Concentrations of Solutions

- a way of describing the relative amounts of solute and solvent in a solution

- three types of concentration:
  1. Parts per Million or Billion
  2. Mass % Concentration (MPC)
  3. Molar Concentration (Molarity)

Concentration in Parts per Million (ppm) or Parts per Billion (ppb)

- used to express very small quantities
- does not refer to the number of particles; it is a mass to mass relationship

$$\text{ppm} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 10^6$$

$$\text{ppb} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 10^9$$

e.g. A fungus that grows on peanuts produces a deadly toxin. Shipments containing more than 25 ppb of this fungus are rejected. A company receives 20 Mg of peanuts. What is the maximum mass of fungus allowed?

20 Mg = 20 000 000 g

$$\text{ppb} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 10^9$$

$$\text{mass of solute} = \text{ppb} \times \frac{\text{mass of solution}}{10^9}$$

$$= \frac{25\text{ppb} \times 20\,000\,000}{10^9} = 0.50 \text{ g}$$

$\therefore$ 20 Mg of peanuts can contain up to 0.50 g of fungus

Mass % Concentration (MPC)

$$\text{MPC} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 100\ \%$$

* mass of solution = mass of solute + mass of solvent

* 1 mL H_2O = 1 g H_2O

e.g. a) Calculate the mass of NH_4NO_3 dissolved in 240 g of a 6.0 % solution.
b) What volume of H_2O in mL's was used to make the solution?

a) MPC = 6.0 %

mass of solution = 240 g

$$\text{MPC} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 100\ \%$$

$$6.0\ \% = \frac{\text{mass of solute}}{240\ \text{g}} \times 100\ \%$$

$$\text{mass of solute} = 240\ \text{g} \times \frac{6.0\ \%}{100\ \%}$$

$$= 14\ \text{g}\ NH_4NO_3$$

b) mass of solution = mass of solute + mass of solvent

mass of solvent = mass of solution - mass of solute

= 240 g - 14 g

= 226 g H_2O

$$\text{volume of } H_2O = 226\ \text{g}\ H_2O \times \frac{1\ \text{mL}\ H_2O}{1\ \text{g}\ H_2O}$$

= 226 mL H_2O

e.g. a solution contains 12.0g of sugar dissolved in 50ml of H2O. What is the mass percent composition (MPC)?

mass of solute = 12.0g
mass of solution = mass of solvent + mass of solute
= 50g + 12.0g = 62g

Remember:
1ml of water ≈ 1g

$$MPC = \frac{\text{mass of solute}}{\text{mass of solvent}} \times 100\%$$

$$= \frac{12g}{62g} \times 100\% = 19.4\%$$

e.g. what volume of H_2O is needed to add to 7.0g of NaCl to produce a MPC of 5%?

$$5.0\% = \frac{7.0g}{\text{mass of solvent}} \times 100\%$$

$$\text{mass of solvent} = \frac{7.0g}{5.0\%} \times 100\% = 140g$$

Remember: mass of solution = mass of solute + mass of solvent

mass of solution = 140g = 7.0g + mass of solvent
140g – 7.0g = 133g

$\therefore$ 133g of H_2O is needed to produce a MPC of 5% with 7.0g of NaCl