## Exponents and Radicals Lesson #6: Rational Exponents - Part One

## Review of the Exponent Laws

The exponent laws with integral exponents and numerical and variable bases were covered in previous math courses.

Complete the table as a review of the exponent laws.

Numerical Bases		Variable Bases		Exponent Laws
$8^3 \times 8^2 =$	= (8 · 8 · 8)(8 · 8)	$a^3 \times a^3$	$a = (a \cdot a \cdot a)(a \cdot a)$	<b>Product Law</b>
₹	$= 8^5$ or $8^{6+2}$		$= a$ or $a^{3+2}$	$(a^m)(a^n) = $
$8^3 \div 8^2 =$	$=\frac{8\cdot 8\cdot 8}{8\cdot 8}$	$a^3 \div a^2$		Quotient Law
=	$=8^1$ or $8^{-2}$		$= a$ or $a^{3}$	$a^m \div a^n = \frac{a^m}{a^n} = $
				(a ≠ 0)
$(8\cdot7)^3 =$	$= (8 \cdot 7)(8 \cdot 7)(8 \cdot 7)$	$(a \cdot b)^3$	$= (a \cdot b)(a \cdot b)(a \cdot b)$	Power of a Product Law
-	$= (8 \cdot 8 \cdot 8)($		$= (a \cdot a \cdot a) (\mathbf{b} \cdot \mathbf{b} \cdot \mathbf{b})$	m Lm
=	$=8^3\cdot7^3$		$=a^{3}b^{3}$	$(ab)^m = a^m b^m$ $(2a) = 4a^n$
$(8)^{3}$	$= \left(\frac{8}{7}\right) \left(\frac{9}{7}\right) \left(\frac{4}{7}\right)$	$\left(\frac{a}{b}\right)^3$	$= \left(\begin{array}{c} a \\ b \end{array}\right) \left(\begin{array}{c} a \\ b \end{array}\right) \left(\begin{array}{c} a \\ b \end{array}\right)$	Power of a Quotient Law
$\lfloor 7 \rfloor$				$(a)^n$
	$8^{3}$		$=\frac{a}{1}$	$\left(\frac{a}{b}\right)^n = \frac{a}{b^n}$
=	$=\frac{8^3}{7^3}$		$=\frac{1}{b^3}$	<u>(b ≠ 0)</u>
$(8^3)^2 =$	$=(8^3)(8^3)$	$(a^3)^2$	$=(a^3)(a^3)$	Power of a Power Law
=	=( <b>8.1.1</b> )( <b>8.5.1</b> )		= (0.0.6)(0.0.0)	
-	$=8^6 \text{ or } 8^{\$ \times 2}$		$= a^6 \text{ or } a^{8 \times 2}$	

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**2.** a) Evaluate i) 
$$8^{\frac{2}{3}} = (8^{\frac{1}{3}})^2 = (\sqrt[3]{8})^2 =$$
 ii)  $8^{\frac{2}{3}} = (8^2)^{\frac{1}{3}} = \sqrt[3]{(8^2)} =$ 

ii) 
$$8^{\frac{2}{3}} = (8^2)^{\frac{1}{3}} = \sqrt[3]{(8^2)} =$$

- **b**) Which of the calculations above is the easier method for evaluating  $8^{\frac{2}{3}}$ ?
- c) Write the following in radical form and evaluate manually. Verify with a calculator.

i) 
$$64^{\frac{3}{2}} =$$

ii) 
$$4^{\frac{5}{2}}$$

iii) 
$$81^{\frac{3}{4}}$$

- 3. a) Use exponent laws to simplify  $8^{\frac{2}{3}} \times 8^{-\frac{2}{3}}$ .
  - **b)** Use the result in a) to write  $8^{-\frac{2}{3}}$  in a form with a positive exponent. Evaluate  $8^{-\frac{2}{3}}$  without using a calculator.

## Rational Exponents

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



 $a^{\frac{m}{n}} = \left(\sqrt[n]{a}\right)^m$  or  $a^{\frac{m}{n}} = \sqrt[n]{a^m}$ ,  $m \in I$ ,  $n \in N$ ,  $a \ne 0$  when m is 0.

Note that if n is even, then a must be non-negative.

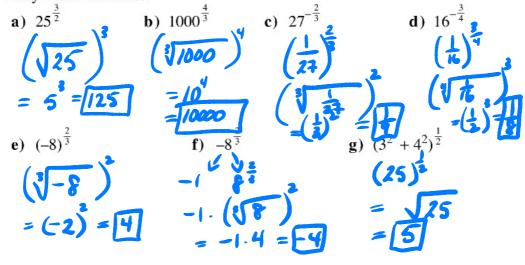
$$a^{-\frac{m}{n}} = \frac{1}{\binom{n}{n}/n}^m$$
 or

$$a^{-\frac{m}{n}} = \frac{1}{\left(\sqrt[n]{a}\right)^m} \quad \text{or} \quad a^{-\frac{m}{n}} = \frac{1}{\sqrt[n]{a^m}}, \quad m \in I, \ n \in N, \ a \neq 0 \text{ when } m \text{ is } 0.$$

Note that if n is even, then a must be positive.



Write the following in radical form and evaluate without using a calculator. Verify with a calculator.



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Write the following in radical form and evaluate without using a calculator.

Verify with a calculator.

a) 
$$\left(\frac{9}{4}\right)^{\frac{3}{2}} = \left(\sqrt{\frac{9}{4}}\right)^3$$

$$= \left(\frac{3}{2}\right)^3 = \boxed{\frac{27}{8}}$$

$$\mathbf{b}) \left(\frac{9}{4}\right)^{-\frac{3}{2}} = \left(\frac{4}{9}\right)^{\frac{3}{2}}$$

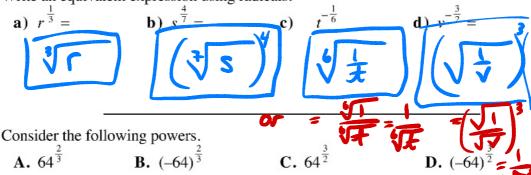
$$= \left(\sqrt{\frac{4}{9}}\right)^{\frac{3}{2}}$$

$$= \left(\frac{3}{3}\right)^{\frac{3}{2}} = \sqrt{\frac{3}{24}}$$

## Complete Assignment Questions #1 - #5



Write an equivalent expression using radicals.





Explain why three of the above powers can be calculated but the other has no meaning.



A cube has a volume of 60 m<sup>3</sup>.

- a) Write a power which represents the edge length of the cube.
- **b**) Write a power which represents the surface area of the cube.
- c) Use a calculator to calculate the edge length and surface area to the nearest tenth.



Write the number 10 in the following forms:

- a) as a power with an exponent of  $\frac{1}{2}$
- **b**) as a power with an exponent of  $\frac{1}{2}$

Complete Assignment Questions #6 - #13

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