## 2.3 Adding and Subtracting Radical Expressions

The same strategies that are used to simplify polynomials can be used for radicals.

Like terms or like radicals must have the same index and the same radicand.

For instance: $x+3x=4x$ or $2\sqrt{3}+3\sqrt{2}+5\sqrt{3}$

$=7\sqrt{3}+3\sqrt{2}$

**Example #1:** Simplify.

a. $9\sqrt{5}-5\sqrt{5}$ *notice that $\sqrt{5}$ cannot be simplified, so we leave it.

$=4\sqrt{5}$

b. $\sqrt[3]{24}-\sqrt[3]{192}-\sqrt[3]{375}$

$=\sqrt[3]{8\cdot3}-\sqrt[3]{64\cdot3}-\sqrt[3]{125\cdot3}$

$=2\sqrt[3]{3}-4\sqrt[3]{3}-5\sqrt[3]{3}$

$=-7\sqrt[3]{3}$

c. $\sqrt{63}+\sqrt{40}-\sqrt{90}-\sqrt{28}$

$=\sqrt{9\cdot7}+\sqrt{4\cdot10}-\sqrt{9\cdot10}-\sqrt{4\cdot7}$

$=3\sqrt{7}+2\sqrt{10}-3\sqrt{10}-2\sqrt{7}$

$=\sqrt{7}-\sqrt{10}$

**Example #2:** Identify the values of the variables for which each radical is defined, then simplify.

a. $6\sqrt{a}+5\sqrt{a}-11\sqrt{a}$

radical has an index of 2, so radicand can't be negative

$\therefore a \geq 0$

$= 11\sqrt{a} - 11\sqrt{a}$

$= 0, \ a \geq 0$

b. $\sqrt{50a^2b}-\sqrt{8a^2b}$

radicals have an index of 2, so radicand can't be negative.

$\therefore a^2 \geq 0, \ \cancel{a \neq 0} \ a \in \mathbb{R}$

$b \geq 0$

$= \sqrt{25 \cdot 2 \cdot (aa)b} - \sqrt{4 \cdot 2 (aa)b}$

$= 5a\sqrt{2b} - 2a\sqrt{2b}$

$= 3a\sqrt{2b}$

c. $\sqrt[3]{27p^3q}+8\sqrt[3]{p^3q}$ $\rightarrow p \in \mathbb{R}, \ q \in \mathbb{R}$

$= \sqrt[3]{27 \cdot 1 (ppp)q} + 8\sqrt[3]{(ppp)q}$

$= 3p\sqrt[3]{q} + 8p\sqrt[3]{q}$

$= 11p\sqrt[3]{q}$

**Example #3:** Simplify.

a. $7\sqrt{m}+2\sqrt{n}+5\sqrt{n}-3\sqrt{m},\ n,m\geq 0$

$=4\sqrt{m}+7\sqrt{n}$

b. $2\sqrt[3]{-3b}+8\sqrt{-3b}-9\sqrt[3]{-3b}+3\sqrt{-3b},\ b\leq 0$

$=-7\sqrt[3]{-3b}+11\sqrt{-3b}$

c. $3\sqrt{32a^5}-2\sqrt{45b^3}+5b\sqrt{125b}-2a\sqrt{72a^3},\ a,b\geq 0$

$=3\sqrt{16\cdot 2\,a^4a}-2\sqrt{9\cdot 5b^2b}+5b\sqrt{25\cdot 5b}-2a\sqrt{36\cdot 2a^2a}$

$=3(4)a^2\sqrt{2a}-2(3)b\sqrt{5b}+5b(5)\sqrt{5b}-2a(6)(a)\sqrt{2a}$

$=12a^2\sqrt{2a}-6b\sqrt{5b}+25b\sqrt{5b}-12a^2\sqrt{2a}$

$=19b\sqrt{5b}$