A. Write an equation to express each of the following relations. Use k as the constant of variation.

1. The area of a rectangle varies jointly as its length and width.
2. The stiffness of a beam varies jointly as its breadth and depth and inversely as the square of its length.
3. The amount of steam per second that will flow through a hole varies jointly as the steam pressure and the area of the cross section of the hole.
4. The volume of a rectangular prism varies jointly as its length, width, and height.
5. The safe load for horizontal beam supported at both ends varies jointly as the width and the square of the depth and inversely as the distance between the two supports.

B. Find the value of the unknown quantity.

1. The variable z varies jointly with x and y. If $z = 72$ when $x = 4$ and $y = 3$, find z when $x = 15$ and $y = 27$.
2. The variable z varies jointly with x and the square root of y. If $x = 3$ and $y = 16$, the value of z is -60. Find the value of y when $z = -120$ and $x = 8$.
3. The variable z varies directly as x and y and inversely as a. If $z = 12$ when $x = 13$ and $y = 20$, and $a = 5$. Find z when x= 13 and $y = 4$ and $a = 8$.
4. The variable z varies jointly as x and y. If $z = 6$ when $x = 4$ and $y = 10$. Find z when x= 20 and $y = 8$.
5. The variable z varies directly as x and inversely as y. If $z = \frac{1}{5}$ when $x = 9$ and $y = 45$. Find z when x= $\sqrt{8}$ and $y = 18$.

C. Simplify each expression.

1. $\left(x^{\frac{4}{5}}\right)^5$

2. $\left(a^{\frac{1}{4}}b^{\frac{3}{2}}\right)^{\frac{1}{2}}$

3. $x^{\frac{3}{4}} \cdot x^{\frac{2}{3}}$

4. $\dfrac{x^{\frac{4}{5}}}{x^{\frac{1}{5}}}$

5. $\dfrac{c^{-2}}{d^{\frac{-1}{3}}}$

6. $\dfrac{1}{z^{-\frac{1}{2}}}$

7. $\left(3x^{\frac{1}{4}}y^{\frac{2}{3}}z^3\right)^{\frac{1}{3}}$

8. $\dfrac{100^{\frac{4}{4}}}{100^{\frac{1}{4}}}$

9. $\dfrac{-80y^{\frac{1}{3}}}{20y^{\frac{3}{4}}}$

10. $\left(\dfrac{2x^{\frac{1}{4}}}{5y^{\frac{1}{3}}}\right)^3$

D. Simplify the following radical.

1. $\sqrt{25x^2}$
2. $2\sqrt{49x^4}$
3. $\sqrt{81x^6y^2}$
4. $\sqrt{169x^2y^4}$
5. $\sqrt[3]{8x^3}$
6. $\sqrt[3]{-125x^6y^{12}}$
7. $\sqrt[4]{256x^{15}y^{18}}$
8. $\sqrt[4]{16x^4y^4z^8}$
9. $\sqrt[5]{32y^{15}z^{20}}$
10. $\sqrt[6]{64x^{36}y^{42}}$

E. Write the given exponential expression in radical form and vice-versa.

1. $5^{\frac{3}{2}}$
2. $\sqrt[3]{x}$
3. $\sqrt[3]{x^7}$
4. $\sqrt[5]{2x^2y^3}$
5. $\sqrt[4]{81x^2y^6}$
6. $\sqrt[3]{x^3y^5}$
7. $\sqrt[3]{(x-1)^2}$
8. $\left(x^{\frac{4}{7}}\right)^{\frac{1}{2}}$
9. $x^{\frac{2}{5}}y^{\frac{3}{5}}$
10. $\left(\frac{2}{3}y^3\right)^{\frac{1}{5}}$

F. Simplify the radicals in each expression, then combine all the similar terms.

1. $\sqrt{2} + \sqrt{12}$
2. $5\sqrt{2} - 3\sqrt{8}$
3. $-2\sqrt{27} + \sqrt{12}$
4. $\sqrt{75} - \sqrt{27}$
5. $2\sqrt{28} - 3\sqrt{63} - \sqrt{112}$
6. $6\sqrt{98} - \sqrt{48} + 2\sqrt{75}$
7. $-7\sqrt{27} + 3\sqrt{75} + 3\sqrt{12}$
8. $y\sqrt{12x^2y} + 2\sqrt{18xy^3} - 4\sqrt{27x^2y^2}$
9. $\sqrt{3x^2y} - 2\sqrt{12x^2y} - 3\sqrt{75x^6y^3}$

G. Perform the indicated operation, then simplify.

1. $\sqrt{9} \cdot \sqrt{100}$
2. $\sqrt{3} \cdot \sqrt{48}$
3. $\sqrt{20a^2} \cdot \sqrt{10b^2}$
4. $\sqrt[3]{x^2yz^2} \cdot \sqrt[3]{xy^3z^3}$
5. $(\sqrt{2} - \sqrt{3})(\sqrt{2} - \sqrt{6})$
6. $(\sqrt{5} + 6)(\sqrt{5} - 6)$
7. $\sqrt{72} \div \sqrt{2}$
8. $\sqrt[3]{320} \div \sqrt[3]{5}$
9. $\sqrt[4]{96} \div \sqrt[4]{3}$

H. Rationalize the denominator of each of the following expressions, then simplify the result.

1. $\dfrac{1}{\sqrt{5}}$

2. $\dfrac{1}{\sqrt[3]{3}}$

3. $\dfrac{4}{3\sqrt{12}}$

4. $\sqrt[4]{\dfrac{4}{3}}$

5. $\dfrac{5}{\sqrt{3b}}$

6. $\sqrt{\dfrac{5x^4y^7}{3xy^2}}$

7. $\dfrac{\sqrt{2}}{1+\sqrt{2}}$

8. $\dfrac{12}{\sqrt{2}-3}$

I. Solve of each radical equation.

1. $\sqrt{x}=2$
2. $\sqrt{2x-3}=1$
3. $\sqrt{x+7}=3$
4. $\sqrt{3x}+1=7$
5. $\sqrt{x-5}-7=0$
6. $\sqrt[3]{x-1}=3$
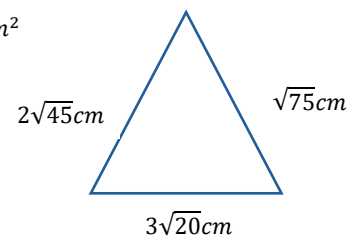7. $3-\sqrt{x-4}=0$
8. $\sqrt[4]{x+3}=4$
9. $\sqrt[3]{x-6}=5$

J. Analyze each problem then solve.
1. Find the sides of a square that has an area of 169 cm^2

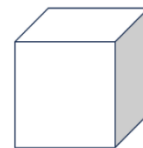$A = 169cm^2$

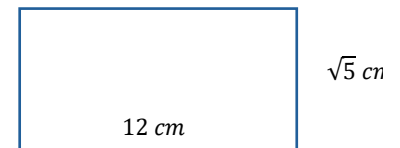2. If the lengths of the sides of a triangle are $2\sqrt{45}cm$, $\sqrt{75}cm$, and $3\sqrt{20}cm$, find its perimeter.

$2\sqrt{45}cm$ $\sqrt{75}cm$ $3\sqrt{20}cm$
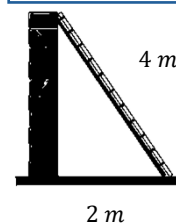
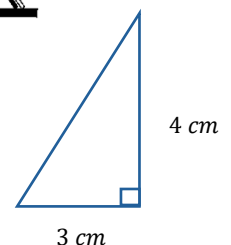3. Find the surface area of a cube whose volume is 125 cm^3

$V = 125cm^3$

4. Find the length of the diagonal of a rectangle $\sqrt{5}$ cm by 12 cm

$\sqrt{5}$ cn
12 cm

5. A $4m$ ladder is leaning on a wall. If the foot of the ladder is $2m$ from the base of the wall, how high is the top of the ladder?

4 m
2 m

6. The legs of a right triangle are $3cm$ and $4cm$. Find its hypotenuse.

4 cm
3 cm

Challenge!

1. Find all the ordered pairs (a, b) satisfying $\sqrt{8+2\sqrt{15}} = \sqrt{a}+\sqrt{b}$ such that a and b are integers. (MTAP Grade 9 – Session 3 Regular)

2. Solve for x: $\sqrt{1+\sqrt{x+\sqrt{2x+1}}} = \sqrt{2+\sqrt{x}}$. (MTAP Grade 9 – Session 3 Regular)

3. Evaluate $\sqrt{5+6\sqrt{5+6\sqrt{5+\cdots}}}$ (MTAP Grade 9 – Session 3 Regular)

4. Find the value of $\left(\sqrt{2}+\sqrt{3}+\sqrt{5}\right)\left(\sqrt{2}+\sqrt{3}-\sqrt{5}\right)\left(\sqrt{2}-\sqrt{3}+\sqrt{5}\right)\left(-\sqrt{2}+\sqrt{3}+\sqrt{5}\right)$ (MTAP Grade 9 – Session 3 Regular).

5. What is the sum of $\left(52+6\sqrt{43}\right)^{\frac{3}{2}}$ and $\left(52-6\sqrt{43}\right)^{\frac{3}{2}}$?

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