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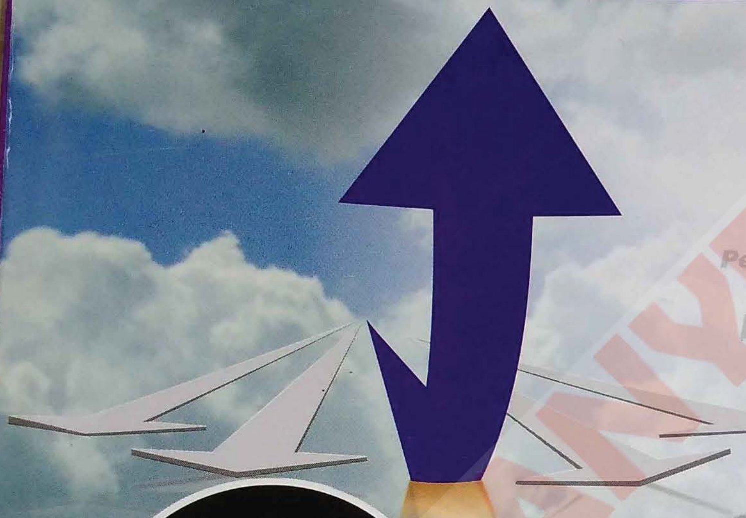

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CHEMISTRY

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PHYSICAL CHEMISTRY

SECTION-I (TOPIC WISE PROBLEMS)

TOPIC 1

ELECTROCHEMISTRY

SECTION - I : STRAIGHT OBJECTIVE TYPE

1.1 The reduction potential of hydrogen half cell will be negative if (T = 298 K) :

(A) P_{H_2} = 1 atm and $[H^+]$ = 1.0 M
(B) P_{H_2} = 2 atm and $[H^+]$ = 2.0 M
(C) P_{H_2} = 2 atm and $[H^+]$ = 1.0 M
(D) P_{H_2} = 1 atm and $[H^+]$ = 2.0 M

1.2 A very thin copper plate is electro-plated with gold using gold chloride in HCl. The current was passed for 20 minutes and the increase in the weight of the plate was found to be 2 gram [Au = 197]. The current passed was:

(A) 0.816 amp.
(B) 1.632 amp.
(C) 2.448 amp.
(D) 3.264 amp.

1.3 Given :

(i) $MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$ $E^0 = x_1 V$
(ii) $MnO_2 + 4H^+ + 2e^- \longrightarrow Mn^{2+} + 2H_2O$ $E^0 = x_2 V$

Find E^0 for the following reaction :

$MnO_4^- + 4H^+ + 3e^- \longrightarrow MnO_2 + 2H_2O$

(A) $x_2 - x_1$
(B) $x_1 - x_2$
(C) $\frac{5x_1 - 2x_2}{3}$
(D) $\frac{2x_1 - 5x_2}{3}$

1.4 The solubility of $[Co(NH_3)_4Cl_2]ClO_4$ ________, if the $\lambda_{Co(NH_3)_4Cl_2^+} = 50$, $\lambda_{ClO_4^-} = 70$ and the measured resistance was 33.5 Ω in a cell with cell constant of 0.20 is ________

(A) 59.75 mmol/L
(B) 49.75 mmol/L
(C) 39.75 mmol/L
(D) 29.75 mmol/L

1.5 We have taken a saturated solution of AgBr. K_{sp} of AgBr is 12×10^{-14}. If 10^{-7} mole of $AgNO_3$ are added to 1 litre of this solution then the conductivity of this solution in terms of 10^{-7} Sm^{-1} units will be

[Given $\lambda^\circ_{(Ag^+)} = 4 \times 10^{-3}$ $Sm^2 mol^{-1}$ $\lambda^\circ_{(Br^-)} = 6 \times 10^{-3}$ $S\,m^2 mol^{-1}$, $\lambda^\circ_{(NO_3^-)} = 5 \times 10^{-3}$ $Sm^2 mol^{-1}$]

(A) 39
(B) 55
(C) 15
(D) 41

1.6 The specific conductivity of an aqueous solution of a weak monoprotic acid is 0.00033 $ohm^{-1}cm^{-1}$ at a concentration 0.02 M. If at this concentration the degree of dissociation is 0.043, then calculate the value of Λ_0 (in ohm^{-1} cm^2 /eqt) :

(A) 483
(B) 438
(C) 348
(D) 384

1.7 At what $\frac{[Br^-]}{\sqrt{[CO_3^{2-}]}}$ does the following cell have its reaction at equilibrium?

$Ag(s) \mid Ag_2CO_3(s) \mid Na_2CO_3(aq) \parallel KBr(aq) \mid AgBr(s) \mid Ag(s)$

$K_{SP} = 8 \times 10^{-12}$ for Ag_2CO_3 and $K_{SP} = 4 \times 10^{-13}$ for AgBr

(A) $\sqrt{1} \times 10^{-7}$
(B) $\sqrt{2} \times 10^{-7}$
(C) $\sqrt{3} \times 10^{-7}$
(D) $\sqrt{4} \times 10^{-7}$

1.8 For the cell prepared from electrode A and B, electrode A : $\frac{Cr_2O_7^{2-}}{Cr^{3+}}$, $E^0_{red.}$ = + 1.33 V and electrode B : $\frac{Fe^{3+}}{Fe^{2+}}$, $E^0_{red.}$ = 0.77 V, which of the following statement is <u>**not correct?**</u>

(A) The electrons will flow from B to A (in the outer circuit) when connections are made.
(B) The standard e.m.f. of the cell will be 0.56 V.
(C) A will be positive electrode.
(D) None of the above.

1.9 Acetic acid has $K_a = 1.8 \times 10^{-5}$ while formic acid has $K_a = 2.1 \times 10^{-4}$. What would be the magnitude of the emf of the cell

$$Pt(H_2)\left|\begin{array}{c}0.1\text{ M acetic acid +}\\ 0.1\text{ M sodium acetate}\end{array}\right|\left|\begin{array}{c}0.1\text{ M formic acid +}\\ 0.1\text{ M sodium formate}\end{array}\right|Pt(H_2)\text{ at }25^\circ C\ ?$$

(A) 0.032 volt (B) 0.063 volt (C) 0.0456 volt (D) 0.055 volt

1.10 Consider the cell Ag(s)|AgBr(s)|Br^- (aq)|| Cl^-(aq) | AgCl(s) | Ag(s) at 25° C . The solubility product constants of AgBr & AgCl are 5×10^{-13} & 1×10^{-10} respectively. For what ratio of the concentrations of Br^- & Cl^- ions would the emf of the cell be zero ?

(A) 1 : 200 (B) 1 : 100 (C) 1 : 500 (D) 200 : 1

1.11 For a saturated solution of AgCl at 25°C, $k = 3.4 \times 10^{-6}$ ohm^{-1} cm^{-1} and that of H_2O (ℓ) used is 2.02×10^{-6} ohm^{-1} cm^{-1}. λ°_m for AgCl is 138 ohm^{-1} cm^2 mol^{-1}, then the solubility of AgCl in moles per liter will be :

(A) 10^{-5} (B) 10^{-10} (C) 10^{-14} (D) 10^{-16}

1.12 A current of 0.1A was passed for 4hr through a solution of cuprocyanide and 0.3745 g of copper was deposited on the cathode. Calculate the current efficiency for the copper deposition. (Cu GAM 63.5 or Cu– 63.5)

(A) 79% (B) 39.5 % (C) 63.25% (D) 63.5%

1.13 With t taken in seconds and I taken in Amp, the variation of I follows the equation

$t^2 + I^2 = 25$

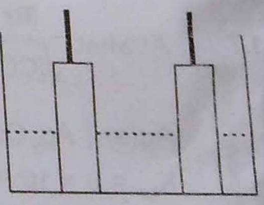
what amount of Ag will be electrodeposited with this current flowing in the interval 0–5 second ? (Ag GAM or Ag = 108)

(A) 22 mg (B) 66 mg (C) 77 mg (D) 88 mg

1.14 You are given the following cell at 298 K, $\underset{}{Zn}\left|\underset{0.01M}{Zn^{++}(aq.)}\right|\left|\underset{1.0\text{ lit.}}{HCl(aq.)}\right|\left|\underset{1.0\text{ atm.}}{H_2(g)}\right|$ Pt with E_{cell} = 0.701V and $E^0_{Zn^{2+}/Zn}$ = – 0.76 V. Which of the following amounts of NaOH (equivalent weight = 40) will just make the pH of cathodic compartment to be equal to 7.0 :

(A) 0.4 grams (B) 4 grams (C) 10 grams (D) 2 grams

1.15 A resistance of 50Ω is registered when two electrodes are suspended into a beaker containing a dilute solution of a strong electrolyte such that exactly half of the them are submerged into solution. If the solution is diluted by adding pure water (negligible conductivity) so as to just completely submerge the electrodes, the new resistance offered by the solution would be



(A) 50 Ω (B) 100 Ω (C) 25 Ω (D) 200 Ω

1.16 The standard reduction potential of a AgCl/Ag electrode is 0.2 V and that of a silver electrode (Ag^+/Ag) is 0.79 V. The maximum amount of AgCl that can dissolve in 10^6 L of a 0.1 M $AgNO_3$ solution is

(A) 0.5 mmol (B) 1.0 mmol (C) 2.0 mmol (D) 2.5 mmol

1.17 Calculate the cell EMF in mV for

$Pt \mid H_2(1atm) \mid HCl\ (0.01\ M) \mid AgCl(s) \mid Ag(s)$ at 298 K

if ΔG_f° values are at 25°C

$-109.56\ \frac{kJ}{mol}$ for AgCl(s) and

$-130.79\ \frac{kJ}{mol}$ for $(H^+ + Cl^-)\ (aq)$

(A) 456 mV (B) 654 mV (C) 546 mV (D) None of these

1.18 Value of Λ_m^∞ for $SrCl_2$ in water at 25°C from the following data :

Conc. (mol/lt)	0.5	1
$\Lambda_m\ (\Omega^{-1}\ cm^2\ mol^{-1})$	260	250

(A) 270 (B) 260 (C) 250 (D) 255

1.19 Calculate the useful work of the reaction $Ag(s) + 1/2Cl_2(g) \longrightarrow AgCl(s)$

Given $E^\circ_{Cl_2/Cl^-} = +1.36\ V$, $E^\circ_{Ag|AgCl|Cl^-} = 0.22\ V$

if $P_{Cl_2} = 1$ atm and T = 298 K

(A) 110 kJ/mol (B) 220 kJ/mol (C) 55 kJ/mol (D) 1000 kJ/mol

1.20 Select the correct statement if -

$E^\circ_{Mg^{2+}/Mg} = -2.4V$, $E^\circ_{Sn^{4+}/Sn^{2+}} = 0.1\ V$, $E^\circ_{MnO_4^-,H^+/Mn^{2+}} = 1.5\ V$, $E^\circ_{I_2/I^-} = 0.5\ V$

Here,

(A) MnO_4^- is the strongest oxidizing agent and Mg is the strongest reducing agent.

(B) $Sn^{4+} + 2I^- \longrightarrow Sn^{2+} + I_2$ is a spontaneous reaction.

(C) $Mg^{2+} + Sn^{2+} \longrightarrow Mg + Sn^{4+}$ is a spontaneous reaction.

(D) Here, weakest oxidizing agent is Sn^{4+} and weakest reducing agent is Mn^{2+}

1.21 A cell $Ag \mid Ag^+ \parallel Cu^{++} \mid Cu$ initially contains 2M Ag^+ and 2M Cu^{++} ions. The change in cell potential after the passage of 10 amp current for 4825 sec is :

(A) – 0.0074 V (B) – 1.00738 V (C) – 0.0038 V (D) none

1.22 For the cell (at 298 K)

$Ag(s) \mid AgCl(s) \mid Cl^-(aq) \parallel AgNO_3\ (aq) \mid Ag(s)$

Which of following is correct -

(A) The cell emf will be zero when ($[Ag^+]$ in anodic compartment = $[Ag^+]$ in cathodic compartment)

(B) The amount of AgCl(s) precipitate in anodic compartment will decrease with the working of the cell.

(C) The concentration of $[Ag^+]$ = constant, in anodic compartment during working of cell.

(D) $E_{cell} = E^0_{Ag^+|Ag} - E^0_{Cl^-|AgCl|Ag} - \frac{0.059}{1}\log\frac{1}{[Cl^-]_a}$

SECTION - II : MULTIPLE CORRECT ANSWER TYPE

1.23 A concentration cell Pt | H_2(g) | HCl (aq) || H_2SO_4(aq) | H_2(g) | Pt is constructed using equal concentration of acids and equal number of moles of H_2 gas in both the compartments at the same temperature. If volume of H_2 gas at the anodic compartment is $\frac{1}{9}$ times the volume of H_2 gas at cathodic compartment.

Which of the following is/are correct for the given cell (log 2 = 0.3, log 3 = 0.48) $\frac{2.303\ RT}{F} = 0.06$ V

(A) Pressure of H_2 gas in both the cell compartments are equal

(B) Concentration of H^+ ion in both the cell compartments are unequal

(C) $E^o_{cell} = 0$ for the above cell

(D) $E_{cell} \neq 0$ for the above cell

1.24 Peroxodisulphate salts ($Na_2S_2O_8$) are strong oxidizing agents used as bleaching agents for fats, oil etc.

Given

$O_2(g) + 4H^{\oplus}(aq) + 4e^- \longrightarrow 2H_2O(\ell)$ $E^o = 1.23$ V

$S_2O_8^{-2} + 2e^- \longrightarrow 2SO_4^{-2}$ (aq) $E^o = 2.01$ V

Which of the following statements is (are) correct ?

(A) Oxygen gas can oxidize sulphate ion to per-oxo disulphate ion ($S_2O_8^{-2}$) in acidic solution.

(B) O_2(g) is reduced to water

(C) Water is oxidised to O_2

(D) $S_2O_8^{-2}$ ions are reduced to SO_4^{-2} ions.

1.25 In which of the following cell (s) : $E_{cell} = E_{cell}^0$?

(A) $Cu(s)\ |Cu^{2+}(0.01M)\ ||\ Ag^+(0.1M)\ |\ Ag(s)$

(B) $\underset{1atm}{Pt, H_2(g)}\ |\ pH = 1\ ||\ Zn^{2+}(0.01M)\ |\ Zn(s)$

(C) $\underset{1atm}{Pt, H_2(g)}\ |\ pH = 1\ ||\ Zn^{2+}(1M)\ |\ Zn(s)$

(D) $\underset{1atm}{Pt, H_2(g)}\ |\ H^+ = 00.1M\ ||\ Zn^{2+}(0.01M)\ |\ Zn(s)$

1.26 Indicate the ***correct*** statements :

(A) Conductivity cells have cell constant values independent of the solution filled into the cell

(B) DC (direct current) is not used for measuring the resistance of a solution.

(C) Kohlrausch law is valid both for strong and weak electrolytes.

(D) The k decreases but λ_M and λ_E increase on dilution.

1.27 A current of 2.68 A is passed for one hour through an aqueous solution of $CuSO_4$ using copper electrodes. Select the correct statement(s) from the following :

(A) increase in mass of cathode = 3.174 g

(B) decrease in mass of anode = 3.174 g

(C) no change in masses of electrodes

(D) the ratio between the change of masses of cathode and anode is 1 : 2 .

1.28 Which is/a
Given, th
(A) Cu^{+1}
(B) Cu an
(C) E^0_{Cu}
(D) All o

1.29 The sta
PbO_2 +
MnO_4^-
Ce^{4+} +
H_2O_2 +
Pick o
(A) Ce
(C) H

1.30 Mark
(A) It
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SECTION

1.31 ST
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1.32 S
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1.28 Which is/are correct among the followings?

Given, the half cell emf's $E^0_{Cu^{+2}|Cu} = 0.337,\ E^0_{Cu^{+1}|Cu} = 0.521$

(A) Cu^{+1} disproportionates.

(B) Cu and Cu^{2+} comproportionates (reverse of disproportionation into Cu^+).

(C) $E^0_{Cu|Cu^{+2}} + E^0_{Cu^{+1}|Cu}$ is positive.

(D) All of these.

1.29 The standard reduction potentials of some half cell reactions are given below :

$PbO_2 + 4H^+ + 2e^- \rightleftharpoons Pb^{2+} + 2H_2O$ $E^0 = 1.455$ V
$MnO_4^- + 8H^+ + 5e^- \rightleftharpoons Mn^{2+} + 4H_2O$ $E^0 = 1.51$ V
$Ce^{4+} + e^- \rightleftharpoons Ce^{3+}$ $E^0 = 1.61$ V
$H_2O_2 + 2H^+ + 2e^- \rightleftharpoons 2H_2O$ $E^0 = 1.71$ V

Pick out the correct statement :

(A) Ce^{+4} will oxidise Pb^{2+} to PbO_2

(B) MnO_4^- will oxidise Pb^{2+} to PbO_2

(C) H_2O_2 will oxidise Mn^{+2} to MnO_4^-

(D) PbO_2 will oxidise Mn^{+2} to MnO_4^-

1.30 Mark out the correct statement(s) regarding electrolytic molar conductivity.

(A) It increase as temperature increases.

(B) It experiences resistance due to vibration of ion at the mean position.

(C) Increase in concentration decreases the electrolytic molar conductivity of both the strong as well as the weak electrolyte.

(D) Greater the polarity of solvent, greater is the electrolytic molar conduction.

SECTION - III : ASSERTION AND REASON TYPE

1.31 **STATEMENT-1 :** Specific conductance decreases with dilution whereas equivalent conductance increases.

STATEMENT-2 : On dilution number of ions per millilitre decreases but total number of ions increases considerably.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1

(C) Statement-1 is True, Statement-2 is False.

(D) Statement-1 is False, Statement-2 is True.

1.32 **STATEMENT-1 :** Zinc protect the iron better than tin even after it cracks.

STATEMENT-2 : $E^0_{OP_{Zn}} < E^0_{OP_{Fe}}$ But $E^0_{OP_{Sn}} > E^0_{OP_{Fe}}$

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.

(C) Statement-1 is True, Statement-2 is False.

(D) Statement-1 is False, Statement-2 is True.

1.33 **STATEMENT-1 :** On increasing dilution, the specific conductance keep on increasing.

STATEMENT-2 : On increasing dilution, degree of ionization of weak electrolyte increases and mobility of ions also increases.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.

(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.

(C) Statement-1 is True, Statement-2 is False.

(D) Statement-1 is False, Statement-2 is True.

1.34 **STATEMENT-1 :** s$E^0_{Fe^{++}|Fe} < E^0_{Ni^{++}|Ni}$ Fe electrode act as cathode and Ni electrode act as anode.

STATEMENT-2 : Because $\Delta G° < 0$ and $E°_{Cell} > 0$, so cell is possible.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement-2 is False.
(D) Statement-1 is False, Statement-2 is True.

SECTION - IV : COMPREHENSION TYPE

Comprehension # 1

A fuel cell is a cell that is continuously supplied with an oxidant and a reductant so that it can deliver a current indefinitely.

Fuel cells offer the possibility of achieving high thermodynamic efficiency in the conversion of Gibbs energy into mechanical work. Internal combustion engines at best convert only the fraction $(T_2 - T_1)/T_2$ of the heat of combustion into mechanical work.

While the thermodynamic efficiency of the fuel cell is given by, $\eta = \frac{\Delta G}{\Delta H}$, where ΔG is the Gibbs energy change for the cell reaction and ΔH is the enthalpy change of the cell reaction.

A hydrogen-oxygen fuel cell may have an acidic or alkaline electrolyte.

$$Pt \mid H_2(g) \mid H^+(aq.) \parallel H_2O(\ell) \mid O_2(g) \mid Pt \;; \qquad \frac{2.303RT}{F} = 0.06$$

The above fuel cell is used to produce constant current supply under constant temperature & 30 atm constant total pressure conditions in a cylinder. If 10 moles H_2 and 5 moles of O_2 were taken initially. Rate of consumption of O_2 is 10 milli moles per minute.

The half-cell reactions are

$$\frac{1}{2}O_2(g) + 2H^+(aq) + 2e^- \longrightarrow H_2O(\ell) \qquad E° = 1.246\ V$$

$$2H^+(aq) + 2e^- \longrightarrow H_2(g) \qquad E° = 0$$

To maximize the power per unit mass of an electrochemical cell, the electronic and electrolytic resistances of the cell must be minimized. Since fused salts have lower electrolytic resistances than aqueous solutions, high-temperature electrochemical cells are of special interest for practical applications.

1.35 Calculate e.m.f. of the given cell at t = 0. (log 2 = 0.3).
(A) 1.255 V (B) 1.35 V (C) 1.3 V (D) 1.246 V

1.36 The above fuel cell is used completely as an electrolytic cell with Cu voltameter of resistance 26.94 Ω using Pt electrodes. Initially Cu voltameter contains 1 litre solution of 0.05 M $CuSO_4$. $[H^+]$ in solution after electrolysis (Assuming no change in volume of solution).
(A) 0.015 M (B) 0.03 M (C) 0.025 M (D) 0.01 M

1.37 If $\lambda_m^\infty(Cu^{2+}) = 0.01\,S\ m^2\ mole^{-1}$, $\lambda_m^\infty(H^+) = 0.035\ S\ m^2\ mole^{-1}$ and $\lambda_m^\infty(SO_4^{2-}) = 0.016\ S\ m^2\ mole^{-1}$, specific conductivity of resulting solution left in copper voltameter after above electrolysis is
(A) $2.57S\ m^{-1}$ (B) $1.75\ S\ m^{-1}$ (C) $1.525\ S\ m^{-1}$ (D) $2.25\ S\ m^{-1}$

Comprehension # 2

The molar conductance of NaCl varies with the concentration as shown in the following table . and all values follows the equation

$\lambda_m^C = \lambda_m^\infty - b\sqrt{C}$ Where λ_m^C = molar specific conductance

λ_m^∞ = molar specific conductance at infinite dilution

C = molar concentration

Molar Concentration of NaCl	Molar Conductance in $ohm^{-1}\ cm^2\ mole^{-1}$
4×10^{-4}	107
9×10^{-4}	97
16×10^{-4}	87

When a certain conductivity cell (C) was filled with 25×10^{-4} (M) NaCl solution. The resistance of the cell was found to be 1000 ohm. At Infinite dilution, conductance of Cl^- and SO_4^{-2} are 80 $ohm^{-1}\ cm^2\ mole^{-1}$ and 160 $ohm^{-1}\ cm^2\ mole^{-1}$ respectively.

1.38 What is the molar conductance of NaCl at infinite dilution ?
(A) 147 $ohm^{-1}\ cm^2\ mole^{-1}$ (B) 107 $ohm^{-1}\ cm^2s\ mole^{-1}$
(C) 127 $ohm^{-1}\ cm^2\ mole^{-1}$ (D) 157 $ohm^{-1}\ cm^2\ mole^{-1}$

1.39 What is the cell constant of the conductivity cell (C)
(A) 0.385 cm^{-1} (B) 3.85 cm^{-1} (C) 38.5 cm^{-1} (D) 0.1925 cm^{-1}

1.40 If the cell (C) is filled with 5×10^{-3} (N) Na_2SO_4 the obserbed resistance was 400 ohm. What is the molar conductance of Na_2SO_4.
(A) 19.25 $ohm^{-1}\ cm^2\ mole^{-1}$ (B) 96.25 $ohm^{-1}\ cm^2\ mole^{-1}$
(C) 385 $ohm^{-1}\ cm^2\ mole^{-1}$ (D) 192.5 $ohm^{-1}\ cm^2s\ mole^{-1}$

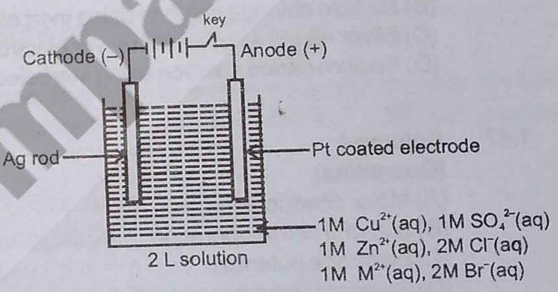
Comprehension # 4

The process of using an electric current to bring about chemical change is called electrolysis. Electrolysis is a process of oxidation and reduction at the respective electrodes due to external current passed in the electrolyte.

The product obtained during electrolysis depends on following factors.

○ The nature of the electrolyte
○ The concentration of electrolyte
○ The nature of the electrode.

Consider the electrolysis of following cell containing aq. solution of $CuSO_4$, $ZnCl_2$ and MBr_2 by using pure silver rod as a cathode and Pt electrode as anode. Assume that M^{2+} does not further oxidise and can not form complex with NH_3. Assume no hydrolysis of any ion.



$E^0_{Cu^{2+}/Cu} = 0.34$ V; $E^0_{M^{2+}/M} = -0.10$ V; $E^0_{Zn^{2+}/Zn} = -0.76$ V; $E^0_{H_2O/H_2} = -0.828$ V; $E^0_{Ag^+/Ag} = 0.80$ V, $\frac{2.303\ RT}{F} = 0.06$

1.41_ After passing 20 amp current from battery for 28950 sec. the remaining conc. of ions in solution given in passage would be : (Assume current efficiency to be 100%).
(A) $[Cu^{2+}] = 0.5M$, $[M^{2+}] = 0.5M$, $[Zn^{2+}] = 0.1M$ (B) $[Cu^{2+}] \approx 0$ M, $[M^{2+}] = 0.5M$, $[Zn^{2+}] = 0.5M$
(C) $[Cu^{2+}] = 0.5M$, $[M^{2+}] = 0.5M$, $[Zn^{2+}] = 0.5M$ (D) $[Cu^{2+}] \approx 0$ M, $[M^{2+}] = 0.5M$, $[Zn^{2+}] = 1M$

1.42_ What will be the volume of gases formed at anode at STP by electrolysis of above solution after passing 20 amp current for 28950 sec. (Assume current efficiency to be 100% and one mole of gas occupies 22.4 L volume at STP).
(A) 44.8 L Br_2 (B) 22.4 L Br_2 (C) 22.4 L Cl_2 (D) 44.8 L Cl_2

1.43_ If 36 mol of NH_3(g) is passed in electrolytic solution given in comprehension (assume no volume change by addition of NH_3), then what would be decreasing order of reduction potential of following :
{ $K_f\ [Cu(NH_3)_4]^{2+} = 1 \times 10^{12}$ and $K_f\ [Zn\ (NH_3)_4]^{2+} = 1 \times 10^9$ }
(A) $M^{2+} > Cu^{2+} > Zn^{2+}$ (B) $Cu^{2+} > M^{2+} > Zn^{2+}$ (C) $M^{2+} > Zn^{2+} > Cu^{2+}$ (D) $Cu^{2+} > M^{2+} > Zn^{2+}$

SECTION - V : MATRIX - MATCH TYPE

1.44 Given $E^0_{cu^{+2}/cu} = 0.34$ V

$E^0_{Cl_2/Cl^-} = 1.36$ V

$E^0_{Br_2/Br^-} = 1.08$ V

$E^0_{I_2/I^-} = 0.54$ V

Column- I	Column- II
(A) $Cu^{+2} + 2Cl \rightarrow Cu + Cl_2$	(p) Can produce electricity in the galvanic cell
(B) $Cl_2 + Cu \rightarrow Cu^{+2} + 2Cl^-$	(q) Can be made to occur in electrolysis cell
(C) $2I^-$ + starch solution + chlorine water	(r) Appearance of brown colour
(D) $2Br^- + CCl_4$ + chlorine water	(s) Appearance of violet colour

1.45 **Match the following :**

Column I	Column II
(A) Working concentration cell	(p) $H_2 + \frac{1}{2}O_2 \longrightarrow H_2O$ + electrical energy
(B) Spontaneous cell reaction	(q) $E^\circ_{cell} = 0$
(C) Non - working Daniel cell	(r) $E_{cell} > 0$
(D) Working fuel cell	(s) Galvanic cell
	(t) For working of concentration cell, concentration of cation in anodic compartment should be less then the cathodic compartment

1.46 Match the column :

Column-I	Column-II
(A) Molten $PbCl_2$ using inert electrode	(p) Metal of salt will reduced
(B) Sodium chloride solution using inert electrode	(q) $H_2O + 2e \rightarrow H_2(g) + 2OH^-$
(C) Silver nitrate solution with silver electrode	(r) Solution become basic after electrolysis
(D) Sodium nitrate solution using inert electrode	(s) Solution become neutral after electrolysis
	(t) Solution become acidic after electrolysis

1.47

Column-I **(Quantities)**	Column-II **(Factors on which dependency exist)**
(A) Molar conductance	(p) Temperature
(B) emf of a cell in operation	(q) Concentration of species involved
(C) Electrode potential	(r) Nature of substance involved
(D) Standard reduction potential	(s) No. of electrons lost or gained in the reaction
	(t) is on additive property.

SECTION - VI : INTEGER TYPE

1.48 A sparingly soluble salt MX is dissolved in water to prepare 1 L saturated solution. Now 10^{-6} mole NaX (assume 100% dissociation) is added into this. Conductivity of this solution is 29×10^{-6} S/m. If K_{sp} of MX is $a \times 10^{-b}$, then find value of (a + b). a is a natural number & $1 \le a \le 9$.

Given : $\lambda^0_{X^-} = 4 \times 10^{-3}$ S m² mol⁻

$\lambda^0_{Na^+} = 5 \times 10^{-3}$ S m² mol⁻

$\lambda^0_{M^+} = 6 \times 10^{-3}$ S m² mol⁻

1.49 100 ml, 0.05M $CuSO_4$ solution is electrolysed by using current of 0.965 Å for 100 min. Find the pH of solution at the end of electrolysis.

1.50 Small spherical ball of silver metal used in jewellery having diameter 0.1 cm, which is obtained by the electrolytic deposition. It total number of balls in jewellery is 10, 000, then calculate the applied amount of electricity in coulombs, which is used on the deposition on electrodes having entire surface 0.12 m^2. [Density of Ag = 10.5]
It is assumed that 3.5% electricity consumed as wastage during electrolysis and 60% of electrode body immersed in electrolyte. [Give your answer in multiple of 10^4]

1.51 The E^o_{Cell} = 1.18 V for
$Zn(s) \mid Zn^{+2}$ (1M) $\|$ Cu^{+2} (1M) $\mid Cu(s)$.
Determine the value of x if when excess granulated zinc is added to 1 M Cu^{+2} solution the $[Cu^{+2}]_{eq.}$ becomes 10^{-x} M. (T = 298 K, $\frac{2.303RT}{F} = 0.059$)

1.52 In the acid base titration [H_3PO_4 (0.1M) + NaOH (0.1M)] e.m.f of the solution is measured by coupling this electrodes with suitable reference electrode. When alkali is added pH of solution is in accordance with equation

$$E_{cell} = E^o_{cell} + 0.059\ pH$$

For H_3PO_4 $Ka_1 = 10^{-3}$; $Ka_2 = 10^{-8}$; $Ka_3 = 10^{-13}$
What is the cell e.m.f. at the IInd end point of the titration if E^o_{cell} at this stage is 1.3805 V.

1.53 The e.m.f. of a cell corresponding to the reaction

$$Zn + 2H^+ (aq) \longrightarrow Zn^{2+} (0.1M) + H_2(g)\ (1\ atm)$$

is 0.26 volt at 25°C. Calculate the pH of the solution at the hydrogen electrode.

1.54 A fuel cell uses $CH_4(g)$ and forms CO_3^{2-} at the anode. It is used to power a car with 80 Amp. for 0.96 hr. How many litres of $CH_4(g)$ (at STP.) would be required ? (V_m = 22.4 L/mol) (F = 96500). Assume 100% efficiency.

1.55 For the cells in opposition,
$Zn(s) \mid ZnCl_2(sol.) \mid AgCl(s) \mid Ag \mid AgCl(s) \mid ZnCl_2(sol.) \mid Zn(s)$
$C_1 = 0.02$ M $\qquad C_2 = 0.5$ M
Find out the emf (in millivolt) of the resultant cell ? (Take log 2 = 0.3, $\frac{RT}{F}$ at 298 K = 0.060)

1.56 The conductivity of a solution may be taken to be directly proportional to the total concentration of the charge carries (ions) present in it in many cases. Using the above fact find the percent decrease in conductivity (k) of a solution of a weak monoacidic base BOH when its 0.1 M solution is diluted to double its original volume. ($K_b = 10^{-5}$ for BOH)(take $\sqrt{50} = 7.07$) (Mark the answer to nearest integer)

1.57 At 0.04 M concentration the molar conductivity of a solution of a electrolyte is 5000 Ω^{-1} cm^2 mol^{-1} while at 0.01 M concentration the value is 5100 Ω^{-1} cm^2 mol^{-1} . Making necessary assumption (Taking it as strong electrolyte) find the molar conductivity at infinite dilution and also determine the degree of dissociation of strong electrolyte at 0.04 M.

TOPIC 2

IONIC EQUILIBRIUM

SECTION - I : STRAIGHT OBJECTIVE TYPE

2.1 Calculate [H^+], [$HCOO^-$] and [OCN^-] in a solution that contains 0.1M HCOOH ($K_a = 2.4 \times 10^{-4}$) and 0.1 M HOCN ($K_a = 4 \times 10^{-4}$).
(A) [H^+] = 8×10^{-3} M (B) [$HCOO^-$] = 3×10^{-3} M (C) [OCN^-] = 5×10^{-3} M (D) All of these

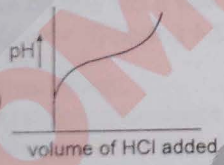
2.2 To prepare a buffer solution of pH = 4.04, amount of Barium acetate to be added to 100 mL of 0.1 M acetic acid solution [$pK_b(CH_3COO^-) = 9.26$] is :
(A) 0.05 mole (B) 0.025 mole (C) 0.1 mole (D) 0.005 mole

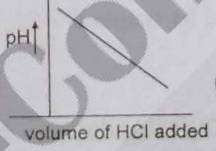
2.3 A 1.458 g of Mg reacts with 80.0 ml of a HCl solution whose pH is –0.477. The change in pH when all Mg has reacted. (Assume constant volume. Mg = 24.3 g/mol.) (log 3 = 0.47, log 2 = 0.301)
(A) –0.176 (B) +0.477 (C) –0.2385 (D) 0.3

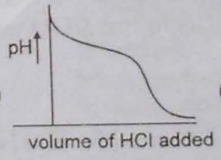
2.4 Find the ΔpH(initial pH – final pH) when 100 ml 0.01 M HCl is added in a solution containing 0.1 mmoles of $NaHCO_3$ solution of negligible volume ($Ka_1 = 10^{-7}$, $Ka_2 = 10^{-11}$ for H_2CO_3) :
(A) 6 + 2 log3 (B) 6 – log3 (C) 6 + 2log2 (D) 6 – 2log3

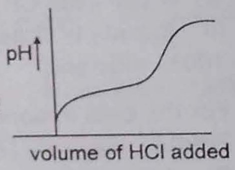
2.5 The ionization constant of benzoic acid is 6.46×10^{-5} and K_{sp} for silver benzoate is 2.5×10^{-13}. How many times silver benzoate more soluble in a buffer of pH = 3.19 as compared to its solubility in pure water ?
(A) 3.317 (B) 9.5 (C) 1000 (D) 7.5

2.6 When 100 ml of 0.1 M NaCN solution is titrated with 0.1 M HCl solution the variation of pH of solution with volume of HCl added will be :

(A)


(B)


(C)


(D)


2.7 The indicator constant for an acidic indicator, HIn is 5×10^{-6} M. This indicator appears only in the colour of acidic form when $\frac{[In^-]}{[HIn]} \le \frac{1}{20}$ and it appears only in the colour of basic form when $\frac{[HIn]}{[In^-]} \le \frac{1}{40}$.
The pH range of indicator is :
(A) 3.7 – 6.9 (B) 4.0 – 6.6 (C) 4.0 – 6.9 (D) 3.7 – 6.6

2.8 Ionisation constant of each HA (weak acid) and BOH (weak base) are 3.0×10^{-7} each at 298K. The percentage degree of hydrolysis of BA at the dilution of 10L is :
(A) 25 (B) 50 (C) 75 (D) 40

2.9 Which of the following concentrations of NH_4^+ will be sufficient to prevent the precipitation of $Mg(OH)_2$ from a solution which is 0.01 M $MgCl_2$ and 0.1 M NH_3 (aq). Given that : K_{SP} of Mg $(OH)_2 = 2.5 \times 10^{-11}$ and K_b for $NH_3(aq) = 2 \times 10^{-5}$.
(A) 0.01 M (B) 0.02 M (C) 0.001 M (D) 0.04 M

2.10 $pOH = 7 - 0.5\, pK_a + 0.5\, pK_b$ is true for aqueous solution containing which pair of cation and anion :
(A) $C_6H_5NH_3^+$, CH_3COO^- (B) NH_4^+, F^-
(C) Both (A) and (B) (D) None of these

2.11 An acid-base indicator which is a weak acid has a pK_a value = 5.35. At what concentration ratio of sodium acetate to acetic acid would the indicator show a colour half-way between those of its acid and conjugate base forms? pK_a of acetic acid = 4.75. [log 2 = 0.3]

(A) 4 : 1 (B) 7 : 1 (C) 5 : 1 (D) 2 : 1

2.12 The indicator constant of phenolphthalein is approximately 10^{-8}. A solution is prepared by adding 100.01 c.c. of 0.01 N sodium hydroxide to 100.00 c.c. of 0.01N hydrochloric acid. If a few drops of phenolphthalein are now added, what fraction of the indicator is converted to its coloured form?

(A) $\frac{1}{3}$ (B) $\frac{3}{4}$ (C) $\frac{1}{2}$ (D) $\frac{9}{11}$

2.13 A certain mixture of HCl and CH_3-COOH is 0.1 M in each of the acids. 20 ml of this solution is titrated against 0.1M NaOH. By how many units does the pH change from the start to the stage when the HCl is almost completely neutralised? K_a for acetic acid = 1.8×10^{-5}.

(A) 2.03 (B) 0.775 (C) 2.325 (D) 3.172

2.14 A buffer solution is made by mixing a weak acid HA ($K_a = 10^{-6}$) with its salt NaA in equal amounts. What should be the amount of acid or salt that should be added to make 90 ml of buffer solution of buffer capacity 0.1 ?

(A) 10 mmoles (B) 22 mmoles (C) 9 mmoles (D) 11 mmoles

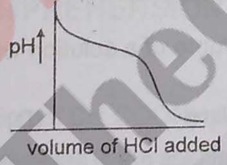
2.15 A sample of water has a hardness expressed as 80 ppm of Ca^{2+}. This sample is passed through an ion exchange column and the Ca^{2+} is replaced by H^+. What is the pH of the water after it has been so treated? [Atomic mass of Ca = 40]

(A) 3 (B) 2.7 (C) 5.4 (D) 2.4

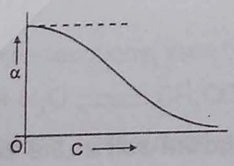
2.16 To a 100 mL of 0.1 M weak acid HA solution, 22.5 mL of 0.2 M solution of NaOH are added. Now, what volume of 0.1 M NaOH solution be added into above solution, so that pH of resulting solution be 4.7 : [Given : $(K_b(A^-) = 5 \times 10^{-10}]$

(A) 5 mL (B) 20 mL (C) 10 mL (D) 15 mL

2.17 (a) When 100 ml of 0.1 M NaCN solution is titrated with 0.1 M HCl solution the variation of pH of solution with volume of HCl added will be :



(b) Variation of degree of dissociation α with concentration for a weak electrolyte at a particular temperature is best represented by :



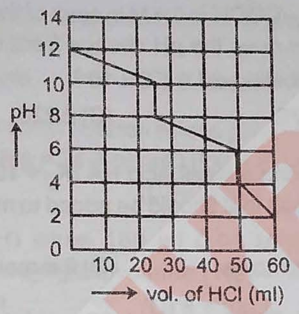
(c) 0.1 M acetic acid solution is titrated against 0.1 M NaOH solution. The difference in pH between 1/4 and 3/4 stages of neutralization of acid will be 2 log 3.

(A) T, F, T (B) F, F, F (C) T, T, T (D) F, T, F

SECTION - II : MULTIPLE CORRECT ANSWER TYPE

2.18 The variation of pH during the titration of 0.5 N Na_2CO_3 with 0.5 N HCl is shown in the given graph. The following table indicates the colour and pH ranges of different indicators :

Indicator	Range of colour change	Colour in acid	Colour in base
Thymol blue	1.2 to 2.8	Red	Yellow
Bromocresol red	4.2 to 6.3	Red	Yellow
Bromothymol blue	6.0 to 7.6	Yellow	Blue
Cresolphethalain	8.2 to 9.8	Colourless	Red



Based on the graph and the table, which of the following statements are true ?

(A) The first equivalence point can be detected by cresolphthalein.

(B) The complete neutralisation can be detected by bromothymol blue.

(C) The second equivalence point can be detected by bromocresol red.

(D) The volume of HCl required for the first equivalence point is half the volume of HCl required for the second equivalence point.

2.19 Which of the following solutions when added to 1L of a 0.1 M CH_3COOH solution will cause no change either in the degree of dissociation of CH_3COOH or in the pH of the solution. $K_a = 1.8 \times 10^{-5}$ for CH_3COOH?

(A) 3 mM HCOOH ($K_a = 6 \times 10^{-4}$)
(B) 0.1 M CH_3COONa
(C) 1.34 mM HCl
(D) 0.1 M CH_3COOH

2.20 A 1 litre solution of pH = 1 diluted upto 10 times. What volume of a solution with pH = 2 is to be added in diluted solution so that final pH remains '2'.

(A) 1 litre (B) 10 litre (C) 100 litre (D) 25 litre

2.21 Select the correct statements :

(A) pH of $NaHCO_3$ solution can be given by $\frac{pK_{H_2CO_3} + pK_{HCO_3^-}}{2}$

(B) Al^{3+} ion is amphoteric

(C) K_{SP} values of metal nitrates are very-very high

(D) Na^+ (aq). is conjugate acid of NaOH (aq).

2.22 Buffer solution A of a weak monoprotic acid and its sodium salt in the concentration ratio x : y has $pH = (pH)_1$. Buffer solution B of the same acid and its sodium salt in the concentration ratio y : x has $pH = (pH)_2$. If $(pH)_2 - (pH)_1 = 1$ unit and $(pH)_1 + (pH)_2 = 9.5$ units, then

(A) $pK_a = 4.75$ (B) $\frac{x}{y} = 2.36$ (C) $\frac{x}{y} = 3.162$ (D) $pK_a = 5.25$

SECTION - III : ASSERTION AND REASON TYPE

2.23 **STATEMENT-1 :** Phenolphthalein can be used as an indicator in the titration of weak acid with NaOH.
STATEMENT-2: Near the end point in the titration of weak acid with NaOH, the pH of the solution is alkaline due to hydrolysis of anion.
(A) Statement-1 is true, Statement-2 is true; Statement-2 is the correct explanation of Statement-1.
(B) Statement-1 is true, Statement-2 is true; Statement-2 is not the correct explanation of Statement-1
(C) Statement-1 is false, Statement-2 is true.
(D) Statement-1 is true, Statement-2 is false.

2.24 **STATEMENT-1 :** It is difficult to distinguish the strengths of the strong acids such as HCl, H_2SO_4, HNO_3, HBr, HI or $HClO_4$ in dilute aqueous solutions.
STATEMENT-2 : In dilute aqueous solution all strong acids donate a proton to water and are essentially 100% ionised to produce a solution containing H_3O^+ ions plus the anions of strong acid.
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True

2.25 **STATEMENT-1 :** 0.20 M solution of NaCN is more basic than 0.20 M solution of NaF.
STATEMENT-2 : 0.20 M solution of NaCN is more basic than 0.20 M solution of CH_3COONa.
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True

2.26 **STATEMENT-1 :** A substance that can either act as an acid or a base is called ampholyte.
STATEMENT-2 : Bisulphide ion (HS^-) and bicarbonate ion (HCO_3^-) are ampholytes.
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1
(C) Statement-1 is True, Statement-2 is False
(D) Statement-1 is False, Statement-2 is True

SECTION - IV : COMPREHENSION TYPE

Comprehension # 1

Consider a solution of CH_3COONH_4 which is a salt of weak acid & weak base.

The equilibrium involved in the solutions are :

$CH_3COO^- + H_2O \rightleftharpoons CH_3COOH + OH^-$ ....(1)

$NH_4^- + H_2O \rightleftharpoons NH_4OH + H^+$ ....(2)

$H^+ + OH^- \rightleftharpoons H_2O$ ....(3)

If we add these three reactions, then the net reaction is

$CH_3COO^- + NH_4^+ + H_2O \rightleftharpoons CH_3COOH + NH_4OH$ ....(4)

Both CH_3COO^- and NH_4^+ get hydrolysed independently and their hydrolysis depends on

(i) their initial concentration

(ii) the value of K_h which is $\frac{K_w}{K_a}$ for CH_3COO^- and $\frac{K_w}{K_b}$ for NH_4^+.

Since both of the ions were produced from the same salt, their initial concentrations are same. Therefore unless & until the value of $\frac{K_w}{K_a}$ and $\frac{K_w}{K_b}$ or K_a and K_b is same, the degree of hydrolysis of ion can't be same.

To explain why we assume that degree of hydrolysis of cation and anion is same, we need now to look at the third reaction i.e., combination of H^+ and OH^- ions. It is obvious that this reaction happens only because one reaction produced H^+ ion and the other produced OH^- ions. We can also note that this reaction causes both the hydrolysis reaction to occur more since their product ions are being consumed. Keep this thing in mind that the equilibrium which has smaller value of equilibrium constant is affected more by the common ion effect. For the same reason if for any reason a reaction is made to occur to a greater extent by the comsumption of any one of the product ion, the reaction with the smaller value of equilibrium constant tends to get affected more.

Therefore we conclude that firstly the hydrolysis of both the ions occurs more in the presence of each other (due to consumption of the product ions) than in each other is absence. Secondly the hydrolysis of the ion which occurs to a lesser extent (due to smaller value of K_h) is affected more than the one whose K_h is greater. Hence we can see that the degree of hydrolysis of both the ions would be close to each other when they are getting hydrolysed in the presence of each other.

2.27 In the hydrolysis of salt of weak acid & weak base :
(A) degree of hydrolysis of cation and anion is different
(B) degree of hydrolysis of cation and anion is same
(C) degree of hydrolysis of cation and anion is different and they can never be assumed same.
(D) degree of hydrolysis of cation and anion is different but they are very close to each other when they are getting hydrolysed in the presence of each other.

2.28 For 0.1 M CH_3COONH_4 salt solution given, $K_{a_{CH_3COOH}} = K_{b_{NH_4OH}} = 2 \times 10^{-5}$.
In this case : degree of hydrolysis of cation and anion is
(A) exactly same
(B) slightly different
(C) can't say
(D) different but can be take approximatly same

2.29 In a solution of $NaHCO_3$, the amphiprotic anion can undergo ionization to form H^+ ion and hydrolysis to form OH^- ion.

$$HCO_3^- + H_2O \xrightleftharpoons{\text{ionization}} CO_3^{2-} + H_3O^+$$

$$HCO_3^- + H_2O \xrightleftharpoons{\text{hydrolysis}} H_2CO_3 + OH^-$$

To calculate pH, suitable approximation is :
(A) $[CO_3^{2-}] = [H_2CO_3]$
(B) degree of ionization = degree of hydrolysis
(C) both (A) and (B)
(D) neither 'A' nore 'B'

Comprehension # 2

When aluminium salts are added to water, $A\ell^{3+}$ ions are immediately attracted to the negative end of polar water molecules. They form hexaaquaaluminum(III) ions, $[Al(H_2O)_6]^{3+}$. This is often written simply as $Al^{+3}(aq)$. However the electric field associated with small, highly charged Al^{+3} ion is so intense that it draws electrons in the O – H bonds of water towards itself. This enables the water molecules to become donors. In aqueous solution, free water molecules act as bases and the following equilibrium is established ;

$$[Al(H_2O)_6]^{3+} + H_2O \rightleftharpoons [Al(OH)(H_2O)_5]^{2+} + H_3O^+$$

Thus, solutions of Al^{+3} salts are acidic, in fact as acidic as vinegar. When a base stronger than H_2O, e.g. S^{2-} is added to aqueous aluminium salts further H^+ ions are removed from $[Al(H_2O)_6]^{3+}$ and insoluble aluminium hydroxide precipitates.

$$2[Al(H_2O)_6]^{3+}(aq) + 3S^{2-}(aq) \longrightarrow 2[Al(OH)_3(H_2O)_3](s) + 3H_2S(g)$$

More stronger base can remove $4H^+$ ions as follows :

$$[Al(H_2O)_6]^{3+} + 4OH^- \rightleftharpoons [Al(OH)_4(H_2O)]^-(aq) + 4H_2O(l)$$

2.30 Which of $[Al(H_2O)_6]^{3+}$, H_2S or H_2O is the strongest acid ?

(A) $[Al(H_2O)_6]^{3+}$ (B) H_2S (C) H_2O (D) all are same

2.31 A base which will behave just like S^{2-} :

(A) CO_3^{2-} (B) CH_3OH (C) NH_4^+ (D) NH_2^-

2.32 Another ion that would behave similar to Al^{+3} (aq) in forming an acidic solution is :

(A) $Be^{2+}_{(aq)}$ (B) $Ba^{2+}_{(aq)}$ (C) Na^+ (D) Tl^+

2.33 $[Al(OH)_3(H_2O)_3]$ (s) more simply written as $Al(OH)_3$(s) is :

(A) acidic (B) basic (C) neutral (D) amphoteric

2.34 Which gas would get absorbed when passed into a solution of Al^{+3} (aq) ?

(A) NH_3 (B) NO (C) CO (D) O_2

SECTION - V : MATRIX - MATCH TYPE

2.35 Match the effect of addition of 0.1 M KOH to 0.1 M, 50 ml H_3PO_4. Ka_1, Ka_2, Ka_3 are the I, II, III ionisation constant of H_3PO_4 :

Column-I	**Column-II**
(A) 75 ml of KOH	(p) $pH = P^{Ka_1}$
(B) 25 ml of KOH	(q) $pH = P^{Ka_2}$
(C) 150 ml of KOH	(r) $pH = \dfrac{P^{Ka_2} + P^{Ka_3}}{2}$
(D) 100 ml of KOH	(s) $pH = 7 + \dfrac{1}{2}[P^{Ka_3} + \log C]$
	(t) $pOH = 7 - \dfrac{1}{2}[P^{Ka_3} + \log C]$

2.36 We mix equal volume of two aqueous solution. Match the following :

Column I	**Column II (pH at 25°C)**
(A) 0.2 M KOH + 0.5 M HCOOH	(p) 0.7
(B) 0.1 M NaCl + 0.1 M $NaNO_3$	(q) between 1 to 7
(C) 0.1 M NH_4Cl + 0.1 M NaOH	(r) 7
(D) 0.5 M HCl + 0.1 M NH_4OH	(s) greater than 7
$[\log_{10} 2 = 0.3]$	(t) less than 7

2.37 Match the following :

If k_a of HCN $= 5 \times 10^{-10}$, k_a of HOCN $= 3.2 \times 10^{-4}$, k_b of $NH_3 = 1.8 \times 10^{-5}$, k_a of $CH_3COOH = 1.8 \times 10^{-5}$

(All data at 25°C)

Column-I	**Column-II** (pH at 25°C)
(A) 10^{-2} M NaCN	(p) pH > 7
(B) 100 ml of 10^{-1} M NaCl + 100 ml of 10^{-1} M HCl + 300 ml of 10^{-1} M NaOH	(q) pH ≠ 7
(C) 10^{-1} M HCl + 10^{-1} M HCN	(r) pH < 7
(D) 10^{-1} M NH_4OCN	(s) pH = 7
	(t) pOH < 7