Rearranging Equation

Any equation can be modified, as long as the same operation is done to both sides.

Examples:

For: $a = b$

Multiply both sides by 2:

$$2a = 2b$$

Divide both sides by 47

$$\frac{2a}{47} = \frac{2b}{47}$$

This ability to manipulate equations is a powerful technique for solving equations:

For $\text{Density} = \frac{\text{Mass}}{\text{Volume}}$

If I want to solve for the mass; then I multiply both sides of the equation by Volume

$$(\text{Volume})\ (\text{Density}) = \frac{(\text{Volume})\ \ (\text{Mass})}{(\text{Volume})}$$

Since (Volume) is in both numerator (top) and denominator (bottom) of the right side of the equation, I can divide simplify that fraction to:

$$(\text{Volume})\ (\text{Density}) = (\text{Mass})$$

If I want to solve for Volume:

Multiply both sides by Volume:

$$(\text{Volume})\ (\text{Density}) = \frac{(\text{Volume})\ \ (\text{Mass})}{(\text{Volume})}$$

Divide both sides by Density

$$\frac{\text{Volume})\ (\text{Density})}{(\text{Density})} = \frac{(\text{Volume})\ \ (\text{Mass})}{(\text{Volume})\ (\text{Density})}$$

Simply the fraction;

$$\text{Volume}) = \frac{(\text{Mass})}{(\text{Density})}$$

"Cross-multiplication"

The technique of multiplying & dividing both sides of an equation can be simplified:

For: $\text{Density} = \dfrac{\text{Mass}}{\text{Volume}}$

The result of a consecutive multiply and divide is called "cross-multiplying"

$$\textbf{Density} = \frac{\textbf{Mass}}{\textbf{Volume}}$$

This is called "cross-multiplication" because

The numerator of both sides of an equation is multiplied by the denominator of other side.

So, solving the above density = mass/volume equation directly for volume:

Volume = mass / Density

Solving directly for mass:

Density x volume = mass

This technique becomes very valuable when solving gas law equations in Unit Eight

Concentrating here only on the mathematical operations:

For the general gas law equation:

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

Using Cross-multiplication:

$$P_1V_1\,T_2 = P_2V_2\,T_1$$

Solving for various terms:

$$P_1 = \frac{P_2V_2\,T_1}{V_1\,T_2}$$

$$V_1 = \frac{P_2V_2\,T_1}{P_1\,T_2}$$

$$T_1 = \frac{P_1V_1\,T_2}{P_2V_2}$$