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ACID-BASE BASIC CONCEPTS

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ABSTRACT

Acids and bases are common solutions that exist everywhere. Almost every liquid that we see in our daily life consists of acidic and basic properties, with the exception of water. They are differ in their properties and are able to neutralize to form H_2O, which will be discussed later in a subsection. The acids and bases can be classified by three major sections i.e. The Arrhenius definition which states that an acid produces H^+ in solution and a base produces OH^-, Later, Bronsted-Lowry who said that acids have an ability to donate protons whereas the bases to accept the protons and thirdly, the Lewis definitions of acids and bases which describes the acid and base as electron acceptor and donor respectively. This review article is throwing light on some important as well as basic aspects of acids and bases including their physical and chemical properties. In addition to this, the study also investigated about the acid and base for their color tests on the litmus paper as identifications, including their ranges as per pH scale.

Keywords: Acid and bases, acid base theory, Arrhenius theory, Bronsted Lowry theory, Lewis acids and Lewis bases, litmus paper, acid base indicators.

INTRODUCTION

OBJECTIVES: To study the various aspects of acid base concepts including their physical and chemical properties.

INTRODUCTION OF ACID AND BASE

In our daily life we use almost all product especially liquid having acidic and basics characters; Water with an exception. They have property to Neutralize H2O completely.

Acid

1. It has property having sour taste.
2. They are colorless when placed in phenolphthalein.
3. A pH indicates Red Color on Blue Litmus and pH > 7.
4. Produces Hydrogen gas while metals Reacts.
5. When Carbonate reacts to produces Carbon dioxide.
6. Common examples are Lemon, Orange, Vinegar, Sulfuric Acid and Hydrochloric acid.[1]

Characteristics of acids

Electronegativity of acids more than Electro positivity of bases reacts and forms dative acid bonds.

1. Due to dilution Strength decreases.
2. Hydrogen gas is formed when metal reacts.
3. Acid has a property which doesn't allow react within itself.
4. Heat is maintained.
5. H+ concentration of water is increased in it.
6. Blue litmus turned into red.

Examples

i) $Na^+ + OH^- \longrightarrow NaOH$
ii) $H + Cl \longrightarrow HCl$
iii) $H + SO_4^{2-} \longrightarrow HSO^{4-}$

Explanation

Solids and gas generally forms Acid by accepting required valence electron. It may be transferring or sharing of electron from one to another. In presence of gases only Acidic Bonds are formed. Such gases like H, N, O, F, Cl plays important role in formation of Acidic bonds.

BASE

1. It has property having Bitter taste.
2. They turned to pink when placed to phenolphthalein.
3. PH indicates Blue on the Red Litmus paper and pH > 7.
4. Its Physical stability is slippery in nature.

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5. Common examples are Soaps, toothpaste, bleach, Cleansing agents, lime water, Sodium Hydroxide.[1]

Characteristics of bases

1. Electro negativity of acids more than Electro positivity of bases reacts and forms ionic base bonds.
2. Due to dilution acids strength decreases.
3. OH- concentration in water increases.
4. It maintains cool
5. Red litmus is turned to Blue.
6. PH> 7.

Examples

NaOH, KOH, Na_2CO_3, N_2O_5 etc.

Explanation

In presence of solids and gases generally Bases are obtained by donating required Valency Electron. It is done by transferring or sharing of electrons from one to another. Gases molecules having valency electrons containing (anions) are involve accepting electrons from solid molecules. In the presence of solids Basic bonds are obtained. And these solids play an important role in formation of base bonds. Such solids like Na^{2+}, Mg^{+2}, Fe^{+2}, Fe^{+3} etc. without these solids there is no formation of basic bonds [2].

INTRODUCTION OF ACID BASE THEORY

The very famous acid-base theory is an elucidated description about acid and bases. Based on the electrostatic force between atoms or molecules, this theory has been amended from the limitations of the Arrhenius theory, the Bronsted Lowery and the Lewis theory.

In 1887, a Swedish scientist named Svante Arrhenius proposed the Arrhenius theory that was based on the concept of Ionization. He failed to explain some acidic and basic nature which doesn't have H+ and OH- ions of molecules such that CO_2, CaO. Based on the theory of proton transfer in atoms, J.N Bronsted and J.M Lowery in 1923 proposed the Bronsted –Lowery theory which failed to explain the He fails to explain the acidic nature of some gases like CO_2, SO_2 etc. and also basic nature of CaO, BaO etc. Lewis theory proposed by Lewis scientist based on transfer of pair electrons in acid and bases. He fails to explain the strength, neutralization, s-p overlap of acid and bases. In chemistry all the fields are covered by this famous theory. It provides the structure of acid and bases in organic compounds and explains the formation of organic and inorganic acid-bases, strengths and salt by the process of neutralization. With the help of structure of acid and bases, it helps us to memorize the distinguished acid and bases [3].

The Arrhenius Theory of Acids and Bases

In the Arrhenius theory acids are defined as substances which dissociate in aqueous solution to give H^+ (hydrogen ions). Bases are defined as substances which dissociate in aqueous solution to give OH^- (hydroxide ions) [4].

Acids are substance that produces Hydrogen ions in ions in solution.

1. Bases are substances that produce hydroxide ion in solution.
2. When hydrogen ions and hydroxide ions react to produce water and neutralization happens.

$$H^+ (aq) + OH^- (aq) \longrightarrow H_2O (l)$$

Both Sodium Hydroxide solution and Ammonia solution neutralizes the hydrochloric acid. In both cases we get a colorless solution which we can crystallize to get a white salt which can be either sodium chloride or ammonium chloride.

$$NaOH (aq) + HCl (aq) \longrightarrow NaCl (aq) + H_2O (l)$$

$$NH_3 (aq) + HCl (aq) \longrightarrow NH_4Cl (aq)$$

In the case of sodium hydroxide, the hydrogen ions released by the acid react with the sodium hydroxide ions released from the sodium hydroxide and this justifies the Arrhenius theory. Anyhow, in the case of Ammonia, the hydroxide ions do not appear .This is due to fact that ammonia react with the water in which it was dissolved to produce ammonia as well as hydroxide ions:

$$NH_3 (aq) + H_2O (l) \rightleftharpoons NH_4^+ (aq) + OH^- (aq)$$

The above reaction is reversible in nature and about 99% of ammonia residue as the ammonia molecules itself in a solution of typical dilute ammonia, the hydroxide ions are there and therefore, we can restrain this into theory of Arrhenius. Likewise, the same reaction happens between ammonia gas and hydroxide chloride

$$NH_3 (g) + HCl (g) \rightarrow NH_4Cl (s)$$

In the above equation, since there ions not any solution, therefore, neither the hydrogen ions are there nor the hydroxide ions. Although it is producing the same product as when the two substances were in solution, even then this will not be considered as an acid base reaction by the Arrhenius theory [5].

The Bronsted Lowery Theory

The Bronsted and Lowry developed a general definition of acid and base. They considered the reactions except those present in aqueous solution. According to them Acids were molecules that are having character to donate its Hydrogen ions e.g. HCL and H_2SO_4. Bases was defined those molecules which have character to accept proton. In this reaction, the proton transfer between reactants. Due to this acid involving a transfer of H^+ ions are called as Proton Acids. So according to Bronsted and Lowry Acids and Bases is defined as, an acid is any molecules or ion that donates a proton to another molecules or ions whereas Bases has tendency to accept or receive that proton. The following statements briefly summarize the Bronsted-Lowry definition.

1. A Bronsted-Lowry acid is a proton donor.
2. A Bronsted-Lowry base is a proton acceptor.

An Example of the Bronsted-Lowry in between Hydrogen Chloride and sodium hydroxide

$$\mathbf{HCl + NaOH \longrightarrow NaCl + H_2O}$$

(Proton donor) (Proton acceptor)

In the above reaction HCL is the acid because of hydrogen ions which has tendency to donate proton whereas Base is NAOH because of hydroxide ion in it which has nature of accept in the proton [6].

The Reaction illustrates Bronsted-Lowry defined as:

$$\mathbf{H_2SO_4 + NH_3 \longrightarrow HSO_4 + NH_4}$$

(Proton donor) (Proton acceptor)

This theory is defined by the way they react with each other which allow the generality.

In term of Equilibrium Expression it may be defined as:

Acid + Base $\rightleftharpoons$ conjugate base + conjugate acid.

With an acid, HA, the equation can be written symbolically as:

$$\mathbf{HA + B \rightleftharpoons A^- + HB^+}$$

In the equation the equilibrium sign to denote that reaction can occur in both forward and backward direction. HA, the acids has tendency to lose proton to become conjugate base, A^-. The Base B, tend to accept a proton to become HB^+ conjugate acid. Generally the reaction based on Acid and Bases are fast so that components of the reaction may usually be dynamic equilibrium with each other [7].

Lewis Theory

The Lewis theory of an acids and bases states that Acids plays to be an Electron acceptor whereas Bases act to be an Electron pair donor. This theory is quite different from previous ones as this theory is depended on electron pair rather than hydrogen atom.

To demonstrate this theory, consider the following example.

$$\mathbf{NH_3\,(g) + BF_3\,(g) \longrightarrow H_3N\,(g) + BF_3\,(g)}$$

This reaction is done between ammonia (NH_3) and boron tri fluoride (BF_3). As there is no transfer of hydrogen atom in this reaction it is concluded that it is Lewis acid base reaction. Now in this reaction NH_3 has a lone pair of Electrons and BF_3 has incomplete octet due to which Boron cannot forms its octet due to deficiency of electons.

Lewis acid base theory shows the products of six types of frontier molecular orbital Lewis acids and four types of frontier molecular orbital Lewis bases.

The Lewis acid types are

1. The proton Lewis acid,
2. s-LUMO Lewis acids,
3. Onium ion Lewis acids,
4. Lobe-LUMO Lewis ac- ids,
5. π-LUMO Lewis acids, and
6. Heavy metal Lewis acids

The Lewis base types are

1. s-HOMO Lewis bases,
2. Complex Anion Lewis bases,
3. Lobe-HOMO Lewis bases, and
4. Π-HOMO Lewis Bases

All of these species is described with respect to its frontier molecular orbital topology, charges, Pearson hard/soft characters and chemistry. Results of 24 types of complexes in the form of a cross products of these acids and bases. For example, when the benzyl cations , π-LUMO Lewis acid, reacts with the hydride ion, an s-HOMO Lewis base, the product toluene obtained is considered as Lewis acid/base complex . Π system has been partially reduced in it. In another example, the products of s-LUMO Lewis acids and s-HOMO Lewis bases, the metal hydrides shows the properties (basicity, in this case) in a congeneric series down the metal groups.[8]

ACID AND BASE INDICATORS

Mostly used method to determine the pH of solution is by using acid base indicator. An indicator is an organic compound also called as "color dye". Whereas most dyes do not change color with the amount of acid or base present, there are many molecules, known as acid - base indicators, which do respond to a change in the hydrogen ion concentration. Most of the indicators are themselves weak acids.

Indicators

Table 1. Identification of acid and base by color change using "litmus" paper and the ranges of acid and bases can be described as:

COLOR	Blue Litmus	Red Litmus	Range
Acid	Shows red	No change	Less than 7
Base	No change	Shows blue	Greater than 7

Other pH papers are able to give colors for every main pH unit. Universal Indicator, which is a solution of a mixture of indicators, is able to also provide a full range of colors for the pH scale. A variety of indicators change color at various pH levels. A properly selected acid-base indicator can be used to visually "indicate" the approximate pH of a sample. An indicator is usually some weak organic acid or base dye that changes colors at definite pH values [8].

Table 2. Some Examples of Acid-Base Indicators [9]

S. No	Indicator	Color Change	Acid	Base
	Thymol Blue	1.2 – 2.8	Red	Yellow
	Methyl Orange	3.1 – 4.4	Red	Yellow
	Methyl Red	4.4 – 6.2	Red	Yellow
	Chlorophenol Red	5.4 – 6.8	Yellow	Red
	Bromothymol Blue	6.2 – 7.6	Yellow	Blue
	Phenol Red	6.4 – 8.0	Yellow	Red
	Phenolphthalein	8.0 -10.0	Colorless	Red
	Alizarin Yellow	10.0 – 12.0	Yellow	Green

SUMMARY

1. According to Bronsted Lowry theory Acid is a proton donor, Base is a proton acceptor.
2. Lewis acid behaves as electron acceptor, Lewis base behaves as electron donor.
3. Acid turns blue litmus paper red; Base turns red litmus paper to blue.
4. Examples of bases are NaOH, $NaHCO_3$ etc.
5. Examples of acids are HCl, H_2SO_4 etc.

CONCLUSION

The study investigated and reviewed for various aspects of acid-base theories including their tests and identifications using litmus papers. There are the discussions of three major theories of acid-base and their chemical and physical aspects in the field of analytical chemistry or pharmaceutical analysis.

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REFERENCES

1. http://chemwiki.ucdavis.edu/Physical_Chemistry/Acids_and_Bases/Acid
2. Kalyan chakravarthy thadaka. Acids-Bases Theory. *Int. Jour. of Mathematics & phy. sci. res. (IJMPSR),* 1(1), 2014, 18-24.
3. Myers, Richard, the Basics of Chemistry, Greenwood Publishing Group, 2003, 157–161.
4. http://chemwiki.ucdavis.edu/Physical_Chemistry/Equilibria/Acid-Base_Equilibria/1._Theories_of_Acids_and_Bases
5. Richard F Daley and Sally J Daley. Org Chem, 5 July 2005, 209.
6. Lew, Kristi, Acids and Bases. Info base Publishing, 2009.
7. Mark R Leach, Lewis Acid/Base Reaction, Meta-Synthesis.Com: Brighton, UK, 1999, 95.
8. http://chemwiki.ucdavis.edu/Physical_Chemistry/Acids_and_Bases/Case_Studies/Acid_and_Base_Indicators
9. http://www.ch.ic.ac.uk/vchemlib/course/indi/indicator.html