

Warm-up 1-31

Simplify each expression using the properties of exponents.

1. x^2x^7

2. $(k^4)^3$

3. h^3h^{-3}

4. $(ab)^9$

5. c^{24}/c^{14}

6. $(a/c)^{14}$

Warm-up 1-31

Simplify each expression using the properties of exponents.

$$1. x^2x^7 = x^{2+7} = x^9$$

$$2. (k^4)^3 = k^{4(3)} = k^{12}$$

$$3. h^3h^{-3} = h^{3+(-3)} = h^0 = 1$$

$$4. (ab)^9 = a^9b^9$$

$$5. c^{24}/c^{14} = c^{24-14} = c^{10}$$

$$6. (a/c)^{14} = \frac{a^{14}}{c^{14}} = a^{14}/c^{14}$$

Section 7.1~ Integer Exponents

What is an integer?

-a positive or negative whole number

A power is a number with a base and an exponent



The base is a repeated factor and the exponent tells how many times the base is multiplied by itself.

Powers are written as:

$$x^4$$

$$8^5$$

Expanded form:

~~$$x \cdot x \cdot x \cdot x$$~~

$$8 \cdot 8 \cdot 8 \cdot 8 \cdot 8$$

Verbal form:
 x to the power of four
 eight raised to the fifth power

Practice: Write each in expanded form and find the value.

$$3^3 = 3 \cdot 3 \cdot 3$$

$$7^4 = 7 \cdot 7 \cdot 7 \cdot 7$$

$$12^2 = 12 \cdot 12$$

$$2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 = 2^6$$

Negative Base

Scenario #1: negative base^{exponent}

Example: $-5^2 = -25$

$$-5 \cdot 5$$

Scenario #2: (negative base)^{exponent}

Example: $(-5)^2 = 25$

$$(-5)(-5)$$

(negative base)^{even} = pos

(negative base)^{odd} = neg

$$(-4)^{22} = \text{pos}$$

$$(-4)^3 = \text{neg}$$

Negative Exponent -

$$x^{-n} = \frac{1}{x^n}, \text{ or } \frac{1}{x^n} = x^{-n}$$

$$h^3 h^{-3} = \frac{h^3}{h^3} = h^0 = 1$$

Example: $5^{-2} = \frac{1}{5^2}$ $(-2)^{-3} = \frac{1}{(-2)^3}$ $4^{-5} = \frac{1}{4^5}$

$$\frac{1}{25} = 0.04 \quad \rightarrow \frac{1}{8} = -0.125$$

$$\frac{1}{a^{-3}} = \frac{a^3}{1} = a^3$$

Exponent Rules

Product Rule- $x^m x^n = x^{m+n}$

Power Rule- $(x^m)^n = x^{mn}$

Power of a Product Rule- $(xy)^n = x^n y^n$

Quotient Rule- $\frac{x^m}{x^n} = x^{m-n}$

Power of a Quotient Rule- $\left(\frac{x}{y}\right)^n = \frac{x^n}{y^n}$

Definitions:

Zero Exponent- $x^0 = 1$

Exponent Definition- $x^n = \text{xxxxx... (n-times)}$

Examples

Simplify

a. $7w^{-4}$

$$\frac{7}{w^4}$$

b. $\frac{-5}{k^{-2}}$

$$-5k^2$$

c. $\frac{a^0 b^{-2}}{c^{-3} d^6}$

$$\frac{c^3}{b^2 d^6}$$

Try These!

a. $2r^0m^{-3}$

$$\frac{2}{m^3}$$

b. $\frac{r^{-3}}{7}$

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

c. $\frac{g^4}{h^{-6}}$

$$g^4h^6$$

Examples

1. A sand fly may have a wingspan up to 5^{-3} m. Simplify this expression.

2. Simplify and Evaluate: a.) 4^{-2} b.) 7^0 c.) $(-5)^{-4}$ d.) -5^{-4}

Try These on your own!

1. $3^5(3^1)$

2. $8^2(8^2)$

3. $z^6(z^3)$

4. $x^4(y^5)$

Try These on your own!

1. $3^5(3^1)$

$$3^6$$

2. $8^2(8^2)$

$$8^4$$

3. $z^6(z^3)$

$$z^9$$

4. $x^4(y^5)$

Steps to Simplify a product of monomials

1. Remove parentheses - group constants together and the group variables together
2. Simplify by using product property

Practice:

$$(5t)(-30t^2)(4a^2b^2)(-ac^2)(3b^2c^2)$$

$$= 5(-30)(4)(-1)(3) a^2 a^1 t t^2 b^2 b^2 c^2 c^2$$

$$= 1800 a^3 b^4 c^4 t^3$$

$$= 1800 a^3 b^4 c^4 t^3$$

Try these! Simplify.

1. $(3m^2)(60mp^2)$

$180m^3p^2$



2. $(8xz)(-10y)(-2yz^2)$

$160xy^2z^3$



3. $x^{3c} x^{4c}$

x^{7c}



4. $(-3h^2)(5g^{-3}h^4)(-g)$



Section 7.3: Power Properties

Power-of-a-Power Property (for monomials)

For all real numbers x and all integers m and n ,

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

Examples:

Simplify and evaluate.

$$(2^3)^4 = 2^{12} \quad (10^3)^2 = 10^6 \quad (p^2)^5 = p^{10} \quad (x^m)^2 = x^{2m}$$

Try These!

1. $(2^6)^2$

2. $(10^4)^5$

3. $(y^3)^5$

4. $(m^3)^x$

Try These!

1. $(2^6)^2$
 2^{12}

2. $(10^4)^5$
 10^{20}

3. $(y^3)^5$
 y^{15}

4. $(m^3)^x$
 m^{3x}

Power-of-a-Product Property

For all real numbers x and y , and all integers n
(monomials-distribute),

$$(xy)^n = x^n y^n$$

Examples:

Simplify

$$(xy)^2 = x^2 y^2$$

$$(x^4 y^2 z^5)^3 = x^{12} y^6 z^{15} (ab^2 c^n)^5 = a^5 b^{10} c^{5n}$$

Try These!

1. $(xy^3)^2$

2. $(x^2y^2z^2)^3$

3. $(abcd)^n$

4. $(-3n^2k^{-4})^2$

Try These!

1. $(xy^3)^2$

$$x^2 y^6$$

2. $(x^2 y^2 z^2)^3$

$$x^6 y^6 z^6$$

3. $(abcd)^n$

$$a^n b^n c^n d^n$$

4. $(-3n^2 k^{-4})^2$

$$(-3)^2 n^4 k^{-8}$$

$$9n^4 k^{-8} = \frac{9n^4}{k^8}$$

More Practice

1. $4(m^2n)^3$

2. $(cd)^3(c^2d)^4$

3. $(2x^3y)^3(xy^4)^2$

4. $(-2r^5s)^2(-3rs^2)^3$

Section 7.4 ~ Quotient PropertiesQuotient Property of Exponents

* applies only to like bases

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

* When dividing like bases, subtract the exponents and leave the base the same

$$\frac{x^6}{x^1} = x^5$$

$$\frac{y^3}{y^7} = y^{-4} = \frac{1}{y^4}$$

Examples

$$1. \frac{3^5}{3^3}$$

$$2. \frac{4^5}{4^{10}}$$

$$3. \frac{m^2 n^6 m^5}{5 n^2 m^{12}}$$

$$4. \frac{12x^2y}{2x^5}$$

$$5. \frac{16m^2 n^5 p^2 n^{-3}}{4 n^{12} p^5}$$

Try These!!

$$1. \frac{3n^4}{3n^3}$$

$$2. \frac{2h^3j^3k^4}{3jk}$$

$$3. \frac{4x^0y^{-2}z^3}{4x}$$

Power of a Quotient

* distribute the exponent to all the exponents of the quotient.

$$\left(\frac{x^1}{y^2} \right)^3 = \frac{x^3}{y^6}$$

Examples

$$1. \left(\frac{6^5}{7^8} \right)^4 = \frac{6^{20}}{7^{32}}$$

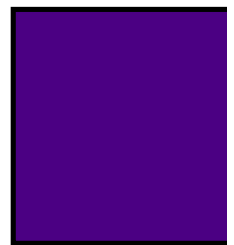
$$2. \left(\frac{m^2 x^3}{m x^5} \right)^3$$

$$= \frac{m^6 x^9}{m^3 x^{15}}$$

$$4. \left(\frac{x^3}{y^{-2}} \right)^4$$

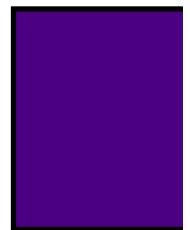
$$\frac{(a^5 a^9)^{-5}}{a^{-15}}$$

Answer: $\frac{1}{a^{55}}$



$$\left(\frac{m^{-3} m^{-7}}{(m^{-4})^{-3}}\right)^5$$

Answer: $\frac{1}{m^{110}}$



Try These!

1. $\left(\frac{6y^7}{x}\right)^4$

2. $\left(\frac{3z^2x^3}{zx^6}\right)^4$

3. $\left(\frac{m^2}{mn^3}\right)^{-5}$

To Polynomials