Key

4.1 Properties of Radicals

- I can simplify radicals
- I can add, subtract and multiply radicals

Roots "undo" powers. We have already worked with square roots (which undo something squared).

nth roots of a number "a"

Square root $\sqrt{a}$ Cube root $\sqrt[3]{a}$ 4th root $\sqrt[4]{a}$ 5th root $\sqrt[5]{a}$

Powers that are helpful to identify:

Perfect Squares (have nice square roots)	$2^2 = 4$	$3^2 = 9$	$4^2 = 16$	$5^2 = 25$	$6^2 = 36$
Perfect Cubes (have nice cube roots)	$2^3 = 8$	$3^3 = 27$	$4^3 = 64$	$5^3 = 125$	$6^3 = 216$
Perfect 4th powers (have nice 4th roots)	$2^4 = 16$	$3^4 = 81$	$4^4 = 256$	$5^4 = 625$	
Perfect 5th powers (have nice 5th roots)	$2^5 = 32$	$3^5 = 243$	$4^5 = 1024$		

Ex 1: $\sqrt{49} = 7$ since $7^2 = 49$. $\sqrt[3]{27} = 3$ since $3^3 = 27$. $\sqrt[4]{16} = 2$ since $2^4 = 16$.

Properties of Radicals:

$$\sqrt[n]{a \cdot b} = \sqrt[n]{a} \cdot \sqrt[n]{b} \qquad \sqrt[n]{\frac{a}{b}} = \frac{\sqrt[n]{a}}{\sqrt[n]{b}}, \ b \neq 0$$

A radical in "simplest" form has no perfect nth powers **and** no radicals in the deominator

Ex 2: Simplify

* look for a perfect cube factor

a. $\sqrt[3]{12} \cdot \sqrt[3]{18}$

$\sqrt[3]{216} = 6$

b. $\frac{\sqrt[4]{80}}{\sqrt[4]{5}} = \sqrt[4]{\frac{80}{5}} =$

$\sqrt[4]{16} = 2$

c. $\sqrt[3]{81} = \sqrt[3]{27} \cdot \sqrt[3]{3}$

$3\sqrt[3]{3}$

Ex 3: Simplify

Need to make the denominator a perfect cube

Need to make the denominator a perfect 5^{th} power

27 is a perfect cube

32 is a perfect 5^{th} power

a. $\frac{4\sqrt{3}}{\sqrt{2}} \cdot \frac{\sqrt{2}}{\sqrt{2}} = \frac{4\sqrt{6}}{2}$

$2\sqrt{6}$

b. $\frac{6}{\sqrt[3]{9}} \cdot \frac{\sqrt[3]{3}}{\sqrt[3]{3}} = \frac{6\sqrt[3]{3}}{\sqrt[3]{27}}$

$= \frac{6\sqrt[3]{3}}{3} = 2\sqrt[3]{3}$

c. $\frac{\sqrt[5]{7}}{\sqrt[5]{8}} \cdot \frac{\sqrt[5]{4}}{\sqrt[5]{4}}$

$\frac{\sqrt[5]{28}}{\sqrt[5]{32}} = \frac{\sqrt[5]{28}}{2}$

Quick Check

Simplify

1. $\sqrt[3]{24}$

$\sqrt[3]{8} \cdot \sqrt[3]{3}$

$2\sqrt[3]{3}$

2. $\sqrt[4]{162}$

$\sqrt[4]{81} \cdot \sqrt[4]{2}$

$3\sqrt[4]{2}$

3. $\frac{4}{\sqrt[3]{32}} \cdot \frac{\sqrt[3]{2}}{\sqrt[3]{2}}$

$\frac{4\sqrt[3]{2}}{\sqrt[3]{64}} = \frac{4\sqrt[3]{2}}{4} = \sqrt[3]{2}$

4. $\frac{\sqrt[4]{2}}{\sqrt[4]{125}} \cdot \frac{\sqrt[4]{5}}{\sqrt[4]{5}} = \frac{\sqrt[4]{10}}{\sqrt[4]{625}}$

$\frac{\sqrt[4]{10}}{5}$

Adding and Subtracting Radicals –
must have the same index and radicand (same root and same number under the root)

Ex 4:

a. $\sqrt[4]{9} + 5\sqrt[4]{9}$

$6\sqrt[4]{9}$

b. $9\sqrt[6]{3} - 2\sqrt[6]{3}$

$7\sqrt[6]{3}$

c. $\sqrt[3]{54} - \sqrt[3]{2}$

$\sqrt[3]{27} \cdot \sqrt[3]{2} - \sqrt[3]{2}$

$3\sqrt[3]{2} - \sqrt[3]{2} = 2\sqrt[3]{2}$

Do and Discuss

1. $\sqrt[7]{2} - 5\sqrt[7]{2}$

$-4\sqrt[7]{2}$

2. $\sqrt[4]{48} + 5\sqrt[4]{3}$

$\sqrt[4]{16} \cdot \sqrt[4]{3} + 5\sqrt[4]{3}$

$2\sqrt[4]{3} + 5\sqrt[4]{3}$

$7\sqrt[4]{3}$

3. $3\sqrt[5]{64} - 3\sqrt[5]{2}$

$3\sqrt[5]{32} \cdot \sqrt[5]{2} - 3\sqrt[5]{2}$

$3 \cdot 2\sqrt[5]{2} - 3\sqrt[5]{2}$

$6\sqrt[5]{2} - 3\sqrt[5]{2} = 3\sqrt[5]{2}$

Additional Resources:

- Textbook: Chapter 6.2 (pg. 421)