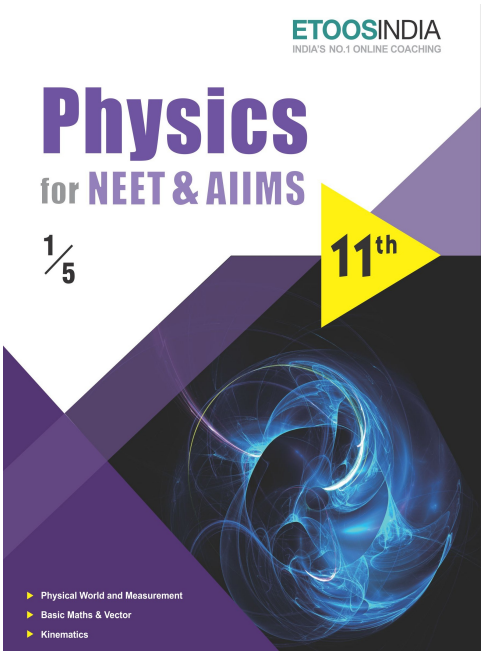
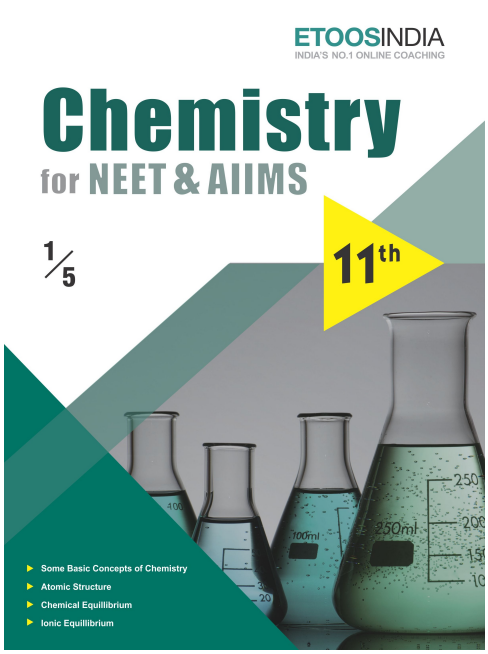
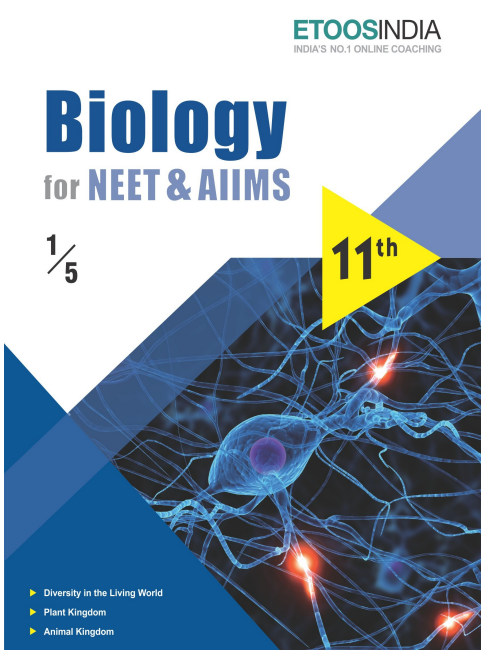
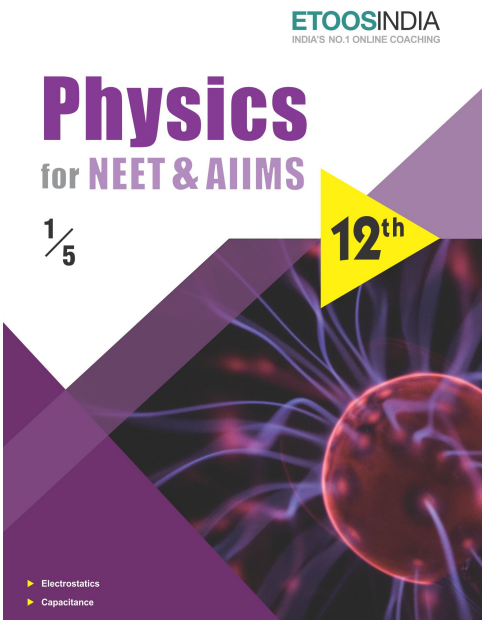
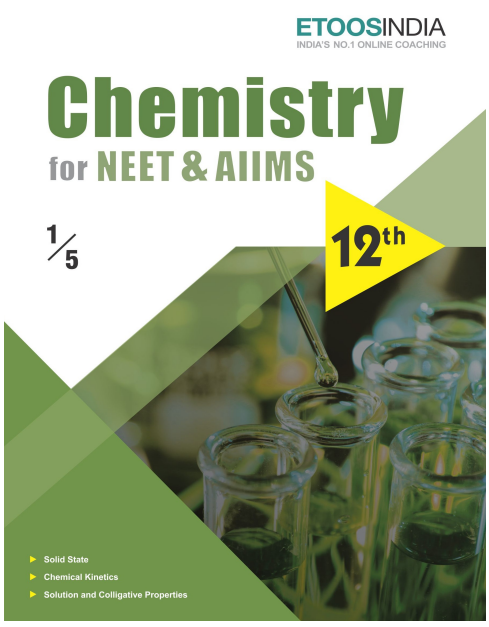
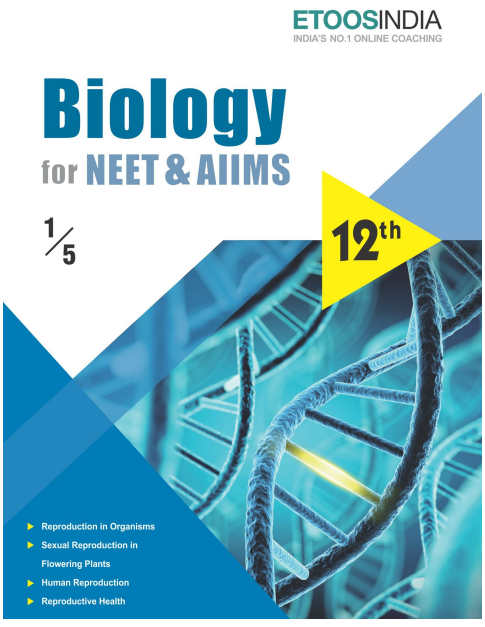












CHAPTER 04

ELECTRO CHEMISTRY

The removal of an electron from the surface of an atom - that is, the ionization of the atom - means a fundamental structural change in its surface layer.

"JOHANNES STARK"

INTRODUCTION

Electrochemistry is the study of production of electricity from energy released during spontaneous chemical reactions and the use of electrical energy to bring about non-spontaneous chemical transformations. The subject is of importance both for theoritical and practical considerations. A large number of metals, sodium hydroxide, chlorine, fluorine and many other chemicals are produced by electrochemical methods. Batteris and fuel cells convert chemical energy into electrical energy and are used on a large scale in various instruments and devices. The reactions carried out electrochemically can be energy efficient and less polluting. Therefore, study of electrochemistry is important for creating new technologies that are ecofriendly. The transmission of sensory signals through cells to brain and vice versa and communication between the cells are known to have electrochemical origin. Electrochemistry, is therefore, a very vast and interdisciplinary subject. In this Unit, we will cover only some of its important elementary aspects.

ELECTROLYTIC CONDUCTANCE

(a) Resistance (R) : Metallic and electrolytic conductors obey ohm's law according to which the resistance of a conductor is the ratio of the applied potential difference **(V)** to the current following**(I)**.

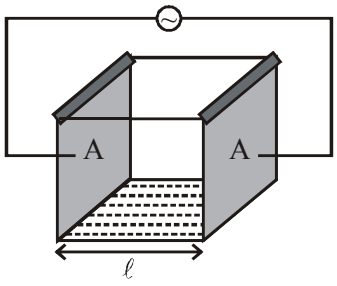
$$R = \frac{V}{I}$$ • R is expressed in ohms.

(b) Conductance (C) : The conductance of a conductor is equal to reciprocal of resistance

$$C = \frac{1}{R}$$ • C is expressed in mho or Siemens(S) or Ω^{-1}

(c) Specific resistance /Resistivity(ρ) : The resistance (R) of a conductor of uniform cross section is directly proportional to its length(ℓ) and inversely proportional to its area of cross section (A)

$$R \propto \frac{\ell}{A} \quad ; \quad R = \rho \frac{\ell}{A}$$



where ρ is a constant and called resistivity or specific resistance.

When $\ell = 1$, $A = 1$, then $\rho = R$

Thus the specific resistance may be defined as the resistance of a conductor of unit length and unit area of cross section.

or

Therefore resistance offered by 1 cm^3 elecrolytic solution is known as resistivity.

- Unit of $\rho \rightarrow$ ohm .cm elecrolyte

(d) Specific conductance / Conductivity(κ) :

It is defined as the reciprocal of specific resistance

$$\kappa = \frac{1}{\rho}$$

The above definitions apply to metallic conductors and electrolytes.

- In the case of solution of electrolytes, the resistance offered by the solution to the flow of current is –
- Directly proportional to the distance between the electrodes

  $R \propto \ell$
- Inversely proportional to the area of cross section of the electrodes

$$R \propto \frac{1}{A} \quad R = \rho \frac{\ell}{A}$$

The conductance $C = \frac{A}{\rho \ell}$

$\because \frac{1}{\rho} = \kappa$ so $\kappa = \frac{C\ell}{A}$

If $\ell =$ 1 cm and $A = 1\ cm^2$ then

$\kappa = C$

Hence specific conductivity of a solution is defined as the conductance of one centimeter cube of the solution of the electrolyte.

Ex. A current of 2 A was passed for 1.5 hours through a solution of $CuSO_4$ when 1.6 g of copper was deposited. Calculate percentage current efficiency.

Sol. Amount of current required to deposit 1 mole Cu (63.5 g) = 2×96500 C

Current required to deposit 1.6g of copper = $\frac{2 \times 96500}{63.5} = 4862.99$ C

Current actually passed through = $2 \times 1.5 \times 60 \times 60 = 10800$

Current efficiency = $\frac{4862.99}{10800} \times 100 = 45.03\%$

ETOOS KEY POINTS

(i) The electric current consists of flow of electrons and the current enters the electrolyte through anode and leaves through the cathode and electrons are being forced into the cell.

(ii) During the electrolysis of aqueous electrolytic solutions, redox processes become complicated because of the formation of ions from water which also take part in the electrolysis.

(iii) Cations arranged in the series of standard reductin electrode potentials in the order Mn^{2+}, Zn^{2+}, Cr^{3+}, Fe^{2+}, Ni^{2+}, Pb^{2+} and H^+ are reduced along with the water molecules during the electrolysis of solutions.

(iv) Anions of hydracids and those of salts of these acids (F^-, Cl^-, Br^-, I^-, S^{2-}, CN^- etc.) hold their electrons less tightly than does the OH^- ion from water. This is the reason why during the electrolysis of aqueous solutions of salts of hydracids, the acid anions are oxidised.

(v) Anions of oxyacids sucha s NO_3^-, SO_3^{2-}, PO_4^{3-} etc. hold their electrons more tightly than the OH^- ions. Hence, during the electrolysis of aqueous solutions of salts of oxyacids, water molecule is oxidised. $[2H_2O - 4e^- \rightarrow O_2 + 4H^+]$, while the salt ions (anions) remain unchanged.

Some Special Cells

(A) Concentration Cells

A concentration cell is a form of galvanic cell that has two equivalent half cells of the same material having difference only in concentrations. For such cell anode and cathode are same so $E^0_{cell} = 0$.

eg. $Pt, H_2(g)(P_1 \text{ atm}) | H^+(C_1) || H^+(C_2) | H_2(g)(P_2 \text{ atm}), Pt$

Anode Reaction : $H_2(P_1) \longrightarrow 2H^+(C_1) + 2e^-$

Cathode Reaction : $2H^+(C_2) + 2e^- \longrightarrow H_2(P_2)$

Cell Reaction : $H_2(P_1) + 2H^+(C_2) \longrightarrow 2H^+(C_1) + H_2(P_2)$

$$E_{cell} = E^0_{cell} - \frac{0.0591}{n} \log \frac{[P]}{[R]}$$

So, $$E_{cell} = 0 - \frac{0.0591}{2} \log \left[\frac{C_1}{C_2}\right]^2 \frac{P_2}{P_1}$$

Case 1 : If $P_1 = P_2 = 1$ atm $E_{cell} = -\frac{0.059}{2} \log \left[\frac{C_1}{C_2}\right]^2$

Etoos Tips & Formulas

(10) KOHLRAUSEH'S LAW :

$\Lambda_m^\infty(A_xB_y) = x\lambda_+^\infty + y\lambda_-^\infty$

$\Lambda_m^\infty(K_2SO_4) = 2\lambda_+^\infty + \lambda_-^\infty$

$\Lambda_m^\infty(Na_3PO_4) = 3\lambda_+^\infty + \lambda_-^\infty$

$\Lambda_m^\infty[Fe_2(SO_4)_3] = 2\lambda_+^\infty + 3\lambda_-^\infty$

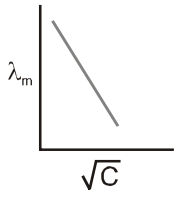
(11) FORMULA

(1) $R = \rho \times \frac{\ell}{A}$

(2) $\lambda_m = k \times \frac{1000}{M}$

(3) $\lambda_{eq.} = k \times \frac{1000}{N}$

(4) for strong electrolyte $\lambda_m = \lambda_{m_\infty} - b\sqrt{C}$



12. The reduction of cations is based on the standard reduction potential provided all ons have 1 M concentration, which follows the order

$Li^+ < K^+ < Ba^{+2} < Ca^{+2} < Na^+ < Mg^{+2} < Al^{+3} < Zn^{+2} < Fe^{+2} < Ni^{+2} < Sn^{+2} < Pb^{+2} < H^+ < Cu^{+2} < Ag^+ < Au^{3+}$

13. From anions the oxidation is based on standard oxidation potentials provided they are at 1 M concentration which follows the order $SO_4^{-2} < NO_3^- < OH^- < Cl^- < Br^- < I^-$

14. $A \mid A^{n+} \mid B^{n+} \mid B$

$$E_{cell} = E^0_{B^{n+1}/B} - E^0_{A^{n+}/A} - \frac{0.059}{n}\log\frac{[A^{n+}]}{[B^{n+}]}$$

15. For non-redox reaction EMF is not defined.

16. For a half cell of the type Cl^- (C) | AgCl | Ag, its half cell potential is equal tothe half cell potential of Ag^+ ($K_{SP}/[Cl^-]$) + Ag but the E° of the two half cells are not same.

17. Concentration cells are those whose E°_{cell} is zero. They are categorized as electrode and electrolyte concentrations cells.

SOLVED EXAMPLE

Ex. 1 Which cell will measure standard electrode potential of copper electrode

(A) $Pt(s)|H_2(g, 0.1\,bar)|H^+(aq., 1\,M)||Cu^{2+}(aq, 1\,M)|Cu$

(B) $Pt(s)|H_2(g, 1\,bar)|H^+(aq., 1\,M)||Cu^{2+}(aq, 2\,M)|Cu$

(C) $Pt(s)|H_2(g, 1\,bar)|H^+(aq., 1\,M)||Cu^{2+}(aq, 1\,M)|Cu$

(D) $Pt(s)|H_2(g, 0.1\,bar)|H^+(aq., 0.1\,M)||Cu^{2+}(aq, 1\,M)|Cu$

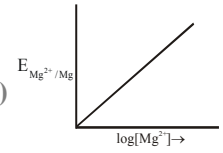
Sol. **(C)** Standard electrode potential of copper electrode can be calculated by constructing a concentration cell composed of two half cell reactions in which concentration of species on left hand and right hand side are unity. In such case cell potential is equal to standard electrode potential.

$$\underbrace{Pt(s)\,|\,H_2(g, 1bar)\,||\,H^+(aq, 1M)\,||}_{\text{Oxidation half cell reaction}}\underbrace{Cu^{2+}(aq,\ 1M)\,|Cu}_{\text{Re duction half cell reaction}}$$

Ex. 2 Electrode potential for Mg electrode varies according to the equation

$E_{Mg^{2+}/Mg} = E^{\ominus}_{Mg^{2+}/Mg} - \frac{0.059}{2}\log\frac{1}{[Mg^{2+}]}$. The graph of $E_{Mg^{2+}/Mg}$ vs $\log[Mg^{2+}]$ is

(A)



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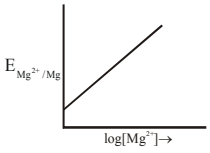

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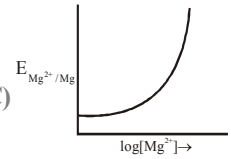
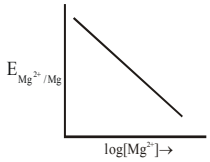


(D)



Sol. **(B)** Electrode potential for Mg electrode varies according to the equation

$$E_{Mg^{2+}/Mg} = E^{\circ}_{Mg^{2+}/Mg} - \frac{0.059}{2}\log\frac{1}{[Mg^{2+}]}$$

$$E_{Mg^{2+}/Mg} = E^{\circ}_{Mg^{2+}/Mg} + \frac{0.059}{2}\log[Mg^{2+}]$$

$$E_{Mg^{2+}/Mg} = \frac{0.059}{2}\log[Mg^{2+}] + E^{o}_{Mg^{2+}/Mg}$$

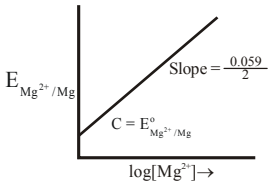
The equation represents equation of straight line. It can be correlated as

$$E_{Mg^{2+}/Mg} = \left(\frac{0.059}{2}\right)\log[Mg^{2+}] + E^{o}_{Mg^{2+}/Mg}$$

$\uparrow$ Y $\quad\uparrow$ M $\quad\uparrow$ X $\quad\uparrow$ +C

So intercept **(C)** = $E^{o}_{Mg^{2+}/Mg}$

Thus equation can be diagrammatically represented as.



Ex. 3 Which of the following statement is correct

(A) E_{cell} and $\Delta_r G$ of cell reaction both are extensive properties

(B) E_{cell} and $\Delta_r G$ of cell reaction both are intensive properties

(C) E_{cell} is an intensive property while $\Delta_r G$ of cell reaction is an extensive property

(D) E_{cell} is an extensive property while $\Delta_r G$ of cell reaction is an intensive property

Sol. **(C)** E_{cell} is an intensive property as it does not depend upon mass of species (number of particles) but $\Delta_r G$ of the cell reaction is an extensive property because this depends upon mass of species (number of particles).

Ex. 4 Which of the following statement is not correct about an inert electrode in a cell

(A) It does not participate in the cell reaction

(B) It provides surface either for oxidation or for reduction reaction

(C) It provides surface for conduction of electrons

(D) It provides surface for redox reaction

Sol. **(D)** An inert electrode in a cell provide surface for either oxidation or for reduction reaction by conduction of electrons through its surface but does not praticipate in the cell reaction.

It does not provide surface for redox reaction.

Exercise # 1 SINGLE OBJECTIVE NEET LEVEL

1. Which of the following will not conduct electricity in aqueous solution
(A) Copper sulphate (B) Sugar
(C) Common salt (D) None of these

2. Strong electrolytes are those which
(A) Dissolve readily in water
(B) Conduct electricity
(C) Dissociate into ions at high dilution
(D) Completely dissociate into ions at all dilutions

3. In aqueous solution, strong electrolytes
(A) Are partially ionized
(B) Do not ionise
(C) Ionise almost completely
(D) Form polymers

4. An electrolyte
(A) Forms complex ions in solution
(B) Gives ions only when electricity is passed
(C) Possesses ions even in solid state
(D) Gives ions only when dissolved in water

5. Electrolytes when dissolved in water dissociates into ions because
(A) They are unstable
(B) The water dissolves it
(C) The force of repulsion increases
(D) The forces of electrostatic attraction are broken down by water

6. Electrolyte can conduct electricity because
(A) Their molecules contain unpaired electrons, which are mobile
(B) Their molecules contain loosely held electrons which get free under the influence of voltage
(C) The molecules break up into ions when a voltage is applied
(D) The molecules are broken up into ions when the electrolyte is fused or is dissolved in the solvent

7. Which one of the following metals could not be obtained on electrolysis of aqueous solution of its salts
(A) Ag (B) Mg (C) Cu (D) Cr

8. Which of the following aqueous solution will conduct an electric current quite well
(A) Glycerol (B) HCl
(C) Sugar (D) Pure water

9. On the electrolysis of aqueous solution of sodium sulphate, on cathode we get
(A) Na (B) H_2
(C) SO_2 (D) SO_3

10. Electrolysis involves oxidation and reduction respectively at
(A) Anode and cathode (B) Cathode and anode
(C) At both the electrodes (D) None of the above

11. Which of the following compounds will not undergo decomposition on passing electricity through aqueous solution
(A) Sugar (B) Sodium Chloride
(C) Sodium Bromide (D) Sodium Acetate

12. During the electrolysis of an electrolyte, the number of ions produced, is directly proportional to the
(A) Time consumed
(B) Electro chemical equivalent of electrolysis
(C) Quantity of electricity passed
(D) Mass of electrons

13. When the sample of copper with zinc impurity is to be purified by electrolysis, the appropriate electrodes are

Cathode	Anode
(A) Pure zinc	Pure copper
(B) Impure sample	Pure copper
(C) Impure zinc	Impure sample
(D) Pure copper	Impure sample

14. In the electrolytic cell, flow of electrons is from
(A) Cathode to anode in solution
(B) Cathode to anode through external supply
(C) Cathode to anode through internal supply
(D) Anode to cathode through internal supply

15. An electric current is passed through an aqueous solution of the following. Which one shall decompose
(A) Urea (B) Glucose
(C) $AgNO_3$ (D) Ethyl alcohol

16. Amount of electricity that can deposit 108 gm of silver from $AgNO_3$ solution is
(A) 1 ampere (B) 1 coulomb
(C) 1 faraday (D) None of the above

Exercise # 2 SINGLE OBJECTIVE AIIMS LEVEL

1. The standard reduction potentials E° of the following systems are

System	E° (volts)
(i) $MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$	1.51
(ii) $Sn^{4+} + 2e^- \longrightarrow Sn^{2+}$	0.15
(iii) $Cr_2O_7^{2-} + 14H^+ + 6e^- \longrightarrow 2Cr^{3+} + 7H_2O$	1.33
(iv) $Ce^{4+} + e^- \longrightarrow Ce^{3+}$	1.61

The oxidising power of the various species decreases in the order

(A) $Ce^{4+} > Cr_2O_7^{2-} > Sn^{4+} > MnO_4^-$

(B) $Ce^{4+} > MnO_4^- > Cr_2O_7^{2-} > Sn^{4+}$

(C) $Cr_2O_7^{2-} > Sn^{4+} > Ce^{4+} > MnO_4^-$

(D) $MnO_4^- > Ce^{4+} > Sn^{4+} > Cr_2O_7^{2-}$

2. Consider the reaction : (T = 298 K)

$Cl_2(g) + 2Br^-(aq) \longrightarrow 2Cl^-(aq) + Br_2(aq.)$

The emf of the cell, when $[Cl^-] = [Br_2] = [Br^-]$ = 0.01M and Cl_2 gas is at 1 atm pressure, will be :

(E° for the above reaction is = 0.29 volt)

(A) 0.54 volt **(B)** 0.35 volt
(C) 0.24 volt **(D)** –0.29 volt

3. $2Ce^{4+} + Co \longrightarrow 2Ce^{3+} + Co^{2+}$ $E^\circ_{cell} = 1.89$ V, $E^\circ_{Co^{2+}/Co} = -0.277$ V hence, $E^\circ_{Ce^{4+}/Ce^{3+}}$ is :

(A) 0.805 V **(B)** 1.62 V
(C) – 0.805 V **(D)** – 1.61 V

4. Given : $E^\circ(Cu^{2+} | Cu) = 0.337$ V and $E^\circ(Sn^{2+} | Sn) = -0.136$ V. Which of the following statements is correct?

(A) Cu^{2+} ions can be reduced by $H_2(g)$
(B) Cu can be oxidized by H^+
(C) Sn^{2+} ions can be reduced by $H_2(g)$
(D) Cu can reduce Sn^{2+}

5. Red hot carbon will remove oxygen from the oxide AO and BO but not from MO, while B will remove oxygen from AO. The activity of metals A, B and M in decreasing order is

(A) A > B > M **(B)** B > A > M
(C) M > B > A **(D)** M > A > B

6. What is the emf at 25° C for the cell, Ag $\left|\begin{matrix}AgBr(s), Br^- \\ a = 0.34\end{matrix}\right|, \left|\begin{matrix}Fe^{3+}, Fe^{2+} \\ a = 0.1 \quad a = 0.02\end{matrix}\right|$ Pt

The standard reduction potentials for the half-reactions

$AgBr + e^- \rightarrow Ag + Br^-$ and $Fe^{3+} + e^- \rightarrow Fe^{2+}$ are + 0.0713 V and + 0.770 V respectively.

(A) 0.474 volt **(B)** 0.529 volt
(C) 0.356 volt **(D)** 0.713 volt

7. $MnO_4^- + 8H^+ + 5e^- \longrightarrow Mn^{2+} + 4H_2O$; $E^\circ = 1.51$ V; $\Delta G_1^0 = -5 \times 1.51 \times F$

$MnO_2 + 4H^+ + 2e^- \longrightarrow Mn^{2+} + 2H_2O$; $E^\circ = 1.23$ V; $\Delta G_2^0 = -2 \times 1.23 \times F$ $E^\circ_{MnO_4^-|MnO_2}$ is

(A) 1.70 V **(B)** 0.91 V
(C) 1.37 V **(D)** 0.548 V

8. A hydrogen electrode placed in a buffer solution of CH_3COONa and CH_3COOH in the ratios of x : y and y : x has electrode potential values E_1 volts and E_2 volts, respectively at 25°C. The pK_a values of acetic acid is (E_1 and E_2 are oxidation potentials)

(A) $\frac{E_1 + E_2}{0.118}$ **(B)** $\frac{E_2 - E_1}{0.118}$

(C) $-\frac{E_1 + E_2}{0.118}$ **(D)** $\frac{E_1 - E_2}{0.118}$

9. The electrode potential of electrode

$M(s) \longrightarrow M^{n+}(aq)\ (2M) + ne^-$.

at 298 K is E_1. When temperature is doubled and concentration is made half, then the electrode potential becomes E_2. Which of the following represents the correct relationship between E_1 and E_2 ?

(A) $E_1 > E_2$ **(B)** $E_1 < E_2$
(C) $E_1 = E_2$ **(D)** Can't be predicted

10. During the preparation of $H_2S_2O_8$ (per disulphuric acid) O_2 gas also releases at anode as byproduct, When 9.72 L of H_2 releases at cathode and 2.35 L O_2 at anode at STP, the weight of $H_2S_2O_8$ produced in gram is

(A) 87.12 **(B)** 43.56
(C) 83.42 **(D)** 51.74

Exercise # 3 PART - 1 MATRIX MATCH COLUMN

1. Match Matrix ($E^0_{Ag^+/Ag} = 0.8$, $K_{SP}(AgCl) = 10^{-10}$).

Column – I	Column – II
(A) $Pt \mid H_2\ (0.1\ bar) \mid H^+\ (0.1\ M) \parallel H^+\ (1\ M) \mid H_2\ (0.01\ bar) \mid Pt$	**(p)** Concentration cell
(B) $Ag \mid AgCl\ (KCl, 0.1M) \parallel Ag^+\ (0.01M) \mid Ag$	**(q)** $E_{cell} > 0$
(C) $Cu \mid Cu^{2+}\ (0.1\ M) \parallel Cu^{2+}\ (0.01\ M) \mid Cu$	**(r)** $E^\circ_{cell} = 0$ but cell is working.
(D) $Pt \mid Cl_2\ (1bar) \mid HCl\ (0.1\ M) \parallel NaCl\ (0.1M) \mid Cl_2 \mid Pt\ (1\ bar)$	**(s)** non working condition

2. Match the column

Column I	Column II
(A) $Zn / Zn^{+2} \mid\mid Mg^{2+} / Mg$ $c_1 \quad c_2 \quad (c_1 = c_2)$	**(p)** $E_{cell} = 0$
(B) $Zn / Zn^{+2} \mid\mid Ag^+ / Ag$ at. equilibrium	**(q)** $E^0_{cell} = 0$
(C) $Ag / Ag^+ \mid\mid Ag^+ / Ag$ $c_1 \quad c_2 \quad (c_1 = c_2)$	**(r)** $E^0_{cell} = +ve$
(D) $Fe / Fe^{+2} \mid\mid Ag / Ag^+$ $c_1 \quad c_2 \quad (c_1 = c_2)$	**(s)** $E^0_{cell} = -ve$

3. **Column-I** and **Column-II** contains four entries each. Entries of **Column-I** are to be matched with some entries of **Column-II**. One or more than one entries of **Column-I** may have the matching with the same entries of **Column-II**.

Column-I	Column-II
(A) Very dilute solution of HCl	**(p)** O_2 evolved at anode
(B) Very dilute solution of NaCl	**(q)** H_2 evolved at cathode
(C) Concentrate solution of NaCl	**(r)** Cl_2 evolved at anode
(D) Fairly concentrate solution of $AgNO_3$	**(s)** Ag deposition at cathode

4.

Column-I	Column-II
(A) Cathode	**(p)** Primary cell
(B) 1 Coulomb	**(q)** Secondary cell
(C) Dry cell	**(r)** 6.24×10^{18} electrones
(D) Lead strong cell	**(s)** Concentration cell
(E) $Zn \mid Zn^{2+}(0.01M) \parallel Zn^{2+}(0.1M) \mid Zn$	**(t)** Positive terminal of electrochemical cell

5.

Column-I	Column-II
(A) Cell constant	**(p)** $E^0_{cathode} + E^0_{anode}$
(B) Anode	**(q)** ℓ/A
(C) Conductance	**(r)** Mass of product deposited by 1 coulomb of electricity.
(D) Electrochemical equivalent	**(s)** $(Resistance)^{-1}$
(E) E^0_{cell}	**(t)** Involve oxidation

6.

Column-I	Column-II
(A) Conductance	**(p)** Cm^{-1}
(B) Specific conductance	**(q)** $Ohm^{-1} cm^2 mol^{-1}$
(C) Cell constant	**(r)** Ohm^{-1}
(D) Equivalent conductance	**(s)** $Ohm^{-1} cm^{-1}$

Exercise # 4

PART - 1 | PREVIOUS YEAR (NEET/AIPMT)

1. The equivalent conductances of Ba^{2+} and Cl^- are 127 76 Ω^{-1} cm^{-1} eq^{-1} respectively at infinite dilution. The equivalent conductance of $Bacl_2$ at infinite dilution will be [CBSE AIPMT 2000]
(A) 139.52 (B) 203
(C) 279 (D) 101.5

2. Cu^+ (aq) is unstable in solution and undergoes simultaneous oxidation and reduction according to the reaction
$2Cu^+(aq) \rightleftharpoons Cu^{2+}(aq) + Cu(s)$
Choose the correct E^0 for above reaction if d
$E^0_{cu^{2+}/cu} = 0.34\ V$ and $E^0_{cu^{2+}/cu^+} = 0.15\ V$
[CBSE AIPMT 2000]
(A) -0.38 V (B) + 0.49 V
(C) + 0.38 V (D) -0.19 V

3. Cell reaction in spontaneous when [CBSE AIPMT 2000]
(A) E^0_{red} is negative (B) E^0_{red} is positive
(C) ΔG^0 is negative (D) ΔG^0 is positive

4. The most convenient method to protect the bottom of the ship made of iron is [CBSE AIPMT 2000]
(A) Coating it with red lead oxide
(B) white tin plating
(C) connecting it with Mg block
(D) connecting it with Pb block

5. Standard electrode potentials are
$Fe^{2+}/Fe, E^0 = -0.4\ V$
$Fe^{3+}/Fe,^{2+}, E^0 = 0.77\ V$
Fe^{2+}, Fe^{3+} and Fe block are kept together, then [CBSE AIPMT 2001]
(A) Fe^{3+} increases
(B) Fe^{3+} decreases
(C) $\frac{Fe^{2+}}{Fe^{3+}}$ remains unchanged
(D) Fe^{2+} decreases

6. In electrolysis of NaCl when Pt electrode is taken then H_2 is liberated at cathode while with Hg cathode it forms sodium amalgam because [CBSE AIPMT 2002]
(A) Hg is more inert than Pt
(B) more voltage is required to reduce H^+ at Hg than at Pt
(C) Na is dissolved inHg while it does not dissolved in Pt
(D) Concentration of H^+ ions is larger when Pt electrode is taken

7. On the basis of the information available from the reaction. [CBSE AIPMT 2003]
$\frac{4}{3}Al + O_2 \rightarrow \frac{2}{3}Al_2, \Delta G = -827 kmol^{-1}$ of O_2, the minimum EMF required to carry out the electrolysis of Al^2O^3 is (F=96500 C mol-1)
(A) 2.14 V (B) 4.28 V
(C) 6.42 V (D) 8.56 V

8. The standard EMF of a galvanic cell involving cell reaction with n-2 is found to be 0.295 V at 25^0C. The equilibrium constant of the reaction would be
(Given F = 96500 C mol^{-1}. [CBSE AIPMT 2004]
(A) 2.0×10^{11} (B) 4.0×10^{12}
(C) 10×10^2 (D) 10×10^{10}

9. 4.5 g of aluminium (atomic mass 27u) is deposited at cathode from Al^{3+} solution by a certain quantity of electric charge. The volume of hydrogen produced at STP from H^+ ions in solution by the same quantity of electric charge will be. [CBSE AIPMT 2005]
(A) 44.8 L (B) 22. 4L
(C) 11.2 L (D) 5.6 L

10. A hypothetical electrochemical cell is shown below
A $|A^+(xM)||$ $B^+(yM)|$ B [CBSE AIPMT 2006]
(A) $A+B^+ \longrightarrow A^+ + B$
(B) $A^+ + B \longrightarrow A + B^+$
(C) $A^+ + e^- \longrightarrow A, B^+ + e^- \longrightarrow B$
(D) the celll reaction cannot be predicted

11. $E^0_{Fe^{2+}/Fe} = -0.441$ V and $E^0_{Fe^{3+}/Fe^{2+}} = 0.771$V the standard emf of the reaction $Fe + 2Fe^{3+} \longrightarrow 3\ Fe^{2+}$ will be [CBSE AIPMT 2006]
(A) 0.111 V (B) 0.330 V
(C) 1.653 V (D) 1.212 V

12. The equilibrium constant of the reaction,
$Cu(s) + 2Ag^+(aq) \longrightarrow Cu^{2+}(aq) + 2Ag(s)m$
$E^0 = 0.46$ V at 298 K is [CBSE AIPMT 2007]
(A) 2.0×10^{10} (B) 4.0×10^{10}
(C) 4.0×10^{15} (D) 2.4×10^{10}

13. The efficiency of a fule cell is given by [CBSE AIPMT 2007]
(A) $\Delta G/\Delta S$ (B) $\Delta G/\Delta H$
(C) $\Delta S/\Delta G$ (D) $\Delta H/\Delta G$

MOCK TEST

STRAIGHT OBJECTIVE TYPE

1. If the standard electrode potential of Cu^{2+}/Cu electrode is 0.34V, what is the electrode potential of 0.01M concentration of Cu^{2+} (T = 298 K)

(A) 0.399 V (B) 0.281 V (C) 0.222 V (D) 0.176 V

2. Calculate the electrode potential at 298°K for Zn/Zn^{2+} electrode in which the activity of zinc ions is 0.001 M and $E^{o}_{Zn/Zn^{2+}}$ is -0.74 volts

(A) 0. 38 volts (B) 0.83 volts (C) 0.40 volts (D) 0.45 volts

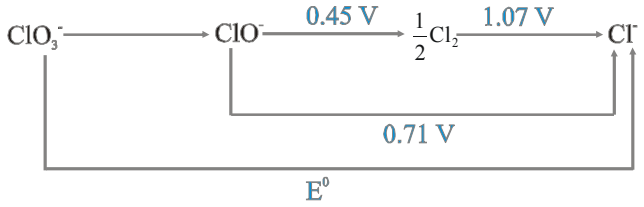
3. Which of the following expression is correct

(A) $\Delta G^{o} = -nFE^{o}_{cell}$ (B) $\Delta G^{o} = +nFE^{o}_{cell}$

(C) $\Delta G^{o} = -2.303RT\, nFE^{o}_{cell}$ (D) $\Delta G^{o} = -nF \log K_C$

4. For the feasibility of a redox reaction in a cell, the e.m.f. should be

(A) Positive (B) Fixed (C) Zero (D) Negative

5. 

The E^0 in the given diagram is,

(A) 0.5 (B) 0.6 (C) 0.7 (D) 0.8

6. What is cell entropy change of the following cell ?

$Pt(s) | H_2(g) | CH_3COOH, HCl | | KCl\,(aq) | Hg_2Cl_2\,(s) | Hg$

P = 1 atm 0.1 M 0.1 M

Emf of the cell ius found to be 0.045 V at 298 K and temperature coefficient is 3.4×10^{-4} V K^{-1}

Given $K_{a(CH_3COOH)} = 10^{-5}$ M

(A) 60 (B) 65.2 (C) 69.2 (D) 63.5

7. Following cell has EMF 0.7995 V.

$Pt | H_2$ (1 atm) $| HNO_3$ (1M) $| | AgNO_3$ (1M) $| Ag$

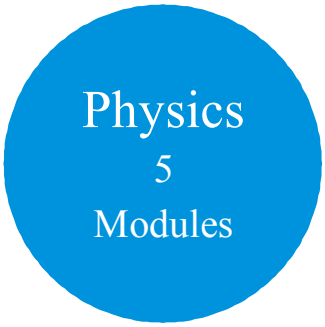
If we add enough KCl to the Ag cell so that the final Cl^- is 1M. Now the measured emf of the cell is 0.222 V. The Ksp of AgCl would be :

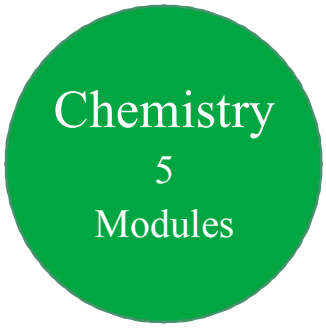
(A) $1 \times 10^{-9.8}$ (B) $1 \times 10^{-19.6}$ (C) 2×10^{-10} (D) 2.64×10^{-14}

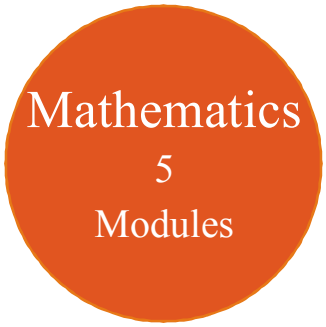
8. The solubility of $[Co(NH_3)_4Cl_2]\,ClO_4$ if the $\lambda_{CO(NH_3)_4Cl_2^+} = 50$, $\lambda_{ClO_4^-} = 70$ and the measured resistance was 33.5 Ω in a cell with cell constant of 0.20 is _____

(A) 59.7 mmol/L (B) 49.7 mmol/L (C) 39.7 mmol/L (D) 29.7 mmol/L

11th Class Modules Chapter Details

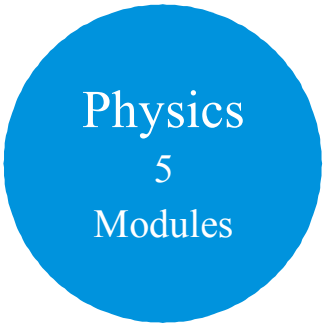


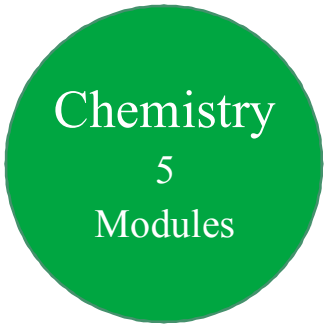


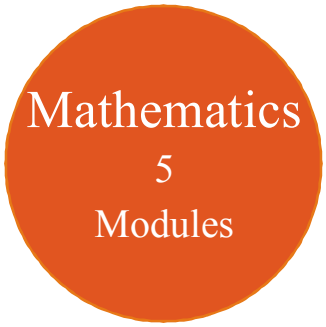


PHYSICS	CHEMISTRY	BIOLOGY
Module-1 1. Physical World & Measurements 2. Basic Maths & Vector 3. Kinematics **Module-2** 1. Law of Motion & Friction 2. Work, Energy & Power **Module-3** 1. Motion of system of particles & Rigid Body 2. Gravitation **Module-4** 1. Mechanical Properties of Matter 2. Thermal Properties of Matter **Module-5** 1. Oscillations 2. Waves	**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	**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

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