13.1   Quantitative Expressions of Concentration
Units of Concentration – Molarity, Molality, Mole Fraction, Weight %

Solution =   Solute + Solvent

→ that which is present in the greatest amount

Molarity:

→ the only one you met in Chem 111

$$M = \frac{\text{Moles of solute}}{\text{Volume of the solution in L}}$$

DRAWBACK: We know nothing quantity wise about the solvent.

Mole Fraction:

$$X = \frac{\text{moles of solute}}{\text{moles of solute + moles of solvent}}$$

Molality:

$$m = \frac{\text{moles of solute}}{\text{mass of solvent (kg)}}$$

DRAWBACK: We know nothing quantity wise about the solution.

Weight %:

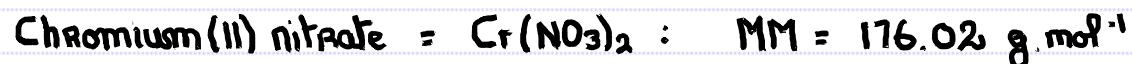$$Wt\% \text{ of } A = \left(\frac{\text{mass of A}}{\text{mass of A + mass B + ...}} \right) 100$$

13.1   Quantitative Expressions of Concentration
Units of Concentration – Molarity, Molality, Mole Fraction, Weight %

What is the **molality** of a **chromium(II) nitrate** solution made by dissolving **27.1g** of chromium(II) nitrate (**MM= 176.02**) in **513g** of water?

3
0.?

Chromium (II) nitrate $= Cr(NO_3)_2$:   MM $= 176.02$ g.mol^{-1}

$$Molality = \frac{moles\ of\ solute}{kg\ of\ solvent}$$

Moles of solute : $\dfrac{27.1g\ Cr(NO_3)_2}{} \bigg| \dfrac{1\ mol}{176.02g} = 0.154$

kg of Solvent : $\dfrac{513g}{} \bigg| \dfrac{1\ kg}{1000g} = 0.513$

$$Molality = \frac{0.154}{0.513} = 0.300\ m$$

13.1   Quantitative Expressions of Concentration
Units of Concentration – Molarity, Molality, Mole Fraction, Weight %

An aqueous solution is **6.00 % by mass hydrochloric acid**. What is the **mole fraction** of **hydrochloric acid** in the solution?

$$6.00\% \text{ HCl} = \frac{6.00g \text{ HCl}}{100g \text{ solvent}} \qquad X = \frac{\text{moles of solute}}{\text{moles of solute} + \text{moles of solvent}}$$

ASSUME: 100g of solution.
$$\therefore \quad 6g \text{ of HCl} + 94g \text{ of } H_2O$$

MM: $H_2O = 18.02g\cdot mol^{-1}$; $HCl = 36.5g\cdot mol^{-1}$

Moles of solute: $\dfrac{6.00g \text{ HCl}}{} \Big| \dfrac{1 mol}{36.5g} = 0.164$

Moles of solvent: $\dfrac{94.00g \text{ } H_2O}{} \Big| \dfrac{1 mol}{18.02g} = 5.22$

$$X = \frac{0.164}{0.164 + 5.22} = 0.0305$$