CHAPTER 04

IONIC EQUILIBRIUM

The point of life is to find equillibrium in what is inherently unstable

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INTRODUCTION

Ionic equilibrium is the equilibrium established between the unionized molecules and the ions in a solution of weak electrolytes. In this lesson we learn about the equilibrium involving ionic species. The equilibrium involving acids and bases are critically important for a wide variety of reactions.

After reading this lesson, we will be able to discuss

Define and explain various concepts of acids and bases

Define conjugate acid base pairs and identify them in an acid-base equilibrium;

Define pH and correlate it with the nature of queous solutions-neutral, acidic or basic:

Define and explain common ion effect in ionisation of weak acids and bases:

Identify the relationship between solubility and solubility product for salts of AB, AB_2, A_2B_2 and A_2B_3 types

It is number of H^+ ions furnished by a molecule of an acid. An acid may be classified according to its basicity. Thus we may have,

(i) Mono basic or Mono protic acids like HCl, HNO_3, CH_3COOH, HCN etc.

(ii) Dibasic or Diprotic acids like, H_2SO_4, H_2CO_3, H_2SO_3, H_2S etc.

(iii) Tribasic or Triprotic acids like H_3PO_4, H_3AsO_4 etc.

Basicity or Protocity of an Acid

Types of acids

Mono basic acid
- Gives single H^+ per molecule e.g HA (HNO_3, $HClO_4$, HCl)

Di basic acid
- Gives two H^+ per molecule e.g H_2A (H_2SO_4, H_3PO_3)

Tri basic acid
- Gives three H^+ per molecule e.g H_3A (H_3PO_4)

It may be defined as the number of OH^- ions furnished by a molecule of a base. A base can be,

(i) Mono acidic or Monohydroxic like NaOH, NH_4OH, AgOH etc.

(ii) Diacidic or dihydroxic like $Ba(OH)_2$, $Mg(OH)_2$, $Ca(OH)_2$, $Sr(OH)_2$ etc.

(iii) Triacidic or trihydroxic like $Fe(OH)_3$, $Al(OH)_3$ etc.

Strength of Acid or Base :

(i) Strength of Acid or Base depends on the extent of its ionisation. Hence equilibrium constant K_a or K_b respectively of the following equilibria give a quantitative measurement of the strength of the acid or base.

(ii) $HA + H_2O \rightleftharpoons H_3O^+ + A^-$;

$$K_a = \frac{[H_3O^+][A^-]}{[HA]}$$

(iii) Similarly

$$B + H_2O \rightleftharpoons BH^+ + OH^- ;$$

$$K_b = \frac{[BH^+][OH^-]}{[B]}$$ here H_2O is szolvent.

ETOOS KEY POINTS

(i) The other ways to represent above equilibrium is :

(a) $HA \xrightleftharpoons{H_2O} H^+ + A^-$; $K_a = \frac{[H^+][A^-]}{[HA]}$

(b) $BOH \xrightleftharpoons{H_2O} B^+ + OH^-$; $K_b = \frac{[B^+][OH^-]}{[BOH]}$

(ii) The larger the value of K_a or K_b, the more complete the ionisation, the higher the concentration of H_3O^+ or OH^- and stronger is the acid or base.

Etoos Tips & Formulas

1. A strong electrolyte is defined as a substance which dissociates almost completely into ions in aqueous solution and hence is a very good conductor of electricity **Ex.**, NaOH, KOH, HCl, H_2SO_4, NaCl, KNO_3 etc.

2. A weak electrolyte is defined as a substance which dissociates to a small extent in aqueous solution and hence conducts electricity also to a small extent e.g. NH_4OH, CH_3COOH etc.

3. Degree of dissociation :- The fraction of the total amount of an electrolyte which dissociates into ions is called the degree of dissociation (α),

   i.e. $$\alpha = \frac{\text{Number of moles dissociated}}{\text{Number of moles taken}}$$

4. According to Arrhenius concept of acids and bases, an acid is a substance which gives H^+ ions in the aqueous solution whereas a base is a substance which gives OH^- ions in the aqueous solution.

5. According to Bronsted-Lowry concept of acids and bases, an acid is a substance which can give a proton and a base is a substance which accepts a proton.

6. According to Lewis concept of acids and bases, an acid is a substance which can accept a lone pair of electrons whereas a base is a substance which can donate a lone pair of electrons.

Types of Lewis Bases

(i) Neutral molecules containing a lone pair of electrons on the central atom like : NH_3, $R\ddot{\underset{\cdot\cdot}{O}}H$, $H_2\ddot{O}$: etc. (ii) All negative ions like F^-, Cl^-, Br^-, I^-, OH^- etc.

Types of Lewis Acids

(i) Molecules having central atom with incomplete octet e.g. BF_3, $AlCl_3$ etc.

(ii) Simple cations e.g. Ag^+ , Cu^{2+}, Fe^{3+} etc.

(iii) Molecules having central atom with empty d-orbitals e.g. $SnCl_4$, SiF_4, PF_5 etc.

(iv) Molecules containing multiple bonds between different atoms e.g. O = C = O.

SOLVED EXAMPLE

Ex. 1 Stomach acid is a solution of HCl with concentration of 2.2×10^{-3} M. what is the pH of stomach acid :
(A) 3.92 (B) 2.65
(C) 4.92 (D) 1.92

Sol. (B) HCl is 100 % ionised so
$[H_3O^+] = 2.2 \times 10^{-3}$ M
pH = – log (2.2×10^{-3} M) or pH = 2.65

Ex. 2 Calculate the $[H_3O^+]$ of blood, the pH of which is 7.2 (slightly basic).
(A) 5×10^{-8} M (B) 6.3×10^{-8} M
(C) 5×10^{-9} M (D) 4×10^{-7} M

Sol. (B) As pH = 7.2 so $[H_3O^+]$ = antilog (–7.2) = 6.3×10^{-8} M

Ex. 3 The pH of an aqueous solution at 25°C made up to 0.3 M, with respect to NaOH and 0.5 M, with respect to acetic acid ($pK_a = 4.76$) would be nearly :
(A) 4.25 (B) 4.93
(C) 4.75 (D) 5.05

Sol. (B) $pH = pK_a - \log \frac{[acid]}{[salt]}$

0.3 M NaOH will react with acid to form 0.3 M CH_3COONa and therefore CH_3COOH concentration will be reduced to 0.2 M.

$pH = 4.76 - \log \frac{0.2}{0.3} = 4.93$

Ex. 4 Calculate the pOH and pH of a 0.1 M CH_3COO^- solution ($K_a = 1.8 \times 10^{-5}$).

$CH_3COO^- + H_2O \rightleftharpoons CH_3COOH + OH^-$
(A) 6.12, 7.88 (B) 4.12, 9.88
(C) 5.13, 8.87 (D) none of the above

Sol. (C) $pH = 7 + \frac{1}{2} pK_a + \frac{1}{2} \log C$

$= 7 + \frac{1}{2} \times 4.74 + \frac{1}{2} \log (0.1)$

pH = 8.87
pOH = 14 – 8.87 = 5.13

Ex. 5 The pH of a solution of NH_3 is 5.806. If its concentration is 0.95 M then what is the value of its dissociation constant ?
(A) anti log [28 + log (0.95) – 23.242]
(B) anti log [11.612 – log (0.95) – 28]
(C) anti log [11.612 – log (0.95) – 14]
(D) anti log [14 + log (0.95) – 11.612]

Sol. (B) Since pH = 14 – pOH and $pOH = \frac{1}{2} pK_b - \frac{1}{2} \log C$

or $pH = 14 - \frac{1}{2} pK_b + \frac{1}{2} \log C$

or $pK_b = 2 (14 + \frac{1}{2} \log C - pH)$

or K_b = antilog [11.612 – log (0.95) – 28]

Ex. 6 The solubility product of $BaSO_4$ is 1.5×10^{-9}. The precipitation in a 0.01 M Ba^{2+} ions solution will start on adding H_2SO_4 of concentration :
(A) 10^{-9} M (B) 10^{-8} M
(C) 10^{-7} M (D) 10^{-6} M

Sol. (D) $[Ba^{2+}][SO_4^{2-}] = 1.5 \times 10^{-9}$ (K_{sp}) and $[Ba^{2+}] = 0.01$ M

so Required $[SO_4^{2-}] = \frac{1.5 \times 10^{-9}}{0.01} = 1.5 \times 10^{-7}$

so $[H_2SO_4] > 1.5 \times 10^{-7}$ for precipitation of $BaSO_4$.

Ex. 7 pH of a saturated solution of $Ca(OH)_2$ is 12. Its solubility product is :
(A) 10^{-6} (B) 4×10^{-6}
(C) 5×10^{-7} (D) None of these

Sol. (C) pH = 12 so $[OH^-] = 10^{-2}$ M

Now $Ca(OH)_{2(s)} \rightleftharpoons Ca^{2+} + 2OH^-$
5×10^{-3}M 10^{-2} M
so $K_{sp} = [Ca^{2+}][OH^-]^2$
$= (5 \times 10^{-3})(10^{-2})^2 = 5 \times 10^{-7}$

Ex. 8 A sample of 100 ml of 0.10 M acid HA ($K_a = 1 \times 10^{-7}$) is titrated with standard 0.10 M KOH. How many mL of KOH will have to be added when the pH in the titration flask will be 7.00 ?
(A) 0 (B) 10
(C) 100 (D) 50

Sol. (D) $pH = pK_a + \log \frac{[Salt]}{[Acid]}$

$7 = 7 + \log \frac{[N_2V_2]}{[N_1V_1 - N_2V_2]}$

$1 = \frac{0.1 \times V_2}{0.1 \times 100 - 0.1 \times V_2}$

or $10 - 0.1 V_2 = 0.1 V_2$
or $V_2 = 50$ mL

Exercise # 1 SINGLE OBJECTIVE NEET LEVEL

1. Which of the following is non-electrolyte
(A) NaCl (B) $CaCl_2$
(C) $C_{12}H_{22}O_{11}$ (D) CH_3COOH

2. Ammonium hydroxide is a
(A) Strong electrolyte
(B) Weak electrolyte
(C) Both under different conditions
(D) Non-electrolyte

3. Ammonium hydroxide is a weak base because
(A) It has low vapour pressure
(B) It is only slightly ionized
(C) It is not a hydroxide of any metal
(D) It has low density

4. Electrolytes when dissolved in water dissociate into their constituent ions. The degree of dissociation of an electrolyte increases with
(A) Increasing concentration of the electrolyte
(B) Decreasing concentration of the electrolyte
(C) Decreasing temperature
(D) Presence of a substance yielding a common ion

5. An electrolyte
(A) Gives complex ions in solution
(B) Dissolves in water to give ions
(C) Is ionized in the solid state
(D) Generates ions on passing electric current

6. A monoprotic acid in 1.00 M solution is 0.01% ionised. The dissociation constant of this acid is
(A) 1×10^{-8} (B) 1×10^{-4}
(C) 1×10^{-6} (D) 10^{-5}

7. Molten sodium chloride conducts electricity due to the presence of
(A) Free electrons
(B) Free ions
(C) Free molecules
(D) Atoms of sodium and chlorine

8. An example for a strong electrolyte is
(A) Urea
(B) Ammonium hydroxide
(C) Sugar
(D) Sodium acetate

9. Which one is strongest electrolyte in the following
(A) NaCl (B) CH_3COOH
(C) NH_4OH (D) $C_6H_{12}O_6$

10. The equivalent conductance at infinite dilution of a weak acid such as HF
(A) Can be determined by measurement of very dilute HF solution
(B) Can be determined by extrapolation of measurements on dilute solutions of HCl, HBr and HI
(C) Can best be determined from measurements on dilute solutions of NaF, NaCl and HCl
(D) Is an undefined quantity

11. Which of the following is not a Lewis acid
(A) CO (B) $SiCl_4$
(C) SO_3 (D) Zn^{2+}

12. Review the equilibrium and choose the correct statement $HClO_4 + H_2O \rightleftharpoons H_3O^+ + ClO_4^-$
(A) $HClO_4$ is the conjugate acid of H_2O
(B) H_3O^+ is the conjugate base of H_2O
(C) H_2O is the conjugate acid of H_3O^+
(D) ClO_4^- is the conjugate base of $HClO_4$

13. A solution of $FeCl_3$ in water acts as acidic due to
(A) Hydrolysis of Fe^{3+} (B) Acidic impurities
(C) Dissociation (D) Ionisation

14. A white substance having alkaline nature in solution is
(A) $NaNO_3$ (B) NH_4Cl
(C) Na_2CO_3 (D) Fe_2O_3

15. Which of the following can act both as Bronsted acid and Bronsted base
(A) Cl^- (B) HCO_3^-
(C) H_3O^+ (D) OH^-

16. Lewis acid
(A) Presence of H atom is necessary
(B) Is a electron pair donor
(C) Always a proton donor
(D) Is a electron pair acceptor

17. For two acids A and B, $pK_a = 1.2$, $pK_b = 2.8$ respectively in value, then which is true
(A) A and B both are equally acidic
(B) A is stronger than B
(C) B is stronger than A
(D) Neither A nor B is strong
(E) None of these

Exercise # 2 SINGLE OBJECTIVE AIIMS LEVEL

1. Which of the following is not correct :

(A) $[H^+] = [OH^-] = \sqrt{K_w}$ for a neutral solution at all temperatures

(B) $[H^+] = [OH^-] = 10^{-7}$ for a neutral solution at all temperatures

(C) $[H^+] > \sqrt{K_w}$ and $[OH^-] < \sqrt{K_w}$ for an acidic solution

(D) $[H^+] < \sqrt{K_w}$ and $[OH^-] > \sqrt{K_w}$ for an alkaline solution

2. Which of the following correctly explains the nature of boric acid in aqueous medium:

(A) $H_3BO_3 \xrightarrow{H_2O} H_3^+O + H_2BO_3^-$

(B) $H_3BO_3 \xrightarrow{2H_2O} 2H_3^+O + HBO_3^{2-}$

(C) $H_3BO_3 \xrightarrow{3H_2O} 3H_3^+O + BO_3^{3-}$

(D) $H_3BO_3 \xrightarrow{H_2O} B(OH)_4^- + H^+$

3. pH for the solution of salt undergoing anionic hydrolysis (say CH_3COONa) is given by:

(A) pH = 1/2 [$pK_w + pK_a + \log C$]

(B) pH = 1/2 [$pK_w + pKa - \log C$]

(C) pH = 1/2 [$pK_w + pK_b - \log C$]

(D) None of these

4. The pH of 0.1 M solution of the following salts increases in the order:

(A) NaCI < NH_4CI < NaCN < HCI

(B) HCI < NH_4CI < NaCI < NaCN

(C) NaCN < NH_4CI < NaCI < HCI

(D) HCI < NaCI < NaCN < NH_4CI

5. The pH of the solution obtanied by mixing 10 mL of 10^{-1} N HCI and 10 mL of 10^{-1} N NaOH is:

(A) 8 (B) 2

(C) 7 (D) None of these

6. pH of water is 7.0 at 25°C. If water is heated to 70°C, the:

(A) pH will decrease and solution becomes acidic

(B) pH will increase

(C) pH will remain constant as 7

(D) pH will decrease but solution will be neutral

7. The ratio of dissociation constant of two weak acids HA and HB is 4. At what moar concentration ratio, the two acids will have same pH in separate solutions:

(A) 2 (B) 0.5

(C) 4 (D) 0.25

8. The reverse process of neutralisation is:

(A) Hydrolysis (B) Decomposition

(C) Dehydration (D) Synthesis

9. 10^{-6} M HCI is diluted to 100 times. Its pH is:

(A) 6.0 (B) 8.0

(C) 6.95 (D) 9.5

10. Which solution will have pH closer to 1.0:

(A) 100 mL of (M/10) HCI + 100 mL of (M/10) NaOH

(B) 55 mL of (M/10) HCI + 45 mL of (M/10) NaOH

(C) 10 mL of (M/10) HCI + 90 mL of (M/10) NaOH

(D) 75 mL of (M/5) HCI + 25 mL of (M/5) NaOH

11. $Ca_3(PO_4)_2$ is insoluble in water. On adding a few drops of HCI to solid $Ca_3(PO_4)_2$ in contact with water, the solid dissolves. The reason is:

(A) The solvent becomes more polar on adding HCI

(B) $Ca_3(PO_4)_2$ combines with HCI to form soluble $CaCI_2$ and H_3PO_4

(C) $Ca(H_2PO_4)_2$ is formed, which dissolves

(D) H_3PO_4, a weak acid is formed and the solubility product of $Ca_3(PO_4)_2$ decrease

12. A certain weak acid has a dissociation contant 1.0×10^{-4}. The equilibrium constant for its reaction with a strong base is:

(A) 1.0×10^{-4} (B) 1.0×10^{-10}

(C) 1×10^{-10} (D) 1.0×10^{-14}

13. K_a for the acid HA is 1×10^{-6}. The value of K for the reaction $A^- + H_3O^+ \rightleftharpoons HA + H_2O$ is

(A) 1×10^{-6} (B) 1×10^{12}

(C) 1×10^{-12} (D) 1×10^{6}

14. The degree of hydrolysis of a salt of weak acid and weak base in its 0.1 M solution is found to be 50%. If the molarity of the solution is 0.2M, the percentage hydrolysis of the salt should be:

(A) 100 % (B) 50 %

(C) 25 % (D) None of these

Exercise # 3 PART - 1 MATRIX MATCH COLUMN

1. (Use log 1.8 = 0.26, Ka of formic acid = 1.8×10^{-4}, Ka of acetic acid = 1.8×10^{-5}, K_b of ammonia=1.8×10^{-5}, Ka_1 of $H_2S = 10^{-7}$ and Ka_2 of $H_2S = 10^{-14}$, for the following matchings)
Match the entries of column II for which the equality or inequality given in the column I are satisfied.

Column I	Column II
(A) 10^{-5} M HCl solution > 0.1 M H_2S solution	(p) α_{water} (degree of dissociation of water)
(B) CH_3COOH solution at pH equal to 4.74 = NH_4OH solution at pH equal to 9.26	(q) $[OH^-]$
(C) 0.1 M CH_3COOH solution = 1.0 M HCOOH solution	(r) α (degree of dissociation)
(D) 0.1 M of a weak acid HA_1(Ka = 10^{-5}) solution < 0.01 M of a weak acid HA_2(Ka = 10^{-6}) solution	(s) pH

2. Match the effect of addition of 1 M NaOH to 50 ml of 1 M $H_2C_2O_4$ (diprotic acid) in column I with column II (Given: $Ka_1 = 10^{-4}$, $Ka_2 = 10^{-9}$)

Column I	Column II
(A) 25 mL of NaOH	(p) Buffer solution
(B) 50 mL of NaOH	(q) pH is independent of concentration of species present in the solution.
(C) 75 mL of NaOH	(r) anionic hydrolyisis
(D) 100 mL of NaOH	(s) pH > 7

3. Match the correct value of Ksp expression in term of solubility (s)

Column-I	Column-II
(A) Al_2O_3	(p) $4s^3$
(B) CaO	(q) $27s^4$
(C) $Al(OH)_3$	(r) $108s^5$
(D) CaF_2	(s) s^2

4. Match the effect of addition of 1 M NaOH to 100 mL 1 M CH_3COOH (in Column I) with pH (in Column II) :

Column-I	Column-II
(A) 25 mL of NaOH	(p) pK_a
(B) 50 mL of NaOH	(q) $pK_a + \log 3$
(C) 75 mL of NaOH	(r) $pK_a - \log 3$
(D) 100 mL of NaOH	(s) $\frac{1}{2}[pK_w + pK_a - \log 2]$

5. When we titrate sodium carbonate solution (in beaker) with hydrochloric acid.

Column-I	Column-II
(A) At the start of titration	(p) Buffer solution of HCO_3^- and CO_3^{2-}
(B) Before the first equivalent point	(q) Buffer solution of H_2CO_3 and HCO_3^-
(C) At the first equivalent point	(r) Amphiprotic anion, pH = $1/2(pK_{a_1} + pK_{a_2})$
(D) Between the first and second equivalent points	(s) Hydrolysis of CO_3^{2-}

Exercise # 4 PART - 1 PREVIOUS YEAR (NEET/AIPMT)

1. The conjugate acid of NH_2^- is **[CBSE AIPMT 2000]**

(A) N_2H_4 **(B)** NH_4^+
(C) NH_2OH **(D)** NH_3

2. Which of the following statements about pH and H^+ ion concentration is incorrect ? **[CBSE AIPMT 2000]**

(A) Addition of one drop of concentrated HCl in NH_4OH solution decreases pH of the solution
(B) A solution of the mixture of one equivalent of each of CH_3COOH and NaOH has a pH of 7
(C) pH of pure neutral water is not zero
(D) A cold and concentrated H2SO4 has lower H^+ ions concentration than a dilute solution of H_2SO_4

3. Which one of the following is true for any diprotic acid, H_2X ? **[CBSE AIPMT 2000]**

(A) $K_{a_2} = K_{a_1}$ **(B)** $K_{a_2} > K_{a_1}$
(C) $K_{a_2} < K_{a_1}$ **(D)** $K_{a_2} = \frac{1}{K_{a_1}}$

4. Ionisation constant of CH_3COOH is 1.7×10^{-5} and concentration of H^+ ions is 3.4×10^{-4}. Then, find out initial concentration of CH_3COOH molecules. **[CBSE AIPMT 2001]**

(A) 3.4×10^{-4} **(B)** 3.4×10^{-3}
(C) 6.8×10^{-4} **(D)** 6.8×10^{-3}

5. Solubility of a M_2S type salt is 3.5×10^{-6}, then find out its solubility product. **[CBSE AIPMT 2007]**

(A) 1.7×10^{-6} **(B)** $17. \times 10^{-16}$
(C) 1.7×10^{-18} **(D)** 1.7×10^{-12}

6. Solubility of MX_2 type electrolytes is 0.5×10^{-4} mol/L, then find out K_{sp} of electrolytes. **[CBSE AIPMT 2002]**

(A) 5×10^{-12} **(B)** 25×10^{-10}
(C) 1×10^{-13} **(D)** 5×10^{-13}

7. Which has highest pH ? **[CBSE AIPMT 2002]**

(A) $CH_3CO^-OK^+$ **(B)** Na_2CO_3
(C) NH_4Cl **(D)** $NaNO_3$

8. Solution of 0.1 N NH_4OH and 0.1 N NH_4Cl has pH 9.25, then find out pK_b of NH_4OH. **[CBSE AIPMT 2002]**

(A) 9.25 **(B)** 4.75
(C) 3.75 **(D)** 8.25

9. The solubility product of AgI at 25ºC is 1.0×10^{-16} $mol^2 L^{-2}$. The solubility of AgI in 10^{-4} N solution of KI at 25°C is approximately (in mol L^{-1}) **[CBSE AIPMT 2002]**

(A) 1.0×10^{-10} **(B)** 1.0×10^{-8}
(C) 1.0×10^{-16} **(D)** 1.0×10^{-12}

10. The solubility product of a sparingle soluble salt AX_2 is 3.2×10^{-11}. Its solubility (in mol/L) is **[CBSE AIPMT 2004]**

(A) 5.6×10^{-6} **(B)** 3.1×10^{-4}
(C) 2×10^{-4} **(D)** 4×10^{-4}

11. The rapid change of pH near the stoichiometric point of an acid base titration is the basis of indicator detection. pH of the solution is related to ratio of the concentrations of the conjugate acid (HIn) and bas (In^-) forms of the indicator given by the expression **[CBSE AIPMT 2004]**

(A) $\log\left[\frac{In^-}{HIn}\right] = pK_{In} - pH$

(B) $\log\left[\frac{HIn}{In^-}\right] = pK_{In} - pH$

(C) $\log\left[\frac{HIn}{In^-}\right] = pH - pK_{In}$

(D) $\log\left[\frac{In^-}{HIn}\right] = pH - pK_{In}$

12. At 25°C, the dissociation constant of a base, BOH is 1.0 × 10–12. The concentration of hydroxyl ions in 0.01 M aqueous solution of the base would be **[CBSE AIPMT 2005]**

(A) 2.0×10^{-6} mol L^{-1} **(B)** 1.0×10^{-5} mol L^{-1}
(C) 1.0×10^{-6} mol L^{-1} **(D)** 1.0×10^{-7} mol L^{-1}

13. What if the correct relationship between the pH of isomolar solutions of sodium oxide (pH_1), sodium sulphide (pH_2), sodium selenide (pH_3) and sodium telluride (pH_4) ? **[CBSE AIPMT 2005]**

(A) $pH_1 > pH_2 \approx pH_3 > pH_4$
(B) $pH_1 < pH_2 < pH_3 < pH_4$
(C) $pH_1 < pH_2 < pH_3 \approx pH_4$
(D) $pH_1 > pH_2 > pH_3 > pH_4$

MOCK TEST

1. The following equilibrium is established when hydrogen chloride is dissolved in acetic acid

$HCl\,(aq) + CH_3COOH\,(aq) \rightleftharpoons Cl^-\,(aq) + CH_3\,COOH_2^+(aq).$

The set that characterises the conjugate acid-base pairs is

(A) (HCl, CH_3COOH) and $(CH_3COOH_2^+, Cl^-)$
(B) $(HCl, CH_3COOH_2^+)$ and (CH_3COOH, Cl^-)
(C) $(CH_2COOH_2^+, HCl)$ and (Cl^-, CH_3COOH)
(D) (HCl, Cl^-) and $(CH_3COOH_2^+, CH_3COOH)$.

2. The following equilibrium is established when $HClO_4$ is dissolved in weak acid HF.

$HF + HClO_4 \rightleftharpoons ClO_4^- + H_2F^+$

Which of the following is correct set of conjugate acid base pair ?

(A) HF and $HClO_4$
(B) HF and ClO_4^-
(C) HF and H_2F^+
(D) $HClO_4$ & H_2F^+

3. Identify the amphoteric species from the following :

(I) H_2O
(II) NH_3
(III) $H_2PO_4^-$
(IV) HCO_3^-

(A) I, II
(B) III, IV
(C) I, II, III
(D) I, II, III, I

4. Which of the following relations is correct ?

(A) $\Delta G^o = RT \ln K_{eq}$
(B) $[H_3O^+] = 10^{pH}$
(C) $\log \frac{Kw_2}{Kw_1} = \frac{\Delta H^o}{2.303R}\left(\frac{1}{T_1} - \frac{1}{T_2}\right)$
(D) $[OH^-] = 10^{-7}$, for pure water at all temperatures.

5. Which of the following is incorrect ?

(A) K_a (weak acid). K_b (conjugate weak base) = K_w
(B) K_a (strong acid). K_b (conjugate weak base) = K_w
(C) K_a (weak acid). K_b (weak base) = K_w
(D) K_a (weak acid). K_b (conjugate strong base) = K_w

6. K_a for the acid HA is 1×10^{-6}. The value of K for the reaction $A^- + H_3O^+ \rightleftharpoons HA + H_2O$ is

(A) 1×10^{-6}
(B) 1×10^{12}
(C) 1×10^{-12}
(D) 1×10^{6}

7. The pK_a value of NH_4^+ is 9. The pK_b value of NH_4OH would be :

(A) 9
(B) 5
(C) 7
(D) 8

8. Which of the following solution will have a pH exactly equal to 8 ?

(A) 10^{-8} M HCl solution at 25ºC
(B) 10^{-8} M H^+ solution at 25ºC
(C) 2×10^{-6} M $Ba(OH)_2$ solution at 25ºC
(D) 10^{-5} M NaOH solution at 25ºC

9. Which of the following solution will have pH close to 1.0 ?

(A) 100 ml of M/10 HCl + 100 ml of M/10 NaOH
(B) 55 ml of M/10 HCl + 45 ml of M/10 NaOH
(C) 10 ml of M/10 HCl + 90 ml of M/10 NaOH
(D) 75 ml of M/5 HCl + 25 ml of M/5 NaOH.

10. 0.1mol HCl is dissolved in distilled water of volume V then at $\lim_{V\to\infty} (pH)_{solution}$ is equal to

(A) zero
(B) 1
(C) 7
(D) 14

11. Dissociation constant of mono basic acids A, B, C and D are 6×10^{-4}, 5×10^{-5}, 3.6×10^{-6} and 7×10^{-10} respectively. The pH values of their 0.1M aqueous solution are in the order.

(A) D> C > B > A
(B) A > B >C > D
(C) D > C > A > B
(D) None

11^{th} Class Modules Chapter Details

Physics
5
Modules

Chemistry
5
Modules

Mathematics
5
Modules

PHYSICS

Module-1

1. Physical World & Measurements
2. Basic Maths & Vector
3. Kinematics

Module-2

1. Law of Motion & Friction
2. Work, Energy & Power

Module-3

1. Motion of system of particles & Rigid Body
2. Gravitation

Module-4

1. Mechanical Properties of Matter
2. Thermal Properties of Matter

Module-5

1. Oscillations
2. Waves

CHEMISTRY

Module-1(PC)

1. Some Basic Conceps of Chemistry
2. Atomic Structure
3. Chemical Equilibrium
4. Ionic Equilibrium

Module-2(PC)

1. Thermodynamics & Thermochemistry
2. Redox Reaction
3. States Of Matter (Gaseous & Liquid)

Module-3(IC)

1. Periodic Table
2. Chemical Bonding
3. Hydrogen & Its Compounds
4. S-Block

Module-4(OC)

1. Nomenclature of Organic Compounds
2. Isomerism
3. General Organic Chemistry

Module-5(OC)

1. Reaction Mechanism
2. Hydrocarbon
3. Aromatic Hydrocarbon
4. Environmental Chemistry & Analysis Of Organic Compounds

BIOLOGY

Module-1

1. Diversity in the Living World
2. Plant Kingdom
3. Animal Kingdom

Module-2

1. Morphology in Flowering Plants
2. Anatomy of Flowering Plants
3. Structural Organization in Animals

Module-3

1. Cell: The Unit of Life
2. Biomolecules
3. Cell Cycle & Cell Division
4. Transport in Plants
5. Mineral Nutrition

Module-4

1. Photosynthesis in Higher Plants
2. Respiration in Plants
3. Plant Growth and Development
4. Digestion & Absorption
5. Breathing & Exchange of Gases

Module-5

1. Body Fluids & Its Circulation
2. Excretory Products & Their Elimination
3. Locomotion & Its Movement
4. Neural Control & Coordination
5. Chemical Coordination and Integration

12th Class Modules Chapter Details

Physics
5
Modules

Chemistry
5
Modules

Mathematics
5
Modules

PHYSICS

Module-1

1. Electrostatics
2. Capacitance

Module-2

1. Current Electricity
2. Magnetic Effect of Current and Magnetism

Module-3

1. Electromagnetic Induction
2. Alternating Current

Module-4

1. Geometrical Optics
2. Wave Optics

Module-5

1. Modern Physics
2. Nuclear Physics
3. Solids & Semiconductor Devices
4. Electromagnetic Waves

CHEMISTRY

Module-1(PC)

1. Solid State
2. Chemical Kinetics
3. Solutions and Colligative Properties

Module-2(PC)

1. Electrochemistry
2. Surface Chemistry

Module-3(IC)

1. P-Block Elements
2. Transition Elements (d & f block)
3. Co-ordination Compound
4. Metallurgy

Module-4(OC)

1. HaloAlkanes & HaloArenes
2. Alcohol, Phenol & Ether
3. Aldehyde, Ketone & Carboxylic Acid

Module-5(OC)

1. Nitrogen & Its Derivatives
2. Biomolecules & Polymers
3. Chemistry in Everyday Life

BIOLOGY

Module-1

1. Reproduction in Organisms
2. Sexual Reproduction in Flowering Plants
3. Human Reproduction
4. Reproductive Health

Module-2

1. Principles of Inheritance and Variation
2. Molecular Basis of Inheritance
3. Evolution

Module-3

1. Human Health and Disease
2. Strategies for Enhancement in Food Production
3. Microbes in Human Welfare

Module-4

1. Biotechnology: Principles and Processes
2. Biotechnology and Its Applications
3. Organisms and Populations

Module-5

1. Ecosystem
2. Biodiversity and Conservation
3. Environmental Issues