Lecture 3 1 Concentration & conversions

Note Title

Chemists calculate concentration in many ways...

- Molarity (M) $M = \frac{\text{moles solute}}{\text{L solution}}$ $\left(\frac{\text{mol}}{\text{L}}\right)$ Vol dep on Temp, M dep on Temp
- molality (m) $m = \frac{\text{moles solute}}{\text{Kg Solvent}}$ $\left(\frac{\text{mol}}{\text{Kg}}\right)$ m doesn't dep on T
- mass percent (%) $\% = \frac{\text{mass solute}}{\text{mass solution}} \cdot 100$ unitless
- parts per million (ppm) $ppm = \frac{\text{mass solute}}{\text{mass solution}} \cdot 10^6$ used when conc. are low
- parts per billion (ppb) $ppb = \frac{\text{mass solute}}{\text{mass solution}} \cdot 10^9$ used when conc are VERY low
- mole fraction (X) $X = \frac{\text{mol solute}}{\text{mol solute} + \text{mol solvent}}$ < 1

Problem: Given a 3.75 (3 S.F.) Molar H_2SO_4 solution with density of 1.225 g/mL (0)

→ Calculate the solution's molality, mass %, and mole fraction $_{H_2SO_4}$.

assumption: Vol = 1.000 L conc. is ind of Vol.

solution... 1) Mass Solution = D V = $1.225\ g/mL \cdot 1{,}000\ mL$ = 1,225 g

solute: 2) moles H_2SO_4 = M V = $3.75\ \frac{mol}{L} \cdot 1.000\ L$ = 3.75 mol H_2SO_4

3) mass H_2SO_4 = $mol_{H_2SO_4} \cdot$ molar mass = 3.75 mol · 98.079 g/mol = 367.79 $g_{H_2SO_4}$

solvent: 4) Solvent mass = (1) Solution mass − (2) mass H_2SO_4 = 1,225 g − 367.79 g = 857.2 g_{H_2O}

5) Solvent moles = mass H_2O / molar mass H_2O = 857.2 g / 18.01 g/mol = 47.5957 mol H_2O

$$\text{molality} = \frac{\text{mol } H_2SO_4}{\text{Kg } H_2O} = \frac{3.75\ \text{mol}}{0.85724\ \text{kg}} = 4.374\ m = 4.37\ m\ (3\ S.F.)$$

$$\text{mass \%} = \frac{\text{mass } H_2SO_4}{\text{mass solution}} \cdot 100 = \frac{367.79\ g}{1225\ g} \cdot 100 = 30.0\%$$

$$\text{mole fraction } X = \frac{\text{mol } H_2SO_4}{\text{mol } H_2SO_4 + \text{mol } H_2O} = \frac{3.75\ \text{mol}}{(3.75 + 47.5957\ \text{mol})} = 0.0730$$

mol fraction H_2SO_4

$X_{H_2O} = 1 - 0.0730 = 0.927$ (X_{H_2O})