

Tonight's Class:

- Chapter 1 Test Return
- Any questions from 2.1-2.2?
- Working through sections 2.2 and 2.3
  - Adding and subtracting radicals (continued)
  - Multiplying and dividing radicals

p 96, #8d

$$\begin{aligned} \sqrt[3]{\frac{-48^{-2}}{54^{\div 2}}} &= \sqrt[3]{\frac{-24^{\div 3}}{27^{\div 3}}} \\ &= \sqrt[3]{\frac{-8}{9}} \\ &= \frac{\sqrt[3]{-8}}{\sqrt[3]{9}} \\ &= \frac{-2}{\sqrt[3]{9}} = -2 \cdot \sqrt[3]{\frac{1}{9}} \\ &= -2 \frac{\sqrt[3]{1}}{\sqrt[3]{9}} = \frac{-2 \cdot 1}{\sqrt[3]{9}} \end{aligned}$$

p 98 # 11a)  $\sqrt[3]{\frac{27x^2}{16}}$   $x \in \mathbb{R}$

odd index

$$\begin{aligned} &= \sqrt[3]{\frac{3^3 \cdot x^2}{8 \cdot 2}} = \sqrt[3]{\frac{\underbrace{3^3} \cdot x^2}{\underbrace{2^3} \cdot 2}} = \frac{3}{2} \sqrt[3]{\frac{x^2}{2}} \end{aligned}$$

e)  $\sqrt[3]{\frac{-27m^8}{16}}$   $m \in \mathbb{R}$

odd index

$$\sqrt[3]{\frac{-27m^6 \cdot m^2}{8 \cdot 2}} = \frac{-3m^2}{2} \sqrt[3]{\frac{m^2}{2}}$$

p 100, #15

SA = "A" square units

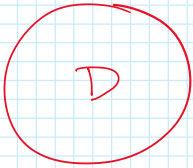
Determine the radii of sphere C and sphere D, in terms of A.

Surface area of sphere A =  $4\pi r^2$

SA = "A" square m.



SA is twice that of sphere B = 2A



SA is 9 times the SA of sphere B = 9A

Surface area of sphere  $A = 4\pi r^2$

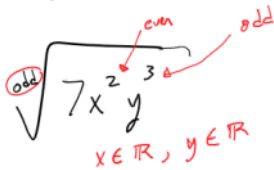
Sphere C, its surface area = 2A

$$\frac{4\pi(r_c)^2}{4\pi} = \frac{2A}{4\pi}$$
$$\sqrt{(r_c)^2} = \sqrt{\frac{2A}{4\pi}}$$

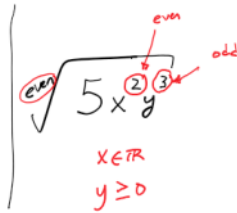
$$r_c = \sqrt{\frac{2A}{4\pi}} \quad \frac{2}{4} = \frac{1}{2}$$

$$r_c = \sqrt{\frac{A}{2\pi}}$$

### Summary:


$$\sqrt[odd]{7x^2y}$$

$x \in \mathbb{R}, y \in \mathbb{R}$


$$\sqrt[even]{5x^2y}$$

$x \in \mathbb{R}$   
 $y \geq 0$

If the index is even, variables in the radicand that have an ODD exponent will be defined only in some places, not for all real numbers.

- By "some places" I mean either for values  $\geq 0$ , or, sometimes, for values  $\leq 0$



Radicals



Radicals



Radicals



Radicals

You may add radicals that have the same index and same radicand.

If this is the case, add the coefficients and keep the radicand the same.

$$2\sqrt{3} + 6\sqrt{2} + 4\sqrt{3} \\ = 6\sqrt{3} + 6\sqrt{2}$$

$$\sqrt[3]{x^2} + \sqrt[3]{27x^2} \\ = \sqrt[3]{x^2} + 3\sqrt[3]{x^2} \\ = 4\sqrt[3]{x^2}$$

$$12\sqrt[3]{10} - 14\sqrt[3]{10} \\ = -2\sqrt[3]{10}$$

$$\sqrt{5x} - \sqrt{20x} + 3\sqrt{x} \\ = \sqrt{5x} - \sqrt{4 \cdot 5x} + 3\sqrt{x} \\ = \sqrt{5x} - 2\sqrt{5x} + 3\sqrt{x} \\ = -\sqrt{5x} + 3\sqrt{x}$$

You may subtract radicals that have the same index and same radicand.

If this is the case, subtract the coefficients and keep the radicand the same.

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### Example 2

### Simplifying Expressions with Variable Radicals

Identify the values of the variables for which each radical is defined then simplify.

a)  $5\sqrt{x} + 3\sqrt{x} - 4\sqrt{x}$

a)  $x \geq 0 \quad (5+3-4)\sqrt{x} = 4\sqrt{x}$

b)  $\sqrt{25a^2b} + \sqrt{4a^2b}$

b)  $a \in \mathbb{R}, b \geq 0$

c)  $\sqrt[4]{81p^3q^5} - 2\sqrt[4]{p^3q^5}$

$$\sqrt{25a^2b} + \sqrt{4a^2b} \\ = \sqrt{25a^2 \cdot b} + \sqrt{4a^2 \cdot b} \\ = 5|a|\sqrt{b} + 2|a|\sqrt{b} \\ = 7|a|\sqrt{b}$$

restrictions

c)  $\sqrt[4]{81p^3q^5} - 2\sqrt[4]{p^3q^5}$   
even index  
 $p \geq 0 \quad q \geq 0$

OR  $p < 0$  and  $q < 0$

These are needed so we can guarantee that what's outside of the  $\sqrt{\quad}$  is positive

$$= \sqrt[4]{81q^4 \cdot p^3 \cdot q} - 2\sqrt[4]{q^4 \cdot 2p^3}$$

$$= 3 \cdot 9 \sqrt[4]{p^3 q} - 2 \cdot 9 \sqrt[4]{p^3 q}$$

$$= |9| \sqrt[4]{p^3 q}$$

CYU, p<sup>104</sup>

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**Example 3** Simplifying with More than One Set of Like Terms

Simplify.

- a)  $2\sqrt{x} - 3\sqrt{y} + 5\sqrt{x} + 2\sqrt{y}$ ,  $x, y \geq 0$   
 b)  $8\sqrt[3]{2x} + 7\sqrt[3]{2x} - 5\sqrt[3]{2x} + 1\sqrt[3]{2x}$ ,  $x \geq 0$   
 c)  $5\sqrt{8x^3} + 4y\sqrt{75y^3} - 2\sqrt{27y^3} - 3x\sqrt{50x}$ ,  $x, y \geq 0$

a)  $7\sqrt{x} - 3\sqrt{y} + 2\sqrt{y} = 7\sqrt{x} - \sqrt{y}$

b)  $3\sqrt[3]{2x} + 8\sqrt[3]{2x}$

c)  $5\sqrt{8x^3} + 4y\sqrt{75y^3} - 2\sqrt{27y^3} - 3x\sqrt{50x}$

$$= 5\sqrt{4 \cdot 2 \cdot x^2 \cdot x} + 4y\sqrt{25 \cdot 3 \cdot y^2 \cdot y} - 2\sqrt{9 \cdot 3 \cdot y^2 \cdot y} - 3x\sqrt{25 \cdot 2 \cdot x}$$

$$= 5 \cdot 2 \cdot x \sqrt{2x} + 4y \cdot 5 \cdot y \sqrt{3y} - 2 \cdot 3 \cdot y^2 \sqrt{3y} - 3x \cdot 5 \sqrt{2x}$$

$$= 10x\sqrt{2x} + 20y^2\sqrt{3y} - 6y^2\sqrt{3y} - 15x\sqrt{2x}$$

$$= (10x - 15x)\sqrt{2x} + (20y^2 - 6y^2)\sqrt{3y}$$

$$= -5x\sqrt{2x} + 14y^2\sqrt{3y}$$

Recap 5 - try it now

Precap 6

2.3 Multiplying and Dividing Radical Expressions

Focus: simplify products and quotients of radical expressions

**Multiplication Property of Radicals:**  
 for  $a, b \geq 0$   
 $\sqrt{ab} = \sqrt{a} \cdot \sqrt{b}$

**Multiply Radicals**

1. Multiply the coefficients.
2. Multiply the numbers inside the radicals.
3. Simplify.

Example:

for  $a, b \geq 0$   
 $\sqrt{ab} = \sqrt{a} \times \sqrt{b}$

You may multiply radicals that have the same index.

If this is the case, multiply the coefficients and multiply the radicands.

Simplify.

3. Simplify.

Example:

$\begin{aligned} \sqrt{6} \times \sqrt{15} &= \sqrt{6 \times 15} \\ &= \sqrt{90} \\ &= \sqrt{9 \times 10} \\ &= 3\sqrt{10} \end{aligned}$	$\begin{aligned} 3\sqrt{2} \times 5\sqrt{6} &= 3 \times 5 \sqrt{2 \times 6} \\ &= 15\sqrt{12} \\ &= 15\sqrt{2 \times 2 \times 3} \\ &= 15 \times 2\sqrt{3} \\ &= 30\sqrt{3} \end{aligned}$
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Examples

1)  $\sqrt{6} \times \sqrt{2} = \sqrt{12}$   
 $= \sqrt{4 \cdot 3}$   
 $= 2\sqrt{3}$

2)  $3\sqrt{6} \times 5\sqrt{3}$   
 $= 15\sqrt{18}$   
 $= 15\sqrt{9 \cdot 2}$   
 $= 15 \cdot 3\sqrt{2}$   
 $= 45\sqrt{2}$

3)  $4\sqrt{3xz} \cdot 5\sqrt{6xy^2}$   
 $= 20\sqrt{3xz \cdot 6xy^2}$   
 $= 20\sqrt{18x^2y^2z}$   
 $= 20\sqrt{9 \cdot 2 \cdot x^2 \cdot y^2 \cdot z}$  (simplify)  
 $= 20 \cdot 3 \cdot x \cdot y \sqrt{2z} = 60xy\sqrt{2z}$

restrictions?  
 $x \geq 0$      $z \geq 0$   
 $y \in \mathbb{R}$

1)  $\sqrt{6}(\sqrt{8} + \sqrt{12})$   
 $= \sqrt{48} + \sqrt{72}$   
 $= \sqrt{16 \cdot 3} + \sqrt{36 \cdot 2}$   
 $= 4\sqrt{3} + 6\sqrt{2}$

$4$ $9$ $16$ $25$ $36$ $\vdots$	$3(x + y)$ $= 3x + 3y$ $3(2x + 5x)$ $= 3(7x)$ $= 21x$	$\left. \begin{array}{l} 3(2x + 5x) \\ = 6x + 15x \\ = 21x \end{array} \right\}$
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$-3\sqrt{12}(5\sqrt{3} - 4\sqrt{6})$

$(4 + 3\sqrt{2})(\sqrt{10} + \sqrt{5})$

$$\begin{aligned}
 & -3\sqrt{12} (5\sqrt{3} - 4\sqrt{6}) && (4+3\sqrt{2})(\sqrt{10} + \sqrt{5}) \\
 = & -15\sqrt{36} + 12\sqrt{72} && = \underline{4\sqrt{10}} + 4\sqrt{5} + 3\sqrt{20} + \underline{3\sqrt{10}} \\
 = & -15 \cdot 6 + 12\sqrt{36 \cdot 2} && = 7\sqrt{10} + 4\sqrt{5} + 3\sqrt{4 \cdot 5} \\
 = & -90 + 12 \cdot 6\sqrt{2} && = 7\sqrt{10} + 4\sqrt{5} + \underbrace{3 \cdot 2\sqrt{5}} \\
 = & -90 + 72\sqrt{2} && = 7\sqrt{10} + \underline{4\sqrt{5}} + \underline{6\sqrt{5}} \\
 & && = 7\sqrt{10} + 10\sqrt{5}
 \end{aligned}$$

$$\begin{aligned}
 (3\sqrt{x} - \sqrt{y})^2 &= (3\sqrt{x} - \sqrt{y})(3\sqrt{x} - \sqrt{y}) \\
 &= 9\sqrt{x^2} - 3\sqrt{xy} - 3\sqrt{xy} + \sqrt{y^2} \\
 &= 9x - 6\sqrt{xy} + y
 \end{aligned}$$

### Division Property of Radicals:

for  $a \geq 0, b > 0$

$$\sqrt{\frac{a}{b}} = \frac{\sqrt{a}}{\sqrt{b}}$$

$$\frac{18\sqrt{20}}{2\sqrt{4}} = 9\sqrt{5}$$

Next time, we'll look at

"rationalizing the denominator"

#### For next class

- Finish worktext questions for 2.2 and the multiplication ones only, from 2.3