Name:_____ Date:_____

# Notes: Laws of Exponents

**Do Now:** Simplify each expression in the left column, then explain in words the exponent law in the middle column. Lastly, in the right column, write a general rule using mathematical symbols.

| **Simplify:** | **Explain:** | **Generalize:** |
|---|---|---|
| $\frac{x^9}{x^3} =$ | When dividing terms with the same base, _____ the exponents. | $\frac{x^a}{x^b} =$ |
| $w^7(w^8) =$ | When multiplying terms with the same base, _____ the exponents. | $x^a(x^b) =$ |
| $(h^3)^4 =$ | To raise a power to a power, _____ _____. | $(x^a)^b =$ |
| $(mn)^7 =$ | To raise a product to a power, _____ _____. | $(xy)^a$ |
| $\left(\frac{c}{d}\right)^3 =$ | To raise a fraction to a power, _____ _____. | $\left(\frac{x}{y}\right)^a$ |

# What Should I Be Able to Do?

**- I can simplify any expression that raises a base to the power of zero.**

**- I can explain the reasoning behind rule for simplifying any base that is raised to the power of zero.**

**- I can simplify any expression with negative exponents.**

**- I can explain the reasoning behind the rule for simplifying an expression with negative exponents.**

**- I can simplify expressions that raises a base to a rational exponent.**

**- I can explain how to simplify expressions that involve raising a base to a rational exponent.**

## Zero Exponent:

How can I simplify $3^0$ ? Hmmmmmmm...

Let's simplify $\frac{3^2}{3^2}$ two different methods....

a) Simplify $\frac{3^2}{3^2}$ by using the laws of exponents.

b) Simplify $\frac{3^2}{3^2}$ by writing the expression out using all of its factors.

Then, $3^0 =$ _____.

Let's try that with a different value... simplify $\frac{m^6}{m^6}$ using two different methods.

Write $\frac{m^6}{m^6}$ in simplest exponential form and in standard form.

a) Simplify $\frac{m^6}{m^6}$ by using the laws of exponents.

b) Simplify $\frac{m^6}{m^6}$ by writing the expression out using all of its factors.

Then, $m^0 =$ _____.

**Generalized Rule:** For any number nonzero real number $x$ , $x^0 =$ _____.

## Negative Exponents:

How can I simplify $5^{-2}$ into a positive exponent? Hmmmmmmm...

Let's simplify $\frac{5^4}{5^6}$ two different methods....

a) Simplify $\frac{5^4}{5^6}$ by using the laws of exponents.

b) Simplify $\frac{5^4}{5^6}$ by writing the expression out using all of its factors.

Then, $5^{-2} =$ _____.

Let's try that with a different value... simplify $\frac{n^{10}}{n^{14}}$ using two different methods.

Write $\frac{n^{10}}{n^{14}}$ in simplest exponential form and in standard form.

a) Simplify $\frac{n^{10}}{n^{14}}$ by using the laws of exponents.

b) Simplify $\frac{n^{10}}{n^{14}}$ by writing the expression out using all of its factors.

Then, $n^{-4} =$ _____.

**Generalized Rule:** For any nonzero real number *x*, if $n$ is a natural number, then $x^{-n} =$ _____.

Simplify the following expressions using only positive exponents.

1) $4^{-1}$ 2) $\frac{2}{3}^{-2}$ 3) $(-10)^{0}$ 4) $\frac{24x^{-7}y^{5}}{8x^{-8}y^{7}z^{-5}}$

# Checkpoint:

Simplify the following expressions using only positive exponents.

1) $\frac{18a^{9}b^{-7}}{27a^{11}b^{-3}}$ 2) $(3x^{3}y^{-2}z^{7})^{2}$

3) $\left(\frac{-40ab^{2}c^{13}}{8ab^{-5}c^{12}}\right)^{-3}$ 4) $(2d^{-24}f^{16}g^{0})^{-3}\ \left(\frac{1}{4}d\right)^{-2}$

**Do Now:** Simplify each of the following expressions without using a calculator.

1) $2^3$ 2) $14^2$ 3) $9^{\frac{1}{2}}$ 4)$4^{\frac{3}{2}}$

But why does this make sense?

What does $\left(\sqrt{5}\right)^2$ equal to?

What does $\left(5^{\frac{1}{2}}\right)^2$ equal to?

What does this tell you about $\sqrt{5}$ and $5^{\frac{1}{2}}$?

What does $\left(\sqrt[3]{8}\right)^3$ equal to?

What does $\left(8^{\frac{1}{3}}\right)^3$ equal to?

What does this tell you about $\sqrt[3]{8}$ and $8^{\frac{1}{3}}$?

**Rational Exponents:** For any rational exponent $\frac{m}{n}$, where $m$ and $n$ are integers and $n \geq 2$,

$$a^{\frac{m}{n}} = \sqrt[n]{a^m}$$

equivalently written

$$a^{\frac{m}{n}} = \left(\sqrt[n]{a}\right)^m$$

1) Explain how $(27)^{4/3}$ can be evaluated using properties of rational exponents to result in an integer answer.

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2) Explain how $\left(8^{\frac{1}{7}}\right)^2$ can be written as the equivalent radical expression $\sqrt[7]{64}$.

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3)Write each in simplest radical form. Then completely simplify, without a calculator.

$a)\ 64^{\frac{1}{3}}$ $b)\ 625^{\frac{1}{4}}$ $c)\ (-8)^{\frac{2}{3}}$ $d)\ 36^{-\frac{1}{2}}$

# Success Criteria

**- I can simplify any expression that raises a base to the power of zero.**

1) $12^0$ 2) $(-2abc)^0$ 3) $[(-3a^{45}b^{-5}c^7)^0]^4$

**- I can explain the reasoning behind rule for simplifying any nonzero real number raised to the power of zero.**

**- I can simplify any expression with negative exponents.**

1) $\left(\frac{1}{9}a^{-101}b^{41}c^{-1}\right)^{-2}\ (3c^4)^{-3}$ 2) $\left(\frac{-48xy^{-12}z^{21}}{-36x^{-2}z^{-5}}\right)^{-3}$

**- I can explain the reasoning behind the rule for simplifying an expression with negative exponents.**

**- I can simplify expressions that raises a base to a rational exponent.**

1) $144^{\frac{1}{2}}$ 2) $32^{\frac{4}{5}}$ 3) $\left(-\frac{27}{8}\right)^{-\frac{2}{3}}$

**- I can explain how to simplify expressions that involve raising a base to a rational exponent.**

Explain how $(81)^{3/4}$ can be evaluated using properties of rational exponents to result in an integer answer.

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Name:_____ Date:_____

# Classwork: Laws of Exponents

Simplify each expression.

1) $\frac{17x^6y^{-7}}{68x^9y^{-9}}$

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

3) $\left(3x^{\frac{3}{2}}y^{-\frac{7}{4}}z^2\right)^0$

4) $\left(\frac{-46xy^{-12}z^{50}}{12x^4y^{-9}z^{21}}\right)^{-2}$

5) $\left(\frac{81x^8}{y^{-44}}\right)^{1/4}$

6) $\left(\frac{4}{3}c^{-43}d^{43}\right)^{-2}\left(\frac{4}{5}c^{-43}d^{20}\right)^2$

7) Explain how $(25)^{5/2}$ can be evaluated using properties of rational exponents to result in an integer answer.

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Write each in simplest radical form. Then completely simplify, without a calculator.

8) $(-216)^{\frac{1}{3}}$

9) $(-32)^{\frac{2}{5}}$

10) $(\frac{16}{625})^{\frac{3}{4}}$

11) $(-\frac{64}{27})^{-\frac{5}{3}}$

12) If $\left(n^{\frac{3}{4}}\right)^{x} = \frac{1}{n^{3}}$, what is the value of $x$?

(1) $-2$
(2) $2$
(3) $-4$
(4) $4$

13) Which equation is equivalent to $y = 11^{x}$ ?

(1) $y = 11^{-x}$
(2) $y = \left(\frac{1}{11}\right)^{x}$
(3) $y = -11^{x}$
(4) $y = \left(\frac{1}{11}\right)^{-x}$

14) Write $\sqrt[3]{x} \cdot \sqrt[4]{x^{3}}$ as a single term with a rational exponent.

15)Which number is the largest?

(1) $\left(\frac{1}{5}\right)^{-1}$
(2) $\left(\frac{1}{5}\right)^{0}$
(3) $\left(\frac{1}{5}\right)^{1/2}$
(4) $\left(\frac{1}{5}\right)^{3}$

16) Explain how $\left(3^{\frac{2}{5}}\right)^{2}$ can be written as the equivalent radical expression $\sqrt[5]{81}$.

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