Solutions and Measuring Solutions

- A **solution** is a homogeneous mixture in which the two or more components mix freely
- The **solvent** is taken as the component present in the largest amount
- A **solute** is any substance dissolved in the solvent

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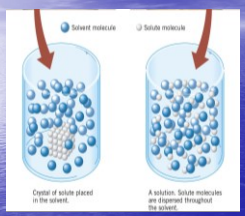

Formation of a solution of iodine molecules in ethyl alcohol. Ethyl alcohol is the *solvent* and iodine the *solute*.

Solutions have variable composition. They may be characterized using a solute-to-solvent ratio called the **concentration**.

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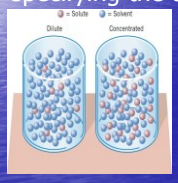
- For example, the **percentage concentration** is the number of grams of solute per 100 g of solution
- The *relative* amounts of solute and solvent are often given without specifying the actual quantities



The **dilute solution** on the left has less solute per unit volume than the (more) **concentrated solution** on the right.

Concentrated and dilute are *relative* terms.

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Ways of Measuring

- Molarity = $\frac{\text{moles of solute}}{\text{Liters of solution}}$
- % mass = $\frac{\text{Mass of solute}}{\text{Mass of solution}} \times 100$
- Mole fraction of component A

$$\chi_A = \frac{N_A}{N_A + N_B}$$

Ways of Measuring

- Molality = $\frac{\text{moles of solute}}{\text{Kilograms of solvent}}$
- Molality is abbreviated **m**
- Normality - read but don't focus on it.
- ppm (parts per million) Parts of component/1,000,000 parts of solution

- There is usually a limit to the amount of solute that can dissolve in a given amount of solvent
  - For example, 36.0 g NaCl is able to dissolve in 100 g of water at 20°C
- A solution is said to be **saturated** when no more solute can be dissolved at the current temperature
- The **solubility** of a solute is the number of grams of *solute* that can dissolve in 100 grams of *solvent* at a given temperature

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- Solubilities of some common substances

Substance	Formula	Solubility (g/100 g water)
Sodium chloride	NaCl	35.7 at 0°C 39.1 at 100°C
Sodium hydroxide	NaOH	42 at 0°C 347 at 100°C
Calcium carbonate	$CaCO_3$	0.0015 at 25°C

A solution containing less solute is called **unsaturated** because it is able to dissolve more solute.

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Molarity

Molarity is one way to measure the concentration of a solution.

$$\text{Molarity (M)} = \frac{\text{moles of solute}}{\text{volume of solution in liters}}$$

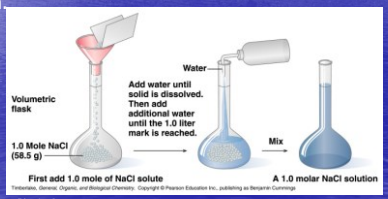
A 1.00 molar (1.00 M) solution contains 1.00 mol solute in every 1 liter of solution.

Units of molarity are: mol/L = M

Preparing a 1.0 Molar Solution

One liter of a 1.00 M NaCl solution

- need 1.00 mol of NaCl
- weigh out 58.5 g NaCl (1.00 mole) and
- add water to make 1.00 liter (total volume) of solution.



GET A CALCULATOR !

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Molarity Practice

- What is the molarity of a solution of NaCl if you have 0.5 mol NaCl in 1.00 L of solution?

0.5 mol NaCl/1.00 L = 0.5 mol/L = 0.5 M

- What is the molar NaCl concentration if you have 0.5 mol NaCl in 0.50 L of solution?

0.5 mol NaCl/0.50 L = 0.5/0.50 mol/L = 1 mol/L = 1 M

Practice

How many moles of HCl are present in 2.5 L of 0.10 M HCl?

Given: 2.5 L of soln
0.10M HCl

Find: mol HCl = 0.10 mol/1 L HCl

$$2.5\ \text{L} \times \frac{0.10\ \text{mol HCl}}{1\ \text{L}} = \frac{?}{}\ \text{mol HCl} =$$

Concentration of Solutions

Interconverting Molarity, Moles, and Volume

How many grams of $CuSO_4$ are needed to prepare 250.0 mL of 1.00 M $CuSO_4$?

Given: 250.0 mL soln and 1.00 M $CuSO_4$
Find: g $CuSO_4$

$$\frac{250.0\ \text{mL}}{} \left| \frac{1.00\ \text{mol}}{1\ \text{L soln}} \right| \frac{1\ \text{L}}{1000\ \text{mL}} \left| \frac{159.6\ \text{g}\ CuSO_4}{1\ \text{mol}} \right| = \_\_\_\ \text{g}\ CuSO_4$$