

## Properties of Exponents

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### Lesson Overview

In this lesson, students will work in pairs to examine patterns in products to make conjectures about general rules for the properties of exponents and test their rule on sample problems to test the validity. Students will share their conjectures with the class and use dialogue to come to agreement on the properties of exponents.

### Standards Addressed

CCSS            8.EE.1 Know and apply the properties of integer exponents to generate equivalent numerical expressions.

### Disciplinary Literacy Best Practices

Focused Listing

Think-Ink-Pair-Share

Give Me Five

Bounce Cards

Making Thinking Visible

Muddiest Point

### Lesson Plan

Time Required – One 60 minute classes

Disciplinary Vocabulary – exponents, negative, multiplication property of exponents, power property of exponents, division property of exponents

Materials Needed:

- Properties of Exponents Exploration (1 copy per student)
- Bounce Cards (1 per student)
- Index Cards
- Practice Problems (may be used as homework)

Assessment: Student dialogue, Muddiest Point, Practice Problems

## Engage

- Ask: “What do you know about exponents? In your notebook, make a focused list as long as possible of everything you know about exponents. “
- Individually, students create focused lists titled “exponents” in their notebooks. (Think-Ink)
- Students share their list with their elbow partner. (Pair-Share)
- Teacher asks students to “Give Me Five” things we know about exponents. Record the proffered ideas on the board or on a chart.
- Teacher: “Today we are going to learn more about exponents, specifically the properties that allow us to work easily with exponents in expressions and equations. As mathematicians, we always look for patterns and learn from what we see to make our work easier in the future. That is what we will be doing today.”

## Explore

- Student pairs use bounce cards to dialogue as they complete the tasks on parts 1-3 of the Properties of Exponents Exploration.
- Facilitate partner dialogue and assist as needed with recognizing patterns. Ask why and justify!

## Explain

- Engage the entire class in dialogue about the patterns they noticed in the examples and the rules they developed. Give Me Five may be used again.
- Teacher will lead students to consensus about the properties of exponents (multiplication, power of power, and division) based on the evidence from their exploration.

## Extend

- Student pairs complete part 4 of the Properties of Exponents Explorations.
- Student pairs use Making Thinking Visible to share their thinking about the proof of the property of zero exponents (Part 4 of the exploration). Each student pair will join another pair to share their thinking about the property for zero exponents. ‘
- Return to the Focused List created at the beginning of class. “What do we now know about exponents that we didn’t know before?” Add new ideas to the chart.
- Students complete practice problems on the properties of exponents.

Lesson Assessment: As an exit ticket, students will write their Muddiest Point on an index card.  
Question: “What one thing is most confusing for you about the work we’ve done today?”

### **Teacher Reflections and Biographical Information**

For students who were new to learning mathematics through exploration, my partner teacher and I divided the lesson across two days instead of completing it in one day. We focused on the first three properties (multiplication property of exponents, power property of exponents, and division property of exponents) on the first day. On the second day, we began with a review of the first three properties followed by the exploration of negative and zero exponents.

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## Exploration: Properties of Exponents

Name: \_\_\_\_\_

**I. Multiplication Property of Exponents**

Complete the table below and answer the questions that follow.

Product	Expanded Form	Exponential Form
$3^2 \cdot 3^3$	$(3 \cdot 3) \cdot (3 \cdot 3 \cdot 3)$	$3^5$
$2^3 \cdot 2^3$		
$2^5 \cdot 2^4$		
$4^7 \cdot 4^1$		
$x^4 \cdot x^2$		

Compare the original product in the first column to the exponential form you found in the third column. What pattern do you see?

Use the pattern to create a general rule for the multiplication property of exponents.

$$x^a \cdot x^b = \underline{\hspace{4cm}}$$

Test your rule on the following expressions to check that it works:

a)  $4^3 \cdot 4^2$

b)  $5^2 \cdot 5^4$

## II. Power Property of Exponents

Complete the table below and answer the questions that follow.

Power	Expanded Form	Exponential Form
$(3^2)^3$	$(3^2) \cdot (3^2) \cdot (3^2) =$ $(3 \cdot 3) \cdot (3 \cdot 3) \cdot (3 \cdot 3)$	$3^6$
$(2^3)^4$		
$(4^5)^2$		
$(x^7)^3$		
$(2 \cdot 3)^2$	$(2 \cdot 3) \cdot (2 \cdot 3) \cdot (2 \cdot 3) =$ $(2 \cdot 2 \cdot 2) \cdot (3 \cdot 3 \cdot 3)$	$2^3 \cdot 3^3$
$(3 \cdot 5)^3$		
$(xy)^3$		

Compare the original power in the first column to the exponential form you found in the third column. What patterns do you see?

Use the pattern to create a general rule for the power properties of exponents.

$$(x^a)^b = \underline{\hspace{10em}}$$

$$(xy)^b = \underline{\hspace{10em}}$$

Test your rule on the following expressions to check that it works:

a)  $(4^3)^4$

b)  $(5 \cdot 2)^2$

### III. Division Property of Exponents

Complete the table below and answer the questions that follow.

Division	Expanded Form	Exponential Form
$\frac{3^5}{3^2}$	$\frac{3 \cdot 3 \cdot 3 \cdot 3 \cdot 3}{3 \cdot 3} = 3 \cdot 3 \cdot 3$	$3^3$
$\frac{2^4}{2^1}$		
$\frac{5^{12}}{5^8}$		
$\frac{4^7}{4^5}$		
$\frac{x^3}{x^1}$		

Compare the original division in the first column to the exponential form you found in the third column. What patterns do you see?

Use the pattern to create a general rule for the power properties of exponents.

$$\frac{x^a}{x^b} = \underline{\hspace{10em}}$$

Test your rule on the following expressions to check that it works:

a)  $\frac{x^6}{x^3}$

b)  $\frac{2^9}{2^7}$

#### IV. Zero and Negative Exponents

Use the property of division from part III to show why  $x^0 = 1$  is true.

Hint: What is  $\frac{2^4}{2^4}$  ?

Use the property of division from part III to make a **conjecture** about negative exponents.

Hint: Write each of the following divisions using expanded form then use your rule from part III. Look for patterns in your answers.

a)  $\frac{3^2}{3^4}$

b)  $\frac{2}{2^5}$

c)  $\frac{x^3}{x^6}$

**Practice: Properties of Exponents**      Name: \_\_\_\_\_

Use the properties of exponents to rewrite each expression in as few terms possible.

(1)  $3^4 =$

(4)  $3^{-2} =$

(7)  $\frac{1}{2^{-3}} =$

(2)  $(-2)^3 =$

(5)  $(-2)^{-3} =$

(8)  $\left(\frac{2}{3}\right)^{-3} =$

(3)  $(-4)^4 =$

(6)  $\left(\frac{3}{4}\right)^3 =$

(9)  $(-25)^0 =$