Rules of Exponents Activity **#1 (Product Rule)**

Expression	Work it out!	End result...
$2^3 \cdot 2^4$	$(2 \cdot 2 \cdot 2) \cdot (2 \cdot 2 \cdot 2 \cdot 2)$ Notice there are seven 2's	2^7
$3^4 \cdot 3^1$		
$5^4 \cdot 5^5$		
$7^2 \cdot 7^6$		
$x^m \cdot x^n$		x^{m+n}

Conclusions

Do you think this rule would work for $4^3 \cdot 6^5$? **Explain.** If so, what do you get as the end result?

$64 \cdot 7776$ $4^3 = 4 \wedge 3$

$497,664$

Rules of Exponents Activity **#2 (Power Rule)**

Expression	Work it out!	End result...
$(3^2)^3$	$3^2 \cdot 3^2 \cdot 3^2 = (3 \cdot 3) \cdot (3 \cdot 3) \cdot (3 \cdot 3)$ Notice there are six 3's	3^6
$(4^3)^4$		
$(2^3)^3$		
$(2^4)^2$		
$(x^m)^n$		x^{mn}

Conclusions

Do you think this rule would work for $(3^2)^5$? **Explain.** If so, what do you get as the end result?

3^{10}

Rules of Exponents Activity **#3 (Power of a Product Rule)**

Expression	Work it out!	End result...
$(3 \cdot 4)^2$	$(3 \cdot 4) \cdot (3 \cdot 4) = (3 \cdot 3) \cdot (4 \cdot 4)$ Notice there are two 3's and two 4's	$3^2 \cdot 4^2$
$(2 \cdot 5)^3$		
$(6 \cdot 3)^4$		
$(4 \cdot 5)^2$		
$(x \cdot y)^n$		$x^n y^n$

Conclusions

Do you think this rule would work for $(7 \cdot 5)^3$? **Explain.** If so, what do you get as the end result?

$7^3 \cdot 5^3$

Rules of Exponents Activity **#6 (Zero Exponent Rule)**

Expression	Work it out!	End result...
$\frac{2^3}{2^3}$	$\frac{2 \cdot 2 \cdot 2}{2 \cdot 2 \cdot 2}$	$2^0 = 1$
$\frac{5^4}{5^4}$	$\frac{1 \cdot \cancel{5} \cdot \cancel{5} \cdot \cancel{5} \cdot \cancel{5}}{\cancel{5} \cdot \cancel{5} \cdot \cancel{5} \cdot \cancel{5}} = 1$	5
$\frac{9^2}{9^2} = 9^{2-2} = 9^0$		
$\frac{6^5}{6^5}$		
x^0		$x^0 = 1$

Conclusions

Do you think this rule would work for 0^0? **Explain.** If so, what do you get as the end result?

$0^0 = \frac{0}{0} = \text{undefined}$

Rules of Exponents Activity **#4 (Quotient Rule)**

Expression	Work it out!	End result...
$\frac{3^5}{3^3}$	$\frac{3\cdot3\cdot3\cancel{\cdot3\cdot3}}{\cancel{3\cdot3\cdot3}}$ Notice you can cancel three 3's on the bottom with three 3's on the top. You're left with only two three's on top.	3^2
$\frac{6^6}{6^3}$	$\frac{\cancel{6\cdot6\cdot6}\,6\cdot6\cdot6}{\cancel{6\cdot6\cdot6}}$	6^3
$\frac{5^2}{5^1}$		
$\frac{8^{10}}{8^5}$	$\frac{\cancel{8\cdot8\cdot8\cdot8\cdot8}\,8\cdot8}{\cancel{8\cdot8\cdot8\cdot8\cdot8}}$	8^2
$\frac{x^m}{x^n}$		x^{m-n}

Conclusions

Do you think this rule would work for $\frac{7^5}{4^3}$? **Explain.** If so, what do you get as the end result?

Rules of Exponents Activity **#7 (Negative Exponent Rule)**

Evaluate the following:

$3^4 = 81$ ÷3
$3^3 = 27$ ÷3
$3^2 = 9$ ÷3
$3^1 = 3$ ÷3
$3^0 = 1$ ÷3
$3^{-1} = \frac{1}{3}$

$3^{-4} = \frac{1}{3^4} = \frac{1}{81}$
$3^{-3} = \frac{1}{27} = \frac{1}{3^3}$
$3^{-2} = \frac{1}{3^2} = \frac{1}{9}$
$3^{-1} = \frac{1}{3}$

$\frac{1}{3} \div 3$
$\frac{1}{3} \cdot \frac{1}{3} = \frac{1}{3^2}$

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

Conclusions

Do you think this rule would work for 4^{-2} **Explain.** If so, what do you get as the end result?

Rules of Exponents Activity **#5 (Power of a Quotient Rule)**

Expression	Work it out!	End result...
$\left(\frac{3}{2}\right)^3$	$\frac{3}{2}\cdot\frac{3}{2}\cdot\frac{3}{2}$ but using fraction multiplication, we see this as $\frac{3\cdot3\cdot3}{2\cdot2\cdot2}$	$\frac{3^3}{2^3}$
$\left(\frac{1}{2}\right)^2$		
$\left(\frac{2}{9}\right)^5$		
$\left(\frac{x}{y}\right)^n$		

Conclusions

Do you think this rule would work for $\left(\frac{5}{0}\right)^3$ **Explain.** If so, what do you get as the end result?

Exponent Escape Room

1. Complete Checkpoint 1:
   Exponent Rule Foldable
2. Complete Checkpoint 2:
   Worksheet Level 1 and 2
3. Find Checkpoint 3:
   Worksheet Level 3 and 4
4. Find Checkpoint 4:
   Worksheet to Get code to
   unlock Treasure!

Practice	Rules and Examples
Ex 1: $7a + -8a$ Ex 2: $9x + 2x - 5x^2 + x^2$ $-a$ $11x - 4x^2$ Ex 3: $3x + 4y + 2 - 7 - 3x^2 + 9y$ $3x + 13y - 5 - 3x^2$	Combining Like Terms: When adding monomials that have the same base and same exponent, add the coefficients $m \cdot x + n \cdot x = (m+n) \cdot x$ $6x + 2x = (6+2)\,x = 8x$
Ex 1: $x^3 \cdot x^8$ Ex 2: $2^4 \cdot 2^2 = 2222 \cdot 22$ $x^{3+8} = x^{11}$ $2^{4+2} = 2^6$ Ex 2: $(2x^2y)(-3x^3y^4) = -6x^5y^5$ $2 \cdot -3 \cdot x \cdot x \cdot xx \cdot x \cdot y \cdot y \cdot y \cdot y$	Product Rule: When multiplying monomials that have the same base, add the exponents. $x^m \cdot x^n = x^{m+n}$ $7x^6 \cdot 5x^2 = 7 \cdot 5 \cdot x^{6+2} = 35x^8$
Ex 1: $\frac{3^5}{3^3}$ Ex 2: $\frac{x^2y^5}{xy^3} = x^{2-1}y^{5-3}$ $= 3^{5-3} = 3^2 = 9$ $= xy^2$ Ex 3: $\frac{36m^3n^5}{-9mn^4} = \frac{36}{-9} m^{3-1} n^{5-4} = -4m^2n$	Quotient Rule: When dividing monomials that have the same base, subtract the exponents. $\frac{x^m}{x^n} = x^{m-n}$ $\frac{14x^6y^0}{7x^2y^3} = \frac{14}{7} x^{6-2}y^{0-3} = 2x^4y^{-3}$
Ex 1: $(x^3)^2$ $x^3 \cdot x^3$ Ex 2: $(3^5)^4$ $x^{3 \cdot 2} = x^6$ $3^{5 \cdot 4} = 3^{20}$ Ex 3: $(z^5)^8 = z^{5 \cdot 8} = z^{40}$	Power Rule: When raising monomials to powers, write the base and multiply the exponents. $(x^m)^n = x^{m \cdot n}$ $(x^6)^2 = x^{6 \cdot 2} = x^{12}$
Ex 1: $(2a)^5$ $2a \cdot 2a \cdot 2a \cdot 2a \cdot 2a$ Ex 2: $(6x^3)^2$ $2^5 a^5$ $6^2 x^{3 \cdot 2} = 36x^6$ $2^{1 \cdot 5} a^{1 \cdot 5} = 32a^5$ $6x^3 \cdot 6x^3$ Ex 3: $(2x^3yz^2)^3$ $2^3 x^{3 \cdot 3} y^3 z^{2 \cdot 3} = 8x^9y^3z^6$	Power of a Product Rule: When raising a product of monomials to powers, write each base and multiply the base's exponent with the outside exponent. $(ax^my^n)^4 = a^4x^{4m}y^{4n}$ $(2x^2y^3)^4 = 2^{1 \cdot 4} x^{2 \cdot 4} y^{3 \cdot 4} = 16x^8y^{12}$
Ex 1: $\left(\frac{x^2}{y}\right)^4 = \frac{x^2}{y} \cdot \frac{x^2}{y} \cdot \frac{x^2}{y} \cdot \frac{x^2}{y}$ Ex 2: $\left(\frac{2x}{3y^2}\right)^3$ $\frac{x^{2 \cdot 4}}{y^{1 \cdot 4}} = \frac{x^8}{y^4}$ $\frac{2^3 x^3}{3^3 y^{2 \cdot 3}} = \frac{8x^3}{27y^6}$	Power of a Quotient Rule: When raising a division of monomials to powers, write each base where it is and multiply the base's exponent with the outside exponent. $\left(\frac{x}{y}\right)^m = \frac{x^m}{y^m}$ $\left(\frac{3m^2n^7}{m}\right)^5 = \frac{3^{1 \cdot 5} m^{2 \cdot 5} n^{7 \cdot 5}}{m^{1 \cdot 5}} = \frac{243m^{10}n^{35}}{m^5}$ $\left(\frac{3m^2n^7}{m}\right)^5 = (3^{1(5)}\, m^{2(5)-1(5)}\, n^{7(5)}) = 3^5\, m^{10-5}\, n^{35} = 243m^5n^{35}$
Ex 1: 4^{-2} $\frac{1}{4^2} = \frac{1}{16}$ Ex 2: $-4x^5y^{-2} = \frac{-4x^5}{y^2}$ Ex 3: $\frac{a^{-2}b^3}{c^{-4}d^{-1}}$ $\frac{b^3c^4d}{a^2}$ Ex 4: $\left(\frac{x^2}{y}\right)^{-3} \left(\frac{y^{-3}}{x^2}\right)^n$ $\frac{x^{-6}}{y^{-3}} = \frac{y^3}{x^6}$	Negative Exponents: The Reciprocal of that factor. If a factor in the numerator or denominator is moved across the fraction bar, the sign of the exponent is changed. $x^{-m} = \frac{1}{x^m}$ $\frac{1}{x^{-m}} = x^m$ $\left(\frac{x}{y}\right)^{-n} = \left(\frac{y}{x}\right)^n$ $x^{-3} = \frac{1}{x^3}$ CAUTION: $-x \neq \frac{1}{x}$ For example: $-3 \neq \frac{1}{3}$
Ex 1: $7^0 = 1$ Ex 2: $(5x^4y^0z^{-2})^2$ $5^{1 \cdot 2} \cdot x^{4 \cdot 2}$ $5^2 x^8 = 25x^8$	Zero Exponent: If a factor is raised to the power of 0, the result is 1 $x^0 = 1$ $(3x^3y^2)^0 = 1$

P

E $(x^3)^2 = x^{3 \cdot 2}$

MD $x^3 \cdot x^2 = x^{3+2} = x^5$

AS $2x^3 + x^3 = 3x^3$

no change in exponent

$\sqrt{x^3} = x^{\frac{3}{2}}$

$\frac{x^3}{x^2} = x^{3-2} = x$

$2x^3 - x^3 = x^3$

no exp change

Fraction

Rational Exponents: Radicals. The denominator is the index of the radical and the numerator is the exponent entire radical or the exponent of the base underneath the radical

Index

$x^{\frac{m}{n}} = \sqrt[n]{x^m} = (\sqrt[n]{x})^m$

$d^{\frac{3}{2}} = \sqrt[2]{d^3} = \sqrt[2]{d^2 \cdot d} = d\sqrt[2]{d}$

$\sqrt{d \cdot d \cdot d}$ $\quad \sqrt{d^2} \cdot \sqrt{d}$ $\quad (d^2 \cdot d)^{\frac{1}{2}}$ $\quad d^{2 \cdot \frac{1}{2}}$ $\quad d\sqrt{d}$ $\quad 1 \cdot \frac{1}{2}$ $\quad \sqrt{\ } = \sqrt[2]{\ }$

Ex 1: $27^{\frac{2}{3}}$

$(\sqrt[3]{27})^2$

$(3)^2 \rightarrow 9$

Ex. 2 $\sqrt[4]{x^5}$

$\sqrt[4]{x \cdot x \cdot x \cdot x \cdot x}$ $\quad = x^{\frac{5}{4}}$

$\sqrt[4]{x^4} \cdot \sqrt[4]{x}$ $\quad x^1 \cdot x^{\frac{1}{4}}$ $\quad = x^{1+\frac{1}{4}}$

$x \sqrt[4]{x}$ $\quad \frac{1}{4}$

Ex. 3: $81^{\frac{3}{2}}$

Put in calculator

$81 \wedge (3/2)$

729

$(\sqrt{81})^3$ $\quad (9)^3$ $\quad 729$

Ex. 4 $25^{\frac{1}{2}}$

$25^{1/2}$

$\sqrt{25}$

5

Exponent Rules

Combining Like Terms:

$$m \cdot x + n \cdot x = (m+n) \cdot x$$

Product Rule:

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

Quotient Rule:

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

Power Rule:

$$(x^m)^n = x^{m \cdot n}$$

Power of a Product Rule:

$$(ax^m y^n)^4 = a^4 x^{4m} y^{4n}$$

Power of a Quotient Rule:

$$\left(\frac{x}{y}\right)^m = \frac{x^m}{y^m}$$

Negative Exponents:

$$x^{-m} = \frac{1}{x^m} \qquad \frac{1}{x^{-m}} = x^m \qquad \left(\frac{x}{y}\right)^{-n} = \left(\frac{y}{x}\right)^n$$

Zero Exponent:

$$x^0 = 1$$