6.1 Notes: Multiplying with Exponents

Key Terms

Base	**Exponent**	**Coefficient**	*Sample*

Exploration A:

* Expand: x^3 *Expand: x^4

* Expand and simplify: $x^3 \cdot x^4$ *What do you notice?

Exploration B:

* Expand: $2a^5$ *Expand: $7a^3$

* Expand and simplify: $2a^5 \cdot 7a^3$ *What do you notice?

Exploration C:

* Expand: $-4h^2g$ *Expand: $3hg^4$

* Expand and simplify: $-4h^2g \cdot 3hg^4$ *What do you notice?

Multiplying Expressions with the Same Base:

Examples #1 – 6: Simplify each expression.

1) $b^7 \cdot b^5 \cdot b$ 2) $3w^4 \cdot -7w^{21}$ 3) $(-10a^3b^{14})(-7ab^2)$

You try #4 – 6!

4) $5p \cdot p^8 \cdot 2p^3$ 5) $(-x^5y)(3xy^4)$ 6) $d^5 \cdot d^{13} \cdot d$

Exploration D: Expand each expression, and then evaluate. Verify on a calculator.

* $(-2)^4$ *-2^4

*$(-2)^3$ *-2^3

Draw a conclusion from your observations.

Examples #7 – 12: Simplify each expression. Evaluate numerical bases.

7) $(-3)^3 \cdot (-3)$ 8) $-5^3 \cdot 5$ 9) $(-2)^2(x^3yw^4)(-2xy^5w^3)$

You try!

10) $(-5)^2 \cdot (-5)$ 11) $4^2 \cdot -4^2$ 12) $(-6)^3(a^5b^4)(-6ab)$

6.2 Notes: Dividing with Exponents

Objectives:

- Students will be able to simplify division with expressions with the same base taken to a power.

Exploration A:

* Expand: x^6 *Expand: x^4

* Expand and simplify: $\frac{x^6}{x^4}$ *What do you notice?

Exploration B:

* Expand: $12a^5$ *Expand: $4a^8$

* Expand and simplify: $\frac{12a^5}{4a^8}$ *What do you notice?

Exploration C:

* Expand: $-4h^2gk$ *Expand: $-6hg^4k$

* Expand and simplify: $\frac{-4h^2gk}{-6hg^4k}$ *What do you notice?

Dividing Expressions with the Same Base:

Examples #1 – 6: Simplify each expression.

1) $\frac{b^7}{b^5}$

2) $\frac{18w^4}{-9w^{21}}$

3) $-\frac{2x^{10}}{4x^{10}}$

You try #4 – 6!

4) $\frac{50p^8}{2p^3}$

5) $\frac{3a^{14}}{9a^{14}}$

6) $\frac{-4w^{10}}{-2w^{12}}$

Examples #7 – 10: Simplify each expression.

7) $\frac{x^4 \cdot x^3}{x}$

8) $\frac{-10a^3b^{14}}{-15a^3b^2}$

You try #9 – 10!

9) $-\frac{2x^5y}{10xy^4}$

10) $\frac{d^5 \cdot d^{13}}{d^6}$

11) Find and correct the error(s) in the solution shown. **Simplify:** $-\frac{3x^5y^3z^4}{12x^7yz^3}$

Solution:

Coefficients: $-12 \div 3 = -4$

Powers for bases

Xs: $7-5=2$

Ys: $3-1=2$

Zs: $4-3=1$

$= -4x^2y^2z$

6.3 Notes: More Rules with Exponents

Objective:

- **Students will simplify exponential expressions with more than one base raised to the same power.**
- **Students will simplify exponential expressions with more than one power.**

Exploration A: Expand out the following expressions and then simplify.

- $(3xy)^2$
- $\left(\frac{5a}{bc}\right)^3$

What do you notice?

Power to a Product Rule	Power to Quotient Rule

Examples #1 – 6: Simplify each expression. Evaluate numerical bases.

1) $(4bd)^3$ 2) $\left(\frac{3x}{y}\right)^4$ 3) $\left(\frac{-5g}{2h}\right)^2$

You try #4 - 6!

4) $(-4fh)^3$ 5) $\left(\frac{8w}{z}\right)^2$ 6) $\left(\frac{9x}{5y}\right)^2$

Exploration B: Expand out the following expressions and then simplify.

- $(5x^4)^2$
- $(a^5b^2)^3$

What do you notice?

Power to a Power Rule

Examples #7 – 12: Simplify each expression. Evaluate numerical bases.

7) $(4b^5)^3$ 8) $(-3x^5)^4$ 9) $-(5a^{10})^2$

You try #10 – 12!

10) $(-10y^3)^3$ 11) $-(8g^6)^2$ 12) $(-7h^{11})^2$

What if there is more than one rule in a single problem?

Examples 13 – 16: Simplify each expression. Evaluate numerical bases.

13) $(2x^8y)^3 \cdot 7x^2$ 14) $\frac{(x^7y^3)^5}{(xy^4)^6}$

You try #15 – 16!

15) $(-4ab^2)^2 \cdot 8a^5b$ 16) $\left(\frac{-3y^7}{xy^5}\right)^2$

6.4 Notes: Zero and Negative Powers

Objectives: Students will be able to simplify expressions with zero and negative powers

Exploration A: Consider the expanded terms. Simplify using exponential notation.

a) $-3 \cdot x \cdot x \cdot x \cdot x \cdot x$

b) $-3 \cdot x \cdot x \cdot x$

c) $-3 \cdot x$

d) -3

For part d), how many times does *x* appear in this expression?

Taking a Base to the Power of Zero

Note: 0^0 is undefined. Why do you think this is so?

Examples 1 – 6: Simplify each expression.

1. a^0
2. $-2x^0$
3. $-6 \cdot (392{,}568{,}132.873)^0$

You try #4 – 6!

4. $(-24x^3 + 10x^4y^{10})^0$
5. $-16b^0$
6. $2(7x^3)^0$

Exploration B: Consider the expanded terms. Simplify using exponential notation. Look for a pattern in your answers!

a) $\frac{x \cdot x \cdot x}{x}$

b) $\frac{x \cdot x \cdot x}{x \cdot x}$

c) $\frac{x \cdot x \cdot x}{x \cdot x \cdot x}$

d) $\frac{x \cdot x \cdot x}{x \cdot x \cdot x \cdot x}$

e) $\frac{x \cdot x \cdot x}{x \cdot x \cdot x \cdot x \cdot x}$

f) $\frac{x \cdot x \cdot x}{x \cdot x \cdot x \cdot x \cdot x \cdot x}$

Negative Exponents

Examples 7 – 12: Simplify each expression. Do not write negative or 0 exponents in your final answer.

7) 5^{-1} 8) $\left(\frac{1}{b}\right)^{-2}$ 9) $\frac{1}{7^{-2}}$

You try #10 – 12!

10) 14^{-1} 11) $\frac{1}{2^{-6}}$ 12) b^{-3}

Examples 13 – 18: Simplify each expression. Do not write negative or 0 exponents in your final answer.

13) $\frac{a^3}{a^{-4}}$ 14) $\frac{x^3y^{10}}{x^7y^{-3}}$ 15) $\frac{5^{-1}b^3d^{-2}}{b^3d^4}$

You try #16 – 18!

16) $\frac{y^{-4}}{y^6}$ 17) $\frac{x^{-4}y^{-2}}{x^7y^{-5}}$ 18) $\frac{x^{-3}y^3}{xy^{-4}}$

Challenge Problems: Simplify each expression.

19) $\frac{5a^{-2}}{a^5b} \cdot \frac{b^3}{25b^{-8}}$ 20) $\left(\frac{3x^2y}{x^{-2}y^4}\right)^{-2}$

6.5 Notes: Solving Exponential Equations

Objectives: Students will be able to solve equations with exponents.

Exploration #1: Which of the following expressions below are equivalent to 9^2? Choose all that apply.

A) 3^4 B) 81^1 C) $\left(\frac{1}{9}\right)^{-2}$ D) $\left(\frac{1}{3}\right)^{-4}$ E) $\left(\frac{1}{81}\right)^{-1}$

Exploration #2: Rewrite the expression $\mathbf{64^5}$ in as many ways as you can thinking of by changing the base and the power. Hint: Use bases that go into 64 like 2, 4, ?

Solving Exponential Equations using the same base.

Examples #1 – 3: Solve the following exponential equations.

1) $6^x = 36$ 2) $2^{x+5} = 8$ 3) $2^x = 2^{3x-7}$

You try #4 – 6!

4) $5^x = 25$ 5) $11^{2x-4} = 121$ 6) $6^{2x-9} = 216$

Solving Multi-Step Exponential Equations:

Examples 7 – 12: Solve the following exponential equations.

7) $3^{x-7}+1=4$

8) $5(3)^{x}=405$

9) $\left(\frac{1}{4}\right)^{5x}=4^{x+8}$

You try #10 – 12!

10) $4\left(\frac{1}{3}\right)^{x}=108$

11) $4^{5x+1}+3=19$

12) $\left(\frac{2}{3}\right)^{4}=\left(\frac{3}{2}\right)^{4x+11}$