Unit 07

Acid Base Chemistry

Descriptive Questions

Q.1. (Ex. Q.4 (i)) Explain Arrhenius concept of acids and bases. 09207001

Ans. Arrhenius concept of acids and bases

Svante Arrhenius, a Swedish Chemist, suggested that acids and bases may be classified in terms of their behavior in water. According to him;

Arrhenius acid

An acid is that substance which dissociates in water to give proton (H^+) or hydronium ion (H_3O^+). Some typical Arrhenius acids are HCl, HNO_3, H_2SO_4 and HCN.

Example

$$HCl_{(aq)} \xrightleftharpoons{H_2O} H_3O^+_{(aq)} + Cl^-_{(aq)}$$

Arrhenius Base

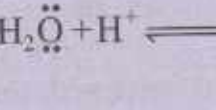
A base is that substance which dissociates in water to give hydroxyl ions (OH^-). Some typical Arrhenius bases are NaOH, KOH and $Ba(OH)_2$.

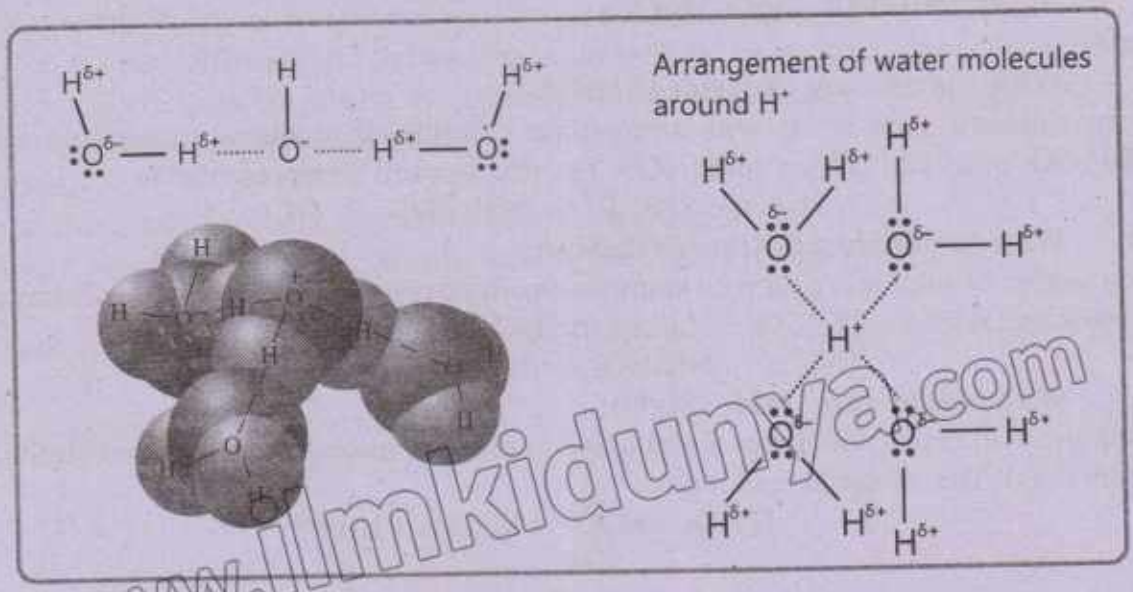
Example

$$NaOH_{(aq)} \xrightleftharpoons{H_2O} Na^+_{(aq)} + OH^-_{(aq)}$$

Role of Water

Water has an essential role to play in Arrhenius concept of acids and bases. Whenever an acid or a base dissociates in water, its molecules participate in reaction by surrounding the resultant proton (H^+) and hydroxyl ion (OH^-). Since proton is very small in size and its charge density is very high, it forms a strong bond with the lone pair of water molecule to give hydronium ion (H_3O^+).





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Q.2. (Ex. Q.4 (ii)) **Compare Arrhenius and Bronsted-Lowry concepts of acids and bases.** 09207002

Ans.

COMPARE		
Aspect	**Arrhenius concept**	**Bronsted Lowry concept**
Definition of Acid	An acid is a substance that donates a proton when dissolved in water.	An acid is a substance that donates a proton but the condition of the presence of water during this donation was however eliminated.
Definition of Base	A base is a substance that donates OH^- ion in water.	A base is a substance that accepts a proton.
Medium	This concept is limited to aqueous medium.	This concept is applicable in any solvent system or may not require any solvent.
Major similarity and difference.	All Arrhenius acid are Bronsted Lowry acids.	All Bronsted Lowry bases are not Arrhenius bases.
Limitations	This concept is limited to aqueous solutions and does not account for acid-base reactions that occur in non-aqueous medium. Also is limited to substances which contain H^+ and OH^- ions but cannot explain the nature of substances. **For example,** Na_2CO_3, K_2CO_3 and NH_3 do not contain any hydroxyl group which will get ionized by water but all these compounds behave as bases and yield OH^- in water.	Although this theory is broader than Arrhenius concept, it still has certain limitations. **For example,** it can't explain the nature of SO_2 and CaO which are acid and base respectively. But cannot donate H^+ ion or accept H^+ ion.

Q.3. (Ex. Q.4 (iii)) **How does sulphuric acid react with the following compounds? NH_4Cl, NH_4NO_3, MgO, $MgCO_3$** 09207003

Ans.

(i) With Ammonium Chloride (NH_4Cl):

When sulphuric acid reacts with ammonium chloride, it produces ammonium sulphate $(NH_4)_2SO_4$ and hydrochloric acid (HCl). The reaction can be represented as:

$$H_2SO_4 + 2NH_4Cl \rightarrow (NH_4)_2SO_4 + 2\,HCl$$

(ii) With Ammonium Nitrate (NH_4NO_3):

The reaction of sulphuric acid with ammonium nitrate results in the formation of ammonium sulphate and nitric acid (HNO_3). The equation for this reaction is:

$$H_2SO_4 + 2NH_4NO_3 \rightarrow (NH_4)_2\,SO_4 + 2\,HNO_3$$

(iii) With Magnesium Oxide (MgO):

Sulphuric acid reacts with magnesium oxide to produce magnesium sulphate ($MgSO_4$) and water (H_2O). The balanced reaction is:

$$H_2SO_4 + MgO \rightarrow MgSO_4 + H_2O$$

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(iv) With Magnesium Carbonate ($MgCO_3$):

When magnesium carbonate reacts with sulphuric acid, it produces magnesium sulphate, carbon dioxide (CO_2), and water. The reaction can be written as:

$$H_2SO_4 + MgCO_3 \rightarrow MgSO_4 + CO_2 + H_2O$$

Q.4. (Ex. Q.4 (iv)) What happens when a base reacts with a non-metallic oxide. What do you infer about the nature of non-metallic oxide? 09207004

Ans. Nature of Reaction.

When a base reacts with a non-metallic oxide, a salt and water are typically formed. This reaction is a type of neutralization reaction. Non-metallic oxides, such as carbon dioxide (CO_2) or sulphur dioxide (SO_2), are generally acidic in nature in this type of reaction.

Example:

For example, when sodium hydroxide (a base) reacts with carbon dioxide (a non-metallic oxide), the following reaction occurs:

$$2NaOH + CO_2 \rightarrow Na_2CO_3 + H_2O$$

By Product Nature & Non-Metallic Oxides

In this case, sodium carbonate (Na_2CO_3) is formed along with water.

We can infer that non-metallic oxides tend to exhibit acidic properties when they react with bases. This characteristic is due to their ability to react with bases to produce salts and water, indicating that they can act as acid in a chemical reaction. Thus, non-metallic oxides are often classified as acidic oxides.

Q.5. (Ex. Q.4 (v)) State the reason of showing acidic character by both dry HCℓ gas and HCℓ solution in water. 09207005

Ans. The acidic character of both dry hydrogen chloride (HC*l*) gas and HC*l* solution in water can be explained by their ability to donate protons (H^+) in a chemical reaction.

(i) Dry HC*l* Gas: Even in its gaseous form, HC*l* can act as an acid. When it comes into contact with moisture or water vapor in the environment, it can dissociate to release H^+ ions. Although dry HC*l* gas is not an acid in the traditional sense, it can still exhibit acidic properties when it interacts with suitable substance.

(ii) HC*l* Solution in Water: When HC*l* is dissolved in water, it completely dissociates into H^+ ions and $C\ell^-$ ions. The presence of H^+ ions in the solution gives the solution its acidic character. The more H^+ ions present, the stronger the acidity of the solution.

Q.6. (Ex. Q.4 (vi)) Differentiate between an acid and its conjugate base. 09207006

Ans. An acid and its conjugate base are related but represent different forms of a chemical species in a proton transfer reaction.

Definitions:

An acid is a substance that can donate a proton (H^+) to another substance.

A conjugate base is a species which is formed by donating a proton by an acid.

Example:

When hydrochloric acid (HC*l*) donates a proton, it becomes its conjugate base, which is the chloride ion (Cl^-).

The reaction can be represented as follows:

$$\underset{\text{Acid}}{HCl} + \underset{\text{Base}}{H_2O} \rightleftharpoons \underset{\substack{\text{Conjugate}\\\text{acid}}}{H_3O^+} + \underset{\substack{\text{conjugate}\\\text{base}}}{Cl^-}$$

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Strength:
Acids can vary in strength, with strong acids completely dissociating in water, while weak acids partially dissociate.
The conjugate base of a strong acid is typically weak and does not readily accept protons, while the conjugate base of a weak acid is stronger and can accept protons more easily.
Role in Reactions:
Acids are proton donors, while conjugate bases act as proton acceptors in acid-base reactions. This relationship is essential in understanding the concept of acid-base equilibria.

Investigative Questions

Q.1. (Ex. Q.5 (i)) Acids play significant roles within human body. Comment on this statement.

09207007

Ans. Acids play significant roles within the human body is. Following are the some importance of acids in various physiological processes are as:

(i) Digestion: One of the most well-known acids in the human body is hydrochloric acid (*HCl*), which is secreted by the stomach lining. It creates an acidic environment that helps break down food, activates digestive enzymes, and kills harmful bacteria that may enter with food.

(ii) pH Balance: Acids are crucial for maintaining the body's pH balance. The human body operates optimally at a specific pH range and various acids help regulate this balance. **For example**, carbonic acid plays a key role in maintaining blood pH.

(iii) Metabolism: Many metabolic processes involve acids. For instance, lactic acid is produced during anaerobic respiration when glucose is broken down for energy in the absence of oxygen. This process is essential during intense exercise when the body requires quick energy.

(iv) Cellular Functions: Acids are involved in various cellular functions, including the synthesis of DNA and RNA. Nucleic acids, which are essential for genetic information, contain acidic components.

(v) Electrolyte Balance: Acids contribute to the balance of electrolytes in the body, which is vital for nerve function and muscle contraction. **For example,** the dissociation of acids in solution can release ions that help conduct electrical signals.

Q.2. (Ex. Q.5 (ii)) What is observed when CO_2 is passed through lime water (i) for a short duration (ii) for long duration?

09207008

Ans. When carbon dioxide (CO_2) is passed through lime water, which is a dilute solution of calcium hydroxide $Ca(OH)_2$, different reactions occur depending on the duration of exposure.

1. For a Short Duration: When CO_2 is bubbled through lime water for a short time, a reaction occurs where carbon dioxide reacts with calcium hydroxide to form calcium carbonate ($CaCO_3$), which is a white precipitate. The solution will turn milky due to the formation of this precipitates. The reaction can be represented as:

$$CO_{2(g)} + Ca(OH)_{2(aq)} \rightarrow CaCO_{3(s)} + H_2O_{(\ell)}$$

2. For a Long Duration: If CO_2 is passed through lime water for an extended period, the initial precipitate of calcium carbonate will eventually dissolve in excess CO_2, forming calcium bicarbonate $Ca(HCO_3)_2$, which is soluble in water. As a result, the milky appearance will disappear, and the solution will become clear again. The reaction for this process can be represented as:

$$CaCO_{3(s)} + CO_{2(g)} + H_2O_{(\ell)} \rightarrow Ca(HCO_3)_{2(aq)}$$

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SLO Based Additional Long Questions

Q.1 Explain Bronsted – Lowry concepts of Acids and Bases? 09207009

Ans.

Bronsted
Lowry concept of acid ad base

- Definition of acid and reaction
- Definition of Base and reaction
- Amphoteric substance
- Conjugate acid and its examples
- Conjugate base and its examples

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Bronsted – Lowry Acids:

An acid is a substance that donates a proton (H^+).

This definition requires that to behave as an acid a compound must have a proton to donate. The condition of the presence of water during this donation was, however, eliminated. All Arrhenius acids are, Bronsted-Lowry acids as well for example, HCl. It dissociates in water to give H^+ and Cl^-. It also donates H^+ to H_2O forming H_3O^+.

Bronsted-Lowry Base:

A base is a substance that accepts a proton.

For example, OH^-, NH_3 and Cl^- are all bases because they have the ability to accept a proton. Note that except OH^- all other species are not Arrhenius bases. All Arrhenius bases are, however, Bronsted-Lowry bases as well.

Bronsted-Lowry and Arrhenius Acid and Base:

All Bronsted-Lowry acids and bases are not Arrhenius acids and bases. NH_4^+ is not Arrhenius acid and NH_3 is not Arrhenius base.

According to Bronsted-Lowry, an acid base reaction is that reaction in which a proton is transferred from a proton donor to its acceptor. This reaction may take place in gas phase or in the presence of any solvent.

Example (i): Consider the following reaction between hydrogen chloride gas and liquid water.

$$\underset{Acid}{HCl_{(g)}} + \underset{Base}{H_2O_{(l)}} \rightleftharpoons H_3O^+_{(aq)} + Cl^-$$

In this reaction, HCl gas acts as an acid because it donates its proton to water which acts as a base.

(ii) Similarly when ammonia gas dissolves in water, a proton is transferred from water to ammonia and ammonium ion is formed.

$$\underset{Base}{NH_{3(g)}} + \underset{Acid}{H_2O_{(l)}} \rightleftharpoons \underset{Conjugate\ base}{OH^-_{(aq)}} + \underset{Conjugate\ acid}{NH_4^+{}_{(aq)}}$$

Ammonia is a base while water is an acid in this reaction. Water has the ability to act both as an acid or a base depending upon the other compound with which it reacts.

Amphoteric Compound:

Water is therefore called an amphoteric compound which means a compound that can behave both as an acid and a base.

In the reverse reaction, OH^- is a base because it accepts a proton donated by the acid NH_4^+. In order to differentiate, OH^- is called the conjugate base while NH_4^+ the conjugate acid.

Examples: Some other examples of Bronsted-Lowry acids and bases.

$$\underset{Acid}{HCN_{(aq)}} + \underset{Base}{H_2O_{(l)}} \rightleftharpoons \underset{Conjugate\ acid}{H_3O^+_{(aq)}} + \underset{Conjugate\ base}{CN^-_{(aq)}}$$

$$HI_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + I^-_{(aq)}$$

Acid Base Conjugate acid Conjugate base

Q.2 Explain chemical Properties of Acids and Bases. 09207010

Ans. (a) Properties of Acids:

Reaction of Acid with metal oxide and Alkalis:

(i) With alkalis or metal oxides, they form salts and water.

$$2HNO_{3(aq)} + CaO_{(s)} \longrightarrow Ca(NO_3)_{2(aq)} + H_2O_{(\ell)}$$

$$H_2SO_{4(aq)} + 2KOH_{(aq)} \longrightarrow K_2SO_{4(aq)} + 2H_2O_{(\ell)}$$

(ii) **Reaction of Acid with metals:**

With reactive metals (Mg, Zn) they form salts and evolve hydrogen gas.

$$Mg_{(s)} + 2HCl_{(aq)} \longrightarrow MgCl_{2(aq)} + H_{2(g)}$$

$$Zn_{(s)} + H_2SO_{4(aq)} \longrightarrow ZnSO_{4(aq)} + H_{2(g)}$$

The unreactive metals Cu, Ag, Au and Pt do not evolve hydrogen gas with acids.

(iii) **Reaction of acid with carbonate and hydrogen carbonate:**

They decompose metal carbonates and hydrogen carbonates evolving carbon dioxide gas.

$$CaCO_{3(s)} + 2HCl_{(aq)} \longrightarrow CaCl_{2(aq)} + H_2O_{(\ell)} + CO_{2(g)}$$

$$2NaHCO_{3(s)} + H_2SO_{4(aq)} \longrightarrow Na_2SO_{4(aq)} + 2H_2O_{(\ell)} + 2CO_{2(g)}$$

(b) Properties of Alkalis

Alkalis are those bases which are soluble in water Examples of alkalis are NaOH, KOH etc. $Ca(OH)_2$ is sparingly soluble in water while $Cu(OH)_2$ is insoluble.

(i) **Reaction of Alkalis and Acid:**

Alkali react with acid to form salt and water

$$NaOH_{(aq)} + HCl_{(aq)} \longrightarrow NaCl_{(aq)} + H_2O_{(\ell)}$$

$$Ca(OH)_{2(aq)} + H_2SO_{4(aq)} \longrightarrow CaSO_{4(aq)} + 2H_2O_{(\ell)}$$

(ii) **Reaction of Alkalis with Ammonium salt:**

Alkali react with ammonium salt and to liberate NH_3 gas.

$$Ca(OH)_{2(aq)} + 2NH_4Cl_{(aq)} \longrightarrow CaCl_{2(aq)} + 2H_2O_{(\ell)} + 2NH_{3(g)}$$

$$NaOH_{(aq)} + NH_4NO_{3(aq)} \longrightarrow NaNO_{3(aq)} + H_2O_{(\ell)} + NH_{3(g)}$$

Exercise Short Question

Q.1 Choose Arrhenius Acids among the following compounds. 09207011

HF, NH_4^+, H_2SO_3, SO_3, H_2S, H_2O

Ans. Arrhenius acids are substances which dissociate in water to give proton (H^+).

Among the compounds, the Arrhenius acids are:

1. HF (Hydrofluoric acid)
2. H_2SO_3 (Sulphurous acid)
3. H_2S (Hydrogen sulphide)
4. H_2O (Water)

These compounds release H^+ ions in solution.

Q.2 How does calcium metal react with dilute H_2SO_4? 09207012

Ans. When calcium metal reacts with dilute sulphuric acid (H_2SO_4), it undergoes a chemical reaction that produces calcium sulphate ($CaSO_4$), which is soluble in water

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and hydrogen gas (H_2),which is released as bubbles.

The overall reaction can be written as:

$$Ca_{(s)} + H_2SO_{4(aq)} \rightarrow CaSO_{4(aq)} + H_2\uparrow_{(g)}$$

This reaction is exothermic, meaning it releases heat.

Q.3 Which salt is formed when HCl reacts with $BaCO_3$? 09207013

Ans. When hydrochloric acid (HCl) reacts with barium carbonate ($BaCO_3$), the product of the reaction are barium chloride ($BaCl_2$), water (H_2O) and carbon dioxide (CO_2).

The overall reaction can be written as:

$$BaCO_{3(s)} + 2HCl_{(aq)} \rightarrow BaCl_{2(aq)} + H_2O_{(l)} + CO_2\uparrow_{(g)}$$

So, the salt formed in this reaction is barium chloride ($BaCl_2$).

Q.4 How will you justify that HSO_4^- is Bonsted-Lowry Acid? 09207014

Ans. Hydrogen sulphate ion is a Bronsted-Lowry acid, we need to look at its ability to donate proton (H^+ion).

According to the Bronsted-Lowry definition, an acid is a substance that can donate a proton to a base. When HSO_4^- donates a proton, it transforms into SO_4^{2-} (sulphate ion). The reaction can be represented as follows:

$$HSO_{4(aq)}^- \rightleftharpoons H_{(aq)}^+ + SO_{4(aq)}^{2-}$$

In this reaction, HSO_4^- donates a proton (H^+) and thus acts a Bronsted–Lowry acid.

Q.5 What chemical name will you give to soap as a compound? 09207015

Ans. The chemical name commonly given to soap as a compound is sodium stearate. Sodium stearate is the sodium salt of stearic acid which is a fatty acid. Soaps are typically formed through the saponification process, where a fat or oil reacts with an alkali resulting in the formation of fatty acid salts, which are what we refer to as soap.

Practice Exercise Questions

Q.6 Name some fruits which contain citric acid. 09207016

Ans. Lemon, Orange and Grapefruit contain citric acid. All citrus fruits contain citric acid.

Q.7 In what ways are mineral acids useful for us? 09207017

Ans. Mineral acids like HCl, H_2SO_4 and HNO_3 are useful in several ways:

i. **Industrial Processes:** H_2SO_4 are essential in manufacturing fertilizers and cleaning metals.

ii. **Food Industry:** Citric acid acts as a preservative and flavor enhancer.

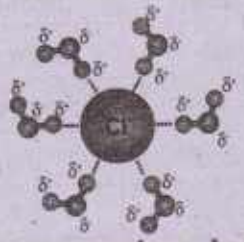
iii. **Cleaning Agents:** Combination of acids are effective for removing rust and mineral deposits.

iv. **Batteries:** Sulphuric acid is crucial in lead-acid batteries.

Q.8 How do chloride ions exist in water? 09207018

Ans. Chloride ions exist in water mainly from the dissolution of salts like sodium chloride (table salt). When NaCl dissolves, it breaks into sodium ions (Na^+) and chloride ions (Cl^-).

The chloride ions are surrounded by water molecules, which stabilize them in the solution.



Q.9 Why does ammonium hydroxide only partially ionize in water? 09207019

Ans. Because ammonium hydroxide is a weak base. That's why, it partially ionize in water.

$$NH_4OH_{(aq)} \rightleftharpoons NH_{4(aq)}^+ + OH_{(aq)}^-$$

Q.10 Give two examples of Bronsted-Lowry bases which are not bases by Arrhenius definition. 09207020

Ans. Two examples of Bronsted-Lowry bases that are not considered bases by Arrhenius definition:

i. Ammonia (NH_3)

ii. Bicarbonate (HCO^-_3) ion.

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Acids and Base

Q.11 Write down characteristic properties of Acids. 09207021

Ans. Characteristic properties of acids:

i. Acids have sour taste. For example unripe citrus fruits or lemon Juice.

ii. They turn blue litmus red.

iii. They are corrosive in concentrated form.

iv. Their aqueous solutions conduct electric current and can burn your skin.

Q.12 Differentiate between organic acids and mineral acids. Give examples.

Ans. 09207022

Organic Acids	Mineral Acids
(i) Acids which are obtained from natural sources are called natural or organic acids.	(i) Mineral or man-made acids are prepared from minerals like sodium chloride or sodium nitrate.
(ii) Some common organic acids are acetic acid (CH_3COOH) citric acid ($C_6H_8O_7$) and Ascorbic acid ($C_6H_8O_6$).	(ii) Common examples of mineral acids are hydrochloric acid (HCl), sulphuric acid (H_2SO_4) and nitric acid (HNO_3).

Q.13 Write some names and sources of organic acids. 09207023

Ans.

Organic acid	Natural source
Acetic acid	Vinegar
Ascorbic acid	Amla, Guava
Citric acid	Lemon, Orange
Lactic acid	Sour milk, curd
Formic acid	Ant sting
Oxalic acid	Tomato
Tartaric acid	Tamarind

Q.14 Why metallic oxides are basic in nature? 09207024

Ans. Metals oxides are basic in nature because they react with acids to form salt and water. For example. Na_2O is basic oxide because it contains oxide ion, O^{2-}, which is a very strong base with a strong tendency to react with water to produce hydroxide ions.

$$Na_2O_{(s)} + H_2O_{(\ell)} \rightarrow 2NaOH_{(aq)}$$

Q.15 Define neutralization reaction. 09207025

Ans. Both acids and alkalis are known to cancel the properties of each other when mixed together in equal amounts. The reaction is called neutralization reaction. A salt and water are formed as a result of this reaction e.g.

$$HCl_{(l)} + NaOH_{(s)} \rightarrow NaCl_{(s)} + H_2O_{(l)}$$

Acid Base → salt+water

Q.16 Write down the uses of oxalic acid. 09207026

Ans. Oxalic acid ($C_2H_2O_4$) is the simplest organic diprotic acid. Its commercial uses include bleaching straw and leather and removing rust and ink stains from fabrics.

Q.17 How metallic oxides are converted into hydroxides? 09207027

Ans. When metal oxides dissolve in water, resulting in metal cations and oxide ions in aqueous solution. Because oxide ions are unstable in water, they immediately accept protons from water molecules and become hydroxide ions.

Example:

Metal oxide + water → Metal hydroxide

$$MgO + H_2O \rightarrow Mg(OH)_2$$

$$MgO \longrightarrow Mg^{+2} + O^{-2}$$

$$O^{-2} + H\text{-}OH \longrightarrow 2OH^-$$

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Different Concepts of Acids and Base

Q.18 Define Arrhenius acid. Give example. 09207028

Ans. An acid is that substance which dissociates in water to give proton(H^+) or hydroxonium ion $(H_3O)^+$. Some typical Arrhenius acids are HCl, HNO_3, H_2SO_4 and HCN.

$$HCl_{(aq)} \xrightleftharpoons{H_2O} H_3O^+_{(aq)} + Cl^-_{(aq)}$$

Q.19 Define Arrhenius base. Give example. 09207029

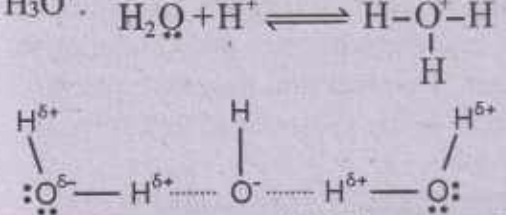
Ans. A base is that substance which dissociates in water to give hydroxyl ions (OH^-). Some typical Arrhenius bases are NaOH, KOH and $Ba(OH)_2$.

$$NaOH_{(aq)} \xrightleftharpoons{H_2O} Na^+_{(aq)} + OH^-_{(aq)}$$

Q.20 What is the role of water in Arrhenius concept of acids and bases?

Ans. Role of water: 09207030

Water has an essential role to play in Arrhenius concept of acids and bases. Whenever an acid or a base dissociates in water, its molecules participate in reaction by surrounding the resultant proton (H^+) and hydroxyl ion(OH^-). Since proton is very small in size and its charge density is very high, it forms a strong bond with the lone pair of water molecule to give hydroxonium ion, H_3O^+.



Q.21 Define strong acid. Give examples.

Ans. An acid that ionizes completely in aqueous solution is called a strong acid. 09207031

For example,

HCl, HNO_3, HNO_3,H_2SO_4etc are strong acids. They ionize almost completely in aqueous solution. All the molecules of strong acids ionize in water.

$$HNO_{3(l)} \xrightleftharpoons{H_2O} H^+_{(aq)} + NO^-_{3(aq)}$$

$$H_2SO_{4(l)} \xrightleftharpoons{H_2O} 2H^+_{(aq)} + SO^{2-}_{4(aq)}$$

Q.22 Define weak acid. Give example. 09207032

Ans. Acids that do not ionize completely in aqueous solutions are called weak acids. Fewer molecules of weak acids ionize in water. **For example**, ethanoic acid (acetic acid) which is found in vinegar ionizes only up to 5% in water. So, ethanoic acid is a weak acid.

$$CH_3COOH_{(l)} \xrightleftharpoons{H_2O} CH_3COO^-_{(aq)} + H^+_{(aq)}$$

Q.23 Define strong base. Give examples. 09207033

Ans. A base that ionizes completely in aqueous solution is termed as strong base. **For example**, $NaOH$ and KOH, are strong bases.

$$NaOH_{(s)} \xrightleftharpoons{H_2O} Na^+_{(aq)} + OH^-_{(aq)}$$

$$KOH_{(s)} \xrightleftharpoons{H_2O} K^+_{(aq)} + OH^-_{(aq)}$$

Q.24 Define weak base. Give example. 09207034

Ans. A base that ionizes to a little extent is called a weak base. Such bases produce few OH^- ions in aqueous solution. **For example,** $Al(OH)_3$ and NH_3 are weak bases.

$$H_2O_{(l)} + NH_{3(g)} \xrightleftharpoons{H_2O} NH^+_{4(aq)} + OH^-_{(aq)}$$

Q.25 Write down limitations of Arrhenius Concept. 09207035

Ans. Limitations of Arrhenius concept:

i. This concept is applicable only in aqueous medium and does not explain nature of acids and bases in non-aqueous medium.

ii. According to this concept, acids and bases are only those compounds which contain hydrogen (H^+) and hydroxyl (OH^-) ions, respectively. It cannot explain the nature of compounds. **For example,** Na_2CO_3, K_2CO_3 and NH_3 do not contain any hydroxyl group which will get ionized by water but all these compounds behave as bases and yield OH^- in water.

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Q.26 Why HCl acts as a strong acid? 09207036

Ans. HCl ionizes completely in aqueous solution that's why, HCl act as a strong acid.

$$HCl_{(aq)} \xrightleftharpoons{H_2O} H^+_{(aq)} + Cl^-_{(aq)}$$

Q.27 What is hyperacidity? 09207037

Ans. Stomach acidity or hyperacidity conditions are a common problem. Most often the problem arises when a person takes fatty and spicy food which cause more acid to produce in the stomach than required.

Q.28 How hyperacidity can be caused and what are its symptom? 09207038

Ans. Our stomach produces hydrochloric acid(HCl) to digest the food that we eat. Whenever we eat, cells within the lining of the stomach produce acid. Problem occurs when these cells produce more acid than your stomach needs. When it happens, the person suffers from stomach acidity. The common indication of such a condition is the feeling of burning sensation right below our breast bones. A person may also feel sour taste in mouth and heart burn or pain near the heart area.

Q.29 How hyperacidity can be cured / What are antacids? 09207039

Ans. The uneasy condition may easily be cured by taking weak bases like calcium hydroxide and magnesium hydroxide commonly known as antacids. These antacids remove minor stomach disorders by neutralizing the stomach acid, but the concentration of hydroxyl ions in them is too low to harm the throat or stomach.

Bronsted – Lowry concepts of Acids and Base

Q.30 Define Bronsted-Lowry acid and base. 09207040

Ans. Bronsted-Lowry acid:

An acid is substance (molecule or ion) that can donate a proton (H^+) to another substance. **e.g** HCl and CH_3COOH.

$$HCl_{(g)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + Cl^-_{(aq)}$$

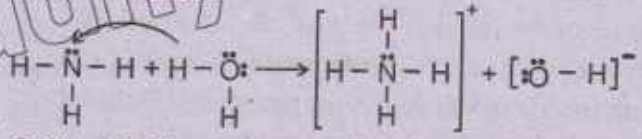
Bronsted-Lowry Base:

A base is a substance that can accept a proton (H^+) from another substance. **e.g** H_2O and NH_3.

$$NH_{3(g)} + H_2O_{(l)} \rightleftharpoons OH^-_{(aq)} + NH^+_{4(aq)}$$

Q.31 Why NH_3 acts as Bronsted-Lowry base? 09207041

Ans. Ammonia (NH_3) act as a base in water. Ammonia is a gas at room temperature when it is dissolved in water, it can accepts proton (H^+) from water and form ammonium (NH_4^+) radical.



Q.32 Define neutralization reaction according to bronsted-Lowry concepts. 09207042

Ans. According to Bronsted-Lowry, an acid base reaction is that reaction in which a proton is transferred from a proton donor to its acceptor. This reaction may take place in gas phase or in the presence of any solvent. For example:

$$HCl_{(g)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + Cl^-$$

Q.33 What is the difference between Arrhenius base and Bronsted-Lowry base?

Ans. Arrhenius base: 09207043

Arrhenius base	Bronsted-Lowry base
A base is a substance which dissociates in aqueous solution to give hydroxide ions (OH^-).	**Bronsted-Lowry base:** Bronsted-Lowry base is a substance which can accept a proton (H^+) from another substance.
For Example: $NaOH_{(aq)} \rightleftharpoons Na^+_{(aq)} + OH^-_{(aq)}$	**For Example:** $HCl_{(g)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{aq} + Cl^-$

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Q.34 What do you mean by neutralization reaction according to Arrhenius acid-base concept? 09207044

Ans. According to Arrhenius concept, acids give (H^+) ions and bases give (OH^-) ions. During neutralization reaction, hydrogen ions (H^+) combine with the equal number of hydroxide ions (OH^-) and both neutralize each other to form water.

$$HC\ell \xrightleftharpoons{H_2O} H_3O^+ + C\ell^-$$

$$NaOH \xrightleftharpoons{H_2O} Na^+ + OH^-$$

Q.35 Prove that water is an amphoteric specie. 09207045

Ans. Water is an amphoteric specie because it acts as an acid as well as a base. When it react with base, it act as acid and act as base when react with acid.

Water acting as acid

$$H_2O_{(l)} + NH_{3(aq)} \rightleftharpoons NH_{4\,(aq)}^{+} + OH^-$$

acid Base Conjugate acid Conjugate base

Water acting as base

$$HCl_{(aq)} + H_2O_{(l)} \rightleftharpoons H_3O^+_{(aq)} + Cl^-$$

acid Base Conjugate acid Conjugate base

Q.36 How can you justify that NH_3 is Bronsted-Lowry base but not Arrhenius base? 09207046

Ans. Ammonia is Bronsted-Lowry base because it has the ability to accept a Proton (H^+) but not Arrhenius base because it does not produce hydroxide ion (OH^-) in aqueous solution.

Properties of Acids and Base

Q.37 Define alkali. 09207047

Ans. A base which is soluble in water is called an alkali. This means that all the bases are not alkalis. On the other hand all the alkalis are bases. Many bases do not dissolve in water. **For example**, copper hydroxide $Cu(OH)_2$, aluminium hydroixide $Al(OH)_3$ and ferric hydroxide $Fe(OH)_3$.

Q.38 When acids react with carbonates and bicarbonates, which gas evolves out? 09207048

Ans. When acids react with carbonates and bicarbonates, carbon dioxide (CO_2) gas evolves out.

Example:

$$CaCO_{3(s)} + 2HCl_{(aq)} \longrightarrow CaCl_{2(aq)} + H_2O_{(l)} + CO_{2(g)}$$

Q.39 When acid reacts with metal, which gas evolves out? 09207049

Ans. When acid react with metal (Mg, Zn) it form salts and evolve out hydrogen gas.

$$Mg_{(s)} + 2HC\ell_{(aq)} \longrightarrow MgCl_{2\,(aq)} + H_{2(g)}$$

$$Zn_{(s)} + H_2SO_{4(aq)} \longrightarrow ZnSO_{4(aq)} + H_{2(g)}$$

Q.40 Name the gas liberated when alkalis react with ammonium salts. 09207050

Ans. Alkalis react with ammonium salts to liberate ammonia gas: **e.g;**

$$NH_4C\ell_{(aq)} + NaOH_{(aq)} \longrightarrow NaC\ell_{(aq)} + NH_{3(g)} + H_2O_{(l)}$$

Q.41 How to clean a blocked drain / What are caustic chemical drain cleaners? 09207051

Ans. One of the ways to clean the drain is to pour half a cup of sodium bicarbonate solution into the drain followed by half a cup of vineger. Cover the drain and wait for thirty minutes. Pour boiling water down the drain.

Caustic chemical drain cleaners are capable of dissolving grease, hair, food and other common blockages. Pour down the caustic cleaner into your drain. Wait for half an hour and then flush your drain with water.

Acid Rain and its Effects

Q.42 Define Acid Rain. How it is formed? 09207052

Ans. When rain water has pH less than 5.6, it is called acid rain. Burning of fossil fuels releases harmful gases in air. These gases (SO_3 and NO_2) when mixed with moisture present in air form acid droplets. These droplets then fall on the ground as acid rain.

$$2SO_{2(g)} + O_{2(g)} \longrightarrow 2SO_{3(g)}$$

$$SO_{3(g)} + H_2O_{(l)} \longrightarrow H_2SO_{4(aq)}$$

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$$2NO_{2(g)} + H_2O_{(l)} \longrightarrow HNO_{3(g)} + HNO_{2(g)}$$

Q.43 What are the effects of acid rain?

Ans. 09207053

i. Effects on Soil

Acid rain makes soil more acidic. It dissolves and washes away nutrients present in the soil which are needed by plants. Many plants cannot live or grow in an acidic soil. It can damage vegetation and plants.

ii. Effect on Aquatic life

Acid rain can make water of the water bodies too acidic for aquatic animals to live in. Due to this, many lakes, rivers, ponds and streams no longer have fish.

iii. Effect on buildings

Acid drain and dry deposition of acidic particles damage buildings, statue, auto mobiles and other structures made up of stone and metal.

Constructed Response Question

Q.1 (Ex.Q. 3 (i)) What chemical name will you give to soap as a compound?

09207054

Ans. The chemical name for soap depends on its composition. Most soaps are salts of fatty acids. For example:

- Sodium stearate: Common in solid soaps.
- Potassium oleate: Found in liquid soaps.

Soap can be described as a salt of a carboxylic acid (e.g., sodium or potassium salts of long-chain fatty acids).

Q.2 (Ex.Q. 3 (ii)) In the presence of a drop of an acid, water is known to ionize as follows:

09207055

$$H_2O_{(l)} \rightleftharpoons H^+ + OH^-$$

In your opinion, which name will be suitable for water: an acid, a base or both?

Ans. In the context of acid-base chemistry, water can be classified as both an acid and a base. This is because water has the ability to donate a proton (H^+) to a base, making it an acid, and it can also accept a proton from an acid, making it a base.

This dual nature of water is described by the Bronsted-Lowry theory of acids and bases. When water donates a proton, it forms hydroxide ions (OH^-) and when it accepts a proton, it forms hydronium ions (H_3O^+).

So, water is considered amphoteric, meaning it can act as both an acid and a base depending on the circumstances.

Q.3 (Ex.Q. 3 (iii)) Why does Na_2CO_3 behave like a base in water? 09207056

Ans. Sodium carbonate (Na_2CO_3), behaves like a base in water due to its ability to dissociate into sodium ions (Na^+) and carbonate ions (CO_3^{2-}) when dissolved in water.

When sodium carbonate is added to water, it dissociates as follows:

$$Na_2CO_3 \rightarrow 2Na^+ + CO_3^{2-}$$

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The carbonate ions (CO_3^{2-}) can react with water in a process called hydrolysis. During this reaction, carbonate ions can accept hydrogen ions (H^+) from water, leading to the formation of bicarbonate ions (HCO_3^-) and hydroxide ions (OH^-):

$$CO_3^{2-} + H_2O \rightleftharpoons HCO_3^- + OH^-$$

The production of hydroxide ions (OH^-) increases the pH of the solution, making it more basic. This is why, sodium carbonate is considered a basic compound when dissolved in water.

Q.4 (Ex.Q. 3 (iv)) Is $NaHCO_3$ a base or an acid? 09207057

Ans. $NaHCO_3$ or sodium bicarbonate is generally considered a weak base. When dissolved in water, it can partially dissociate into sodium ions (Na^+) and bicarbonate ions (HCO_3^-).

$$NaHCO_3 \rightarrow Na^+ + HCO_3^-$$

The bicarbonate ion (HCO_3^-) can act as a base by accepting a proton (H^+) from an acid, which can lead to the formation of carbonic acid (H_2CO_3):

$$HCO_3^- + H^+ \rightleftharpoons H_2CO_3$$

This ability to accept protons is what gives sodium bicarbonate its basic properties. However, it can also act as a weak acid when it donates a proton, making it amphoteric.

Q.5 (Ex. Q. 3 (v)) What is the difference between a strong acid and a concentrated acid? 09207058

Ans.

Strong Acid	Concentrated Acid
• A strong acid is an acid that completely dissociates into its ions in water. This means that when a strong acid is dissolved in water, all of its molecules break apart into hydrogen ions (H^+) and the corresponding anions.	• A concentrated acid refers to the amount of acid present in a solution relative to the amount of water. A concentrated acid has a high concentration of acid molecules. Concentration is typically expressed in moles per liter (M).
• Examples of strong acids include hydrochloric acid (HCl), sulphuric acid (H_2SO_4), and nitric acid (HNO_3).	• For example, you can have concentrated hydrochloric acid, which is a strong acid, but you can also have a diluted version of hydrochloric acid, which would still be a strong acid but with a lower concentration.

Multiple Choice Questions (Exercise)

Tick (✓) the correct answer.

1. Which acid is not used as a food or mixed with food? 09207059

(a) Tartaric acid (b) Ascorbic acid
(c) Citric acid (d)Formic acid

2. While baking, which gas is responsible for raising the bread and making it soft? 09207060

(a) Oxygen (b) Carbon dioxide
(c) Nitrogen (d) Carbon monoxide

3. Predict the main characteristics of the reactions of metals with acids. 09207061

(a) Metals are dissolved
(b) Metals are converted into salts
(c) Hydrogen gas is evolved
(d)All the above mentioned characteristics are true

4. How many hydroxide ions, calcium hydroxide will release in water? 09207062

(a) 1 (b) 2
(c) Zero (d) 3

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5. **In a neutralization reaction between KOH and H_3PO_4, how many molecules of KOH will react with one molecule of H_3PO_4?** 09207063
(a) 2 (b) 1
(c) 3 (d) 4

6. **Which acid is used in the preparation of soap?** 09207064
(a) Tartaric acid (b) Citric acid
(c) Stearic acid (d) Oxalic acid

7. **Which compound is formed when SO_2 is dissolved in water?** 09207065
(a) SO_3 (b) H_2SO_3
(c) H_2SO_4 (d) $H_2S_2O_7$

8. **Which of the following contains oxalic acid?** 09207066
(a) Tomato (b) Orange
(c) Tamarind (d) Sour milk

9. **Which compound in the following reaction is behaving as a conjugate base?** 09207067

$$CH_3COOH_{(aq)} + H_2O_{(l)} \longrightarrow CH_3COO^- + H_3O^+_{(aq)}$$

(a) CH_3COOH (b) H_2O
(c) CH_3COO^- (d) H_3O^+

10. **When a chemical reaction is carried out with a substance Z; a gas is produced which turns red litmus paper blue. What is the reaction?** 09207068
(a) Reaction of an acid with a metal carbonate
(b) Reaction of an acid with ammonium salt
(c) Reaction of an alkali with a metal carbonate
(d) Reaction of an alkali with ammonium salt

SLO Based Additional MCQs

Acid and Bases

11. **A base is a substance which neutralizes an acid. Which of these substances is not a base?** 09207069
(a) aqueous ammonia
(b) sodium chloride
(c) sodium carbonate
(d) calcium oxide

12. **Acetic acid is used for:** 09207070
(a) flavouring food
(b) making explosives
(c) etching designs
(d) cleaning metals

13. **Acids means.** 09207071
(a) sour (b) bitter
(c) sweet (d) salty

14. **All acids turn blue litmus:** 09207072
(a) red (b) colourless
(c) pink (d) white

15. **All bases turn red litmus:** 09207073
(a) colourless (b) blue
(c) pink (d) white

Arrhenius Concepts of Acids and Bases

16. **Which of the following cannot be classified as Arrhenius acid?** 09207074
(a) HNO_3 (b) H_2CO_3
(c) CO_2 (d) H_2SO_4

17. **Milk of magnesia contains $Mg(OH)_2$. It is used as antacid. It neutralizes excess stomach acid. Which salt is formed in this reaction?** 09207075
(a) $MgSO_4$ (b) $MgCO_3$
(c) $MgCl_2$ (d) MgO

18. **According to Arrhenius concept acid is a substance which dissociates in aqueous solution to give:** 09207076
(a) hydrogen ions (b) hydroxide ions
(c) protons (d) pair of electrons

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19. **According to Arrhenius concept base is a substance which dissociates in aqueous solution to give:** 09207077
(a) hydrogen ions (b) hydroxide ions
(c) protons (d) pair of electrons

20. **Which one is not an Arrhenius base?** 09207078
(a) NaOH (b) KOH
(c) $Ca(OH)_2$ (d) NH_3

21. **Which one is not an Arrhenius acid?** 09207079
(a) HCl (b) H_2SO_4
(c) CO_2 (d) HNO_3

Bronsted-Lowry concepts of Acids and Bases

22. **Which of the following is Bronsted base?** 09207080
(a) NH_3 (b) HCl
(c) CH_3COOH (d) H_3O^+

23. **Ammonia is a base, because it** 09207081
(a) Ionizes in water to give OH^- ions
(b) Contains OH group
(c) Can accept an election pair
(d) Can accept proton

24. **Consider the following reaction?**
$H_2O + HCl \rightleftharpoons H_3O^+ + Cl^-$
Which species is an proton acceptor in this reaction? 09207082
(a) H_2O (b) HCl
(c) H_3O^+ (d) none

25. **According to Bronsted and Lowry concept, an acid is a substance that can donate:** 09207083
(a) proton (b) Electron pair
(c) Neutron (d) Electron

26. **A substance which can behave as an acid as well as a base is called:** 09207084
(a) acid
(b) base
(c) amphoteric specie
(d) neutral specie

Properties of Acid and Bases

27. **A reaction between an acid and a base produces:** 09207085
(a) salt and water (b) salt and gas
(c) salt and an acid (d) salt and a base

28. **Which acid is present in our stomach?** 09207086
(a) nitric acid (b) hydrochloric acid
(c) sulphuric acid (d) all of the above

29. **When acids react with metals, which gas is evolved?** 09207087
(a) H_2 (b) O_2
(c) Cl_2 (d) N_2

30. **When acids react with carbonates and bicarbonates, which gas is produced:** 09207088
(a) H_2 (b) CO_2
(c) Cl_2 (d) N_2

31. **Alkalis react with ammonium salts to liberate:** 09207089
(a) SO_2 (b) CO_2
(c) NH_3 (d) H_2

32. **Which is used to manufacture soap?** 09207090
(a) NaOH (b) $Ca(OH)_2$
(c) NH_4OH (d) $Mg(OH)_2$

33. **Acid rain has pH less than:** 09207091
(a) 7 (b) 6
(c) 4 (d) 5.6

34. **Caustic chemical drain cleaner are capable of dissolving:** 09207092
(a) Grease (b) Hair
(c) Food (d) All of these

Answer Key

1	d	2	b	3	D	4	b	5	c
6	c	7	b	8	a	9	c	10	d

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11	b	**12**	a	**13**	a	**14**	a	**15**	b
16	c	**17**	c	**18**	a	**19**	b	**20**	d
21	c	**22**	a	**23**	d	**24**	a	**25**	a
26	c	**27**	a	**28**	b	**29**	a	**30**	b
31	c	**32**	a	**33**	d	**34**	d		

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