Zero and Negative Exponents

Learning Targets: I can evaluate any expression to the zero power.
I can simplify exponential expressions with negative exponents.

Fill in the blanks. Look for patterns to help you! Use fractions where necessary – **no decimals**!

Exponent, n	Value of 2^n
4	$2^4 = 16$
3	$2^3 = 8$
2	$2^2 = 4$
1	$2^1 = 2$
0	$2^0 = 1$
-1	$2^{-1} = \frac{1}{2}$
-2	$2^{-2} = \frac{1}{2^2} = \frac{1}{4}$
-3	$2^{-3} = \frac{1}{2^3} = \frac{1}{8}$

Exponent, n	Value of 3^n
4	$3^4 = 81$
3	$3^3 = 27$
2	$3^2 = 9$
1	$3^1 = 3$
0	$3^0 = 1$
-1	$3^{-1} = \frac{1}{3}$
-2	$3^{-2} = \frac{1}{3^2} = \frac{1}{9}$
-3	$3^{-3} = \frac{1}{3^3} = \frac{1}{27}$

Exponent, n	Value of 4^n
4	$4^4 = 256$
3	$4^3 = 64$
2	$4^2 = 16$
1	$4^1 = 4$
0	$4^0 = 1$
-1	$4^{-1} = \frac{1}{4}$
-2	$4^{-2} = \frac{1}{4^2} = \frac{1}{16}$
-3	$4^{-3} = \frac{1}{4^3} = \frac{1}{64}$

What do you notice about a number to the zero power? it is always 1

Describe what a negative exponent means: it puts the base in denominator w/ positive exponent

Zero and Negative Exponents

- For any real number a, $a^0 =$ 1.
- For any real number a, $a^{-n} =$ $\frac{1}{a^n}$ and $\frac{1}{a^{-n}} =$ a^n.

  This means _____

Examples:

$5^0 = 1$ $\quad (36^2)^0 = 1$ $\quad 2^{-1} = \frac{1}{2^1} = \frac{1}{2}$ $\quad 3^{-2} = \frac{1}{3^2}$ $\quad \frac{1}{4^{-1}} = 4$ $\quad \frac{1}{8^{-2}} = 8^2$

cross the line + change the sign.

Examples: Simplify the expression. Write your answer as a fraction in simplest form. Do not evaluate.

1. 6^0

1

2. 6^{-3}

$\frac{1}{6^3} = \frac{1}{216}$

3. k^{-5}

$\frac{1}{k^5}$

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

$\frac{1}{(-3)^2} = \frac{1}{9}$

5. $x^0 \cdot y^{-3}$

$1 \cdot \frac{1}{y^3} = \frac{1}{y^3}$

6. $3^5 \cdot 3^{-4}$

3

7. $5^{-7} \cdot 5^9$

5^2

8. $3^{-2} \cdot 3^2$

$3^0 = 1$

9. $(w^3)^{-2}$

$w^{-6} = \frac{1}{w^6}$

10. $(6^{-1})^2$

$6^{-2} = \frac{1}{6^2} = \frac{1}{36}$

11. $(8^3)^{-1}$

$8^{-3} = \frac{1}{8^3} = \frac{1}{512}$

12. $(2^{-6})^{-3}$

2^{18}

13. $(m^{-2}n)^2$

$m^{-4}n^2 = \frac{n^2}{m^4}$

14. $(m^3p^{-2})^{-1}$

$m^{-3}p^2 = \frac{p^2}{m^3}$

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

$\frac{x^{18}}{y^{-12}} = x^{18}y^{12}$

More Examples: Simplify the expression. Remember: This means no negative exponents, evaluate any numbers and reduce the fraction if possible.

1. x^{-8}

$\frac{1}{x^8}$

2. $3x^{-5}$

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

3. $\frac{7}{x^{-2}}$

$7x^2$

4. $\frac{9}{x^{-4}}$

$9x^4$

5. y^4x^{-4}

$\frac{y^4}{x^4}$

6. $2x^{-2}y^{-3}$

$\frac{2}{x^2y^3}$

7. $(5a)^{-2}$

$\frac{1}{(5a)^2} = \frac{1}{25a^2}$

8. $(5x)^0$

1

9. $\frac{1}{(3x)^{-3}}$

$(3x)^3 = 27x^3$

10. $\frac{1}{2x^{-5}y^2}$

$\frac{x^5}{2y^2}$

Evaluating Exponential Expressions

Learning Target: ***I can evaluate an exponential expression with one or two variables given specific values.***

Evaluate each expression. Leave fractions as fractions, just be sure to put in simplest form (reduce!!)

Hint: Simplify the expression if possible <u>BEFORE</u> substituting in the number!!

1. $3x$ when $x = 2$

$3(2) = \boxed{6}$

2. $\frac{24}{x^2}$ when $x = 3$

$\frac{24}{3^2} = \frac{24}{9} = \boxed{\frac{8}{3}}$

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

$\frac{2^2x^4}{y^6} = \frac{4x^4}{y^6}$

$\frac{4(3^4)}{4^6} = \frac{4 \cdot 81}{4096} = \frac{324}{4096} = \boxed{\frac{81}{1024}}$

4. $\frac{n^2 \cdot n^5}{n^3}$ when $n = -3$

$\frac{n^7}{n^3} = n^4$

$(-3)^4 = \boxed{81}$

5. $\frac{6}{g^2} \cdot \frac{8g^3h^{-2}}{gh}$ when $g = 2, h = 3$

$\frac{48g^3}{g^3 \cdot h \cdot h^2} = \frac{48}{h^3} =$

$\frac{48}{3^3} = \frac{48}{27} = \boxed{\frac{16}{9}}$

6. $(d^3)^2$ when $d = 2$

d^6

$2^6 = \boxed{64}$

7. n^3 when $n = 6$

$6^3 = \boxed{216}$

8. $2m \cdot \frac{3m}{n}$ when $m = 6, n = 10$

$\frac{6m^2}{n} = \frac{6 \cdot 6^2}{10} = \frac{6 \cdot 36}{10}$

$= \frac{216}{10} = \boxed{\frac{108}{5}}$

9. $\left(\frac{5x^3y}{y^4}\right)^3$ when $x = 2, y = 3$

$\frac{5^3x^9y^3}{y^{12}} = \frac{125x^9}{y^9}$

$= \frac{125(2)^9}{3^9} = \frac{125 \cdot 512}{19683} = \boxed{\frac{64000}{19683}}$

10. $\frac{2x^2}{x^2y}$ when $x = 8, y = 4$

$= \frac{2}{y} = \frac{2}{4} = \boxed{\frac{1}{2}}$

11. $\frac{k}{7} \cdot \frac{4k^3m^{-3}}{m^2}$ when $k = 4, m = 3$

$\frac{4k^4}{7m^2m^3} = \frac{4k^4}{7m^5}$

$\frac{4(4^4)}{7(3^5)} = \frac{4 \cdot 256}{7 \cdot 243} = \boxed{\frac{1024}{1701}}$

12. $\frac{w^3 \cdot w^4}{w^9}$ when $w = -5$

$\frac{w^7}{w^9} = \frac{1}{w^2}$

$\frac{1}{(-5)^2} = \boxed{\frac{1}{25}}$

13. $\frac{4x^{-2}}{2y^{-1}}$ when $x = 2, y = -3$

$\frac{4y^1}{2x^2} = \frac{4(-3)}{2(2^2)} = \frac{-12}{8}$

$= \boxed{-\frac{3}{2}}$

14. $\frac{2m}{4n^2} \cdot \frac{3m^4}{n}$ when $m = 1, n = 8$

$\frac{6m^5}{4n^3} = \frac{6(1^5)}{4(8^3)} = \frac{6 \cdot 1}{4 \cdot 512}$

$= \frac{6}{2048} = \boxed{\frac{3}{1024}}$

15. $12x^4 \cdot \frac{3x}{9x^5}$ when $x = 10$

$\frac{36x^5}{9x^5} = \frac{36}{9} = \boxed{4}$