\frac{1}{64}$

2 y^x 6 = 64

Common Error

When multiplying powers, do not multiply the bases. $2^3 \cdot 2^4 = 2^7$, not 4^7.

Key Ideas

Product of Powers Property

Words To multiply powers with the same base, add their exponents.

Numbers $2^3 \cdot 2^4 = 2^{3+4} = 2^7$

Algebra $a^m \cdot a^n = a^{m+n}$

Power of a Power Property

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

Numbers $(3^5)^4 = 3^{5 \cdot 4} = 3^{20}$

Algebra $(a^m)^n = a^{mn}$

Power of a Product Property

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

Numbers $(5 \cdot 4)^3 = 5^3 \cdot 4^3$

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

Example 5 Finding a Power of a Product

a. $(2x)^3 = 2^3 \cdot x^3$ — Power of a Product Property

$= 8x^3$ — Simplify.

b. $(3xy)^2 = 3^2 \cdot x^2 \cdot y^2$ — Power of a Product Property

$= 9x^2y^2$ — Simplify.

Try It **Simplify the expression.**

13. $(5y)^4$

5^4y^4

$625y^4$

14. $(ab)^5$

a^5b^5

15. $(0.5mn)^2$

$0.25m^2n^2$

In-Class Practice

1 I don't understand yet. | 2 I can do it with help. | 3 I can do it on my own. | 4 I can teach someone else.

WRITING EXPRESSIONS USING EXPONENTS **Write the product using exponents.**

16. $0.4 \cdot 0.4 \cdot w \cdot w \cdot w \cdot w$

17. $\frac{1}{8} \cdot \frac{1}{8} \cdot y \cdot y \cdot y$

EVALUATING EXPRESSIONS **Evaluate the expression.**

18. $(-0.2)^3$

19. -0.5^4

20. $\left(-\frac{1}{3}\right)^3$

FINDING POWERS **Simplify the expression. Write your answer as a power.**

21. $d^8 \cdot d^3$

22. $(g^6)^3$

23. $\left(-\frac{1}{3}\right)^5 \cdot \left(-\frac{1}{3}\right)^7$