Powers and Exponents

1) Power Rules

2) Multiplying and Dividing polynomials with monomials
-Multiplying binomials

3) Working with Negative Exponents

4) Multiplying Power to a power

Lesson objectives | Teachers' notes

Subject: Mathematics

Topic: Powers and Exponents

Grade(s): Grade 8

Prior knowledge: Integers and Variables

Lesson notes:

8.EE.1: Know and apply the properties of integer exponents to generate equivalent numerical expressions. For example, $3^2 \times 3^{-5} = 3^{-3} = 1/33 = 1/27$.

Lesson objectives | Teachers' notes

Multiplying and Dividing Monomials
But what is a monomial?

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$7x$

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$17 - c$ $8f^2g$ $\frac{3}{4}$ $\frac{5}{t}$

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No, variable can not be in the deniminator

Aim: What are the Laws of Exponents for Multiplication and Division?

Just like we can multiply two numbers together, we can also multiply two exponents (or two monomials) together. To do this, we follow the *Product of Powers Rule.*

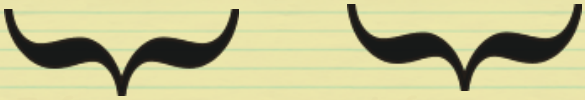
Product of Powers Rule: To multiply exponents that have the same base, simply add the exponents.

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

Aim: What are the Laws of Exponents for Multiplication and Division?

This can be seen if we actually count factors when multiplying exponents

$7^5 \cdot 7^4 =$



It is very important to remember that bases have to be THE SAME!!!!!!

Examples

1) $5^2 \cdot 5$ 2) $x^3 \cdot x^5$ 3) $w^6 \cdot w^{15}$

When there is a coefficient (number in front of the variable) we multiply them together.

4) $-3x^2 \cdot 4x^5$ 5) $2x^5 \cdot 3x^7$ 6) $-2a^3 \cdot (-8a^4)$

Aim: What are the Laws of Exponents for Multiplication and Division?

Dividing exponents... To divide exponents that have the same base, simply subtract the exponents. This is the Quotient of Powers Rule.

$$a^9 \div a^5 = a^{(9-5)} = a^4$$

Examples

7) $\frac{f^8}{f^3}$

8) $\frac{g^{52}}{g^2}$

When there is a coefficient, we divide them.

9) $\frac{12x^5}{2x^2}$

10) $\frac{(-2)^5 \cdot 3^4 \cdot 5^7}{(-2)^2 \cdot 3 \cdot 5^4}$

11) $\frac{15n^7}{3n^4}$

~~Homework~~ -

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11 & 12 are extra credit

Remember…….multiply, add exponents
divide, subtract exponents

Let's Practice

1) $(2c^3)(10c^4)$	2) $\frac{25x^{11}}{5x^4}$
3) $(12x^9)\div(3x^3)$	4) $(x^3)(x^7)(x^3)$
5) $\frac{14d^{12}}{7d^8}$	6) $(2x^4)(3x^5)(5x^7)$
7) $(3x^4)(-2x^5y^2)(-4xy)$	8) $\frac{72x^5y^4}{12xy}$
9) $\frac{(5x^2y^4)(12x^6y)}{6x^3y^4}$	10) $\frac{(-4a^3b^4)(9a^6b^3)}{(2a^3b)(3ab^5)}$

Name_____ Date_____

Laws of Exponents

1) $3m^2 \bullet 4m^3$	2) $\frac{4x^3y^4z^6}{2xy^2z}$
3) $(2x^4y)(-3x^7y)(-4x^5)$	4) $\frac{50a^4b^2c^9}{25a^3b^2c}$
5) $\frac{(2x^2y^4)(4x^3y^2)}{(x^3y)(2x^4y^5)}$	6) $\frac{(12x^3y^4)(3x^4y^6)}{4x^4y^7}$
7) $\frac{12x^6y^9z^6}{4x^5y^7z^6}$	8) $(-10d^5e^2f)(-2d^2e^4)(-4f^4)$
9) $\frac{(16a^3b^5c^2)(4abc^6)}{(8a^2b^3c^{-4})}$	10) $\frac{(5de^3)(12d^4e)}{6d^3e^3}$

Aim: How do we multiply a monomial with a polynomial? How do we divide a polynomial by monomial?

DO NOW:

1) $\dfrac{(2xy)(3x^4y^3z^3)}{6x^2y^2z^2}$

Aim: How do we multiply a monomial with a polynomial? How do we divide a polynomial by monomial?

To multiply a monomial by a polynomial:

- **Distribute**
- **Follow the Laws of Exponents**
  1. **Multiply the coefficients**
  2. **If the bases are the same keep the base and add the exponents**

$2x(3x^2 + 4x - 6) =$

Aim: How do we multiply a monomial with a polynomial? How do we divide a polynomial by monomial?

To divide a polynomial by a monomial:

- **Divide each piece of the numerator by the denominator**
- **Divide the coefficients**
- **Follow the Laws of Exponents**
  1. **Divide the coefficients**
  2. **If the bases are the same keep the base and subtract the exponents**

Example:

$$\frac{25x^4 - 15x^3 + 5x^2}{5x} =$$

Let's Practice:

1) $\frac{8x^5+4x^4+2x^2}{2x^2}$	2) $8a(-2a+3b-2c)$
3) $\frac{5tu^5+15t^4u^2-10t^3u}{10tu^4}$	4) Simplify $\frac{20a^5-30a^4+40a}{-10a}$
5) $3x(2x^2-4xy+5)$	6) $2xy(3x^3-2x^5y+6y^3)$

Aim: How do we simplify negative exponents?

DO NOW

1) $\frac{132x^8y^7z^{12}}{3x^5y^2z}$	2) $(-4a^3b^4)(-2b^6)(-5a^9)$

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Zero Exponents: Any quantity raised to a power of zero is equal to one.

Examples:

1) $321^0 =$	2) $(3xy^3)^0 =$	3) $m^0 =$

Bonus: Why do zero exponents = 1?

Aim: How do we simplify negative exponents?

Negative Exponents: a number with a negative exponent is equal to the reciprocal of that power with a positive exponent.

$$a^{-2} = \frac{1}{a^2}$$

* any base with a negative exponent is equal to 1 over the base with a positive exponent.

$$2^{-3} = \frac{1}{2^3} = \frac{1}{8}$$

The base, 2, does not change. The negative exponent becomes positive -- in the denominator.

Aim: How do we simplify negative exponents?

To Multiply and Divide with negative exponents.

1) Follow the Laws of Exponents when multiplying and dividing

2) If your answer contains negative exponents, re-write your answer using positive exponents

Example:

Problem	***After Division***	***Simplified***
$\frac{q^3}{q^5} = ?$	$\frac{q^3}{q^5} = q^{-2}$	$\frac{1}{q^2}$

Example Problem	*After Multiplication/Division*	*Simplified*
$(-4x^2y^3)(3x^{-6}y)$		
$\frac{-36a^5b^4}{12a^7b^4}$		

Let's practice: Simplify and express answers using positive exponents

1) x^{-7}	2) $(2x^{-3})(-4x^{-4})$
3) $\dfrac{48x^4y^6}{-16x^8y^3}$	4) $\dfrac{30ab^3y^4}{10ab^6y^2}$
5) $(-2x^2y^3)(-3xy^{-8})$	6) $\dfrac{-22d^5e^7f^4}{2d^5e^7f^6}$
7) $\dfrac{(3w^2x^3y^4)(-4w^2x^6y)}{(6w^4x^{12}y^6)}$	8) $\dfrac{(-4a^5b^2c^3)}{(2a^9bc^4)}$

Name_____ **Date**_____

Exponents

1) $(6y^3) \bullet (4x^2y^5)$	2) When $3a^2-2a+5$ is subtracted from a^2+a-1 the result is…….
3) Simplify: $3x(4x^2y-5x^3y^2-2)$	4) Simplify: $(-5a^0b^{-3}c^4)$
5) Simplify: $\frac{(9a^{-2}b^{-5})(10a^8b^{10})}{(3ab)(5ab)}$	6) Simplify each expression a) $6a^2b^0$ b) $(2x^4y^{-4}z)^0$
7) Simplify: $\frac{(2a^3b^7)(5a^5b^6)}{5ab}$	8) If the base of a parallelogram is represented by $(2x-4)$ and the height is represented by $(x+5)$ what is the area of the parallelogram in terms of x?
9) What polynomial will produce the sum $8x^2-x+2$ when added to $3x^2-5x-3$?	10) $\frac{5tu^5+50t^4u^2}{10tu^4}=$ a) $2u+5u^2t^3$ b) $\frac{u}{2}+\frac{5t^3}{u}$ c) $\frac{tu}{2}+\frac{5t^3}{u}$ d) $\frac{u}{2}+\frac{5t^3}{u^2}$
11) Evaluate $(2xy+3y^3)^0$ when x = -2 and y = -4	12) Rewrite the following expression with positive exponents: $\frac{12x^2y^3z^6}{4x^5y^7z^6}$

Name_____ **Date**_____

Working With Negative Exponents

Write using only positive exponents.

1) $-4x^{-3}y^{4}$	2) $(2x)^{-3}$
3) $\frac{15x^{4}y^{3}z}{3x^{5}yz}$	4) 3^{-4}
5) $\frac{42a^{3}b^{4}c}{-7a^{4}b^{2}c^{5}}$	6) Simplify when a = 2 and b = 4 $(2a^{2}b^{3})^{0}$
5) $\frac{42a^{3}b^{4}c}{-7a^{4}b^{2}c^{5}}$	6) Simplify when a = 2 and b = 4 $(2a^{2}b^{3})^{0}$
7) $(-2x^{-3}y^{4})(-4x^{2}y^{-8})$	8) $\frac{(3xy^{2})(4x^{2}y^{3})}{6x^{4}y}$
9) $\frac{(7a^{2}b^{3})(4ab)}{(2a^{3}b^{2})(14a^{9}b^{3})}$	10) $\frac{25x^{2}y^{5}}{5x^{5}y^{5}}$

Aim: How do we raise a power to a power?

Do Now:

1) $\dfrac{(-12x^3y^{-5})(3xy^{-3})}{(-4x^2y^{-2})(3xy^{-1})}$

Aim: How do we raise a power to a power?

When multiplying a power to a power we use the following rule:

$$(x^n)^m = x^{nm}$$

This simply means when raising a power to a power you multiply the exponents

Examples:

1) $(x^3)^2$	• The rule says to keep the base and MULTIPLY the exponents x^{6} • You could also expand the terms and follow the Laws of Exponents $x^3 \bullet x^3 = x^6$
2) $(b^3)^4 =$	3) $(x^4)^6 =$

When there are coefficients we follow the same rule BUT we also apply the exponent to the coefficient.

Examples:

1) $Simplfy: (3a^2)^2$	2) $Simplify: (-2x^3)^2$
3) $Simplify: (4x^3)^4$	4) $Simplify: 2(-3a^{-3})^5$

Attachments

- Fluency exponents in expanded form
- Fluency Product Rule Numerals
- Fluency Product Rule Variables
- Fluency Quotient Rule
- Fluency Quotient Rule Variables
- Fluency power rule variables
- Extra Credit Laws of exponents