12.2 Solution Concentration

Lab Solutions

Concentration: amount of solute dissolved in solvent.

Care for a spot of tea?

Percent by Mass

Ratio of solute's mass expressed as percent.

$$\%\,mass = \frac{mass\ solute}{total\ mass\ of\ solution} \bullet 100\%$$

1. Ex: What is the % mass of a solution made of 12.6 grams NaCl and 100.0 grams water?

Mass solute: 12.6 g
Mass solution: 12.6 g NaCl + 100.0 g water = 112.6 g

$$\%\,mass = \frac{12.6\,g\ NaCl}{112.6\,g\ solution} \bullet 100\% = 11.2\%\ NaCl$$

Percent by Volume

Used when both solute and solvent are liquids: ratio of solute's volume expressed as a percent (alcohol demo).

$$\%\,volume = \frac{volume\ solute}{total\ solution\ volume} \bullet 100\%$$

2. What is the % volume of ethanol in a solution containing 35 mL ethanol and 155 mL water?

Volume solute: 35 mL
Volume total: 35 mL + 155 mL = 190 mL

$$\%\,volume = \frac{35\,mL}{190\,mL} \bullet 100\% = 18.42\%\ ethanol$$

Molarity (M)

Moles of solute dissolved per liter of solution:

$$M = \frac{moles\ solute}{liters\ of\ solution}$$

Molarity units are mol/L.

Ex 3: what's the molarity if 1.8 moles NaCl are dissolved in water, making 2.5 liters of solution?

$$M = \frac{moles\ dissolved}{liters\ of\ solution} = \frac{1.8\,mol}{2.5\,L} = 0.72\,M\ NaCl$$

4. Another Molarity Example

Often, you make a mass to mole conversion first.

What is the molarity of a NaCl solution if 18 g are dissolved and made into a 0.25 L solution?
NaCl molar mass = 58.44 g/mole.

Moles of NaCl:

$$18\,g\ NaCl \bullet \frac{1\,mol\ NaCl}{58.44\,g\ NaCl} = 0.31\,mol\ NaCl$$

Then:

$$M = \frac{0.31\,mol\ NaCl}{0.25\,L\ solution} = 1.2\,M$$

5. More Molarity!

How many g NaCl are needed to make 1.8 L of a 0.35 M solution?

First, calculate moles NaCl:

$$M = \frac{moles\ solute}{liters\ solution}$$

$$moles\ solute = M \bullet L = 0.35\frac{mol}{L} \bullet 1.8L = 0.63\ moles\ NaCl$$

Last: moles to mass conversion (NaCl = 58.44 g/mol)

$$0.63\ mol\ NaCl \bullet \frac{58.44\ g\ NaCl}{1.0\ mol\ NaCl} = 36.8\ g\ NaCl$$

Making Solutions

To make 1.0 L of a 1.0 M aqueous solution of NaCl:

1. Mass out one mole of NaCl (58.44 g).
2. Dissolve in 500 mL of water in a Volumetric Flask
3. Add water to the 1000 mL mark.

6. If you added NaCl to 1000 mL water, how would that affect concentration?

You'd have a volume larger than 1 L: the solution would be less than 1 M.

Volumetric Flask

Diluting Molar Solutions

Stock solution: a concentrated solution.

Dilute solution: a solution prepared from a stock solution.

Dilution equation (from condition 1 to condition 2):

$M_1V_1 = M_2V_2$	M = molarity V = volume

7. Dilution Example

To what volume would you dilute 55 mL of a 3.5 M stock solution to get a concentration of 0.36 M?

$$M_1V_1 = M_2V_2$$

$$V_2 = \frac{M_1V_1}{M_2}$$

$$= \frac{3.5\,M \bullet 55\,mL}{0.36\,M} = 535\,mL$$

8. Another Dilution Example

What would the resulting concentration be, if 250 mL of 3.8 M NaCl were diluted to 1.0 L?

First, realize V_2 = 1000 mL

$$M_1V_1 = M_2V_2$$

$$M_2 = \frac{M_1V_1}{V_2}$$

$$= \frac{3.8\,M \bullet 250\,mL}{1000\,mL} = 0.95\,M\ NaCl$$

Homework

12.2 Problems
Due: Next Class