2/6/2019

Solution Concentrations

Quantitative measures:

$\frac{1}{x} = x^{-1}$

Molarity (M) (molar conc) $= \frac{\#\text{mol solute}}{\#\text{L solution}}$ (mol / L)

UNITS: $\frac{\text{mol}}{\text{L}}$ or $\text{mol}\cdot\text{L}^{-1}$ OR M

- vol changes w/ T

as T↑, V↑, M↓ // as T↓, V↓, M↑

Urgh!

~~Molar~~ Molality (m) (molal conc) $= \frac{\#\text{mol solute}}{\#\text{kg solvent}}$ (mol / kg)

UNITS: $\frac{\text{mol}}{\text{kg}}$ or $\text{mol}\cdot\text{kg}^{-1}$ or m

- doesn't change w/ T
- inconvenient to weigh large masses.

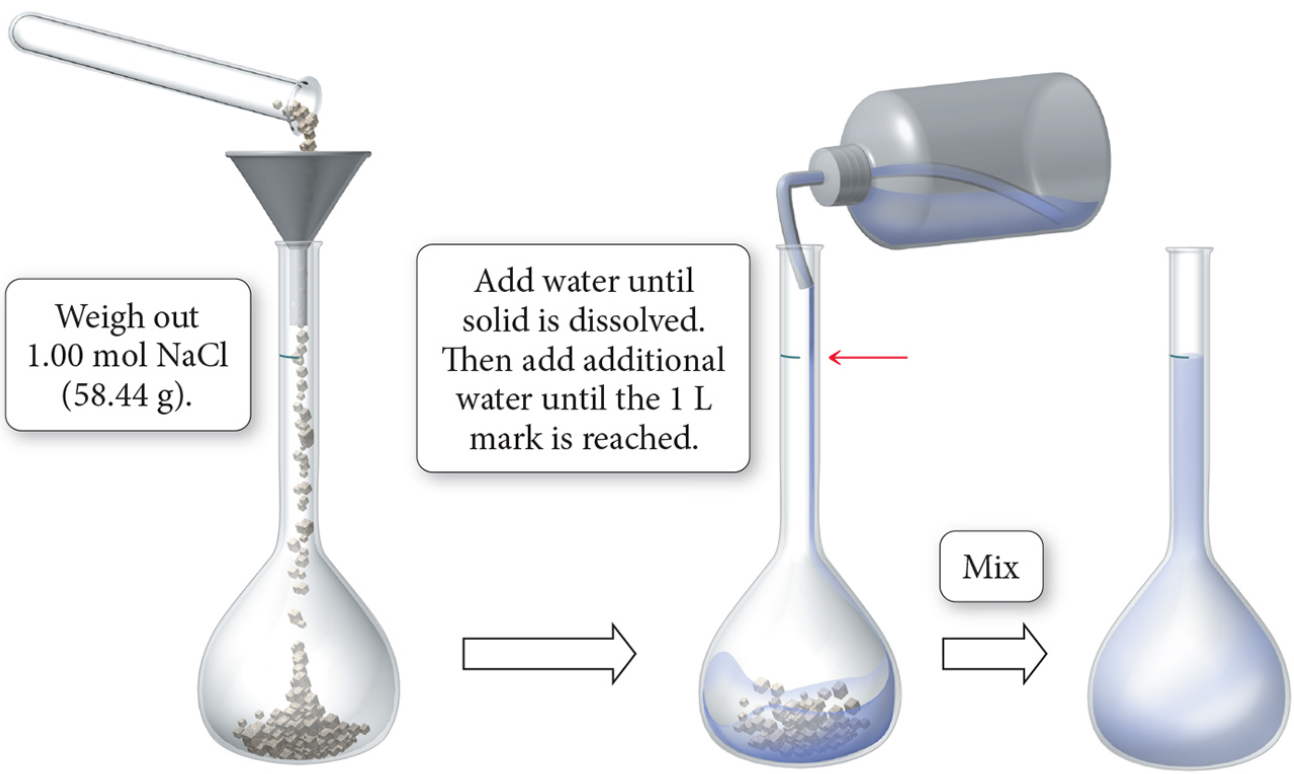
Q: If we dissolve 50.0g solute ($M_0 = 25.0\ \text{g/mol}$) in 100.0g solvent. What is its molal conc?

molal conc $= \frac{\#\text{mol solute}}{\#\text{kg solvent}}$ (mol / kg)

$50.0\,\text{g} \times \frac{\text{mol}}{25.0\,\text{g}} = 2.00\,\text{mol}$ (3 s.f.)

$100.0\,\text{g} \times \frac{\text{kg}}{10^3\,\text{g}} = 0.1000\,\text{kg}$ (4 s.f.)

$\Rightarrow$ molal conc $= \frac{2.00\,\text{mol}}{0.1000\,\text{kg}} = 20.0\,\text{m}$



Be careful when preparing solutions of a fixed molar concentration. It is the total SOLUTION volume, (not the total SOLVENT volume) that needs to be carefully controlled!

Parts by mass / Parts by volume

- commonly reported as % — percent (per-100) / cent
  - sometimes: ppm, ppb
    parts per million, parts by billion.

- ratio of $\frac{\text{solute}}{\text{solution}} \times \text{factor}$

ex: % by mass $= \frac{\text{mass solute}}{\text{mass soln}} \times 100$

ex: 1.35g NaCl in 151g soln.

$$\% \text{ by mass (NaCl)} = \frac{1.35\text{g}}{151\text{g}} \times 100 = 0.894\%$$

We can use these %'s as simple conversion factors!

ex: soln that is 15% by mass, means...

$$\frac{15\text{g solute}}{100\text{g soln}}$$ conversion factor!

Q: How much soln do we need in order to have 25g solute?

$$25\text{g solute} \times \frac{100\text{g soln}}{15\text{g solute}} = 170\text{g soln}$$

More dilute sol^n, we use ppm
ppb

$$\% = \frac{\text{mass solute}}{\text{mass sol}^n} \times 100$$

$$ppm = \text{"} \times 10^6$$

$$ppb = \text{"} \times 10^9$$

For parts by volume ... same set-ups as above:
just use vol in place of mass.

$$\%\,(\text{volume}) = \frac{\text{volume solute}}{\text{vol. sol}^n} \times 100 \quad \text{etc.}$$

Example: Budweiser is 4.0% ethanol by mass. (4.0 g ethanol in 100. g beer.)
Q: What is its volume %?

d (Budweiser) = 1.004 g/mL, d (ethanol) = 0.799 g/mL

A: Need vol%: define: $\frac{\text{vol (ethanol)}}{\text{vol (sol}^n\text{)}} \times 100 = \frac{5.06\text{ mL}}{99.60\text{ mL}} \times 100$ (vol (ethanol)?)

ASSUME 100-g beer

vol ethanol

$d = m/V \Rightarrow V = m/d = \frac{4.0\text{ g}}{0.799\text{ g/mL}} = 5.06\text{ mL}$ (4.0 g; d = 0.799 g/mL)

$= 5.1\%$ by vol.

vol beer $V = m/d = \frac{100\text{ g}}{1.004\text{ g/mL}} = 99.60\text{ mL}$ (4 s.f.)