Laws of Exponents

Strand: Expressions and Operations

Topic: Using exponents

Primary SOL: A.2 The student will perform operations on polynomials, including
a) applying the laws of exponents to perform operations on expressions.

Related SOL: A.1

Materials

- Exploring Exponents activity sheet (attached)

Vocabulary

exponent, monomial expression, product, quotient

Student/Teacher Actions: What should students be doing? What should teachers be doing?

1. Review the definition of *exponent*, and have students give examples. Be sure that students understand that $2^3 = 2 \times 2 \times 2$, and review the distinction between exponential form (2^3) and expanded form ($2 \times 2 \times 2$).
2. Distribute the Exploring Exponents activity sheet, and have students complete it in pairs or small groups.
3. Lead a class discussion of the patterns seen and algebraic expressions found for each of the different laws. As ideas are shared, ask students to repeat what is said, add to what is said, and agree or disagree with what is said. This will allow more students to be involved in the conversation and help those who need more time to catch on to the ideas presented.

Assessment

- **Questions**
  - How would you explain the law for multiplying exponents with the same base?
  - How would you explain the law for raising an exponent to a power?
  - How would you explain the law for dividing exponents with the same base?
  - How would you describe negative exponents to someone who has not learned about them?
- **Journal/Writing Prompts**
  - Compare and contrast multiplying and dividing exponents with the same base.
  - Explain why the laws you discovered for multiplying and dividing exponents with the same base do or do not apply to multiplying and dividing exponents with different bases.
  - If you cannot remember any of the laws for exponents that you discovered in class, explain what you could do to rediscover them.

- **Other Assessments**
    - Give students practice problems in which they use the laws discovered in this lesson and combinations of these laws to simplify expressions containing exponents.

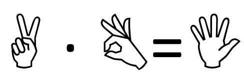
Extensions and Connections (for all students)

- Have students create a matching game involving expressions containing exponents and the simplified forms of these expressions.
- In earlier grades, students encountered negative exponents when using scientific notation. Connect this knowledge with what they have just learned about negative exponents.

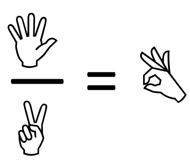
Strategies for Differentiation

- Review vocabulary, as needed.
- Have students create a graphic organizer to summarize the laws of exponents they have explored. Consider partially filling out the organizer for students, as needed.
- If students need guidance as to where to start when simplifying an expression containing negative exponents, instruct them to start by simplifying negative exponents and then move on to simplifying powers with the same base.
- Provide more than one completed example for students, as necessary, on the attached Exploring Exponents activity sheet.
- Use Algeblocks to model exponent rules (limited to the third power)
- Use fingers to represent exponents, as follows:

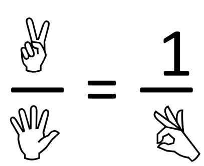
$$x^2 \cdot x^3 = x^5$$



$$\frac{x^5}{x^2} = x^3$$



$$\frac{x^2}{x^5} = \frac{1}{x^3}$$



Note: The following pages are intended for classroom use for students as a visual aid to learning.

Exploring Exponents

Name ______________________________________ **Date**______________________

1. Explore multiplying exponents with the same base by completing the table below. Use the last two rows to write your own examples.

	Column 1 rewritten in expanded form	**Column 2 rewritten in exponential form**
$2^3 \cdot 2^5$	$2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2$	2^8
$4^5 \cdot 4^2$		
$3^1 \cdot 3^6$		
$x^4 \cdot x^7$		
$(-2)^2 \cdot (-2)^3$		
$(-x)^4 \cdot (-x)^3$		
$(1/2)^2 \cdot (1/2)^4$		

2. Compare column 1 with column 3. Describe any pattern(s) you see.

3. Describe a way to find the exponents in column 3 without having to use expanded form. Write your strategy, using only algebraic symbols.

4. Explore raising an exponent or product of exponents to a power by completing the table below. Use the last two rows to write your own examples.

	Column 1 rewritten in expanded form	**Column 2 rewritten in exponential form**
$(2^3)^4$	$(2 \cdot 2 \cdot 2)(2 \cdot 2 \cdot 2)(2 \cdot 2 \cdot 2)(2 \cdot 2 \cdot 2)$	2^{12}
$(4^5)^2$		
$(x^4)^9$		
$(xy)^5$		
$(3x^2)^4$		
$(-5x^2y^3)^2$		
$(-x^3yz^2)^4$		

5. Compare columns 1 and 3. Describe any pattern(s) you see.

6. Describe a way to find the exponents in column 3 without having to use expanded form. Write your strategy, using only algebraic symbols.

7. Explore dividing exponents with the same base by completing the table below. Use the last two rows to write your own examples.

	Column 1 rewritten in expanded form	Column 2 rewritten in exponential form
$\frac{2^5}{2^3}$	$\frac{2 \cdot 2 \cdot 2 \cdot 2 \cdot 2}{2 \cdot 2 \cdot 2}$	2^2
$\frac{4^5}{4^1}$		
$\frac{x^9}{x^3}$		
$\frac{2x^2y^3}{4xy^2}$		
$\frac{-6x^{-2}y^6}{4x^3y^{-2}}$		

8. Compare columns 1 and 3. Describe any pattern(s) you see.

9. Describe a way to find the exponents in column 3 without having to use expanded form. Write your strategy, using only algebraic symbols.

10. Look at the tables below. What patterns do you notice? Complete the tables by filling in the missing values.

4^6	
4^5	
4^4	
4^3	64
4^2	16
4^1	4
4^0	

3^5	243
3^4	81
3^3	27
3^2	9
3^1	
3^0	
3^{-1}	

2^3	8
2^2	4
2^1	2
2^0	
2^{-1}	
2^{-2}	
2^{-3}	

11. What do you notice about negative exponents and the exponent zero? Continue the tables to show more negative exponents, if needed.

Take what you have explored from above and simplify the following expressions.

12. $(4x^2y^3z)\ (-2xy^4z^2)$

13. $(3x^{-2}y^4z^3)\ (-x^5y^{-3}z^7)$

14. $\frac{(2x^3y^4)(-5x^2)}{2x^4y}$

15. $\left(\frac{2x^2}{4x}\right)^2$

16. $\frac{4x^3y^2z}{2x^2y^2} \cdot \frac{3x^5y^4z^3}{3x^4yz^3}$

17. $(-5x^{-4}y^3)^0 \cdot (2x^3y^4)$