Unit 5: Radical Expressions Name:________________________

Secondary 3H: 5-2 Notes: Adding and Subtracting Radicals

Warm-Up:

- The volume V of a wooden beam is $V = ls^2$, where l is the length of the beam and s is the length of one side of its square cross section. If the volume of the beam is $1200\ in^3$ and its length is $96\ in.$ what is the side length? Leave your answer in radical form. Make sure to rationalize the denominator.

$V = ls^2$

$s^2 = \frac{V}{l}$

$s = \sqrt{\frac{V}{l}}$

$s = \sqrt{\frac{1200}{96}}$

$s = \sqrt{\frac{25}{2}} = \frac{\sqrt{25}}{\sqrt{2}} \cdot \frac{\sqrt{2}}{\sqrt{2}} = \frac{\sqrt{50}}{2} = \boxed{\frac{5\sqrt{2}}{2}\text{ in}}$

Adding and Subtracting Radical Expressions:

- Like radicals with numbers:
  - $\sqrt{2} + 3\sqrt{2} = 4\sqrt{2}$
  - $2\sqrt[3]{7} - 5\sqrt[3]{7} = -3\sqrt[3]{7}$
  - $4\sqrt{3} + \sqrt{13} =$ can't add radicand is different
- Like radicals with variables:
  - $\sqrt{5xy} + 8\sqrt{5xy} = 9\sqrt{5xy}$
  - $\sqrt[3]{9x^2y} - 8\sqrt[3]{9x^2y} = -7\sqrt[3]{9x^2y}$

How do you know if you have "like" radicals?

- same index
- same radicand

What is really happening when we add or subtract??

- Using the distributive property:
  - $a\sqrt[n]{x} + b\sqrt[n]{x} =$

$\sqrt[n]{x}(a+b) = (a+b)\sqrt[n]{x}$

  - $a\sqrt[n]{x} - b\sqrt[n]{x} =$

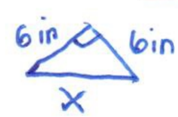
$\sqrt[n]{x}(a-b) = (a-b)\sqrt[n]{x}$

Got it?

- What is the simplified form of each expression?
  - $3\sqrt{5x} - 2\sqrt{5x} = \sqrt{5x}$
  - $6x^2\sqrt{7} + 4x\sqrt{5}$ already simplified
  - $12\sqrt[3]{7xy} - 8\sqrt[3]{7xy} = 4\sqrt[3]{7xy}$

Do you really have it?

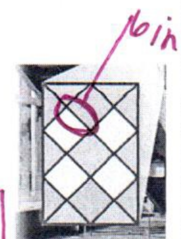
- In this stained glass window design, the side of each small square is $6\ in.$ Find the perimeter of the window to the nearest tenth of an inch.



$6^2 + 6^2 = x^2$

$72 = x^2$

$x = \sqrt{72}$



$P = 10(\sqrt{72}) = \boxed{84.9\text{ in}}$

Simplifying BEFORE adding or subtracting…

- Although you cannot combine radicals with different radicands, it may be possible to simplify the radicals so that the radicands are the same:
  - $\sqrt{12} + \sqrt{75} - \sqrt{3}$

    4 3   25 3

    2 2   5 5

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

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

Got it?

- Simplify:
  - $\sqrt[3]{250} + \sqrt[3]{54} - \sqrt[3]{16}$

    3 3 3 2   2 2 2 2

    9 6   4 4

    25 10

    5 5 5 2

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

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

  - $3\sqrt[3]{81} - 2\sqrt[3]{54}$ < 9 6   3 3 3 2

    9 9

    3 3 3 3

    $3(3)\sqrt[3]{3} - 2(3)\sqrt[3]{2}$

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

- **Multiplying Binomial Radical Expressions** $(a+b)$ $(\sqrt{a}+\sqrt{b})$ $(\sqrt{a}+b)$
  - How do you think you could multiply the following binomial radical expressions?

    double distribution "FOIL"

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

      $20 + 16\sqrt{2} + 10\sqrt{2} + 8(\sqrt{2})^2$

      $\boxed{36 + 26\sqrt{2}}$

    - $(3 - \sqrt{7})(5 + \sqrt{7})$

      $15 + 3\sqrt{7} - 5\sqrt{7} - 7$

      $\boxed{8 - 2\sqrt{7}}$

Got it?

- Find the products of each radical expression:
  - $(3 - 4\sqrt{2})(5 - 6\sqrt{2})$

    $15 - 18\sqrt{2} - 20\sqrt{2} + 24(2) = \boxed{63 - 38\sqrt{2}}$

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

    $3 + \sqrt{15} + \sqrt{15} + 5$

    $\boxed{8 + 2\sqrt{15}}$

Multiplying Conjugates

- Conjugates are expressions, like $\sqrt{a}+\sqrt{b}$ *and* $\sqrt{a}-\sqrt{b}$ that differ $\boxed{\text{only in the signs}}$ of the second terms.
  - $(5-\sqrt{7})(5+\sqrt{7})$

$25 + \cancel{5\sqrt{7}} - \cancel{5\sqrt{7}} - 7$

$\boxed{18}$

Got it?

- What is each product?
  - $(3+\sqrt{8})(3-\sqrt{8})$

$9 - 8 = \boxed{1}$

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

$2 - 5 = \boxed{-3}$

Rationalizing the Denominator

- How can you rewrite the expression with a rationalized denominator?
  - $\dfrac{3\sqrt{2}}{(\sqrt{5}-\sqrt{2})} \dfrac{(\sqrt{5}+\sqrt{2})}{(\sqrt{5}+\sqrt{2})}$

$\dfrac{3\sqrt{10}+3\sqrt{4}}{5-2} = \dfrac{\cancel{3}\sqrt{10}+\cancel{3}(2)}{\cancel{3}}$

$\boxed{\sqrt{10}+2}$

Got it?

- Can you rewrite these expressions with rationalized denominators?
  - $\dfrac{2\sqrt{7}}{\sqrt{3}-\sqrt{5}} \dfrac{(\sqrt{3}+\sqrt{5})}{(\sqrt{3}+\sqrt{5})}$

$\dfrac{2\sqrt{21}+2\sqrt{35}}{3-5} = \dfrac{2\sqrt{21}+2\sqrt{35}}{-2}$

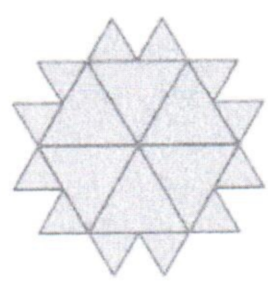
$= \boxed{-\sqrt{21}-\sqrt{35}}$

  - $\dfrac{4x}{(3-\sqrt{6})} \cdot \dfrac{(3+\sqrt{6})}{(3+\sqrt{6})}$

$\dfrac{12x+4x\sqrt{6}}{9-6} = \boxed{\dfrac{12x+4x\sqrt{6}}{3}}$

STAMP QUESTION

- The design on a parquet floor, shown at the right, is made of equilateral triangles. The side of a large triangle is 6 in., and the side of a small triangle is 3 in. Find the total area of the design to the nearest tenth of a square inch.



Hint: Find the area of each individual triangle.