1.4 & 1.5: Adding/Subtracting/Multiplying/Dividing Radicals

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Adding/Subtracting Radicals

If two radical terms have the same radical factor then you can add and subtract them as if the radical was a variable

Ex:

$5\sqrt{3} + 1\sqrt{3} = 6\sqrt{3}$

$\sqrt{\underset{9\times3}{27}} + \sqrt{\underset{4\times3}{12}} - \sqrt{\underset{4\times2}{8}} =$

$3\sqrt{3} + 2\sqrt{3} - 2\sqrt{2} = 5\sqrt{3} - 2\sqrt{2}$

$-3\sqrt{12} + 4\sqrt{75} =$

$-3\sqrt{4\cdot3} + 4\sqrt{25\cdot3}$

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

$-6\sqrt{3} + 20\sqrt{3} = 14\sqrt{3}$

$3x\sqrt{63y} - 5\sqrt{28x^2y} =$

$3x\sqrt{9\cdot7y} - 5\sqrt{4\cdot7x^2y}$

$(3x)(3)\sqrt{7y} - (5)(2)(x)\sqrt{7y}$

$9x\sqrt{7y} - 10x\sqrt{7y} =$

$(9x - 10x)\sqrt{7y} = \underline{-x\sqrt{7y}}$

$\frac{5}{2}\sqrt[3]{16x^4y^5} - xy\sqrt[3]{54xy^2} =$

$\frac{5}{2}\sqrt[3]{(8)(2)x^3x\cdot y^3\cdot y^2} - xy\sqrt[3]{(27)(2)xy^2}$

$\left(\frac{5}{\cancel{2}}\right)(\cancel{2})(x)(y)\sqrt[3]{2xy^2} - xy(3)\sqrt[3]{2xy^2}$

$5xy\sqrt[3]{2xy^2} - 3xy\sqrt[3]{2xy^2}$

$\underline{2xy\sqrt[3]{2xy^2}}$

you should know these

$2^3 = 8$	$2^4 = 16$
$3^3 = 27$	$3^4 = 81$
$4^3 = 64$	$4^4 = 256$
$5^3 = 125$	$5^4 = 625$

Multiplying/Dividing Radicals

When you multiply or divide a radical you must multiply or divide the coefficients separately from the terms inside the radical sign.

Ex:

$2\sqrt{6}\cdot5\sqrt{3} = 10\sqrt{18}$

$= 10\sqrt{9\cdot2}$

$= (10)(3)\sqrt{2}$

$= \underline{30\sqrt{2}}$

$-3\sqrt{2x}\cdot4\sqrt{3x} = -12\sqrt{6x^2}$

$= \underline{-12x\sqrt{6}}$

$(2\sqrt{3} - 3\sqrt{2})(2\sqrt{3} + \sqrt{2}) =$

First
Outer
Inner
Last

$(2\sqrt{3})(2\sqrt{3}) + 2\sqrt{3}\sqrt{2} - (3\sqrt{2})(2\sqrt{3}) - 3\sqrt{2}\sqrt{2}$

$4\sqrt{9} + 2\sqrt{6} - 6\sqrt{6} - 3\sqrt{4}$

$4\cdot3 + (-4\sqrt{6}) - 3\cdot2$

$12 - 4\sqrt{6} - 6 = \underline{6 - 4\sqrt{6}}$

$(\sqrt{x} - 2)^2 = (\sqrt{x} - 2)(\sqrt{x} - 2)$

$= \sqrt{x}\sqrt{x} - 2\sqrt{x} - 2\sqrt{x} + 4$

$= \underline{x - 4\sqrt{x} + 4}$

$\frac{\sqrt{x^3}}{\sqrt[3]{x}} = \frac{x^{3/2}}{x^{1/3}} = x^{\frac{3}{2} - \frac{1}{3}}$

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

$= x^{\frac{9}{6} - \frac{2}{6}}$

$= x^{7/6}$

$= \sqrt[6]{x^7}$

$\frac{4\sqrt{5x}}{\sqrt[4]{10x^3}} = \sqrt[4]{\frac{5x}{10x^3}}$

$= \sqrt[4]{\frac{1}{2x^2}}\ \sqrt[4]{2x^2}$

$= \frac{1}{\sqrt[4]{2x^2}}\sqrt[4]{2x^2}$

$= \frac{\sqrt[4]{2x^2}}{\sqrt[4]{4x^4}}\left(\frac{\sqrt[4]{4}}{\sqrt[4]{4}}\right)$

$= \frac{\sqrt[4]{8x^2}}{\sqrt[4]{16x^4}}$

$= \frac{\sqrt[4]{8x^2}}{2x}$

* Simplify: no radical in the denominator

$\frac{3}{\ \ }\quad \frac{3}{(2 - \ \ )}\cdot\frac{(2+\sqrt{5})}{(2+\ \ )}$

$$= \frac{\sqrt[4]{8x^2}}{2x}$$

$$\frac{3}{2-\sqrt{5}} = \frac{3}{(2-\sqrt{5})}\frac{(2+\sqrt{5})}{(2+\sqrt{5})}$$

$$\boxed{\begin{array}{c}\text{conjugate} \\ (x-y) \quad (x+y)\end{array}}$$

$$= \frac{6+3\sqrt{5}}{4+\cancel{2\sqrt{5}}-\cancel{2\sqrt{5}}-5}$$

$$= \frac{6+3\sqrt{5}}{4-5}$$

$$= \boxed{-6-3\sqrt{5}}$$

$$\sqrt[3]{\frac{2}{y}} = \frac{\sqrt[3]{2}}{\sqrt[3]{y}} \cdot \frac{\sqrt[3]{y^2}}{\sqrt[3]{y^2}}$$

$$= \frac{\sqrt[3]{2y^2}}{\sqrt[3]{y^3}}$$

$$= \boxed{\frac{\sqrt[3]{2y^2}}{y}}$$

$$\frac{\sqrt{a}+\sqrt{2b}}{\sqrt{a}-\sqrt{2b}} = \frac{(\sqrt{a}+\sqrt{2b})}{(\sqrt{a}-\sqrt{2b})}\frac{(\sqrt{a}+\sqrt{2b})}{(\sqrt{a}+\sqrt{2b})}$$

$$= \frac{(\sqrt{a}+\sqrt{2b})^2}{a+\cancel{\sqrt{2ab}}-\cancel{\sqrt{2ab}}-2b}$$

$$= \boxed{\frac{(\sqrt{a}+\sqrt{2b})^2}{a-2b}}$$

$$(\sqrt{a}+\sqrt{2b})(\sqrt{a}+\sqrt{2b}) = a+\sqrt{2ab}+\sqrt{2ab}+2b$$

$$= a+2\sqrt{2ab}+2b$$