

1.2

Product of Powers Property

Learning Target: Generate equivalent expressions involving products of powers.

- Success Criteria:**
- I can find products of powers that have the same base.
 - I can find powers of powers.
 - I can find powers of products.

Number Sense and Operations

MA.7.NSO.1.1 Know and apply the Laws of Exponents to evaluate numerical expressions and generate equivalent numerical expressions, limited to whole-number exponents and rational number 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
$2^2 \cdot 2^4$	$2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2$	2^6
$7^3 \cdot 7^2$	$7 \cdot 7 \cdot 7 \cdot 7 \cdot 7$	7^5
$5^1 \cdot 5^6$	$5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 \cdot 5$	5^7
$10^3 \cdot 10^5$	$10 \cdot 10 \cdot 10 \cdot 10 \cdot 10 \cdot 10 \cdot 10 \cdot 10$	10^8
$6^2 \cdot 6^2$	$6 \cdot 6 \cdot 6 \cdot 6$	6^4



When there is a dot in the middle of the same base, Add the exponents.

$$2^2 \cdot 2^4$$

$$4 + 2 = 6$$

$$(2^6)$$

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MTR **USE**
STRUCTURE

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

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.

$(7^3)^2$ $(6^2)^2$ $(3^2)^3$ $(2^2)^4$ $(5^2)^5$
 7 · 7 · 7 twice 7 · 7 · 7 · 7 · 7 · 7
 (7^6) (6^4) (3^6) (2^8) (5^{10})

when there are parentheses in between the exponents, multiply them

Exploration 2 Finding Powers of Products

Work with a partner. 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
$(2 \cdot 3)^3$	$2 \cdot 3 \cdot 2 \cdot 3 \cdot 2 \cdot 3$	$2^3 \cdot 3^3$
$(2 \cdot 5)^2$	$2 \cdot 5 \cdot 2 \cdot 5$	$2^2 \cdot 5^2$
$(5 \cdot 4)^3$	$5 \cdot 4 \cdot 5 \cdot 4 \cdot 5 \cdot 4$	$5^3 \cdot 4^3$

the exponent goes to each base in the parentheses.

1.2 Lesson

Common Error

When multiplying powers, do not multiply the bases.
 $4^2 \cdot 4^3 = 4^5$, not 16^5 .

Key Ideas

Product of Powers Property

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

Numbers $4^2 \cdot 4^3 = 4^{2+3} = 4^5$

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 $(4^6)^3 = 4^{6 \cdot 3} = 4^{18}$

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

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

Example 1 Multiplying Powers with the Same Base

watch me

a. $2^4 \cdot 2^5 = 2^{4+5}$
 $= 2^9$

Product of Powers Property

Simplify.

b. $4^3 \cdot 4^7 = 4^{3+7}$
 $= 4^{10}$

Product of Powers Property

Simplify.

c. $5 \cdot 5^6 = 5^1 \cdot 5^6$
 $= 5^{1+6}$
 $= 5^7$

Rewrite 5 as 5^1 .

Product of Powers Property

Simplify.

A number written without an exponent has an exponent of 1.

Try It

Simplify the expression. Write your answer as a power.

1. $6^2 \cdot 6^4$

6^6

2. $2^3 \cdot 2^6$

2^9

3. $3 \cdot 3^{12}$

3^{13}



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Example 2 Finding a Power of a Power

a. $(3^4)^3 = 3^4 \cdot 3$
 $= 3^{12}$

Power of a Power Property

Simplify.

b. $(8^5)^4 = 8^5 \cdot 4$
 $= 8^{20}$

Power of a Power Property

Simplify.

Try It

Simplify the expression. Write your answer as a power.

4. $(4^3)^5$
 4^{15}

5. $(7^2)^4$
 7^8

6. $(5^3)^2$
 5^6

Example 3 Finding a Power of a Product

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

Power of a Product Property

b. $(3 \cdot 4)^2 = 3^2 \cdot 4^2$

Power of a Product Property

Try It

Simplify the expression. Write your answer as a product of powers.

7. $(5 \cdot 7)^4$
 $5^4 \cdot 7^4$

8. $(2 \cdot 9)^5$
 $2^5 \cdot 9^5$

9. $(11 \cdot 12)^2$
 $11^2 \cdot 12^2$

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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.

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

10. $4^7 \cdot 4^4$
 4^{11}

11. $(8^5)^3$
 8^{15}

12. $3^5 \cdot 3^7$
 3^{12}

FINDING A POWER OF A PRODUCT Simplify the expression. Write your answer as a product of powers.

13. $(2 \cdot 7)^4$
 $2^4 \cdot 7^4$

14. $(3 \cdot 5)^6$
 $3^6 \cdot 5^6$

15. $(8 \cdot 9)^3$
 $8^3 \cdot 9^3$



In-Class Practice

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16. **REASONING** Can you use the Product of Powers Property to simplify $5^2 \cdot 6^4$? Explain.

NO they do not have the same base.

17. **OPEN-ENDED** Write an expression that simplifies to 2^{12} using the Product of Powers Property.

$$(2^2)^6$$

$$2^{10} \cdot 2^2$$

$$2^6 \cdot 2^6$$

Example 4 B.E.S.T. Test Prep: Modeling Real Life

7
MTR

One gigabyte (GB) of computer storage space is 2^{30} bytes. The storage details of a computer are shown. How many bytes of total storage space does the computer have?

Details

Local Disk (C:)

Local Disk

Free Space: 16 GB

Total Space: 64 GB

- (A) 2^{34} (C) 2^{180}
(B) 2^{36} (D) 128^{30}

The computer has 64 gigabytes of total storage space. Notice that you can write 64 as a power, 2^6 .

Use a verbal model to solve the problem.

$$\begin{aligned} \text{Total number of bytes} &= \text{Number of bytes in a gigabyte} \cdot \text{Number of gigabytes} \\ &= 2^{30} \cdot 2^6 && \text{Substitute.} \\ &= 2^{30+6} && \text{Product of Powers Property} \\ &= 2^{36} && \text{Simplify.} \end{aligned}$$

- The computer has 2^{36} bytes of total storage space. So, the correct answer is (B).

