

1.4 Radical Operations

Reducing radicals:

1) Factor tree

2) Circle groups of index

3) Circled groups come out, everything else stays in

• multiply everything outside radical & everything inside

1) Simplify

a) $\sqrt{63}$

$9 \wedge 7$

$\boxed{3 \ 3}$
 $\boxed{3 \ \sqrt{7}}$

b) $3\sqrt{112}$

$56 \wedge 2$
 $28 \wedge 2$
 $7 \wedge 4$

$3 \cdot 2 \cdot 2 \sqrt{7}$
 $\boxed{12 \sqrt{7}}$

$2 \cdot 2$

c) $\sqrt[3]{108}$

$2 \wedge 54$

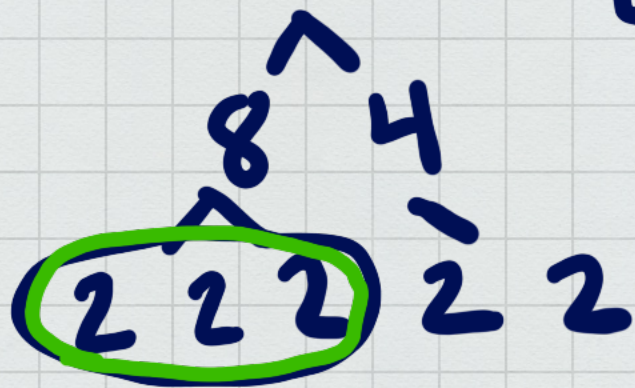
$2 \wedge 27$

$\boxed{3 \sqrt[3]{4}}$
 $9 \wedge 3$
 $\boxed{3 \ 3}$

* if you have a negative with an odd index, it always comes out

ex: $\sqrt[3]{-32} = -\sqrt[3]{32} = \boxed{-2\sqrt[3]{4}}$

* the kind of root you're taking



2) a) $\sqrt{12x^3}$
 4 \wedge 3 \wedge 1 \wedge 1
 2 2 \wedge 1 \wedge 1 \wedge 1
 (circled 2 2) (circled x) (circled x) (circled x)

$\boxed{2|x|\sqrt{3x}}$

Absolute value signs:
 1) Real number
 2) Even index *
 3) Odd amount of variable comes out

b) $\sqrt{24x^4y^2}$
 4 \wedge 6 \wedge 2 \wedge 1 \wedge 1
 2 2 \wedge 2 3 \wedge 1 \wedge 1 \wedge 1
 (circled 2 2) (circled 2 3) (circled x) (circled x) (circled x) (circled y)

$2xx y \sqrt{2 \cdot 3}$
 $\boxed{2x^2|y|\sqrt{6}}$

Adding/subtracting radicals

- reduce all radicals first
- combine like terms - add coefficients of like radicals

$$3) a) \sqrt{8} + 4\sqrt{2}$$

$$\begin{array}{c} 4 \sqrt{2} \\ \uparrow \\ 2 \cdot 2 \end{array}$$

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

$$b) -2\sqrt{5} + 6\sqrt{3} - 2\sqrt{20} - \sqrt{12}$$

$$\begin{array}{cc} 4 \sqrt{5} & 4 \sqrt{3} \\ \uparrow & \uparrow \\ 2 \cdot 2 & 2 \cdot 2 \end{array}$$

$$-2 \cdot 2\sqrt{5}$$

$$-2\sqrt{3}$$

$$\begin{array}{cccc} -2\sqrt{5} & + 6\sqrt{3} & - 4\sqrt{5} & - 2\sqrt{3} \end{array}$$

$$\boxed{-6\sqrt{5} + 4\sqrt{3}}$$

Multiplying radicals

- when roots have same index, you can multiply the insides & combine under same root

$$4) \text{ a) } \sqrt[2]{10} \cdot \sqrt[3]{15} = \sqrt[2]{10} \sqrt[3]{15}$$

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

$5\sqrt{6}$

$\sqrt[2]{10} \sqrt[3]{15}$

Dividing radicals

- rationalize denominator - no roots in bottom
- if no add/sub in denominator, multiply top & bottom by root of denominator

$$5) \quad a) \quad \frac{5}{\sqrt{2}} \cdot \frac{\sqrt{2}}{\sqrt{2}}$$

$$= \boxed{\frac{5\sqrt{2}}{2}}$$

$$\sqrt{2} \cdot \sqrt{2} = \sqrt{4} = 2$$

$$b) \quad \frac{2}{6\sqrt{3}} \cdot \frac{\sqrt{3}}{\sqrt{3}}$$

- If there is add/sub in denominator, multiply top & bottom by conjugate - switch sign between terms of binomial (2 terms)

$$\square \frac{3}{4+\sqrt{2}} \cdot \frac{4-\sqrt{2}}{4-\sqrt{2}} = \boxed{\frac{12-3\sqrt{2}}{14}}$$

$$3(4-\sqrt{2}) = 12-3\sqrt{2}$$

$$(4+\sqrt{2})(4-\sqrt{2}) = \begin{array}{l} * \sqrt{2} \cdot -\sqrt{2} \\ = -\sqrt{4} = -2 \end{array}$$

$$16 - \cancel{4\sqrt{2}} + \cancel{4\sqrt{2}} - 2$$

$$16 - 2 = 14$$

HW

$$21) \frac{5}{3-4\sqrt{3}} \cdot \frac{3+4\sqrt{3}}{3+4\sqrt{3}}$$

* can't have negative
in bottom

$$= \frac{15+20\sqrt{3}}{-39}$$

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

switch all
signs

$$9 - 48 = -39$$

$$-4\sqrt{3} \cdot 4\sqrt{3}$$

$$-16\sqrt{9}$$

$$-16 \cdot 3 = -48$$

$$\boxed{\frac{-15-20\sqrt{3}}{39}}$$