# IONIC EQUILIBRIUM-I

## Exercise-1

**Marked questions are recommended for Revision.**

## PART - I : SUBJECTIVE QUESTIONS

### Section (A) : pH calculation : Solutions of polyprotic weak acids, Solutions of Polyacidic weak bases

**Commit to memory :**

Solution of a polyprotic weak acid ($H_xA$) : $pH = \frac{1}{2}(pK_{a_1} - \log C)$ [if $\alpha_1 \le 0.1$ or 10%] ; $[H_{x-2}A^{2-}] = K_{a2}$

Solution of a polyprotic weak base (B) : $pOH = \frac{1}{2}(pK_{b_1} - \log C)$[if $\alpha_1 \le 0.1$ or 10%] ; $[BH_2^{2+}] = K_{b2}$

**A-1.** What is the pH of 0.01 M $H_2S$ solution ? Also determine $[HS^-]$ & $[S^{2-}]$. Given: For $H_2S$, $K_{a_1} = 9 \times 10^{-8}$, $K_{a_2} = 1.2 \times 10^{-13}$.

**A-2.** Calculate the pH of 0.74 g/L aqueous solution of propane-1,2-diamine. Given : $pK_{b_1}$ & $pK_{b_2}$ for base is 4.18 & 7.39 respectively.

### Section (B) : pH calculation : Solutions containing mixture of weak monoprotic acid and strong acid, Solutions containing mixture of weak monoacidic base and strong base

**Commit to memory :**

Mixture of weak acid (monoprotic) and a strong acid: $[H^+]_f = C_1$ (just not considering the $H^+$ ions from WA).

Mixture of weak base (monoacidic) and a strong base: $[OH^-]_f = C_1$ (just not considering the $H^+$ ions from WB).

**B-1.** Upon passing 0.01 mole HCl gas through 100 mL of 0.05 M Formic acid solution ($K_a = 1.8 \times 10^{-4}$), determine change in pH of solution and $[HCOO^-]$ in resulting solution.

**B-2.^** Determine pH & $[NH_4^+]$ in a solution obtained by mixing equal volumes of 0.02 M KOH solution and 0.2 M $NH_3.H_2O$ solution ($K_b = 2 \times 10^{-5}$). Also calculate % dissociation of $NH_3.H_2O$ in the final solution.

### Section (C) : pH calculation : Solutions containing mixture of weak acids, Solutions containing mixture of weak bases

**Commit to memory :**

Mixture of two weak acids (both monoprotic) : $[H^+] = C_1\alpha_1 + C_2\alpha_2 = \sqrt{C_1K_{a_1} + C_2K_{a_2}}$

Mixture of two weak bases (both monoacidic) : $[OH^-] = C_1\alpha_1 + C_2\alpha_2 = \sqrt{C_1K_{b_1} + C_2K_{b_2}}$

**C-1.** Calculate $[H^+]$, $[HCOO^-]$ and $[OCN^-]$ in a solution that contains 0.1 M HCOOH ($K_a = 2.4 \times 10^{-4}$) and 0.1 M HOCN ($K_a = 4 \times 10^{-4}$).

### Section (D) : pH calculation : Solutions containing mixture of weak polyprotic acid and strong acid, Solutions containing mixture of weak Polyacidic base and strong base

**Commit to memory :**

Mixture of a polyprotic weak acid and a strong acid : $[H^+] = [H^+]$ from SA

Mixture of a polyprotic weak base and a strong base : $[OH^-] = [OH^-]$ from SB

**D-1.** What is $[HS^-]$ & $[S^{2-}]$ in solution of 0.01 M HCl and 0.1 M $H_2S$ ? (Given that for $H_2S$ : $K_{a_1} = 10^{-7}$ and $K_{a_2} = 10^{-14}$)

**Section (E) : pH calculation : Solutions of salt of weak polyprotic acid and strong base, Solutions of salt of weak Polyacidic base and strong acid, Solutions of amphiprotic species.**

**Commit to memory :**

Solution containing polyvalent anion ($A^{x-}$) of weak polyprotic acid ($H_xA$) :

$$K_{h_1} = \frac{K_w}{K_{a_x}} \; ; \; h = \sqrt{\frac{K_{h_1}}{C}} \; ; \; pH = \frac{1}{2}[pK_w + pK_{a_x} + \log C]$$

Solution containing polyvalent cation ($BH_y^{y+}$) of weak polyprotic base (B) :

$$K_{h_1} = \frac{K_w}{K_{b_y}} \; ; \; h = \sqrt{\frac{K_{h_1}}{C}} \; ; \; pH = \frac{1}{2}[pK_w - pK_{b_y} - \log C]$$

Solution containing amphiprotic anion of acid $H_xA$ : $pH(H_{x-1}A^-) = \left(\frac{pK_{a_1} + pK_{a_2}}{2}\right)$ ; $pH(H_{x-2}A^{2-}) = \left(\frac{pK_{a_2} + pK_{a_3}}{2}\right)$

**E-1.** Calculate the pH of 0.1 M $Na_3A$ of solution (salt of a tribasic acid $H_3A$). Assume only first step hydrolysis to be significant. Given : $K_{a_1}, K_{a_2}$ & $K_{a_3}$ for $H_3A$ are $10^{-4}$, $10^{-7}$ & $10^{-9}$ respectively.

**E-2.** What is the pH of M/20 $KHC_8H_4O_4$ solution ? Given : $H_2C_8H_4O_4$ is a dibasic acid with $pK_{a_1}$ & $pK_{a_2}$ as 2.94 & 5.44 respectively.

## PART - II : ONLY ONE OPTION CORRECT TYPE

**Section (A) : pH calculation : Solutions of polyprotic weak acids, Solutions of Polyacidic weak bases**

**Commit to memory :**

Solution of a polyprotic weak acid ($H_xA$) : $pH = \frac{1}{2}(pK_{a_1} - \log C)$ [if $\alpha_1 \le 0.1$ or 10%] ; $[H_{x-2}A^{2-}] = K_{a_2}$

Solution of a polyprotic weak base (B) : $pOH = \frac{1}{2}(pK_{b_1} - \log C)$ [if $\alpha_1 \le 0.1$ or 10%] ; $[BH_2^{2+}] = K_{b_2}$

**A-1.** $K_{b_1}$ of $N_2H_4$ is $4 \times 10^{-6}$. Then, what is the acid dissociation constant of $N_2H_5^+$ and $N_2H_6^{2+}$ respectively ?

(A) data insufficient, $4 \times 10^{-6}$
(B) data insufficient, $2.5 \times 10^{-8}$
(C) $2.5 \times 10^{-9}$, data insufficient
(D) $2.5 \times 10^{-9}$, $4 \times 10^{-6}$

**A-2.** For ortho phosphoric acid,

$H_3PO_4 (aq) + H_2O (aq) \longrightarrow H_3O^+ (aq) + H_2PO_4^- (aq)$ ; $K_{a_1}$

$H_2PO_4^- (aq) + H_2O (aq) \longrightarrow H_3O^+ (aq) + HPO_4^{2-} (aq)$ ; $K_{a_2}$

$HPO_4^{2-} (aq) + H_2O (aq) \longrightarrow H_3O^+ (aq) + PO_4^{3-} (aq)$ ; $K_{a_3}$

The correct order of $K_a$ values is :

(A) $K_{a_1} > K_{a_2} < K_{a_3}$
(B) $K_{a_1} < K_{a_2} < K_{a_3}$
(C) $K_{a_1} > K_{a_2} > K_{a_3}$
(D) $K_{a_1} < K_{a_2} > K_{a_3}$

**A-3.** In a solution of 0.1 M $H_3PO_4$ acid : (Given $K_{a_1} = 10^{-3}, K_{a_2} = 10^{-7}, K_{a_3} = 10^{-12}$ )

**(i)** Concentration of $H_3PO_4$ is :
(A) 0.01 M
(B) 0.09 M
(C) 0.05 M
(D) 0.1 M

**(ii)** Concentration of $H_2PO_4^-$ is :
(A) 0.01 M
(B) 0.09 M
(C) 0.02 M
(D) 0.04 M

**(iii)** Concentration of $HPO_4^{2-}$ is :
(A) $10^{-7}$ M
(B) $10^{-8}$ M
(C) $10^{-3}$ M
(D) $10^{-4}$ M

**(iv)** Concentration of $PO_4^{3-}$ is :
(A) $10^{-20}$ M
(B) $10^{-17}$ M
(C) $10^{-15}$ M
(D) $10^{-12}$ M

**(v)** pH of solution is :
(A) 1 (B) 2 (C) 4 (D) 5

**A-4.** Generally, in aqueous solutions of weak polyacidic bases, $OH^-$ ions produced fron 2nd ionisation are negligible because of :
(A) $K_{b_2} << K_{b_1}$
(B) Common ion effect exerted by $OH^-$ ions produced from 1st ionisation.
(C) Both (A) & (B)
(D) None of these

## Section (B) : pH calculation : Solutions containing mixture of weak monoprotic acid and strong acid, Solutions containing mixture of weak monoacidic base and strong base

**Commit to memory :**
Mixture of weak acid (monoprotic) and a strong acid : $[H^+]_f = C_1$ (just not considering the $H^+$ ions from WA).
Mixture of weak base (monoacidic) and a strong base : $[OH^-]_f = C_1$ (just not considering the $H^+$ ions from WB).

**B-1.** The dissociation constant of acetic acid at a given temperature is $1.69 \times 10^{-5}$. The degree of dissociation of 0.01 M acetic acid in the presence of 0.01 M HCl is :
(A) $1.69 \times 10^{-7}$ (B) $1.69 \times 10^{-5}$ (C) $1.69 \times 10^{-3}$ (D) $2.9 \times 10^{-2}$

**B-2.** On adding 100 mL of $10^{-2}$ M NaOH solution to 100 mL of 0.01 M Triethyl amine solution ($K_b = 6.4 \times 10^{-5}$), change in pH of solution with respect to triethylamine solution will be :
(A) – 0.8 (B) + 0.8 (C) + 1.1 (D) – 1.1

**B-3.** In above question, concentration of Triethyl ammonium ion ($[C_6NH_{16}^+]$) in resulting solution will be :
(A) 100 $K_b$ (B) 200 $K_b$ (C) 10 $K_b$ (D) $K_b$

## Section (C) : pH calculation : Solutions containing mixture of weak acids, Solutions containing mixture of weak bases

**Commit to memory :**
Mixture of two weak acids (both monoprotic) : $[H^+] = C_1\alpha_1 + C_2\alpha_2 = \sqrt{C_1K_{a_1} + C_2K_{a_2}}$
Mixture of two weak bases (both monoacidic) : $[OH^-] = C_1\alpha_1 + C_2\alpha_2 = \sqrt{C_1K_{b_1} + C_2K_{b_2}}$

**C-1.** Consider an aqueous solution, 0.1 M each in HOCN, HCOOH, $(COOH)_2$ and $H_3PO_4$. For HOCN, we can write : $K_a(HOCN) = \frac{[H^+][OCN^-]}{[HOCN]}$. $[H^+]$ in this equation is :
(A) $H^+$ ions released by HOCN
(B) Sum of $H^+$ ions released by all monoprotic acids
(C) Sum of $H^+$ ions released only the first dissociation of all the acids.
(D) Overall $H^+$ ion concentration in the solution.

**C-2.** What are $[H^+]$, $[A^-]$ and $[B^-]$ in a solution that contains 0.03 M HA and 0.1 M HB. $K_a$ for HA and HB are $3.0 \times 10^{-4}$ and $1.0 \times 10^{-10}$ respectively.
(A) $[H^+] = 3 \times 10^{-3}$ M (B) $[A^-] = 3 \times 10^{-3}$ M
(C) $[B^-] = 3.33 \times 10^{-9}$ M (D) All of these

**C-3.** pH of a solution obtained by mixing equal volumes of 0.1 M Triethyl amine ($K_b = 6.4 \times 10^{-5}$) & $\frac{4}{45}$ M $NH_4OH$ ($K_b = 1.8 \times 10^{-5}$) will be :
(A) 11.3 (B) 10.3 (C) 12.3 (D) 11.45

**C-4.** At 25ºC, $K_b$ for BOH = $1.0 \times 10^{-12}$. A 0.01 M solution of BOH has what value of $[OH^-]$ ?
(A) $1.0 \times 10^{-6}$ M (B) $\sqrt{2} \times 10^{-7}$ M (C) $1.0 \times 10^{-5}$ M (D) $2.0 \times 10^{-6}$ M

**Section (D) : pH calculation : Solutions containing mixture of weak polyprotic acid and strong acid, Solutions containing mixture of weak Polyacidic base and strong base**

**Commit to memory :**
Mixture of a polyprotic weak acid and a strong acid : $[H^+] = [H^+]$ from SA
Mixture of a polyprotic weak base and a strong base : $[OH^-] = [OH^-]$ from SB

**D-1.** For a solution obtained by mixing equal volumes of 0.02 M KOH solution & 0.2 M B (weak diacidic base; $K_{b_1} = 10^{-7}$ & $K_{b_2} = 10^{-14}$) solution :
(A) pH = 12 (B) $[BH^+] = 10^{-6}$ M (C) $[BH_2^{2+}] = 10^{-18}$ M (D) All of these

**Section (E) : Salt hydrolysis, pH calculation : Solutions of salt of monoprotic acid and monoacidic base.**

**Commit to memory :**

Salt of strong acid and weak base : $K_h \times K_b = K_w$ ; $h = \sqrt{\frac{K_h}{c}}$ ; $pH = \frac{1}{2}$ $[pK_w - pK_b - \log c]$ (valid if h < 0.1 or 10%)

Salt of strong base and weak acid : $K_h \times K_a = K_w$ ; $h = \sqrt{\frac{K_h}{c}}$ ; $pH = \frac{1}{2}$ $[pK_w + pK_a + \log c]$ (valid if h < 0.1 or 10%)

Salt of weak acid and weak base : $K_h \times K_a \times K_b = K_w$ ; $\left(\frac{h}{1-h}\right) = \sqrt{K_h}$ ; $pH = \frac{1}{2}[pK_w + pK_a - pK_b]$

**E-1.** The pH of a solution obtained by mixing 100 mL of 0.2 M $CH_3COOH$ with 100 mL of 0.2 M NaOH would be : ($pK_a$ for $CH_3COOH$ = 4.74)
(A) 4.74 (B) 8.87 (C) 9.10 (D) 8.57

**Section (F) : pH calculation : Solutions of salt of weak polyprotic acid and strong base, Solutions of salt of weak Polyacidic base and strong acid, Solutions of amphiprotic species.**

**Commit to memory :**
Solution containing polyvalent anion ($A^{x-}$) of weak polyprotic acid ($H_xA$) :

$$K_{h_1} = \frac{K_w}{K_{a_x}} \text{ ; } h = \sqrt{\frac{K_{h_1}}{C}} \text{ ; } pH = \frac{1}{2}[pK_w + pK_{a_x} + \log C]$$

Solution containing polyvalent cation ($BH_y^{y+}$) of weak polyprotic base (B) :

$$K_{h_1} = \frac{K_w}{K_{b_y}} \text{ ; } h = \sqrt{\frac{K_{h_1}}{C}} \text{ ; } pH = \frac{1}{2}[pK_w - pK_{b_y} - \log C]$$

Solution containing amphiprotic anion of acid $H_xA$ :

$$pH(H_{x-1}A^-) = \left(\frac{pK_{a_1} + pK_{a_2}}{2}\right) \text{ ; } pH(H_{x-2}A^{2-}) = \left(\frac{pK_{a_2} + pK_{a_3}}{2}\right)$$

**F-1.** For a $BH_2Cl_2$ solution (chloride salt of a diacidic base B): (Dissociation constants of base are $K_{b_1}$ & $K_{b_2}$ )
(A) $K_{h_1} << K_{h_2}$ (B) $K_{h_1} = \frac{K_w}{K_{b_1}}$ (C) $K_{h_1} = \frac{K_w}{K_{b_2}}$ (D) $K_{h_2} = \frac{K_{b_1}}{K_w}$

**F-2.** Select the correct statement regarding above solution :
(A) Anion will undergo hydrolysis producing $OH^-$ & solution is expected to be basic.
(B) Anion will not undergo hydrolysis & solution is expected to be basic.
(C) Cation will undergo hydrolysis producing $H_3O^+$ & solution is expected to be acidic.
(D) Cation will undergo hydrolysis producing $OH^-$ & solution is expected to be acidic.

**F-3.** pH of 0.1 M $Na_2HPO_4$ and 0.2 M $NaH_2PO_4$ are respectively: ($pK_a$ for $H_3PO_4$ are 2.2, 7.2 and 12)
(A) 4.7, 9.6 (B) 9.6, 4.7 (C) 9.3, 4.4 (D) 4.4, 9.3

**F-4.** The pH of which salt solution is independent of its concentration ?
1. $(CH_3COO)C_5H_5NH$ 2. $NaH_2PO_4$ 3. $Na_2HPO_4$ 4. $NH_4CN$
(A) 1, 2, 3, 4 (B) 1, 4 (C) 2, 3 (D) 1, 2, 3

# Exercise-2

**Marked questions are recommended for Revision.**

## PART - I : ONLY ONE OPTION CORRECT TYPE

**1.** In a solution obtained by mixing 100 mL of 0.25 M Triethylamine ($K_b = 6.4 \times 10^{-5}$) & 400 mL of $\frac{M}{18}$ $NH_4OH$ ($K_b = 1.8 \times 10^{-5}$) :
(A) $[NH_4^+] = 4 \times 10^{-4}$ M (B) $[C_6NH_{16}^+] = 1.6 \times 10^{-3}$ M
(C) Both (A) & (B) (D) None of these

**2.** Ratio of $[HA^{2-}]$ in 1 L of 0.1 M $H_3A$ solution ($K_{a_1} = 10^{-5}$; $K_{a_2} = 10^{-8}$ & $K_{a_3} = 10^{-11}$) & upon addition of 0.1 mole HCl to it will be :
(A) 10 (B) 100 (C) 1000 (D) 10,000

**3.** Calculate the degree of hydrolysis and pH of 0.005 M $K_2CrO_4$. $K_{a_2} = 5 \times 10^{-7}$ for $H_2CrO_4$. (It is essentially strong for first ionization)
(A) $h = 2 \times 10^{-3}$ (B) h = 0.01 (C) pH = 5 (D) pH = 9.7

## PART - II : SINGLE AND DOUBLE VALUE INTEGER TYPE

**1.** For a solution of weak triprotic acid $H_3A$ ($K_{a_1} >> K_{a_2}, K_{a_3}$; $K_{a_2} = 10^{-8}$; $K_{a_3} = 10^{-13}$), $[A^{3-}] = 10^{-17}$ M. Determine pH of solution. Report your answer as ‘0’, if you find data insufficient.

**2.** Calculate $[H^+]$ in a 0.2 M solution of dichloroacetic acid ($K_a = 5 \times 10^{-2}$) that also contains 0.05 M $H_2SO_4$. Report your answer after multiplying it by 400.

**3.** Calculate the ratio of concentrations of $HCOO^-$ & $OCN^-$ ions in a solution containing 0.1 M HCOOH ($K_a = 1.8 \times 10^{-4}$) and 0.1 M HOCN ($K_a = 4 \times 10^{-4}$). If simplest ratio is a : b, report your answer as (a + b).

**4.** In a solution containing 0.01 M HCl and 0.1 M $H_2CO_3$, ratio of $[H^+]$ produced from strong acid & weak acid respectively is: 1. Report your answer as x/500. Given: $K_{a_1}$ & $K_{a_2}$ of $H_2CO_3$ are $4 \times 10^{-7}$ & $4 \times 10^{-11}$ respectively.

**5.** Calculate the change in pH of 0.1 M $Na_2HA$ solution after diluting it to ten times the original volume. (Given that for $H_3A$ : $K_{a_1} = 10^{-4}$, $K_{a_2} = 10^{-7}$, $K_{a_3} = 10^{-11}$)

**6.** What is the pOH of a 0.5 M $Na_3PO_4$ solution ? Report your answer as 10 × pOH.
($K_{a_1} = 7.5 \times 10^{-3}$, $K_{a_2} = 6.2 \times 10^{-8}$, $K_{a_3} = 4 \times 10^{-13}$)

## PART - III : ONE OR MORE THAN ONE OPTIONS CORRECT TYPE

**1.** If $K_{a_1}$ and $K_{a_2}$ of $H_2SO_4$ are $10^{-2}$ and $10^{-6}$ respectively at a certain temperature, then :
(A) $K_{a_1} > K_{a_2}$ because it is easy to abstract $H^+$ from $H_2SO_4$ and less easy to abstract $H^+$ from $HSO_4^-$.
(B) $K_{a_1}$ and $K_{a_2}$ may be measured in acetic acid.
(C) $K_{a_1}$ and $K_{a_2}$ are measured in $H_2O$.
(D) the $H^+$ ion conc. of 0.01 M $H_2SO_4$ will be less than 0.02 M.

**2.** When 0.1 mole solid NaOH is added in 1 L of 0.1 M $NH_3(aq)$ ($K_b = 2 \times 10^{-5}$), then select the correct statement(s) :
(A) degree of dissociation of $NH_3$ approaches to zero.
(B) change in pH by adding NaOH would be 1.85.
(C) In solution, $[Na^+] = 0.1$ M, $[NH_3] = 0.1$ M, $[OH^-] = 0.2$ M.
(D) on addition of $OH^-$, $K_b$ of $NH_3$ does not changes.

**3.** Which of the following solutions when added to 1L of a 0.01 M $CH_3COOH$ solution will cause no change in the degree of dissociation of $CH_3COOH$ and pH of the solution ? $K_a = 1.6 \times 10^{-5}$ for $CH_3COOH$?
(A) 0.6 mM HCOOH ($K_a = 8 \times 10^{-4}$) (B) 0.1 M $CH_3COONa$
(C) 0.4 mM HCl (D) 0.01 M $CH_3COOH$

# Exercise-3

*** Marked questions may have more than one correct option.**

## PART - I : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

**1.** Will the pH of water be same at 4ºC and 25ºC ? Explain. **[JEE-2003, 2/60]**

**2.** A weak acid HX at 25ºC has the dissociation constant $1 \times 10^{-5}$. It forms a salt NaX on reaction with caustic soda. The percentage hydrolysis of 0.1 M solution of NaX is : **[JEE-2004(S), 3/84]**
(A) 0.0001% (B) 0.01 % (C) 0.1 % (D) 0.15 %

**3.** The dissociation constant of a substituted benzoic acid at 25ºC is $1.0 \times 10^{-4}$. The pH of 0.01 M solution of its sodium salt is : **[JEE-2009, 4/160]**

**4.** Amongst the following, the total number of compounds whose aqueous solution turns red litmus paper blue is : **[JEE-2010, 3/163]**

| | | | | |
|---|---|---|---|---|
| KCN | $K_2SO_4$ | $(NH_4)_2C_2O_4$ | NaCl | $Zn(NO_3)_2$ |
| $FeCl_3$ | $K_2CO_3$ | $NH_4NO_3$ | LiCN | |

## PART - II : JEE (MAIN) (PREVIOUS YEARS)

### JEE(MAIN) OFFLINE PROBLEMS

**1.** In aqueous solution, the ionization constants for carbonic acid are : **[AIEEE-2010, 4/144]**
$K_1 = 4.2 \times 10^{-7}$ and $K_2 = 4.8 \times 10^{-11}$
Select the correct statement for a saturated 0.034 M solution of the carbonic acid.
(1) The concentration of $CO_3^{2-}$ is 0.034 M.
(2) The concentration of $CO_3^{2-}$ is greater than that of $HCO_3^-$.
(3) The concentration of $H^+$ and $HCO_3^-$ are approximately equal.
(4) The concentration of $H^+$ is double that of $CO_3^{2-}$.

**2.** An aqueous solution contains 0.10 M $H_2S$ and 0.20 M HCl. If the equilibrium constant for the formation of $HS^-$ from $H_2S$ is $1.0 \times 10^{-7}$ and that of $S^{2-}$ from $HS^-$ ions is $1.2 \times 10^{-13}$ then the concentration of $S^{2-}$ ions in aqueous solution is : **[JEE(Main)-2018, 4/120]**
(1) $6 \times 10^{-21}$ (2) $5 \times 10^{-19}$ (3) $5 \times 10^{-8}$ (4) $3 \times 10^{-20}$

# Answers

## EXERCISE - 1

### PART - I

**A-1.** pH = 4.52, $3 \times 10^{-5}$ M, $1.2 \times 10^{-13}$ M **A-2.** 10.91

**B-1.** –1.52, $9 \times 10^{-5}$ M. **B-2.** 12, $2 \times 10^{-4}$ M, 0.2 %

**C-1.** $[H^+] = 8 \times 10^{-3}$ M, $[HCOO^-] = 3 \times 10^{-3}$ M, $[OCN^-] = 5 \times 10^{-3}$ M

| | | | | | |
|---|---|---|---|---|---|
| **D-1.** | $10^{-6}$ M, $10^{-18}$ M | **E-1.** | 11 | **E-2.** | pH = 4.19 |

## PART - II

**A-1.** (C) **A-2.** (C) **A-3.** **(i)** (B) **(ii)** (A) **(iii)** (A) **(iv)** (B) **(v)** (B)

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **A-4.** | (C) | **B-1.** | (C) | **B-2.** | (B) | **B-3.** | (D) | **C-1.** | (D) |
| **C-2.** | (D) | **C-3.** | (A) | **C-4.** | (B) | **D-1.** | (D) | **E-1.** | (B) |
| **F-1.** | (C) | **F-2.** | (C) | **F-3.** | (B) | **F-4.** | (A) | | |

# EXERCISE - 2

## PART - I

**1.** (C) **2.** (D) **3.** (A)

## PART - II

**1.** 4 **2.** 60 **3.** 29 (actual answer = 9 : 20) **4.** 5

**5.** 0 **6.** 10

## PART - III

**1.** (ABD) **2.** (ABD) **3.** (ACD)

# EXERCISE - 3

## PART – I

**1.** It will not be same at two different temperatures. **2.** (B) **3.** 8 **4.** **3**

## PART – II

### JEE(MAIN) OFFLINE PROBLEMS

**1.** (3) **2.** (4)