Name : Alia Alaf.

Subject : Chemistry.

⇒ **Q. 1 (a):** Explain the Arrhenius equation. Also high light its applications and limitations:-

(1) Arrhenius Equation:-

"Arrhenius equations explain the effect of temperature on the rate of a chemical reation."

Usually with the increase of temperature rate of a chemical reaction is also increase.

(2) Mathmatically:-

$$K = Ae^{-\frac{Ea}{RT}}$$

where: K = Rate constant.

A = Arrhenius constant.

e = base of natural logarithum.

E_a = Activation energy.

R = General gas constant.

T = Temperature.

By taking natural log of above equation

$$\ln K = \ln\left(Ae^{-\frac{Ea}{RT}}\right)$$

$$\ln k = \ln A + \ln e^{-\frac{Ea}{RT}}$$

$\because$ $2.303 \log \neq \ln$.

$$\ln k = \ln A \left(-\frac{Ea}{RT} \ln e\right)$$

$$2.303 \log k = \ln A - \frac{Ea}{RT}.$$

$$2.303 \log k = 2.303 \log A - \frac{Ea}{RT}$$

By dividing 2.303 on both sides.

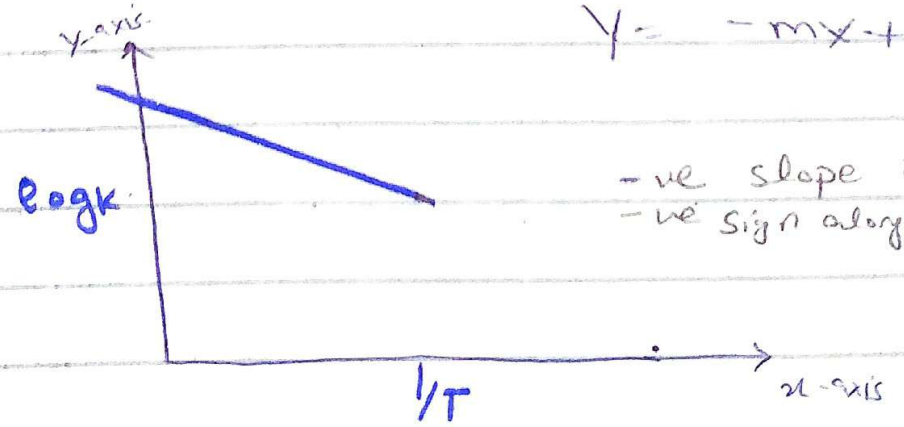
$$\frac{2.303 \log k}{2.303} = \frac{2.303 \log A}{2.303} - \frac{Ea}{2.303 RT}$$

$$\boxed{\log k = \log A - \frac{Ea}{2.303 RT}}$$

(4) ⇒ Grapically Representations:-

According to straight line equation

$$Y = -mx + C.$$



-ve slope is due the -ve sign along $\frac{Ea}{2.303 RT}$

⇒ (5) Applications of Arrhenius equation:-

(1). Identification of Acids and Bases:-

Arrhenius theory helps distinguish between acids and bases in

aqueous solutions. Acids release H^+ ions in aqueous solution and bases release OH^- ions in aqueous solutions.

Example:- $HCl \longrightarrow H^+ + Cl^-$ (Acid)

$NaOH \longrightarrow Na^+ + \bar{O}H$ (Base)

(2). **Calculation of pH and pOH:-**

This theory is useful for determining the pH (acidity level) and pOH (alkalinity level) of a solution.

(3) **Neutralization Reactions:-**

It explains how acids and bases react to form salt and water in a neutralization Reaction.

$$HCl + NaOH \longrightarrow NaCl + H_2O$$

(4) **Use of Indicators:-**

The theory helps in identifying acidic and basic solution using indicators like litmus paper, phenolphthalein and methyl orange.

(5). Many industrial processes rely on acids and bases. Such as fertilizer production, pharmaceuticals and

battery industries.

(6). Biologically it helps explain the role of acids like HCl in digestion.

⇒ (6) Limitations of Arrhenius Concept:-

(1). For the basic or acidic properties -the presence of water is a must. Dry HCl cannot function as an acid. HCl considered acid only it is dissolved in water and not in any other solvent.

(2). This concept fails to explain the acidic and basic nature of the substances in non-aqueous solvents.

(3). It throws no light what so ever on the acidic character of certain salts like $AlCl_3$, BCl_3 etc.

(4) A explanation is needed for explaining the fundamental nature of NH_3 and metallic oxides as well as the acid nature of non-metal oxides.

⇒ **Q. No. 1(b):-** Explain various acid base theories. What are hard and soft acids and bases?

⇒ **(1) Acid-Bases concept:-**

Acids and Bases have characteristic Properties They were first recognized by these properties.

(i). Acids are sour in taste } Bases are bitter.

(ii). Acids and bases react with each other during neutralization and Produce salts.

(iii). Acids and bases change the colour of some dyes like litmus and Phenolphthalein such dyes called indicators.

⇒ **(2) Arrhenius concept of acids and Bases:-**

According to Arrhenius concept.

Acids:- Hydrogen containing substance Producing H^+ ions in aqueous solution is called acid.

$$HCl_{(aq)} \longrightarrow H^+_{aq} + Cl^-_{aq}$$

Bases:- Hydroxyl group (-OH) containing substance producing OH^- ions in aqueous solution is called base.

$$NaOH_{(aq)} \longrightarrow Na^+_{(aq)} + OH^-_{aq}$$

⇒ Neutralization:-

The reaction of H^+ ions with hydroxyl (OH^-) ions to form water molecules is called neutralization.

$$H^+_{(aq)} + OH^-_{(aq)} \longrightarrow H_2O_{(l)}$$

⇒ (3) Lowry - Bronsted concept of Acids and Bases:-

This concept is based on the transfer of Proton (H^+). According to Lowry-Bronsted concept of acids and bases.

Acids:- A substance that can donate a proton to another substance is called Acids.

Bases:- A substance that can accept a proton is called bases.

Example:-

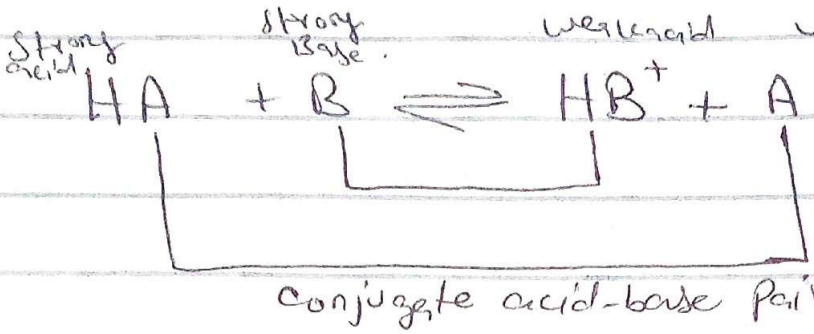
For example HCl dissolves in water, it donates a proton to H_2O. Therefore, HCl is a Lowry-Bronsted Acid. Water accepts the proton from the HCl. Therefore, it is a Lowry-Bronsted Base.

$$\underset{\text{acid}}{HCl_{(g)}} + \underset{\text{Base.}}{H_2O_{(l)}} \longrightarrow H_3O^+ + Cl^-$$

Conjugate Acid - Base Pairs:-

An acid and base differing only in the presence and absence of

a Proton are called conjugate Acid-Base pairs.



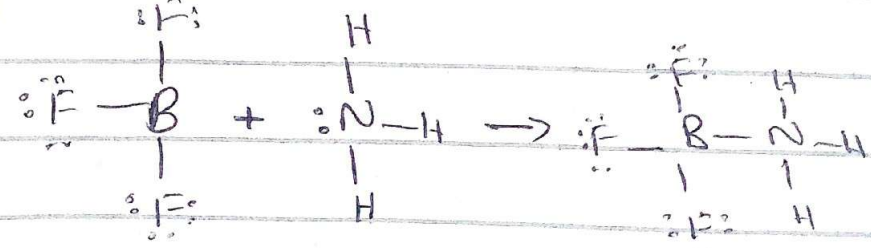
⇒ (4) Lewis concept of Acids and Bases:-

This concept uses shared electron pair. An ~~base~~ is an electron pair acceptor and a ~~acid~~ is an electron pair acceptor.

Acid:- A species with vacant orbital and can accept an electron pair is called acid.

Base:- A species which can donate an electron pair for forming a coordinate covalent bond is called base.

Example:-



Lewis acid Lewis base.

⇒ (5) Soft and Hard Acids and Bases concept:-

In 1963 Pearson gave Pearson's Principle. It is based on the polarization considerations. Pearson introduced the idea of hard and soft acids and bases. He divided the acids and bases on the basis of polarizability.

(a) **Hard bases:-** The donor atom in this base:

(i) has low polarizability.
(ii) has high electronegativity.
(iii) not easily oxidized,
(iv) Thus inaccessible or hold tightly to their valence electrons.
(v) F^-, Cl^-, OH^- are hard bases.

(b) **Soft bases:-** The donor atom in this base.

(i) has high polarizability.
(ii) has Low electronegativity.
(iii) easily oxidized.
(iv) Position of their valence electrons easily shifted by positive charges in the neighbourhood.
(v) H^-, CO, I^- are soft bases.

(c) Hard Acid:

The acceptor atom of a hard acid

(i) is small sized

(ii) has a high positive charge.

(iii) has no valence electrons that can be easily excited.

(iv) H^+, Li^+, Ca^{2+}, Al^{3+} are hard acids.

(d) Soft Acids:-

The acceptor atom in soft acid

(i) is large in sized

(ii) has zero or low positive charge.

(iii) has several valence electrons

(iv) Cu^+, Ag^+, BH_3 are soft acids.