CHAPTER 7

Acids, Bases and Salts

Acids

A substance which have sour taste and turns blue litmus red is called an acid. According to modern concepts.

- Acids give hydrogen ion in aqueous solution.

(Arrhenius concept)

$$HCl \xrightarrow{H_2O} H^+ + Cl^-$$

- Acids donate proton (hydrogen ion) **(Bronsted lowry concept)**.

$$HCl + NH_3 \rightarrow Cl^- + NH_4^+$$

Donor — Conjugate base

(A conjugate acid-base pair differs by a proton).

- Acids has tendency to accept electrons, *i.e.*, these behave as electrophile **(Lewis concept)** *e.g.*, electron deficient species like BF_3, $AlCl_3$, positive ions like Na^+, K^+, and molecules having multiple bond between dissimilar atoms (*e.g.*, CO_2, SO_2, etc.)

Sources of Some Acids

Acid	Source
Citric acid	Lemon, orange, grapes
Maleic acid	Unripe apple
Tartaric acid	Tamarind
Lactic acid	Milk
Acetic acid	Vinegar
Oxalic acid	Tomato
Hydrochloric acid	Stomach and chemicals
Formic acid	Red ant

Properties of Acids

- Acids give hydrogen gas with more reactive metals.

$$\underset{\text{Metal}}{Zn} + 2HCl \longrightarrow \underset{\text{Salt}}{ZnCl_2} + \underset{\text{Hydrogen}}{H_2}$$

- Acid evolve carbon dioxide (CO_2) gas with metal carbonates and bicarbonates. *e.g.*,

$$\underset{\text{Metal carbonate}}{MCO_3} + \underset{\text{Acid}}{H_2SO_4} \longrightarrow MSO_4 + H_2O + CO_2$$

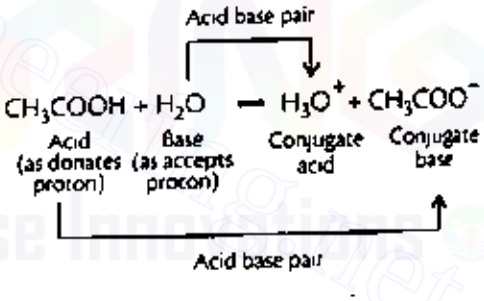
- In aqueous solution, they are conductor of electricity, due to the presence of free H^+ ions.

Bases

The substance which has bitter taste and turns red litmus blue, is called a base. According to modern concepts,

- Bases give hydroxyl ion (OH^- ion) in aqueous solution. *e.g.*, NaOH, KOH, CsOH, $Mg(OH)_2$ etc. **(Arrhenius concept)**
- Bases have a tendency to accept proton **(Bronsted-Lowry concept)** *e.g.*, NH_3, H_2O etc.
- Bases have a tendency to donate electron pair **(Lewis concept)** *e.g.* simple anions like Cl^-, F^-, OH^- etc. molecules containing lone pairs like $\ddot{N}H_3$, $R-\ddot{O}-H$, $R-\ddot{O}-R$ etc.

Acid and Base in a Reaction



pH Scale

- S.P.L. Sorensen, suggested a scale to express the hydrogen ion concentration $[H^+]$, acidity or basicity of an aqueous solution, which is known as pH scale. This scale is based on the ionic product of water.
- The pH of solution is defined as
  "The negative logarithm to the base 10 of the hydrogen ion concentration in gram ion or mole per litre"
  i.e., $pH = -\log[H^+]$
- The logarithm to the base 10 of inverse of $[H^+]$ ion concentration in the solution is its pH.

$$pH = \log\frac{1}{[H^+]}$$

- The negative power to which 10 must be raised in order to express the $[H^+]$ ion concentration of a solution in gram ion or mole per litre, is its pH.

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

- In pure water or in neutral aqueous solution,

$$[H^+] = 10^{-7} \text{ so pH} = 7$$

- In an acidic solution $[H^+] > 10^{-7}$ so pH < 7
- In an alkaline solution $[H^+] < 10^{-7}$ so pH > 7
- **pH of some common substances is**

Soft drinks	2.0-4.0
Tears	7.4
Lemon	2.2-2.4
Sea water	8.5
Human urine	4.8-8.4
Cow's milk	6.5
Rain water	6.0
Human blood	7.36-7.42

pOH Scale

- The pOH value of an aqueous solution may be defined as the negative logarithm of the hydroxide ion concentration i.e.

$$pOH = -\log[OH^-] \text{ or } pH + pOH = 14$$

Common Ion Effect

Addition of a strong electrolyte in a solution of weak acids or bases decreases the ionisation of acid or base due to the presence of common ion. This is called common ion effect. *e.g.*,

$$H_2S \rightleftharpoons 2H^+ + S^{2-}$$
(Weak acid)

$$HCl \rightarrow H^+ + Cl^-$$
(Strong acid; Common ion (excess))

So the reaction (i) goes into reverse direction

Salts

When acid and base react together, they form salt and water. This reaction is known as neutralisation reaction, *e.g.*,

$$\underset{\text{Acid}}{HNO_3} + \underset{\text{Base}}{KOH} \longrightarrow \underset{\text{Salt}}{KNO_3} + \underset{\text{Water}}{H_2O}$$

- When acid and base both are strong, 13.7 kcal energy is released. However, if either the acid or the base is weak energy released is less than 13.7 kcal.
- KNO_3, K_2SO_4, $NaNO_3$, KCl, NaCl, KNO_3, are salts of strong acids and strong base, so they cannot be hydrolysed and their aqueous solution is neutral.

Points to be Remember

- Most of the acids contain hydrogen.
- Pickels are kept in glass jar because acid present in them reacts with the metal of metallic pot to give poisonous substances.
- HCl, H_2SO_4, HNO_3 are mineral acids and are much stronger than organic acids
- A water soluble base is called an alkali. That's why all alkalies are base but all bases are not alkali.
- Aquaregia is a mixture of concentrated hydrochloric acid and concentrated nitric acid in the ratio 3 : 1.

Exercise

1. Blue litmus paper is converted into red in solution of
   (a) acid (b) base
   (c) alkali (d) salt
2. Red litmus paper is changed into blue in solution of
   (a) base (b) acid
   (c) salt (d) None of these
3. In neutralisation reaction product is
   (a) acid (b) base
   (c) salt and water (d) None of these
4. The acid used in lead storage battery is
   (a) oxalic acid (b) HNO_3
   (c) H_2SO_4 (d) HCl
5. An acid is a substance which
   (a) donates a proton (b) accepts an electron
   (c) give H^+ in water (d) All of these
6. Tartaric acid is obtained from
   (a) apples (b) citrous fruit
   (c) grapes (d) tomato
7. The negative logarithmic value of hydrogen ion is called
   (a) pH (b) pOH (c) pK_a (d) pK_b
8. Acids react with bases to give
   (a) ester (b) alcohol
   (c) salt (d) None of these
9. Which one among the following will you put into pure water in order to pass electric current through it?
   (a) Kerosene (b) Mustard oil **(COS 2011 II)**
   (c) Lemon juice (d) Sugar
10. Match Column I with Column II and select the correct answer from codes given below the Columns.

Column I	Column II
A. Lactic acid	1. Lemon
B. Acetic acid	2. Rancid butter
C. Citric acid	3. Milk
D. Butyric acid	4. Vinegar

Codes

	A	B	C	D
(a)	3	4	1	2
(b)	2	4	3	1
(c)	2	1	4	3
(c)	1	2	3	4

11. Match Column I with Column II and select the correct answer using the codes given below the Columns.

Column I (Acid)	Column II (Source)
A. Lactic acid	1. Tamarind
B. Tartaric acid	2. Orange
C. Oxalic acid	3. Tomato
D. Citric acid	4. Sour curd

(CDS 2011 II)

Codes

	A	B	C	D		A	B	C	D
(a)	2	3	1	4	(b)	2	1	3	4
(c)	4	3	1	2	(d)	4	1	3	2

12. Water is neither acidic nor alkaline because
(a) it boils at a high temperature
(b) it cannot donate or accept electrons
(c) it can dissociate into equal number of hydrogen and hydroxyl ions
(d) it cannot accept or donate protons

13. Formic acid is obtained from
(a) red ants (b) fats (c) vinegar (d) orange

14. Aqua-regia used by alchemists to separate silver and gold is a mixture of **(CDS 2009 I)**
(a) hydrochloric acid (concentrated) and nitric acid (concentrated)
(b) hydrochloric acid (concentrated) and sulphuric acid (concentrated)
(c) nitric acid (concentrated) and sulphuric acid (concentrated)
(d) hydrochloric acid (dilute) and sulphuric acid (dilute)

15. Which is not a Lewis base?
(a) H_2O (b) NH_3 (c) CO_2 (d) BF_3

16. Boric acid turns turmeric paper
(a) brown (b) black
(c) blue (b) red

17. Which of the following is a Lewis base?
(a) NH_3 (b) HCl
(c) HF (d) HNO_3

18. **Statement (I)** Addition of water to an aqueous solution of HCl decreases the pH.
Statement (II) Addition of water suppresses the ionisation of HCl. **(CDS 2009 I)**
(a) Both the statements are individually true and statement II is the correct explanation of statement I.
(b) Both the statements are individually true but statement II is not the correct explanation of statement I.
(c) Statement I is true but statement II is false.
(d) Statement I is false but statement II is true.

19. An aqueous solution of NH_4Cl is
(a) basic (b) neutral
(c) acidic (d) amphoteric

20. Aqueous solution contains
(a) H_2 (b) OH^-
(c) H^+ (d) H_3O^+

21. The pH value of wine is
(a) 6.5 (b) 2.8
(c) 8.5 (d) 7.0

22. The pH value of sea water is
(a) 8.5 (b) 2.6
(c) 3.0 (d) 2.5

23. What is the pH value of pure water? **(CDS 2008 I)**
(a) 1 (b) 6
(c) 7 (d) 10

24. The flavour of apple is mainly due to which one of the following? **(CDS 2007 I)**
(a) Formalin (b) Benzene
(c) Ethanol (d) Benzaldehyde

25. What is the purpose of adding baking soda to dough? **(CDS 2007 II)**
(a) To generate moisture
(b) To give a good flavour
(c) To give good colour
(d) To generate carbon dioxide

26. The acid used in eye wash is
(a) oxalic acid (b) nitric acid
(c) boric acid (d) None of these

27. The acid used to remove rust spot is
(a) boric acid (b) turmeric acid
(c) oxalic acid (d) None of these

28. Maleic acid is found in the
(a) apples (b) vinegar
(c) milk (d) lemons

Answers

1. (a)	**2.** (a)	**3.** (c)	**4.** (c)	**5.** (d)	**6.** (c)	**7.** (a)	**8.** (c)	**9.** (c)	**10.** (a)
11. (d)	**12.** (c)	**13.** (a)	**14.** (a)	**15.** (d)	**16.** (a)	**17.** (a)	**18.** (c)	**19.** (c)	**20.** (d)
21. (b)	**22.** (a)	**23.** (c)	**24.** (c)	**25.** (d)	**26.** (c)	**27.** (c)	**28.** (a)		