# ACIDS, BASES AND SALTS

## SECTION - I
## Short Answer Questions
## (2 Marks)

1. Give the equations for the preparation of sulphuric acid and phosphoric acid from the oxides of sulphur and phosphorous?

**A.** **i)** Sulphuric acid is formed by dissolving of sulphur trioxide in water. The chemical equation is

$$\underset{\begin{pmatrix}\text{Sulphur}\\ \text{trioxide}\end{pmatrix}}{SO_3} + \underset{(\text{Water})}{H_2O} \longrightarrow \underset{(\text{Sulphuric Acid})}{H_2SO_4}$$

**ii)** Phosphoric acid is formed by dissolving of phosphorous pentoxide in water. The Chemical equation is

$$\underset{\begin{pmatrix}\text{Phosphorous}\\ \text{Pentoxide}\end{pmatrix}}{P_2O_5} + 3H_2O \longrightarrow \underset{(\text{Phosphoric acid})}{2H_3PO_4}$$

2. Give the equation for the preparation of sulphurous acid, carbonic acid, nitric acid from their oxides?

**A.** **i)** $\underset{(\text{Sulphurdioxide})}{SO_2} + H_2O \longrightarrow \underset{(\text{Sulphurous acid})}{H_2SO_3}$

**ii)** $\underset{(\text{Carbonic dioxide})}{CO_2} + H_2O \longrightarrow \underset{(\text{Carbonic acid})}{H_2CO_3}$

**iii)** $N_2O_5 + H_2O \longrightarrow \underset{(\text{Nitric acid})}{2HNO_3}$

3. Give the equations for the preparation of magnesium hydroxide and zinc hydroxide from the oxides of magnesium and zinc?

**A.** **i)** $\underset{\begin{pmatrix}\text{Magnesium}\\ \text{Oxide}\end{pmatrix}}{MgO} + \underset{(\text{Water})}{H_2O} \longrightarrow \underset{\begin{pmatrix}\text{Magnesium}\\ \text{Hydroxide}\end{pmatrix}}{Mg(OH)_2}$

**ii)** $\underset{(\text{Zinc oxide})}{ZnO} + H_2O \longrightarrow \underset{(\text{Zinc hydroxide})}{Zn(OH)_2}$

4. Give the equations for the preparation of sodium hydroxide, calcium hydroxide from the oxides of sodium and calcium?

**A.** **i)** $Na_2O + H_2O \longrightarrow 2NaOH$

(Sodium oxide) (Sodium hydroxide)

**ii)** $CaO + H_2O \longrightarrow Ca(OH)_2$

(Calcium oxide) (Calcium hydroxide)

5. Write two chemical properties of acids with equations?

**A.** **Chemical properties of acids**

**i)** Acids liberate hydrogen gas by reacting with metals like Zinc, Magnesium etc.,

$2HCl + Mg \longrightarrow MgCl_2 + H_2 \uparrow$

$H_2SO_4 + Zn \longrightarrow ZnSO_4 + H_2$

**ii)** Acids react with bases to form salt and water.

$HCl + NaoH \longrightarrow NaCl + H_2O$

$HNO_3 + KOH \longrightarrow KNO_3 + H_2O$

6. Write two chemical properties of bases with equations.

**A.** **i)** On heating bases decompose into metal oxides and water.

$Cu(OH)_2 \longrightarrow CuO + H_2O$

$2Fe(OH)_3 \longrightarrow Fe_2O_3 + 3H_2O$

**ii)** Bases reacts with acids to form salt and water.

$NaOH + HCl \longrightarrow NaCl + H_2O$

$Ca(OH)_2 + 2HCl \longrightarrow CaCl_2 + 2H_2O$

7. Write the Arrhenius theory of acids and bases?

**A.** According to Arrhenius theory "An acid is substance which produces $H^+$ ions in aqueous solution".

**Eg:** $HCl \longrightarrow H^+ + Cl^-$

$CH_3COOH \longrightarrow H^+ + CH_3COO^-$

"A base is a substance which produces $OH^-$ ions in aqueous solution".

**Eg:** $NaOH \longrightarrow Na^+ + OH^-$

$KOH \longrightarrow K^+ + OH^-$

8. What is ionic product of water? Gives its value at 25°C?

**A.** **i)** **Ionic Product:** The product of concentration of $H^+$ and $OH^-$ ions in one mole of water is defined as the ionic product of water.

It is represented by $K_w$.

Ionic product $K_w = [H^+]\times[OH^-]$

The $K_w$ is temperature dependent.

$K_w$ value increases with increase in temperature.

**ii)** The value of $K_w$ of water at 25°C is $1.0\times10^{-14}$.

9. Write the values of $H^+$ ion concentration of acidic solution, neutral solution and basic solution?

**A.** For acidic solution the $[H^+] > 10^{-7}$

For neutral solution the $[H^+] = 10^{-7}$

For basic solution the $[H^+] < 10^{-7}$

10. How, we divide the substances into acids and bases on the basis of pH scale?

**A.** If the pH value of substances is 0 to 7, then they are said to be acids.

If the pH value of substances is 7 to 14, then they are said to be bases.

## SECTION-II
## Very Short Answer Questions
## (1 Mark)

1. Arrange the following acids in the increasing order of volatility: HC*l*, $H_2SO_4$, $CH_3COOH$?

A. Volatilities of some commonly used acids are in the order.

$CH_3COOH > HCl > H_2SO_4$

2. Give one limitation of Arrhenius theory?

A. This theory explains the nature of substances which are soluble in water only.

3. How the ionic product changes with an addition of an acid or base to the water?

A. The ionic product of water ($K_w$) remains constant even after addition of acid or base.

4. Who introduced the term "pH"

A. Sorensen

5. Define "pH"

A. " pH is defined as the negative logarithm of $H^+$ ion concentration".

$pH = -\log_{10}[H^+]$

6. Write the pH value of urine?

A. 4.8 – 7.5

7. Write the pH value of saliva?

A. 6.4 – 6.9

8. What is the value of Aerated water?

A. 5.5

9. If the hydrogen ion concentration is $10^{-11}$ then its pH is what?

A. 11

10. Define strong acid?

A. **Strong acid:** If an acid is completely ionized, it is called strong acid.
**Eg:** HC*l*, $H_2SO_4$.

11. What is weak acid?

A. **Weak acid:** If an acid is partially ionized, then it is called weak acid.
**Eg:** $CH_3COOH$, $H_3PO_4$

12. Define strong base?

A. **Strong base:** If a base is completely ionized, then it is called strong base.
**Eg:** NaOH, KOH

13. What is a weak base?

A. **Weak base:** If a base is partially ionized, then it is called weak base.
**Eg:** $NH_4OH$

14. Define the heat of neutralization?

A. **Heat of Neutralization:** It is defined as the heat liberated when one mole of acid reacts with one mole of base.

## Long Answer Questions
## (4 Marks)

1. Define an acid, a base and the heat of neutralization according to Arrhenius?

A. **According to Arrhenius Theory:**
**Acid:** An acid is a substance which produces $H^+$ ions in an aqueous solution.
**Base:** base is a substance which produces $OH^-$ ions in aqueous solution.
**The Heat of Neutralisation:** It is the heat liberated when one mole of $H^+$ ions combine with mole of $OH^-$ ions.

$$H^+ + OH^- \longrightarrow H_2O + 13.7 \text{ K.Cal / mole}$$

2. What are the limitations of Arrhenius theory?

A. **Limitations of Arrhenius Theory:**

**a)** This theory explains the nature of substances which are soluble in water only. This cannot give any information about substances which are insoluble in water and also about the nature of substances in other solvents. For example HC*l* acts as an acid when it is dissolved in water. But when it is dissolved in Benzene it does not produce $H^+$ ions and does not show any acidic properties. $SiO_2$ is insoluble in water but acidic in nature. $CaCO_3$ is insoluble in water but basic in nature.

**b)** Arrhenius theory fails to explain the acidic nature of some substances like $CO_2$, $SO_2$, $SO_3$ and $P_2O_5$ etc., which do not have $H^+$ ions of their own. They get the $H^+$ ions by reacting with water and not by ionization.

**c)** There are certain basic substances without having $OH^-$ ions of their own. They too produce $OH^-$ ions by reacting with water.
**Eg:** MgO, CaO, $NH_3$, $Na_2O$, etc.,

$$MgO + H_2O \longrightarrow Mg(OH)_2 \rightarrow Mg^{++} + 2OH^-$$

**d)** Arrhenius theory fails to explain the acidic nature of some substances like $CO_2$, $SO_2$ and $SO_3$ etc., which do not have $H^+$ ions by their own. They get the $H^+$ ions by reacting with water and not by ionization.

$$SO_2 + H_2O \longrightarrow H_2SO_3 \longrightarrow H^+ + HSO_3^-$$

$$CO_2 + H_2O \longrightarrow H_2CO_3 \longrightarrow H^+ + HCO_3^-$$

$$SO_3 + H_2O \longrightarrow H_2SO_4 \longrightarrow H^+ + HSO_4^-$$

**e)** Consider the following reactions.

$$SO_3 + CaO \longrightarrow CaSO_4$$

$$SiO_2 + FeO \longrightarrow FeSiO_3$$

In these reactions $SO_3$ and $SiO_2$ acts as acids and CaO, FeO as bases. Such a classification of substances into acids and bases are not accounted under Arrhenius theory.

**f)** Recent experiments show that there is no independent existence for proton in aqueous solution. It is present in the form of hydronium ion ($H_3O^+$)

$$H^+ + H_2O \longrightarrow H_3O^+$$

3. Define strong acid, strong base, weak acid and weak base. Give one example for each?

A. **Strong Acid:** The acids which is completely ionized (100%) is called strong acids.
**Eg:** HC*l*, $H_2SO_4$, $HNO_3$ etc.,

**Strong Base:** The base which is completely ionized (100%) is called strong base.
**Eg:** NaOH, KOH, LiOH etc.,
**Weak acid:** The acid which is incompletely ionized (<100%) is called weak acid.
**Eg:** $CH_3COOH$, $H_2CO_3$ etc.,

**Weak base:** The base which is incompletely ionized (<100%) is called weak base.
**Eg:** $NH_4OH$, $Mg(OH)_2$, A*l*$(OH)_3$ etc.,

Salts of a strong acid and a strong base are neutral with pH value of 7. On the other hand, salts of a strong acid and weak base are acidic with pH value less than 7 and those of a strong base and weak acid are basic in nature; with pH value more than 7.

4. The heat of neutralisation for a reaction between strong acid and a strong base is 13.7 K.Cal/mole. Explain why it is less than 13.7 K.Cal/mole for a reaction involving a weak acid or a weak base?

A. The heat of neutralisation value for a reaction between a strong acid and a strong base is 13.7 K.Cal/mole. But it is less than 13.7 K.Cal/mole for a reaction involving a weak acid or a weak base. This is due to consumption of some heat energy to ionise the weak acid or weak base. **Eg:** The heat of neutralisation for a reaction between NaoH and $CH_3COOH$ is 13.4 K.Cal/mole only. Therefore 0.3 K.Cal of heat is used to ionize the acetic acid $CH_3COOH + NaOH \rightarrow CH_3COONa + H_2O + 13.4$ K.Cal/mole.

## PROBLEMS
## (4 Marks)

1. Calculate the pH of 0.001M HC*l*?

HC*l* is a strong acid, it ionizes completely and produces equal concentrations of $H^+$ and $Cl^-$

The concentration of HC*l* = $[H^+] = 0.001M$

$pH = -\log_{10}[H^+]$

$= -\log_{10}(0.001)$

$= -\log_{10} 1\times10^{-3}$

$\left(\because \log_a^n = n\log a \;;\; \log_{10}^{10} = 1\right)$

$= -(-3)\log_{10}{}^{10}$

$= +3$

$\therefore$ The pH of 0.001M HC*l* is 3

2. In a solution the $[H^+]$ is $1\times10^{-4}$, Find the pH value of the solution.

Given $[H^+] = 1\times10^{-4}$

$pH = -\log_{10}[H^+]$

$= -\log10\ (1\times10^{-4})$

$\left(\because \log_{10}^{10} = 1\right)$

$= -(-4)\ \log_{10}{}^{10}$

$= 4$

$\therefore$ pH = 4

## Part - B
## Multiple Choice Questions

## (1/2 Mark)

1. The chemical formula of "sulphurous acid"
   a) $H_2SO_4$ b) $HSO_4$ c) $H_2SO_3$ d) $H_3SO_2$

2. Which is the more volatile acid.
   a) $CH_3COOH$ b) $HCl$ c) $H_2SO_4$ d) NaOH

3. What is the chemical formula of "Carbonic acid"
   a) $H_2CO_4$ b) $H_2CO_3$ c) $HCO_3$ d) $HC_2O_3$

4. The colour of methyl orange indicator in acidic medium is
   a) Yellow b) Green c) Orange d) Red

5. Bases change the orange colour of the methyl orange solution into which colour.
   a) Yellow b) Green c) Orange d) Red

6. The colour of the phenolphthalein indicator in basic solution is
   a) Yellow b) Green c) Pink d) Orange

7. On heating bases gives
   a) Metallic carbonates b) Metallic sulphides
   c) Metallic sulphates d) Metallic oxides

8. Of these which can produce $H^+$ ions in aqueous solution.
   a) NaOH b) KOH c) $CH_3COOH$ d) $Al(OH)_3$

9. Pure water is which type of conductor of electricity?
   a) Good b) Bad c) a, b d) None

10. If the temperature of water increases the ionisation
    a) decreases b) Also increases
    c) Constant d) Variable

11. The ionic product of water at 25°C is
    a) $1.0 \times 10^{-14}$ b) $10.0 \times 10^{-14}$ c) $0.1 \times 10^{-14}$ d) $0.01 \times 10^{-14}$

12. The pH value of lemon juice is
    a) 2.4 b) 0.24 c) 24.0 d) None

13. In a solution at 25°C the $[H^+]$ value is $5\times10^{-8}$ then $[OH^-]$ is
    a) $10^{-6}$ b) $2\times10^{-7}$ c) $5\times10^{-8}$ d) $10^{-14}$

14. At 50°C, in a solution $[OH^-]$ value is $5.3\times10^{-8}$ then $[H^+]$ value is
    a) $10^{-6}$ b) $5.3\times10^{-6}$ c) $5.3\times10^{-14}$ d) $10^{-14}$

15. Which is the correct

a) $pH = -[H^+]$ b) $pH = -[OH^{-1}]$

c) $pH = -\log_{10}[H^+]$ d) $pH = -\log_{10}[OH^{-1}]$

16. The pH of solution whose $[H^+]$ is $1\times10^{-4}$ is

a) 1 b) 10 c) –4 d) +4

17. If the pH of a solution is 8, its $[H^+]$ is

a) $\log 10^{-8}$ b) $10^8$ c) $10^{-8}$ d) 8

18. The value of $K_w$ changes with changing of

a) $[H^+]$ b) $[OH^-]$ c) Temperature d) Pressure

19. Weak acids ionize up to

a) 50% b) 100%

c) Less than 100% d) More than 100%

20. If the pH of a solution is 10, its $[H^+]$ is

a) log 10 b) $\log_{10}{}^{10}$ c) $10^{-10}$ d) [–10]

21. The formula of hydronium ion is

a) $H_2O$ b) $OH^-$ c) $H_3O^+$ d) $NH_4^+$

22. Quantity of heat of neutralisation between a strong acid and strong base is

a) 13.7 K.Cal/mole b) 1.37 K.Cal/mole

c) 13.7 Cal/mole d) 1370 Cal/mole

23. The concept of pH was introduced by

a) Sorensen b) Lewis c) Arrhenius d) Wage

24. Teh scale of acidity (or) basicity is

a) Absolute scale b) pH scale

c) Kelvin scale d) None

25. For a reaction involving weak acid (or) weak base, the heat of neutralization is

a) Less than 13.7 K.Cal $mol^{-1}$ b) Less than 13.7 Cal $mol^{-1}$

c) Less than 1.37 K.Cal $mol^{-1}$ d) Less than 1.37 K.Cal $mol^{-1}$

**KEY**

| | | | | |
|---|---|---|---|---|
| 1) c | 2) a | 3) b | 4) d | 5) a |
| 6) c | 7) d | 8) c | 9) b | 10) b |
| 11) a | 12) a | 13) b | 14) a | 15) b |
| 16) d | 17) c | 18) c | 19) c | 20) c |
| 21) c | 22) a | 23) a | 24) b | 25) a |

## Fill in the Blanks
## (1/2 Mark)

1. Acids are ——— to taste
2. Acids turn ——— litmus to ———
3. Bases are ——— to touch.
4. Bases turn ——— litmus to ———
5. An acid and a base reacts to form ———
6. Acids liberate carbon dioxide by reacting with ——— and ———
7. ——— is insoluble in water but acidic in nature.
8. ——— is insoluble in water but basic in nature.
9. The ionisation is ——— dependent.
10. The value of ionic prduct of water ($K_w$) at 0°C ———
11. The extent of ionization of water increases with increasing ———
12. The extent of ionization of weak acid (or) weak base increases with ———
13. The pH value of gastric juice ———
14. The pH of acids is in the range of ——— to ———
15. The pH of base is in the range of ——— to ———
16. The pH of NaC*l* solution is ———
17. The body fluid whose pH is greater than 7 is ———
18. The pH value of pure water is ———
19. The strength of an acid or a base is measured in terms of extent of ———
20. The concentration of the $H^+$ and $OH^-$ is always equal to ———

**KEY**

| | | |
|---|---|---|
| 1) Sour | 2) Blue, Red | 3) Soapy |
| 4) Red, Blue | 5) Salt | 6) Carbonates, Bicarbonates |
| 7) $SiO_2$ | 8) $CaCO_3$ | 9) Temperature |
| 10) $1.14\times10^{-15}$ | 11) In temperature | 12) Dilution |
| 13) 1 to 2 | 14) 1 to 7 | 15) 14 |
| 16) 7 | 17) Blood | 18) 7 |
| 19) Ionisation | 20) $10^{-14}$ | |

## MATCHING

**I.**

| **Group-A** | | **Group-B** |
|---|---|---|
| 1) $H_2SO_3$ | ( ) | a) Carbonic acid |
| 2) $H_2CO_3$ | ( ) | b) Phosphoric acid |
| 3) $H_2SO_4$ | ( ) | c) Sulphuric acid |
| 4) $H_3PO_4$ | ( ) | d) Phosphorous acid |
| 5) $H_3PO_3$ | ( ) | e) Sulphurous acid |

**II.**

| **Group-A** | | **Group-B** |
|---|---|---|
| pH values of | | |
| 1) Lemon juice | ( ) | a) 7 |
| 2) Aerated water | ( ) | b) 2.4 |
| 3) Pure water | ( ) | c) 5.5 |
| 4) Saliva | ( ) | d) 7.32 – 7.45 |
| 5) Blood | ( ) | e) 6.4 – 6.9 |

**III.**

| **Group-A** | | **Group-B** |
|---|---|---|
| 1) pH > 7 | ( ) | a) 100% |
| 2) pH < 7 | ( ) | b) < 100% |
| 3) Heat of neutralization of strong acid and strong base | ( ) | c) acid |
| 4) Weak acid ionize upto | ( ) | d) 1.37 K.Cal |
| 5) Strong acid ionize upto | ( ) | e) 1.37 K.Cal $mol^{-1}$ |
| | ( ) | f) Base |

**KEY**

| | | | | | |
|---|---|---|---|---|---|
| I. | 1-e | 2-a | 3-c | 4-b | 5-d |
| II. | 1-b | 2-c | 3-a | 4-e | 5-d |
| III. | 1-f | 2-c | 3-e | 4-b | 5-a |