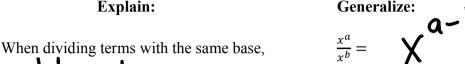
### Notes: Laws of Exponents

**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:** 



When multiplying terms with the same base, 
$$x^a(x^b) = x^{a+b}$$
 the exponents.

To raise a power to a power, multiply

The exponents

$$(x^a)^b = \chi^{ab}$$

$$(x^a)^b = \mathbf{X}^{\mathbf{ab}}$$

$$(xy)^a$$
  $X^a$   $Y^a$ 

$$\frac{\left(\frac{c}{d}\right)^3}{\sqrt{d^3}}$$

To raise a fraction to a power, raise

The numerator and denominator to the power

# What Should I Be Able to Do?

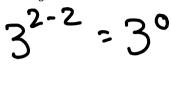
- I can simplify any expression that raises a base to the power of zero.
- I can explain the reasoning behind rule for simplifying any base that is raised to the power of zero.
- I can simplify any expression with negative exponents.
- I can explain the reasoning behind the rule for simplifying an expression 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<sup>o</sup> ? Hmmmmmm...

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

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



3°

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

Then, 
$$3^0 = _{\_\_}$$
.

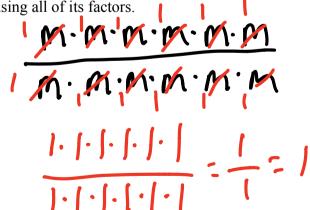
Let's try that with a different value... simplify  $\frac{m^6}{m^6}$  using two different methods.

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 Exponent:

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

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.

$$\frac{15.5.5.5}{5.5.5.5} = \frac{1}{5.5}$$

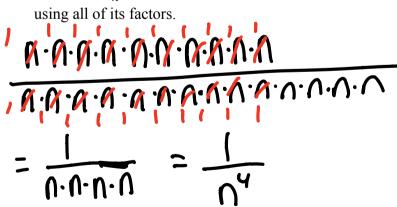
$$= \frac{1}{5.2}$$

Then, 
$$5^{-2} = \frac{1}{5^2}$$

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

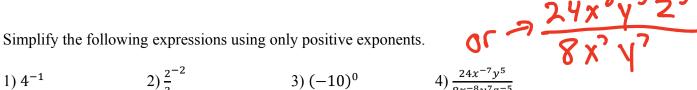
Write  $\frac{n^{10}}{n^{14}}$  in simplest exponential form and in standard form.

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, 
$$n^{-4} = 1$$
.

Generalized Rule: For any number nonzero real number x, if n is a natural number, then  $x^{-n} = \underline{\phantom{a}}$ 



$$\frac{1}{4} \frac{2)\frac{2}{3}}{4} \frac{3^{2}}{2^{1}}$$
Checkpoint:



$$\frac{1)\frac{18a^{9}b^{-7}}{27a^{11}b^{-3}}}{3} - 7 + (+3) = -4$$

$$\frac{2}{3} - 2 + 3$$

$$\frac{3}{3} \times 4 \times 4$$

$$\frac{3}{3} \times 4 \times 4$$

$$\frac{2}{3} \times 4 \times 4$$

$$\frac{3}{3} \times 4 \times 4$$

$$\frac{4}{3} \times 4 \times 4$$

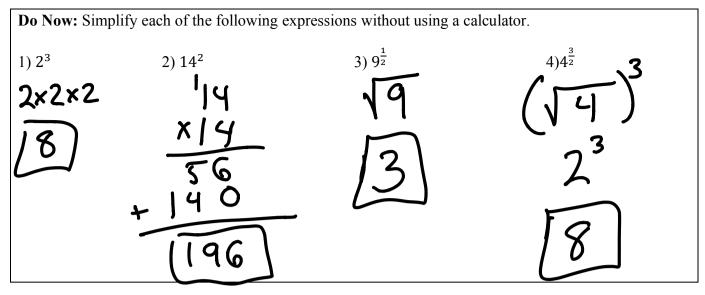
$$\frac{$$

$$\frac{8ab^{-5}c^{12}}{40ab^{2}c^{13}}$$

$$\frac{5b^{-7}c^{-1}}{5b^{2}c^{3}}$$

$$\frac{1}{125b^{2}c^{3}}$$

4) 
$$(2d^{-24}f^{16}g^{0})^{-3} \left(\frac{1}{4}d\right)^{-2}$$
 $\left(\frac{7}{4}d^{72}f^{-48}\right)\left(\frac{1}{4}d^{-2}\right)$ 
 $\left(\frac{1}{8}d^{72}f^{-48}\right)\left(\frac{1}{6}d^{-2}\right)$ 
 $2d^{70}f^{-48}$ 
 $2d^{70}$ 



But why does this make sense?

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

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

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

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

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

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

ais tell you about 
$$\sqrt[3]{8}$$
 and  $8^{\frac{3}{3}}$ ? are equal

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

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

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

Rewrite (27) in radical form where the numerator is the power and the denominator is the index on the radical, (327) or 327. First evaluate 3/27 = 3. Then evaluate 3" = 81.

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

First multiply the exponents to obtain 8.

Then rewrite 8 into radical form  $\sqrt[7]{8^2}$ . Evaluate  $\sqrt[8]{8^2}$  to get  $\sqrt[6]{64}$ . Thus  $\sqrt[8]{8^2}$  =  $\sqrt[7]{64}$ .

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

$$3\sqrt{(-8)^{\frac{2}{3}}}$$

$$(-2)^{2}=4$$

$$\frac{d) \, 36^{-\frac{1}{2}}}{\sqrt{36}} = \frac{1}{6}$$

### **Success Criteria**

	-			-			-				
_	can	simplify	anv ex	nression	that	raises	a hase	· to	the	nower	of zero.
	CHI	SIIII SIII y	unity Ch	DI COSTOII	CIIII	I CLID CO	u vusi		CIIC	pomer	UI ZCI UI

 $1) 12^{0}$ 

 $(-2abc)^0$ 

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

- I can explain the reasoning behind rule for simplifying any raised to the n

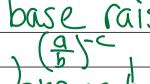
zero real number raised

- I can simplify any expression with negative exponents.

- 1)  $\left(\frac{1}{9}a^{-101}b^{41}c^{-1}\right)^{-2} (3c^4)^{-3}$



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

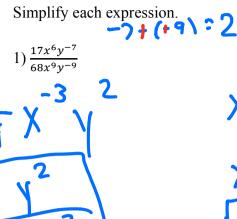






- I can simnlify expression	ons that raises a base to a rational	exponent
1) 144 <sup>1/2</sup> 1) 144 <sup>1/2</sup>	$\sqrt{5/32}$	3) $\left(-\frac{27}{8}\right)^{-\frac{2}{3}}$
[12]	(2)4	(3) -8 /2
	[[6]	$\left(\frac{-2}{3}\right)^2$
		ising a base to a rational exponent.
answer.  First rewrit	(-1) 3/4	ical form (4/81)3.
Then evalu		- (3)3. Finally,
(3) - 61.		

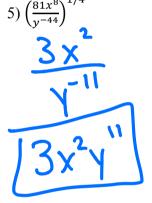
#### **Classwork: Laws of Exponents**



$$\begin{array}{c} 2) \left( x^{\frac{1}{3}} y^{\frac{3}{4}} \right)^{-12} \\ X & & \\ \end{array}$$

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

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



$$\begin{pmatrix}
6) \left(\frac{4}{3}c^{-43}d^{43}\right)^{-2} \left(\frac{4}{5}c^{-43}d^{20}\right)^{2} \\
9 \left(\frac{86}{3}c^{-86}\right) \left(\frac{16}{25}c^{-86}d^{46}\right) \\
-\frac{9}{25}d^{-46}$$

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

into radical form, (J evaluate \[ \frac{75}{55} \tag{et} \left(\frac{5}{5}\right)^5. Finally

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

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

$$3 - 216$$

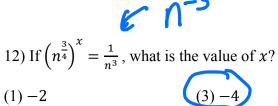
$$-6$$

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

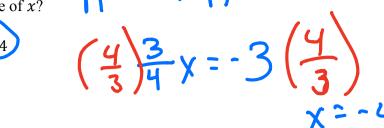
$$(-2)^{2}$$

$$\begin{array}{c}
10) \left(\frac{16}{625}\right)^{\frac{3}{4}} \\
9 \\
16 \\
625 \\
25
\end{array}$$

$$\begin{array}{c}
11) \left(-\frac{64}{27}\right)^{-\frac{5}{3}} \\
\left(-\frac{27}{64}\right)^{-\frac{5}{3}} \\
\left(\frac{3}{64}\right)^{-\frac{27}{3}} \\
\left(\frac{3}{$$



(2) 2



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

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

$$X^{\frac{3}{3}} \cdot X^{\frac{3}{4}} = X^{\frac{1}{3}} + \frac{3}{4}$$

$$\frac{1}{3} + \frac{3}{4} = \frac{4}{12} + \frac{9}{12} = \frac{13}{12}$$

$$13/12$$

15) Which number is the largest?

$$(1)\left(\frac{1}{5}\right)^{-1} = 5$$

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

$$(4)\left(\frac{1}{5}\right)^{3} = 125$$

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

First multiply the exponents to obtain 3.

Then courte 3''s into cadical form to obtain  $\sqrt[5]{3^4}$ . Then evaluate 3' to obtain  $\sqrt[5]{81}$ .