Operations on Radicals Lesson #1:
Adding and Subtracting Radicals

Investigation 1

In the last unit we verified that addition of radicals cannot be done by adding the radicands.

In order to develop a rule for adding and subtracting radicals, complete the work below.

a) Use a calculator to investigate which of the following radical statements are true. Circle the statements which are true and place a single line through the expressions which are false.

i) $\sqrt{2}+5\sqrt{2}=6\sqrt{2}$ true

ii) $4\sqrt[3]{5}-7\sqrt[3]{5}=-3\sqrt[3]{5}$ true

iii) $5\sqrt{8}-2\sqrt{8}+7\sqrt{8}=10\sqrt{8}$ true

iv) ~~$7\sqrt{5}+7\sqrt[3]{5}=14\sqrt[5]{5}$~~ false

v) ~~$\sqrt[3]{3}+\sqrt[3]{2}=\sqrt[3]{5}$~~ false

b) Use the results in a) to suggest a rule for adding and subtracting radicals.

Radicals can be added or subtracted if they have the same radicand and the same index

c) Simplify the following. Express the answer as a mixed radical.

i) $8\sqrt{7}-3\sqrt{7}+15\sqrt{7}$ $= 20\sqrt{7}$

ii) $18\sqrt[5]{10}+12\sqrt[5]{10}-7\sqrt[5]{10}$ $= 23\sqrt[5]{10}$

iii) $5\sqrt{x}-4\sqrt{x}$ $= \sqrt{x}$

Investigation 2

$8x-3x+15x=20x$

$8x^2+3x-2x^2=6x^2+3x$

a) Use a calculator to verify that the following statements are true.

i) $\sqrt{2}+\sqrt{8}=3\sqrt{2}$ True

ii) $5\sqrt{12}+6\sqrt{48}=34\sqrt{3}$ True

b) Does this appear to contradict the rule you wrote in Investigation #1 b)? yes

c) Complete the following by writing each radical in simplest mixed form to show that the rule can be modified.

i) $\sqrt{2}+\sqrt{8}$ not simplest form

$=\sqrt{2}+\sqrt{4\cdot2}$

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

ii) $5\sqrt{12}+6\sqrt{48}$

$=5\sqrt{4\cdot3}+6\sqrt{16\cdot3}$

$=5(2)\sqrt{3}+6(4)\sqrt{3}$

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

$= 3\sqrt{2}$

$= 5(2)\sqrt{3} + 6(4)\sqrt{3}$

$= 10\sqrt{3} + 24\sqrt{3}$

$= 34\sqrt{3}$

Adding and Subtracting Radicals

In order to add and subtract radicals, they must be able to be expressed as **like radicals**, i.e. radicals with the SAME radicand **and** the SAME index.

Write each expression in terms of a single radical.

a) $\sqrt{80} - \sqrt{20}$

$= 4\sqrt{5} - 2\sqrt{5} = 2\sqrt{5}$

b) $\sqrt[3]{80} + \sqrt[3]{270}$

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

$= 5\sqrt[3]{10}$

c) $7\sqrt{27} - 3\sqrt{75} + 2\sqrt{147}$

$= 7(3)\sqrt{3} - 3(5)\sqrt{3} + 2(7)\sqrt{3}$

$= 21\sqrt{3} - 15\sqrt{3} + 14\sqrt{3}$

$= 20\sqrt{3}$

Simplify by combining like radicals.

a) $-5\sqrt{108} + \frac{3}{4}\sqrt{8} - \frac{5}{4}\sqrt{48} + \frac{1}{2}\sqrt{50}$

$= -5(6)\sqrt{3} + \frac{3}{4}(2)\sqrt{2} - \frac{5}{4}(4)\sqrt{3} + \frac{1}{2}(5)\sqrt{2}$

$= -30\sqrt{3} + \frac{6}{4}\sqrt{2} - 5\sqrt{3} + \frac{5}{2}\sqrt{2}$

$= -35\sqrt{3} + \frac{8}{2}\sqrt{2} = -35\sqrt{3} + 4\sqrt{2}$

b) $\frac{\sqrt[3]{64}}{8} + 2\sqrt[3]{375} - \frac{2\sqrt[3]{54}}{3} - \frac{5\sqrt[3]{24}}{2}$

$= \frac{1}{8}\sqrt[3]{64} + 2\sqrt[3]{375} - \frac{2}{3}\sqrt[3]{54} - \frac{5}{2}\sqrt[3]{24}$

$= \frac{1}{8}(4) + 2(5)\sqrt[3]{3} - \frac{2}{3}(3)\sqrt[3]{2} - \frac{5}{2}(2)\sqrt[3]{3}$

$= \frac{4}{8} + 10\sqrt[3]{3} - 2\sqrt[3]{2} - 5\sqrt[3]{3}$

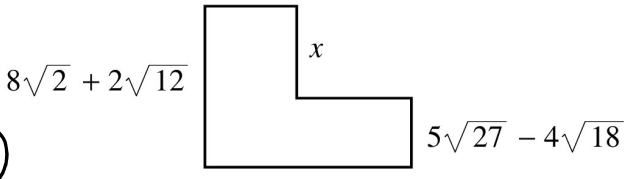
$= \frac{1}{2} + 5\sqrt[3]{3} - 2\sqrt[3]{2}$

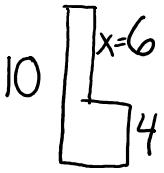
$= \frac{1}{2} + 5\sqrt[3]{3} - 2\sqrt[3]{2}$

Complete Assignment Questions #1 - #5

Find the length of x

a) as an exact value
b) as a decimal to the nearest tenth





$X = 8\sqrt{2} + 2\sqrt{12} - (5\sqrt{27} - 4\sqrt{18})$

$X = 8\sqrt{2} + 2\sqrt{12} - 5\sqrt{27} + 4\sqrt{18}$

$X = 8\sqrt{2} + 2(2)\sqrt{3} - 5(3)\sqrt{3} + 4(3)\sqrt{2}$

$X = 8\sqrt{2} + 4\sqrt{3} - 15\sqrt{3} + 12\sqrt{2}$

a) $X = 20\sqrt{2} - 11\sqrt{3}$

b) $9.2317\ldots = 9.2$

60, 7

Complete Assignment Questions #6 - #13

Assignment

1. Simplify.

a) $5\sqrt{7} - 2\sqrt{7}$ **b)** $9\sqrt[3]{13} + 2\sqrt[3]{13}$ **c)** $4\sqrt{11} - 9\sqrt{11} + \sqrt{11}$

d) $4\sqrt{5} - 2\sqrt{2} + 8\sqrt{2}$ **e)** $13\sqrt[4]{a} + 7\sqrt[4]{a}$ **f)** $-3\sqrt{2} + 6\sqrt{3} - 9\sqrt{3} + 4\sqrt{2}$

2. Write each expression in terms of a single radical.

a) $\sqrt{125} - \sqrt{5}$ **b)** $\sqrt{27} + \sqrt{12}$ **c)** $\sqrt{24} - \sqrt{54} + 2\sqrt{6}$

d) $\sqrt{150} + \sqrt{216}$ **e)** $\sqrt[3]{16} + \sqrt[3]{128}$ **f)** $-3\sqrt{175} + 8\sqrt{28} - \sqrt{63}$

g) $\sqrt[4]{16} + \sqrt[4]{162}$ **h)** $2\sqrt{700} - 6\sqrt{63}$ **i)** $-7\sqrt[3]{54} - 2\sqrt[3]{250}$

g) $\sqrt[4]{16} + \sqrt[4]{162}$ **h)** $2\sqrt{700} - 6\sqrt{63}$ **i)** $-7\sqrt[3]{54} - 2\sqrt[3]{250}$

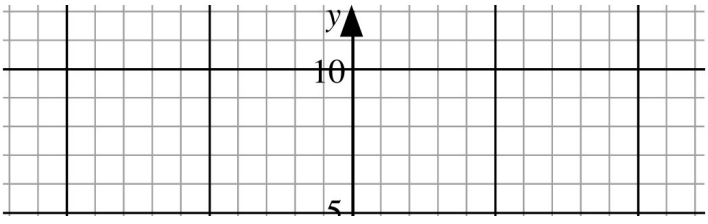
3. Simplify by combining like radicals.

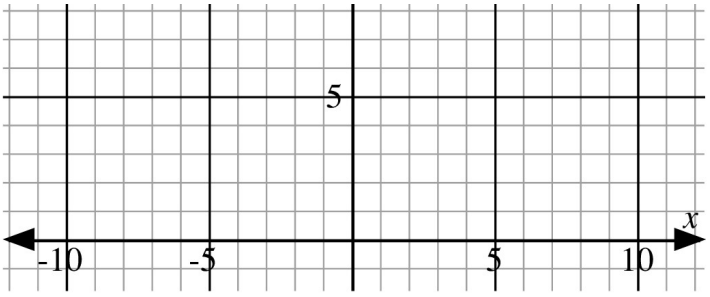
a) $\sqrt{20} + \sqrt{72} - \sqrt{45}$ **b)** $\sqrt{27} + \sqrt{12} - \sqrt{32} - \sqrt{8}$

c) $\sqrt{98} - \sqrt{20} + \sqrt{18}$ **d)** $2\sqrt{252} - \sqrt{726} - 5\sqrt{63}$

e) $2\sqrt[3]{108} + \sqrt[3]{32} + 3\sqrt[3]{256}$ **f)** $12\sqrt{150} - 5\sqrt{54} + 3\sqrt{24}$

4. Plot the points $A(-6, 0)$, $B(10, 0)$, and $C(2, 4)$. and determine, in simplest radical form, the perimeter of $\triangle ABC$.





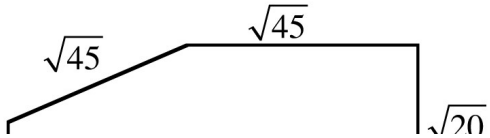
5. Write in simplest radical form.

a) $\frac{1}{3}\sqrt{63} + \frac{2}{5}\sqrt{700} - \frac{2}{3}\sqrt{112} + \frac{3}{2}\sqrt{28}$

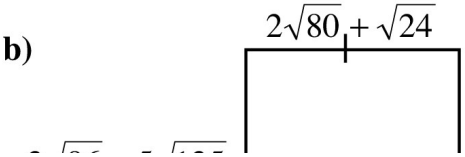
b) $\frac{7\sqrt[3]{1024}}{2} + \frac{5\sqrt[3]{2000}}{12} - 3\sqrt[3]{686} + \frac{1}{8}\sqrt[3]{128}$

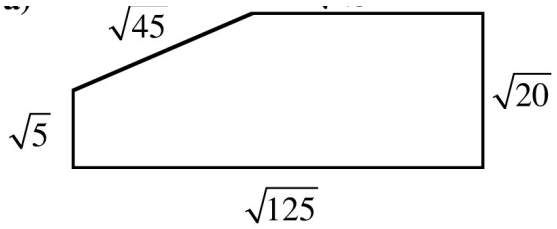
6. Determine the perimeter of the following figures in simplest radical form.

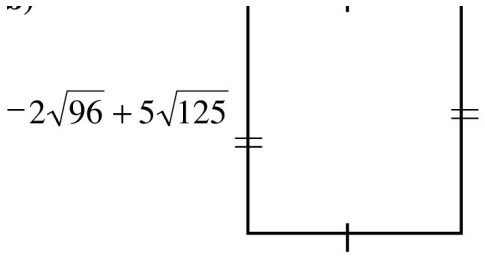
a)



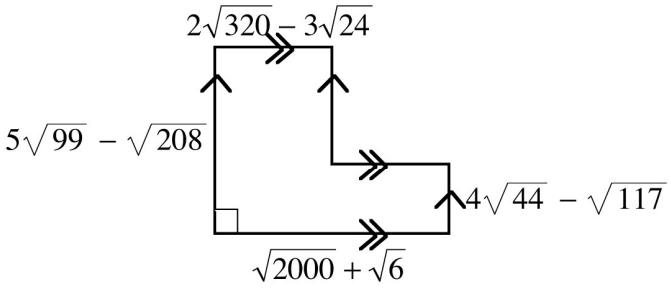
b)







7. Determine a radical expression for the length of each of the missing sides.



8. Determine the next two terms of the following sequences.

a) $4+2\sqrt{2}\,,\ 6+3\sqrt{2}\,,8+4\sqrt{2}\,,\ldots.$ **b)** $6+2\sqrt{3}\,,3+\sqrt{3}\,,\ 0,\ldots.$

Multiple Choice **9.** $\sqrt{75}+\sqrt{3}$ equals

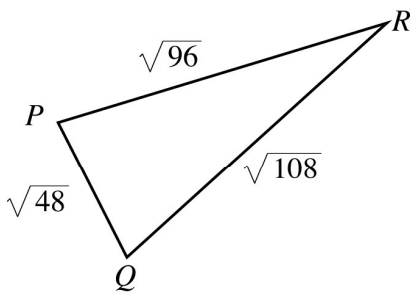
A. $6\sqrt{3}$
B. $26\sqrt{3}$
C. $\sqrt{78}$
D. $3\sqrt{5}+\sqrt{3}$

10. Given that $x-2\sqrt{5}=\sqrt{45}$, then $\sqrt{5}+x$ is equal to

A. $2\sqrt{5}$
B. $3\sqrt{5}$
C. $4\sqrt{5}$
D. $6\sqrt{5}$

11. In simplest radical form the perimeter of ΔPQR is

A. $\sqrt{252}$
B. $6\sqrt{7}$
C. $10\sqrt{3}+4\sqrt{6}$
D. $52\sqrt{3}+16\sqrt{6}$



Numerical Response **12.** When simplified, the expression $\sqrt{52} + \sqrt{208} - \sqrt{13} + \sqrt{169}$ can be written in the form $p\sqrt{13} + q$. The value of pq is _____.

(Record your answer in the numerical response box from left to right.)

Operations on Radicals Lesson #2:
Multiplying Radicals

Investigation *Investigating Multiplication Properties of Radicals*

Use a calculator to determine whether the following statements are true or false.

a) $\sqrt{2} \times \sqrt{3} = \sqrt{6}$ True **b)** $(2\sqrt{5})(-4\sqrt{3}) = -8\sqrt{15}$ True **c)** $\sqrt{2} \cdot \sqrt[3]{4} = \sqrt[3]{8}$ False

d) $2\sqrt[3]{10} \times 3\sqrt[3]{7} = 6\sqrt[3]{70}$ True **e)** $(4\sqrt[3]{5})(7\sqrt{6}) = 28\sqrt[6]{30}$ False

Based on the results from a) - e), write a rule which describes the process of multiplying radicals.

- same index
- multiply radicand by radicand
- multiply coefficient by coefficient

Multiplying Radicals

To multiply radicals, the index must be the same in each radical.

- Multiply numerical coefficients by numerical coefficients.
- Multiply radicand by radicand.
- Simplify into mixed radical form if possible.

It is usually easier to convert each radical to its simplest mixed form before multiplying.

Multiply and simplify where possible.

a) $\sqrt{8} \cdot \sqrt{8}$ $= \sqrt{64} = 8$

b) $(4\sqrt{5})(3\sqrt{6})$ $= 12\sqrt{30}$

c) $(4\sqrt{x})(3\sqrt{y})$ $= 12\sqrt{xy}$

d) $-2\sqrt{8} \times 5\sqrt{12}$ $= -10\sqrt{96}$

OR $\sqrt{4}\sqrt{3}$ $5(2)\sqrt{3}$

$\sqrt{4}\sqrt{2}$ $\sqrt{16}\sqrt{6}$

$-2(2)\sqrt{2} = -10(4)\sqrt{6}$

$-4\sqrt{2} = -40\sqrt{6}$

$-4\sqrt{2} \times 10\sqrt{3} = -40\sqrt{6}$

Expand and simplify.

a) $\sqrt{5}(2\sqrt{10} - \sqrt{5})$ $= 2\sqrt{50} - \sqrt{25}$

b) $2\sqrt{5}(3\sqrt{45} - 8\sqrt{5} + 3\sqrt{20})$ $= 6\sqrt{225} - 16\sqrt{25} + 6\sqrt{100}$ $= 6(15) - 16(5) + 6(10)$

$= 2\sqrt{50} - \sqrt{25}$

$\sqrt{25}\sqrt{2}$

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

$= 10\sqrt{2} - 5$

$= 6\sqrt{225} - 16\sqrt{25} + 6\sqrt{100}$

$= 6(15) - 16(5) + 6(10)$

$= 90 - 80 + 60$

$= 70$

c) $2(\sqrt{3} - \sqrt{5}) - \sqrt{2}(\sqrt{6} + \sqrt{10})$

$= 2\sqrt{3} - 2\sqrt{5} - \sqrt{12} - \sqrt{20}$

$\sqrt{4}\sqrt{3}$ $\sqrt{4}\sqrt{5}$

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

d) $-4\sqrt{a}(\sqrt{a} + 9\sqrt{b})$

$= -4a + 36\sqrt{ab}$

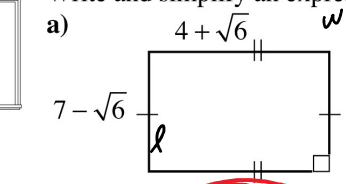
$\sqrt{a \cdot a}$

$\sqrt{a^2}$

Class Ex. #3

Write and simplify an expression for the area of each shape.

a)



$A = \ell w$

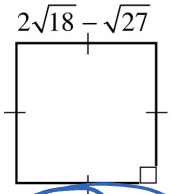
$A = (7 - \sqrt{6})(4 + \sqrt{6})$

$= 28 + 7\sqrt{6} - 4\sqrt{6} - \sqrt{36}$

$= 28 + 3\sqrt{6} - 6$

$= 22 + 3\sqrt{6}$

b)



Simplify

$2\sqrt{18} - \sqrt{27}$

$\sqrt{9}\sqrt{2}$ $\sqrt{9}\sqrt{3}$

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

$6\sqrt{2} - 3\sqrt{3}$

$A = (6\sqrt{2} - 3\sqrt{3})(6\sqrt{2} - 3\sqrt{3})$

$= 36\sqrt{4} - 18\sqrt{6} - 18\sqrt{6} + 9\sqrt{9}$

$= 36(2) - 36\sqrt{6} + 9(3)$

$= 72 - 36\sqrt{6} + 27$

$= 99 - 36\sqrt{6}$

Complete Assignment Questions #1 - #10

Multiplying Conjugate Binomials

Expand the following expressions:

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

$= \sqrt{25} + \sqrt{10} - \sqrt{10} - \sqrt{4}$

$= 5 - 2 = 3$

ii) $(2\sqrt{7} + 8)(2\sqrt{7} - 8)$

$= 4\sqrt{49} - 16\sqrt{7} + 16\sqrt{7} - 64$

$= 4(7) - 64 = 28 - 64 = -36$

The pairs of binomials above are called **conjugates** of each other.
What do you notice about the product of two conjugate binomials?

Note

- Conjugate binomials are pairs of binomials in the form $a\sqrt{b} + c\sqrt{d}$ and $a\sqrt{b} - c\sqrt{d}$.
- The product of conjugate binomials is always a rational number of the form $a^2b - c^2d$.

Class Ex. #4

Write the conjugate of each, then multiply each pair.

a) $4\sqrt{6} + 3$

conjugate: $4\sqrt{6} - 3$

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

b) $-3\sqrt{11} + \sqrt{2}$

conjugate: $-3\sqrt{11} - \sqrt{2}$

$= (-3\sqrt{11} + \sqrt{2})(-3\sqrt{11} - \sqrt{2})$

c) $5\sqrt{x} - \sqrt{y}$

conjugate: $5\sqrt{x} + \sqrt{y}$

$(5\sqrt{x} - \sqrt{y})(5\sqrt{x} + \sqrt{y}) = 25\sqrt{x^2} + 5\sqrt{xy} - 5\sqrt{xy} - \sqrt{y^2}$

conjugate: $4\sqrt{6}-3$

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

$= 16(6) - 9$

$= 96 - 9 = 87$

conjugate: $-3\sqrt{11}-\sqrt{2}$

$= (-3\sqrt{11}+\sqrt{2})(-3\sqrt{11}-\sqrt{2})$

$= 9(11) - 2$

$= 99 - 2$

$= 97$

conjugate: $5\sqrt{x}+\sqrt{y}$

$(5\sqrt{x}-\sqrt{y})(5\sqrt{x}+\sqrt{y})$

$= 25\sqrt{x^2} + 5\sqrt{xy} - 5\sqrt{xy} - \sqrt{y^2}$

$= 25x - y$

$= 25x - y$

Complete Assignment Questions #11 - #17

Assignment

1. Multiply and simplify where possible. Do not use a calculator.

a) $(\sqrt{7})(\sqrt{3})$ **b)** $4\sqrt{3} \times 2\sqrt{5}$ **c)** $-3\sqrt{5} \times 2\sqrt{2}$ **d)** $6\sqrt{p} \times 8\sqrt{q}$

e) $(\sqrt{15})(\sqrt{3})$ **f)** $10\sqrt{5} \times 9\sqrt{5}$ **g)** $3\sqrt{6} \cdot 5\sqrt{10}$ **h)** $\sqrt{a} \times 10\sqrt{a}$

i) $7\sqrt{54} \cdot 2\sqrt{6}$ **j)** $(\sqrt{32})(\sqrt{6})$ **k)** $\sqrt{15} \times 3\sqrt{27}$

2. In each case, write each radical as the product of two mixed radicals in two different ways.

a) $15\sqrt{18}$ **b)** $35\sqrt{6}$

3. Express in simplest form. Do not use a calculator.

a) $(\sqrt{3})^2$ **b)** $(4\sqrt{2})^2$ **c)** $(-3\sqrt{5})^2$ **d)** $-(\sqrt{12})^2$ **e)** $(\sqrt{5})^3$

4. Express in simplest form.

a) $\sqrt{5} \times 2\sqrt{3} \times 3\sqrt{2}$ **b)** $2\sqrt{6} \times 2\sqrt{3} \times 3\sqrt{2}$ **c)** $(-2\sqrt{6})(2\sqrt{3})(-3\sqrt{5})$

4. Express in simplest form.

a) $\sqrt{5} \times 2\sqrt{3} \times 3\sqrt{2}$ **b)** $2\sqrt{6} \times 2\sqrt{3} \times 3\sqrt{2}$ **c)** $(-2\sqrt{6})(2\sqrt{3})(-3\sqrt{5})$

$= 12\sqrt{90}$ $= 12(3)\sqrt{10}$

$90 = 9 \times 10 = 3 \times 3 \times 5 \times 2$ $= 36\sqrt{10}$

d) $\left(\frac{2}{3}\sqrt{27}\right)(\sqrt{6})$ **e)** $2\sqrt{\frac{8}{25}} \times 5\sqrt{2}$ **f)** $3\sqrt[3]{16} \times 2\sqrt[3]{4} \times 2\sqrt[3]{2}$

$= 10\sqrt{\frac{16}{25}}$

$= 10\frac{\sqrt{16}}{\sqrt{25}} = 10\frac{4}{5}$

$= \frac{40}{5} = 8$

$16 = 4 \times 4 = 2 \times 2 \times 2 \times 2$

$= 3(2)\sqrt[3]{2} \times 2\sqrt[3]{4} \times 2\sqrt[3]{2}$

$= 6\sqrt[3]{2} \times 2\sqrt[3]{4} \times 2\sqrt[3]{2}$

$= 24\sqrt[3]{16}$

$= 24(2)\sqrt[3]{2} = 48\sqrt[3]{2}$

5. Consider the product $6\sqrt{5} \times 3\sqrt{8}$.

a) Use a **two decimal place approximation** for each radical to determine a two decimal place approximation for the product.

b) Determine the **exact value** of the product as a mixed radical in simplest form.

c) Determine a **two decimal place approximation** to the answer in b).

d) Which of the two decimal place approximations is more accurate? Explain.

6. Expand and simplify where possible.

a) $\sqrt{6}(2\sqrt{6} - \sqrt{5})$ **b)** $\sqrt{2}(1 - \sqrt{2})$ **c)** $2\sqrt{3}(2\sqrt{7} - 4\sqrt{5})$

7. Expand and simplify.

a) $\sqrt{3}(2\sqrt{6} - \sqrt{12})$ **b)** $\sqrt{8}(\sqrt{6} - \sqrt{2})$ **c)** $\sqrt{y}(\sqrt{x} - 9\sqrt{y})$

d) $2\sqrt{11}\left(3\sqrt{2}-\sqrt{50}+3\sqrt{32}\right)$

e) $\sqrt{5}\left(3\sqrt{5}-\sqrt{75}+3\sqrt{3}\right)$

8. Simplify.

a) $\left(4+\sqrt{27}\right)\left(1-\sqrt{12}\right)$

b) $\left(2\sqrt{3}-\sqrt{10}\right)\left(\sqrt{6}-7\sqrt{20}\right)$

$= 2\sqrt{18}-14\sqrt{60}-\sqrt{60}+7\sqrt{200}$

$= 2\sqrt{18}-15\sqrt{60}+7\sqrt{200}$

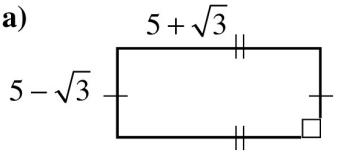
$= 2(3)\sqrt{2}-15(2)\sqrt{15}+7(10)\sqrt{2}$

$= 6\sqrt{2}-30\sqrt{15}+70\sqrt{2}$

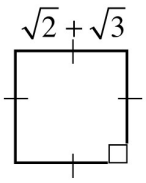
$= \boxed{76\sqrt{2}-30\sqrt{15}}$

9. Write and simplify an expression for the area of each shape.

a)

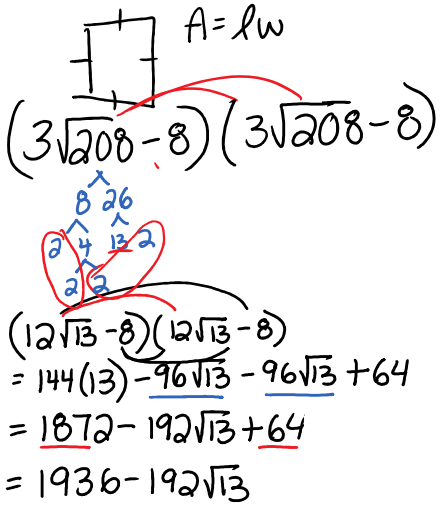


b)



c) rectangle $2\sqrt{10}$ by $\left(\sqrt{6}+4\sqrt{5}\right)$

d) square with sides $3\sqrt{208}-8$



10. Expand and simplify.

a) $\left(5\sqrt{3}-2\right)^2$

b) $\left(4\sqrt{6}-\sqrt{2}\right)^2$

c) $2\left(\sqrt{15}-3\sqrt{5}\right)^2$

d) $\left(7\sqrt{x}-2\sqrt{y}\right)^2$

11. Expand and simplify.

a) $\left(\sqrt{5}+1\right)\left(\sqrt{5}-1\right)$ **b)** $\left(\sqrt{8}+\sqrt{7}\right)\left(\sqrt{8}-\sqrt{7}\right)$ **c)** $\left(2\sqrt{6}-\sqrt{2}\right)\left(2\sqrt{6}+\sqrt{2}\right)$

12. Write the conjugate of each.

a) $\sqrt{2}-\sqrt{5}$ **b)** $4+\sqrt{7}$ **c)** $-3\sqrt{8}-15$

13. Write the conjugate of each, then multiply each pair.

a) $\sqrt{3}-1$ **b)** $2+\sqrt{5}$ **c)** $2\sqrt{6}-\sqrt{3}$

13. Write the conjugate of each, then multiply each pair.

a) $\sqrt{3} - 1$ **b)** $2 + \sqrt{5}$ **c)** $2\sqrt{6} - \sqrt{3}$

d) $2\sqrt{8} + \sqrt{27}$ **e)** $\sqrt{32} - \sqrt{3}$ **f)** $-3\sqrt{40} + 2\sqrt{10}$

Multiple Choice **14.** For all values of a and b, $\left(\sqrt{a} - \sqrt{b}\right)\left(\sqrt{a} + \sqrt{b}\right)$ is equal to

A. $\sqrt{(a-b)(a+b)}$
B. $a - b$
C. $a + b$
D. $a^2 - b^2$

15. $\left(\sqrt{2}\right)^5$ is equal to

A. $\sqrt{10}$
B. $5\sqrt{2}$
C. $4\sqrt{2}$
D. 32

16. The expression $\sqrt{5}\left(\sqrt{10} + 12\sqrt{5}\right) - \sqrt{7}\left(\sqrt{7} - 2\sqrt{14}\right)$ can be simplified to the form $a + b\sqrt{c}$, where a, b and c are integers. The value of $a + b + c$ is _____.

(Record your answer in the numerical response box from left to right.)

17. If $p \oplus q$ means "$(p - q)$ multiplied by q" then the value of $\sqrt{6} \oplus \sqrt{3}$ can be simplified to the form $a + b\sqrt{c}$, where a, b and c are integers.

17. If $p \oplus q$ means "$(p - q)$ multiplied by q" then the value of $\sqrt{6} \oplus \sqrt{3}$ can be simplified to the form $a + b\sqrt{c}$, where a, b and c are integers.
The value of c is _____.

(Record your answer in the numerical response box from left to right.)

Answer Key

1. **a)** $\sqrt{21}$ **b)** $8\sqrt{15}$ **c)** $-6\sqrt{10}$ **d)** $48\sqrt{pq}$ **e)** $3\sqrt{5}$ **f)** 450 **g)** $30\sqrt{15}$
h) $10a$ **i)** 252 **j)** $8\sqrt{3}$ **k)** $27\sqrt{5}$

2. Answers may vary.
a) $(3\sqrt{3})(5\sqrt{6})$ or $(5\sqrt{3})(3\sqrt{6})$ **b)** $(5\sqrt{2})(7\sqrt{3})$ or $(7\sqrt{2})(5\sqrt{3})$

3. **a)** 3 **b)** 32 **c)** 45 **d)** -12 **e)** $5\sqrt{5}$

4. **a)** $6\sqrt{30}$ **b)** 72 **c)** $36\sqrt{10}$ **d)** $6\sqrt{2}$ **e)** 8 **f)** $48\sqrt[3]{2}$

5. **a)** 113.94 **b)** $36\sqrt{10}$ **c)** 113.84 **d)** c) because rounding is not done until the last step.

6. **a)** $12 - \sqrt{30}$ **b)** $\sqrt{2} - 2$ **c)** $4\sqrt{21} - 8\sqrt{15}$

7. **a)** $6\sqrt{2} - 6$ **b)** $4\sqrt{3} - 4$ **c)** $\sqrt{xy} - 9y$ **d)** $20\sqrt{22}$ **e)** $15 - 2\sqrt{15}$

8. **a)** $-14 - 5\sqrt{3}$ **b)** $76\sqrt{2} - 30\sqrt{15}$

9. **a)** 22 **b)** $5 + 2\sqrt{6}$ **c)** $4\sqrt{15} + 40\sqrt{2}$ **d)** $1936 - 192\sqrt{13}$

10. **a)** $79 - 20\sqrt{3}$ **b)** $98 - 16\sqrt{3}$ **c)** $120 - 60\sqrt{3}$ **d)** $49x - 28\sqrt{xy} + 4y$

11. **a)** 4 **b)** 1 **c)** 22

12. **a)** $\sqrt{2} + \sqrt{5}$ **b)** $4 - \sqrt{7}$ **c)** $-3\sqrt{8} + 15$

13. **a)** $\sqrt{3} + 1,\ 2$ **b)** $2 - \sqrt{5},\ -1$ **c)** $2\sqrt{6} + \sqrt{3},\ 21$
d) $2\sqrt{8} - \sqrt{27},\ 5$ **e)** $\sqrt{32} + \sqrt{3},\ 29$ **f)** $-3\sqrt{40} - 2\sqrt{10},\ 320$

14. B **15.** C **16.**

7	4		

17.

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