Unit 5 Laws of Exponents

5-1 Zero & Negative Exponents

Anything to the power of zero = 1 ☺

$a^0 = 1$ For any rational number *a* except 0.
Ex. $8^0 = 1$

*Negative exponents: The power is in the wrong place – You must move the power to make it positive

For any rational number *a* except 0, and for all whole numbers *m*,

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

Ex. $4^{-2} = \frac{1}{4^2}$

The fraction answer is called written with a fraction bar or only using positive exponents.

$\frac{1}{7^3}$

7^{-3} is called written with negative exponents.

$5^3 = 5 \cdot 5 \cdot 5$
$5^2 = 5 \cdot 5$
$5^1 = 5$
$5^0 = 1$
$5^{-1} = \frac{1}{5}$
$5^{-2} = \frac{1}{5^2} = \frac{1}{5 \cdot 5}$
$5^{-3} = \frac{1}{5^3} = \frac{1}{5 \cdot 5 \cdot 5}$

Simplify each expression

1. $38y^0$
2. $(67x)^0$
3. $(-5)^{-2}$
4. -5^{-2}
5. $\frac{3x^{-2}}{y}$
6. $\frac{8}{2x^{-3}}$
7. $x^{-5}\ y^{-9}$
8. $\frac{6a^{-1}c^3}{d^0e^{-2}}$

Evaluate if *x* = –2 and y = -3

9. $(3x)^{-2}\ \ 2y^{-3}$

5-2 Scientific Notation

Scientific Notation:

a way to write numbers using powers of 10

- You write a number in scientific notation as the product of two factors.

$8,200,000,000,000 = 8.2 \times 10^{12}$

Write in ***scientific*** notation.

1. 2,100,000

2. 0.000023

3. 0.07×10^{13}

4. 0.91×10^{-4}

Write each number in ***standard*** notation.

5. 8.34×10^{-6}

6. 3.21×10^{8}

7. 214×10^{5}

8. 321.56×10^{6}

Supplemental: Metric System

	Kilo-	**Hecto-**	**Deka-**	**Unit**	**Deci-**	**Centi-**	**Milli-**
Length	Kilometer (km)	Hectometer (hm)	Dekameter (dam)	Meter (m)	Decimeter (dm)	Centimeter (cm)	Millimeter (mm)
Capacity	Kiloliter (kL)	Hectoliter (hL)	Dekaliter (daL)	Liter (L)	Deciliter (dL)	Centiliter (cL)	Milliliter (mL)
Mass	Kilogram (kg)	Hectogram (hg)	Dekagram (dag)	Gram (g)	Decigram (dg)	Centigram (cg)	Milligram (mg)

Left to Right: largest to smallest and each unit is $\frac{1}{10}$ of the size of the unit before it.

kilo- hecto- deka- unit deci- centi- milli-

5-3 & 5-4 Multiplication Properties of Exponents & More

Multiplying Monomials:

* Multiply the coefficients (numbers in front of the variables)

*Add the exponents!

For any rational number a, and for all whole numbers m and n.
$a^m \cdot a^n = a^{m+n}$

Ex. $8^4 \cdot 8^3 = 8^{4+3} = 8^7$
$(8 \cdot 8 \cdot 8 \cdot 8)(8 \cdot 8 \cdot 8) = 8^7$

Raising Powers to Powers

*Distribute the Exponents

*Multiply the powers

* Take the coefficient to the power

For any rational number a, and any whole number m and n.
$(a^m)^n = a^{n \cdot m}$

Ex. $\left(3^5\right)^4 = 3^{5 \cdot 4} = 3^{20}$

Simplify each expression

1. $(21c^2)(c^4)$

2. $(3x^5y^3)(-7x^{-2}y^3)$

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

4. $(6b^4y)^2$

5. $(3b^{-2})^2(a^2b^4)^3$

6. $(m^?)^3 = m^{-12}$

5-5 Division Properties of Exponents

<u>*Dividing Monomials*</u>:

* Simplify/Divide
the coefficients (numbers in front of the variables)

*Subtract the exponents!

For any number *a* except 0, and for all whole numbers *m* and *n*.

$\frac{a^m}{a^n} = a^{m-n}$

Ex. $\frac{4^5}{4^2} = 4^{5-2} = 4^3$ $\frac{4\cdot4\cdot4\cdot4\cdot4}{4\cdot4} = 4^3$

For any rational numbers *a* and *b* except *b* = 0, and for any whole number *n*,

$\left(\frac{a}{b}\right)^n = \frac{a^n}{b^n}$

Ex. $\left(\frac{x^2}{4}\right)^3 = \frac{(x^2)^3}{4^3} = \frac{x^6}{64}$

Review…

Simplify each expression

1. $\frac{x^9}{x^5}$

2. $\frac{2x^4y^{16}}{3x^8y^5z^{-6}}$

3. $\frac{15p^3j^{-4}}{5p^{-3}j^6}$

4. $\frac{4a^8b^3c^2}{-28a^5b^{-6}c^2}$

5. $\frac{-144a^0b^{-3}c^4}{12b^5c^{-2}}$

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

7. $(3c^{-2}d)^{-3}$

8. $(3cd^4)^2(-2c^4d^{-2})^3$

9. $(4x^7yz^{-3})(-x^{-3}y^0z^9)$

5-6 Using Square Roots and Simplifying Radicals

All positive real numbers have two square roots, a positive (or principal) square root and a negative square root, each written with the radical symbol $\sqrt[2]{}$ or $\sqrt{}$. The number or expression inside is called the radicand.

Zero has only one square root, 0.

Negative real numbers do not have real square roots.

Simplest Radical Form (SRF)

A rational expression is in simplest form when:
1. No radical has a perfect square factor other than 1
2. No fractions are under a radical
3. No radicals are in the denominator

Examples

$\sqrt{49} = 7$

$\sqrt{144} = 12$

$\sqrt{-25} = \text{no real numbers}$

1. $\sqrt{16}$

2. $\sqrt{198}$

3. $\sqrt{75}$

4. $\sqrt{225}$

5. $\dfrac{\sqrt{5}}{\sqrt{2}}$

Try This

a. $\sqrt{81}$

b. $\sqrt{225}$

c. $\sqrt{24}$

d. $\sqrt{96}$

e. $\sqrt{12}$

f. $\sqrt{500}$

g. $\frac{\sqrt{10}}{\sqrt{18}}$

h. $\frac{\sqrt{6}}{\sqrt{27}}$

Simplifying Radicals with Variables

Simplify:

1. $\sqrt{x^6}$

2. $\sqrt{49x^2}$

3. $\sqrt{10} \cdot \sqrt{40}$

4. $\sqrt{3n} \cdot \sqrt{24n}$

5. $\sqrt{36n} + \sqrt{25n}$

6. $\sqrt{54n} + \sqrt{24n}$

7. $\sqrt{48n} - \sqrt{27n}$

8. $\frac{\sqrt{3}}{\sqrt{7x}}$

9. $\sqrt{\frac{3x^6}{16x^4}}$