The Sulations

College of Health and Medical Techniques

Department of Anesthesiology

2nd Grade

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6074

Lecture 4

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Some important units of measurement

SI Units

Scientists throughout the world have adopted a standardized system of units known as the **International System of Units (SI).** This system is based on the seven fundamental base units shown in Table below.

SI Base Units

Physical Quantity	Name of Unit	Abbreviation
Mass	kilogram	kg
Length	meter	m
Time	second	s
Temperature	kelvin	K
Amount of substance	mole	mol
Electric current	ampere	A
Luminous intensity	candela	cd

Some important units of measurement

1. Mass

- **Mass (m)** **is an measure of the quantity of matter**.

The Distinction Between Mass and Weight

- **Weight (w)** **is the force of gravitational attraction between that matter and Earth.**
- Because gravitational attraction varies with geographical location, the weight of an object depends on where you weigh it. **For example**, a crucible weighs less in Denver than in Atlantic City.
- **Note**: weight of an object depends on where you weigh it **due to the difference in the gravity**.

Some important units of measurement

2. The Mole

- **The mole** (abbreviated mol): **is the amount of the specified substance that contains the same number of particles as the number of carbon atoms in exactly 12 grams of ^{12}C**.
- This important number is **Avogadro's number** $N_A = 6.022 \times 10^{23}$.

3. The molar mass

- **The molar mass MM of a substance: is the mass in grams of 1 mole of the substance**.
- We calculate molar masses by summing the atomic masses of all the atoms appearing in a chemical formula.

$$MM = \sum AM$$

Some important units of measurement

Example1: Find the molar mass of formaldehyde CH_2O

$$AM_C = 12 \qquad AM_H = 1 \qquad AM_O = 16$$

Solution:

$$MM_{CH_2O} = 1\ X\ AM_C + 2\ X\ AM_H + \ 1\ X\ AM_O$$

$$MM_{CH_2O} = 1\ X\ 12 + 2\ X\ 1 + \ 1\ X\ 16 = 30\ g/mol$$

One mole of formaldehyde CH_2O weight 30 g.

Example2: Find the molar mass of glycose $C_6H_{12}O_6$?

$$MM_{C_6H_{12}O_6} = 6\ X\ AM_C + 12\ X\ AM_H + \ 6\ X\ AM_O$$

$$MM_{C_6H_{12}O_6} = 6\ X\ 12 + 12\ X\ 1 + \ 6\ X\ 16$$

$$= 180\ g/mol$$

One mole of formaldehyde $C_6H_{12}O_6$ weight 180 g.

Calculating the Amount of a Substance in Moles

$$Moles\ of\ substance = \frac{Mass\ of\ substance}{Molar\ mass\ of\ substance}$$

$$n\ (mol) = \frac{m\ (g)}{MM\ (\frac{g}{mol})}$$

Example 3: Find the number of moles and millimoles of benzoic acid (MM = 122.1 g/mol) that are contained in 2.00 g of the pure acid?

Solution: If we use HBz to represent benzoic acid.

$$n\ (mol) = \frac{m\ (g)}{MM\ (\frac{g}{mol})}$$

$$n_{HBz} = \frac{2\ (g)}{122.1\ (\frac{g}{mol})} = 0.0164\ mol\ HBz \quad = 16.4\ mmol\ HBz$$

Calculating the Amount of a Substance in gram

$$n\ (mol) = \frac{m\ (g)}{MM\ (\frac{g}{mol})}$$

$$m\ (g) = n\ (mol)\ X\ MM\ (\frac{g}{mol})$$

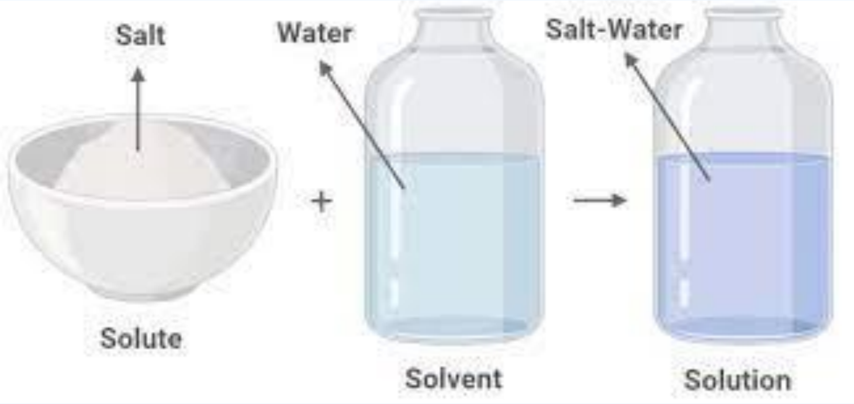
Example 4: Find the mass in gram of benzoic acid (MM = 122.1 g/mol) that are contained 0.0164 mol

$$m\ (g) = n\ (mol)\ X\ MM\ (\frac{g}{mol})$$

$$m\ (g) = 0.0164\ X\ 122.1 = 2.00\ g$$

The solution

- **The solution is defined as a homogeneous mixture of substances consists of a solvent and one or more solutes,** whose proportions vary from one solution to another.
- In general the mixture is has **different composition**
- By contrast, a pure substance has **fixed composition**.
- **The solvent** is **the medium in which the solutes are dissolved**.
- The fundamental units of solutes are usually ions or molecules.



The solution

- **A substance may dissolve with or without reaction with the solvent**.
- For example, when metallic sodium reacts with water, there is the evolution of bubbles of hydrogen and a great deal of heat. A chemical change occurs in which H2 and soluble ionic sodium hydroxide, NaOH, are produced.

$$2Na(s) + 2H_2O \longrightarrow 2Na^+(aq) + 2OH^-(aq) + H_2(g)$$

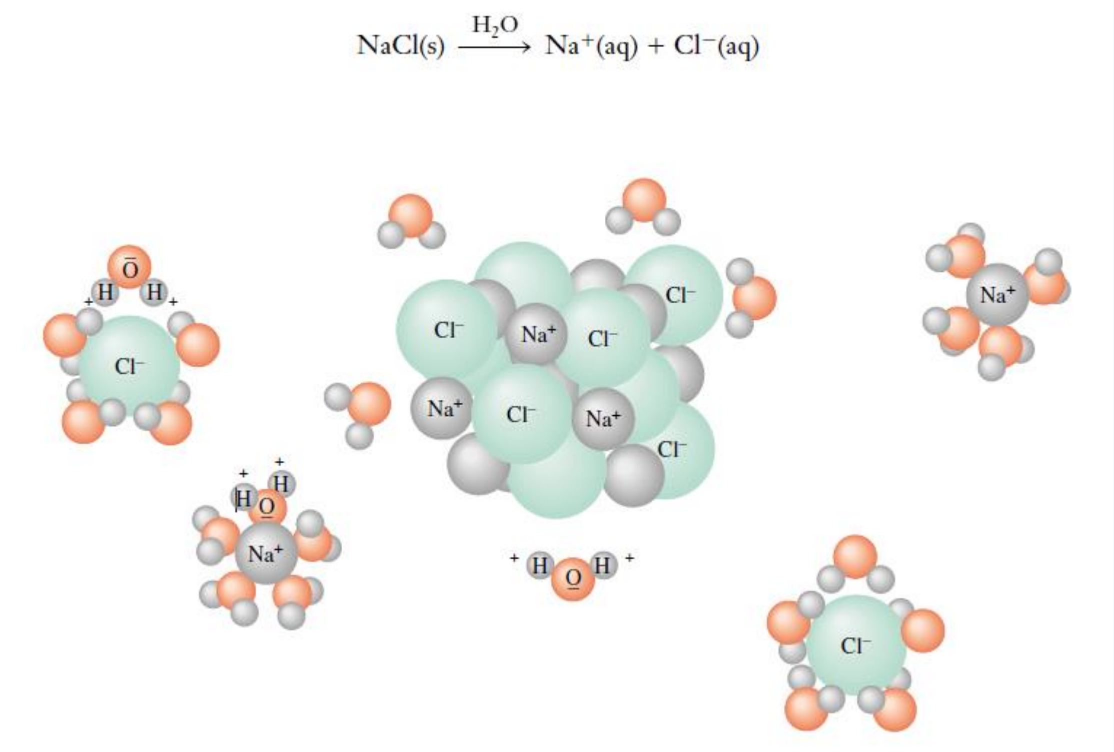
- **The dissolution of sodium in water** is an example of dissolution **with reaction.**
- Solid sodium chloride, NaCl, on the other hand, dissolves in water with no evidence of chemical reaction.

$$NaCl(s) \xrightarrow{H_2O} Na^+(aq) + Cl^-(aq)$$

- **The dissolution of sodium chloride** in water is an example of dissolution **without reaction**.

Why does sodium chloride dissolve in water?

- The H+ of the polar H2O molecule helps to attract Cl- away from the crystal. and, Na+ is attracted by the O2-. The ions are separated from the crystal, And surrounded by water molecules, to complete the hydration process.



Concentration of Solutions

In this lecture, four fundamental ways of expressing solution concentration, we will describe.

1. Molar concentration.
2. Normal concentration.
3. Percent concentration.
4. Solution-diluent volume ratio, and
5. p-functions.

1. Molar Concentration

- The **molar concentration** ***Cx*** of a solution of a solute species *x* **is the number of moles of that species that is contained in 1 liter of the solution**

Concentration of Solutions

$$Molar\ concentration = \frac{Moles\ of\ substance}{Volume\ of\ solution}$$

$$M\left(\frac{mol}{L}\right) = \frac{n(mol)}{V\ (L)}$$

But

$$n(mol) = \frac{m(g)}{MM(\frac{g}{mol})}$$

$$M\left(\frac{mol}{L}\right) = \frac{m(g)}{MM\left(\frac{g}{mol}\right) x V\ (L)}$$

Example : Calculate the **molar concentration** of ethanol in an aqueous solution that contains 2.30 g of C_2H_5OH (46.07 g/mol) in 3.50 L of solution?

$$M\left(\frac{mol}{L}\right) = \frac{m(g)}{MM\left(\frac{g}{mol}\right) x\ V\ (L)}$$

$$M_{C_2H_5OH}\left(\frac{mol}{L}\right) = \frac{2.3(g)}{46.07\left(\frac{g}{mol}\right) x\ 3.5\ (L)} = 0.0143\ \left(\frac{mol}{L}, or\ M\right)$$

Example : Calculate the **mass** (g) of $BaCl_2$ (244.3 g/mol) in the 2.00 L solution of it that has molar concentration 0.108 M ?

$$M\left(\frac{mol}{L}\right) = \frac{m(g)}{MM\left(\frac{g}{mol}\right) x\, V\ (L)}$$

$$m(g) = M\left(\frac{mol}{l}\right) x\ MM\left(\frac{g}{mol}\right) x\ V\ (L)$$

$$m(g) = 0.108\left(\frac{mol}{l}\right) x\ 244.3\left(\frac{g}{mol}\right) x\ 2\ (L) = 52.77\ g$$

2. Normality concentration

- Normality (N). Is a number of equivalent per liter.

$$N\,(\frac{eq}{L}) = \frac{Number\ of\ equivalents(eq)}{Volume\ of\ solution\ (L)}$$

$$N\,(\frac{eq}{L}) = \frac{meq\ (eq)}{V\ (L)}$$

But

$$meq = \frac{m\ (g)}{eq\ mass\ (\frac{g}{eq})}$$

2. Normality concentration

$$N\ \left(\frac{eq}{L}\right) = \frac{m\ (g)}{eq\ mass\ \left(\frac{g}{eq}\right) x\ V\ (L)}$$

Where

$$Eq\ mass\ \left(\frac{g}{eq}\right) = \frac{molar\ mass\ (\frac{g}{mol})}{h}$$

Where h depend on the type of the reaction

Compare between molarity and normality

$$M\left(\frac{mol}{L}\right) = \frac{n(mol)}{V\ (L)}$$

$$n(mol) = \frac{m(g)}{MM(\frac{g}{mol})}$$

$$M\left(\frac{mol}{L}\right) = \frac{m(g)}{MM\left(\frac{g}{mol}\right) x\ V\ (L)}$$

$$N\ (\frac{eq}{L}) = \frac{meq\ (eq)}{V\ (L)}$$

$$meq = \frac{m\ (g)}{eq\ mass\ (\frac{g}{eq})}$$

$$N\ \left(\frac{eq}{L}\right) = \frac{m\ (g)}{eq\ mass\ \left(\frac{g}{eq}\right) x\ V\ (L)}$$

$$Eq\ mass\ \left(\frac{g}{eq}\right) = \frac{MM\ (\frac{g}{mol})}{h}$$

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