Proportions in Solution Mixtures

Expressing Concentration with %, ppm, ppb & ppt

$$\frac{\text{amount of solute}}{\text{amount of solution}} \times \text{representative quantity} \begin{cases} 10^2 \\ 10^6 \\ 10^9 \\ 10^{12} \end{cases} \begin{array}{l} \rightarrow \text{parts per hundred } \% \\ \rightarrow \text{parts per million ppm} \\ \rightarrow \text{parts per billion ppb} \\ \rightarrow \text{parts per trillion ppt} \end{array}$$

Concept of ppm: 1 ppm = 1 part of substance in one million parts of water solution, or 1/1,000,000
1 ppm = approximately one second in 11.6 days

Concept of ppb: 1 ppb = 1 part of substance in one billion parts of water solution, or 1/1,000,000,000
1 ppb = approximately one second in 31.7 years

Concept of ppt: 1 ppt = 1 part in one trillion parts of water solution, or 1/1,000,000,000,000
1 ppt = approximately 1.6 days out of the present age of the earth (approx 4.5 billion yrs)

PROCEDURE:

Step 1   convert all volumes to mL and all masses to grams

Step 2   divide $\rightarrow \dfrac{\text{amount of solute}}{\text{amount of solution}}$ the units <u>must</u> match dimensions (g/g, g/mL, or kg/L)

Step 3   multiply by $\begin{cases} 10^2 \\ 10^6 \\ 10^9 \\ 10^{12} \end{cases} \begin{array}{l} \rightarrow \text{parts per hundred } \% \\ \rightarrow \text{parts per million ppm} \\ \rightarrow \text{parts per billion ppb} \\ \rightarrow \text{parts per trillion ppt} \end{array}$

Example Problem 1 (**percent**):

Find the % concentration of a solution in which 6.8 g of NaCl has been dissolved making a solution with a volume of 85 mL.

$$\% = \frac{\text{amount of solute}}{\text{amount of solution}} \times 100 = \frac{6.8 \text{ g } NaCl}{85 \text{ mL solution}} \times 100 = \boxed{80.\% \ NaCl}$$

Example Problem 2 (**ppm**):

Find the concentration in ppm of a solution in which 0.0059 g of NaCl has been dissolved making a solution with a volume of 750 mL.

$$ppm = \frac{\text{amount of solute}}{\text{amount of solution}} \times 10^6 = \frac{0.0059 \text{ g } NaCl}{750 \text{ mL solution}} \times 10^6 = \boxed{7.9 \ ppm \ NaCl}$$

Using percent

Finding the amount of solute in a certain amount of solution

Example Problem:

An NaCl solution has a concentration of 5.6%. What mass of NaCl is contained in 25 mL of this solution?

Step 1   Change unit label

5.6% becomes 5.6 g/100mL

Step 2

$$\frac{5.6g}{100mL}(25mL) = 1.4g$$

Finding the volume of solution that gives a certain amount of solute

Example Problem:

An NaCl solution has a concentration of 5.6%. What volume of solution will provide a mass of 0.75 g of NaCl?

Step 1   Change unit label

5.6% becomes 5.6 g/100mL

Step 2

$$0.75g\left(\frac{100mL}{5.6g}\right) = 13mL$$

Using ppm

Finding the amount of solute in a certain amount of solution

Example Problem:

An NaCl solution has a concentration of 132 ppm. What mass of NaCl is contained in 250 mL of this solution?

Step 1   Change unit label

132 ppm becomes 132 g/ 1,000,000 mL

Step 2

$$\frac{132\ g}{1,000,000\ mL}(250\ mL) = 0.033\ g$$

Finding the volume of solution that gives a certain amount of solute

Example Problem:

An NaCl solution has a concentration of 132 ppm. What volume of solution will provide a mass of 0.024 g of NaCl?

Step 1   Change unit label

132 ppm becomes 132 g/ 1,000,000 mL

Step 2

$$\frac{1,000,000\ mL}{0.033\ g}(0.024\ g) = 180\ mL$$