

OPEN STUDENT FOUNDATION

Chapters: 2

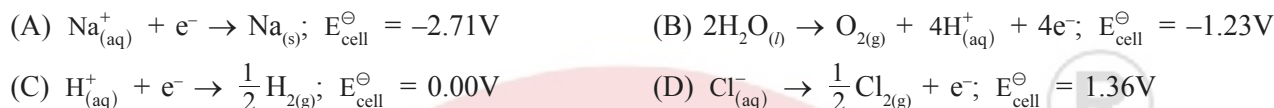
STD:12th Chemistry Practice Sheet Day -2

Date : 19/02/24

Section A

- Choose correct answer from the given options. [Each carries 1 Mark] [5]

1. In the electrolysis of aqueous sodium chloride solution which of the half-cell reaction will occur at anode ?



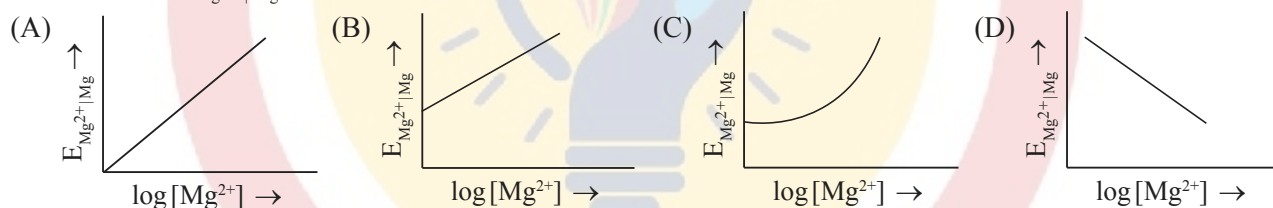
2. Which of the statements about solutions of electrolytes is not correct ?

- (A) Conductivity of solution depends upon size of ions.
 (B) Conductivity depends upon viscosity of solution
 (C) Conductivity does not depend upon solvation of ions present in solution.
 (D) Conductivity of solution increases with temperature.

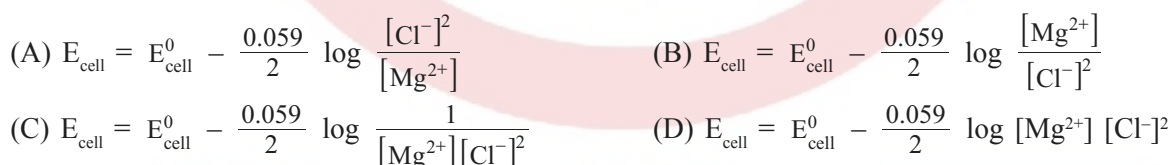
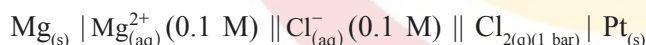
3. Electrode potential for Mg electrode varies according to the equation :

$$E_{\text{Mg}^{2+}|\text{Mg}} = E_{\text{Mg}^{2+}|\text{Mg}}^\ominus - \frac{0.59}{2} \log \frac{1}{[\text{Mg}^{2+}]}$$

The graph of $E_{\text{Mg}^{2+}|\text{Mg}} \rightarrow \log [\text{Mg}^{2+}]$ is



4. Which of the following is correct as a Nearest equation for the given electrochemical cell ?



5. For how much time, 10 ampere electric current should be passed through a dilute aqueous NiSO_4 solution during electrolysis using inert electrode, in order to get 5.85 gm Nickel ? [At. mass of Ni = 58.5 gm]

- (A) 1930 sec. (B) 3860 sec. (C) 965 sec. (D) 9650 sec.

Section B

- Write the answer of the following questions. [Each carries 2 Marks] [6]

- Write down faradays law
- Calculate the potential of hydrogen electrode in contact with a solution whose pH is 10.
- Suggest a way to determine the \wedge_m^0 value of water.

Section C

- Write the answer of the following questions. [Each carries 3 Marks] [12]

4. Three electrolytic cells A, B, C containing solutions of ZnSO_4 , AgNO_3 and CuSO_4 , respectively are

connected in series. A steady current of 1.5 amperes was passed through them until 1.45 g of silver deposited at the cathode of cell B. How long did the current flow ? What mass of copper and zinc were deposited ?

5. Explain construction of the galvanic cell according to Daniell cell and Explain electrode potential.
6. Derive nernst Equation For Daniel cel
7. What is weak electrolyte ? Explain relation between concentration of weak electrolyte and molar conductivity.

Section D



● Write the answer of the following questions. [Each carries 4 Marks]

[12]

8. Write Note on Hydrogen - Oxygen fuel cell.
9. What is the standard electrode potential ? Explain it details.
10. Resistance of a conductivity cell filled with 0.1 mol L^{-1} KCl solution is 100Ω . If the resistance of the same cell when filled with 0.02 mol L^{-1} KCl solution is 520Ω . calculate the conductivity and molar conductivity of 0.02 mol L^{-1} KCl solution. The conductivity of 0.1 mol L^{-1} KCl solution is 1.29 S/m .

OSF

OPEN STUDENT FOUNDATION

Chapters: 2

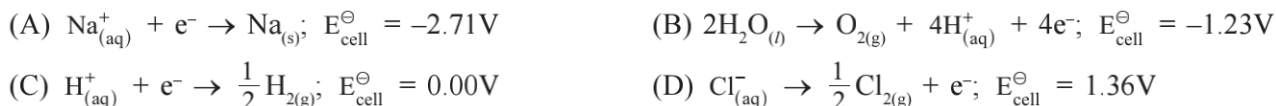
STD:12th Chemistry Practice Sheet Day -2

Date : 19/02/24

Section A

- Choose correct answer from the given options. [Each carries 1 Mark] [5]

1. In the electrolysis of aqueous sodium chloride solution which of the half-cell reaction will occur at anode ?



➡ Ans : (D)

2. Which of the statements about solutions of electrolytes is not correct ?

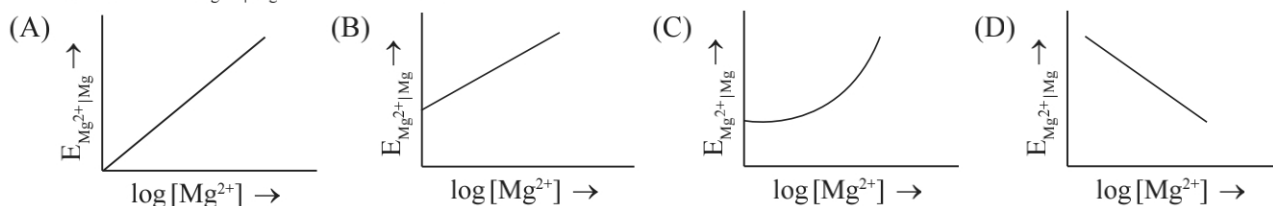
- (A) Conductivity of solution depends upon size of ions.
 (B) Conductivity depends upon viscosity of solution
 (C) Conductivity does not depend upon solvation of ions present in solution.
 (D) Conductivity of solution increases with temperature.

➡ Ans : (C)

3. Electrode potential for Mg electrode varies according to the equation :

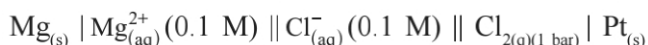
$$E_{\text{Mg}^{2+}|\text{Mg}} = E_{\text{Mg}^{2+}|\text{Mg}}^\ominus - \frac{0.59}{2} \log \frac{1}{[\text{Mg}^{2+}]}$$

The graph of $E_{\text{Mg}^{2+}|\text{Mg}} \rightarrow \log [\text{Mg}^{2+}]$ is



➡ Ans : (B)

4. Which of the following is correct as a Nearest equation for the given electrochemical cell ?



(A) $E_{\text{cell}} = E_{\text{cell}}^0 - \frac{0.059}{2} \log \frac{[\text{Cl}^-]^2}{[\text{Mg}^{2+}]}$ (B) $E_{\text{cell}} = E_{\text{cell}}^0 - \frac{0.059}{2} \log \frac{[\text{Mg}^{2+}]}{[\text{Cl}^-]^2}$
 (C) $E_{\text{cell}} = E_{\text{cell}}^0 - \frac{0.059}{2} \log \frac{1}{[\text{Mg}^{2+}][\text{Cl}^-]^2}$ (D) $E_{\text{cell}} = E_{\text{cell}}^0 - \frac{0.059}{2} \log [\text{Mg}^{2+}] [\text{Cl}^-]^2$

➡ Ans : (D)

5. For how much time, 10 ampere electric current should be passed through a dilute aqueous NiSO_4 solution during electrolysis using inert electrode, in order to get 5.85 gm Nickel ? [At. mass of Ni = 58.5 gm]

- (A) 1930 sec. (B) 3860 sec. (C) 965 sec. (D) 9650 sec.

➡ Ans : (A)

Section B

- Write the answer of the following questions. [Each carries 2 Marks] [6]

1. Write down faradays law

⇒ (1) **First Law :**

⇒ The amount of chemical reaction which occurs at any electrode during electrolysis by a current is proportional to the quantity of electricity passed through the electrolyte (solution or melt).

⇒ (2) **Second Law :**

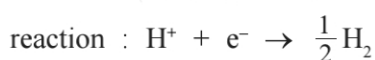
⇒ The amounts of different substances liberated by the same quantity of electricity passing through the electrolytic solution are proportional to their chemical equivalent weights (Atomic Mass of Metal ÷ Number of electrons required to reduce the cation).

2. Calculate the potential of hydrogen electrode in contact with a solution whose pH is 10.

⇒ pH = 10

$$-\log [\text{H}^+] = 10$$

$$\therefore [\text{H}^+] = 10^{-10}$$



$$E_{\text{cell}} = E_{\text{cell}}^0 - \frac{0.059}{n} \log \frac{1}{[\text{H}^+]}$$

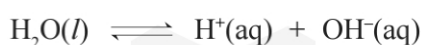
$$= 0.0 - \frac{0.059}{1} \log \frac{1}{10^{-10}}$$

$$= -0.059 \log 10^{10}$$

$$= -0.59 \text{ V}$$

3. Suggest a way to determine the \wedge_m^0 value of water.

⇒ Ionization of water



⇒ Applying Kohlrausch's law

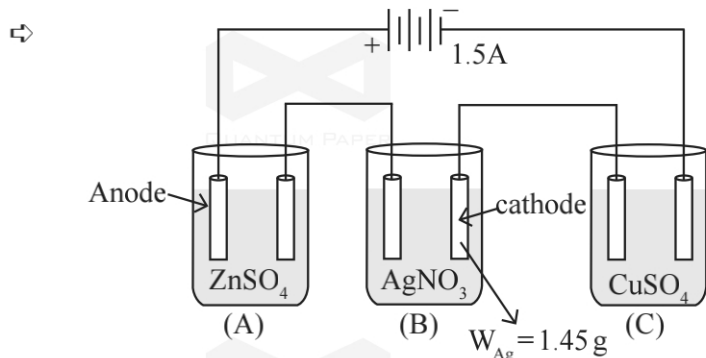
$$\begin{aligned} \wedge_{\text{m}(\text{H}_2\text{O})}^0 &= \wedge_{\text{m}(\text{H}^+)}^0 + \wedge_{\text{m}(\text{Cl}^-)}^0 \\ &= (\wedge_{\text{H}^+}^0 + \wedge_{\text{Cl}^-}^0) + (\wedge_{\text{Na}^+} + \wedge_{\text{OH}^-}) - (\wedge_{\text{Na}^+} + \wedge_{\text{Cl}^-}) \\ &= \wedge_{\text{m}(\text{HCl})}^0 + \wedge_{\text{m}(\text{NaOH})}^0 - \wedge_{\text{m}(\text{NaCl})}^0 \end{aligned}$$

⇒ hence, by knowing the \wedge_m^0 value of HCl, NaOH and NaCl, the \wedge_m^0 value of water can be determined.

Section C

● Write the answer of the following questions. [Each carries 3 Marks] [12]

4. Three electrolytic cells A, B, C containing solutions of ZnSO_4 , AgNO_3 and CuSO_4 , respectively are connected in series. A steady current of 1.5 amperes was passed through them until 1.45 g of silver deposited at the cathode of cell B. How long did the current flow? What mass of copper and zinc were deposited?



$\therefore 108 \text{ g Ag}$ obtain by 1F

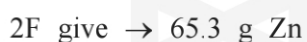
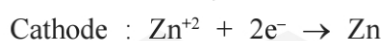
$\therefore 1.45 \text{ g Ag}$ obtain by (?)

$$F = \frac{1.45 \times 1}{108} = 0.01342 \text{ F}$$

$$F = \frac{I \times t}{96,500}$$

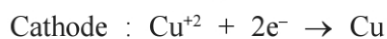
$$\therefore 0.01342 = \frac{1.5 \times t}{96,500}$$

$$\therefore t = \frac{0.01342 \times 96500}{1.5} = 863.73 \text{ sec.}$$



$\therefore 0.01342 \text{ F}$ give \rightarrow (?)

$$W_{Zn} = \frac{0.01342 \times 65.3}{2} = 0.438 \text{ g Zn}$$



$\therefore 0.01342 \text{ F}$ give \rightarrow (?)

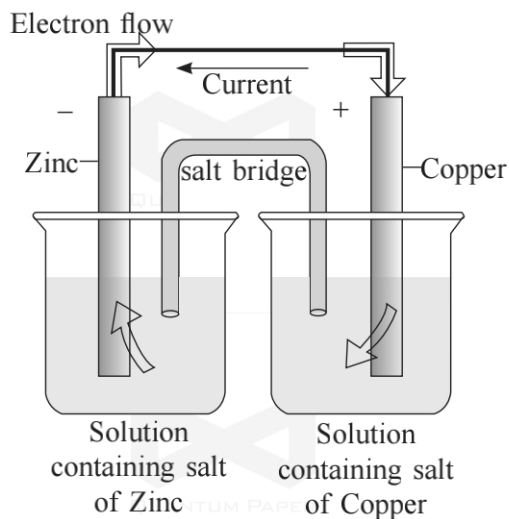
$$W_{Cu} = \frac{0.01342 \times 63.5}{2} = 0.426 \text{ g Cu}$$

5. Explain construction of the galvanic cell according to Daniell cell and Explain electrode potential.

⇒ We can construct innumerable number of galvanic cells on the pattern of Daniell cell by taking combination of different half-cells

⇒ Each half-cell consists of a metallic electrode dipped into an electrolyte. The two half-cells are connected by a metallic wire through a voltmeter and a switch externally.

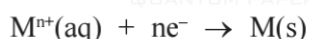
⇒ The electrolytes of the two half-cells are connected internally through a salt bridge as shown in Fig.



- ⇒ Sometimes, both the electrodes dip in the same electrolyte solution and in such cases we don't require a salt bridge.
- ⇒ At each electrode-electrolyte interface there is a tendency of metal ions from the solution to deposit on the metal electrode trying to make it positively charged.
- ⇒ At the same time, metal atoms of the electrode have a tendency to go into the solution as ions and leave behind the electrons at the electrode trying to make it Negatively charged.
- ⇒ At equilibrium, there is a separation of charges and depending on the tendencies of the two opposing reactions, the electrode may be positively or negatively charged with respect to the solution.
- ⇒ A potential difference develops between the electrode and the electrolyte which is called electrode potential.
- ⇒ When the concentrations of all the species involved in a half-cell in unity then the electrode potential is known as standard electrode potential.
- ⇒ In a galvanic cell, the half-cell in which oxidation takes place is called anode and it has a Negative potential with respect to the solution.
- ⇒ The other half-cell in which reduction takes place is called cathode and it has positive potential with respect to the solution.
- ⇒ Thus, there exists a potential difference between the two electrodes and as soon as the switch is in the on position the electrons flow from Negative electrode to positive electrode. The direction of current flow is opposite to that of electron flow.

6. Derive nernst Equation For Daniel cel

- ⇒ Concentration of Electrolyte in Electrochemical cell is Unity (1M). It is not true always.
- ⇒ Nernst Derive Equation For Calculating E_{cell} when concentration of electrolyte is not unity this equation is known as nernst equation.



- ⇒ Electrode potential of above reaction is

$$E_{(\text{Mn}^{+}|\text{M})} = E^{\ominus}_{(\text{Mn}^{+}|\text{M})} - \frac{RT}{nF} \ln \frac{[\text{M}]}{[\text{M}^{n+}]}$$

but concentration of solid M is taken as unity and we have

$$E_{(\text{Mn}^{+}|\text{M})} = E^{\ominus}_{(\text{Mn}^{+}|\text{M})} - \frac{RT}{nF} \ln \frac{1}{[\text{M}^{n+}]}$$

Where, $E^{\ominus}_{Mn+|M}$ = Standard Electrode potential

R = gas constant

T = Temperature

F = Faraday (96427 C·mol⁻¹)

[Mⁿ⁺] = concentration of Mⁿ⁺

n = No. of Electron

⇒ For Daniell Cell Zn act as anode and Cu act as cathode so,

$$\text{For cathode : } E_{(Cu^{2+}|Cu)} = E^{\ominus}_{(Cu^{2+}|Cu)} - \frac{RT}{2F} \ln \frac{1}{[Cu^{2+}(aq)]}$$

$$\text{For Anode : } E_{(Zn^{2+}|Zn)} = E^{\ominus}_{(Zn^{2+}|Zn)} - \frac{RT}{2F} \ln \frac{1}{[Zn^{2+}(aq)]}$$

The cell potential,

$$\begin{aligned} E_{\text{cell}} &= E_{(Cu^{2+}|Cu)} - E_{(Zn^{2+}|Zn)} \\ &= E^{\ominus}_{(Cu^{2+}|Cu)} - \frac{RT}{2F} \ln \frac{1}{[Cu^{2+}(aq)]} - E^{\ominus}_{(Zn^{2+}|Zn)} + \frac{RT}{2F} \ln \frac{1}{[Zn^{2+}(aq)]} \\ &= E^{\ominus}_{(Cu^{2+}|Cu)} - E^{\ominus}_{(Zn^{2+}|Zn)} - \frac{RT}{2F} \ln \left(\ln \frac{1}{[Cu^{2+}(aq)]} - \ln \frac{1}{[Zn^{2+}(aq)]} \right) \end{aligned}$$

$$E_{\text{cell}} = E^{\ominus}_{\text{cell}} - \frac{RT}{2F} \ln \frac{[Zn^{2+}]}{[Cu^{2+}]}$$

⇒ It can be seen that $E_{(\text{cell})}$ depends on the concentration of both Cu^{2+} and Zn^{2+} ions. It increase with increase in the concentration of Cu^{2+} ions and decrease in the concentration of Zn^{2+} ions.

⇒ R = 8.314 J mol⁻¹ k⁻¹

T = 298 K

F = 96487

ln = 2.303 log

Substituting this value in above equation.

$$E_{(\text{cell})} = E^{\ominus}_{(\text{cell})} - \frac{0.059}{2} \log \frac{[Zn^{2+}]}{[Cu^{2+}]}$$

7. What is weak electrolyte? Explain relation between concentration of weak electrolyte and molar conductivity.

⇒ Electrolyte which is incompletely Ionized in its aqueous solution are known as weak electrolyte.

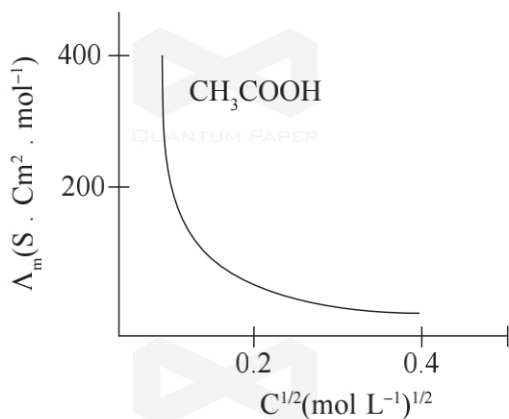
⇒ Weak electrolytes like acetic acid have lower degree of dissociation at higher concentrations and hence for such electrolytes, the change in \wedge_m with dilution is due to increase in the degree of dissociation and consequently the number of ions in total volume of solution that contains 1 mol of electrolyte.

⇒ In such cases \wedge_m increases steeply on dillution, especially near lower concentrations, Therefore \wedge_m^0 cannot be obtained by extra polation of \wedge_m to zero concentration.

⇒ At infinite dilution (i.e. concentration c → zero) electrolyte dissociates completely (a = 1), but at such low concentration the conductivity of the solution is so low that it cannot be measured accurately.

⇒ Therefore, \wedge_m^0 for weak electrolytes is obtained by using Kohlrausch law of independent migration

of ions.



⇒ At any concentration c , if α is the degree of dissociation then it can be approximated to the ratio of molar conductivity Λ_m at the concentration c to limiting molar conductivity, Λ_m^0 . Thus we have :

$$\alpha = \frac{\Lambda_m}{\Lambda_m^0}$$

$$K_a = \frac{c\alpha^2}{(1-\alpha)} = \frac{c\Lambda_m^2}{\Lambda_m^0 \left(1 - \frac{\Lambda_m}{\Lambda_m^0}\right)} = \frac{c\Lambda_m^2}{\Lambda_m^0 (\Lambda_m^0 - \Lambda_m)}$$

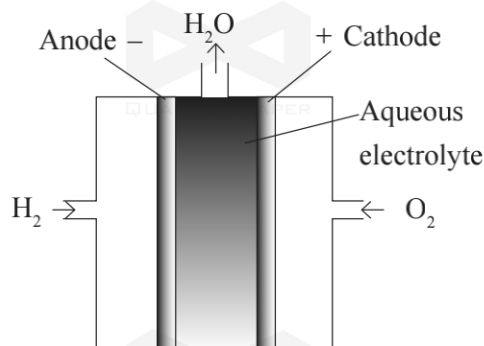
Section D

● Write the answer of the following questions. [Each carries 4 Marks]

[12]

8. Write Note on Hydrogen - Oxygen fuel cell.

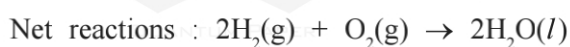
⇒ One of the most successful fuel cells uses the reaction of hydrogen with oxygen to form water



⇒ In the cell, hydrogen and oxygen are bubbled through porous carbon electrodes into concentrated aqueous sodium hydroxide solution.

⇒ Catalysts like finely divided platinum or palladium metal are incorporated into the electrodes for increasing the rate of electrode reactions.

⇒ The electrode reactions are given below :



9. What is the standard electrode potential ? Explain it details.

⇒ Reduction potential of electrode at standard condition at 298K Temperature and 1 bar pressure is known as standard electrode potential.

- ⇒ The standard electrode potentials are very important and we can extract a lot of useful information from them.
- ⇒ If the standard electrode potential of an electrode is greater than zero then its reduced form is more stable compared to hydrogen gas.
- ⇒ If the standard electrode potential is Negative then hydrogen gas is more stable than the reduced form of the species.
- ⇒ It can be seen that the standard electrode potential for fluorine is the highest in the Table indicating that fluorine gas (F_2) has the maximum tendency to get reduced to fluoride ions (F^-)
- ⇒ Therefore fluorine gas is the strongest oxidising agent and fluoride ion is the weakest reducing agent.
- ⇒ Lithium has the lowest electrode potential indicating that lithium ion is the weakest oxidising agent while lithium metal is the most powerful reducing agent in an aqueous solution.
- ⇒ It may be seen that as we go from top to bottom in Table the standard electrode potential decreases and with this, decreases the oxidising power of the species on the left and increase the reducing power of the species on the right hand side of the reaction.
 1. A Negative E^\ominus means that the redox couple is a stronger reducing agent than the H^+/H_2 couple
 2. A positive E^\ominus means that the redox couple is a weaker reducing agent than the H^+/H_2 couple.

↑	Reactin (Oxidised from + ne ⁻)	→ Reduced form)	E ⁰ /V
	F ₂ (g) + 2e ⁻	→ 2F ⁻	2.87
	CO ³⁺ + e ⁻	→ Co ²⁺	1.81
	H ₂ O ₂ + 2H ⁺ + 2e ⁻	→ 2H ₂ O	1.78
	MnO ₄ ⁻ + 8H ⁺ + 5e ⁻	→ Mn ²⁺ + 4H ₂ O	1.51
	Au ³⁺ + 3e ⁻	→ Au(s)	1.40
	Cl ₂ (g) + 2e ⁻	→ 2Cl ⁻	1.36
	Cr ₂ O ₇ ²⁻ + 14H ⁺ + 6e ⁻	→ 2Cr ³⁺ + 7H ₂ O	1.33
	O ₂ (g) + 4H ⁺ + 4e ⁻	→ 2H ₂ O	1.23
	MnO ₂ (s) + 4H ⁺ + 2e ⁻	→ Mn ²⁺ + 2H ₂ O	1.23
	Br ₂ + 2e ⁻	→ 2Br ⁻	1.09
	NO ₃ ⁻ + 4H ⁺ + 3e ⁻	→ NO _(g) + 2H ₂ O	0.97
	2Hg ²⁺ + 2e ⁻	→ Hg ₂ ²⁺	0.92
	Ag ⁺ + e ⁻	→ Ag(s)	0.80
	Fe ³⁺ + e ⁻	→ Fe ²⁺	0.77
	O ₂ (g) + 2H ⁺ + 2e ⁻	→ H ₂ O ₂	0.68
	I ₂ + 2e ⁻	→ 2I ⁻	0.54
	Cu ⁺ + e ⁻	→ Cu(s)	0.52
	Cu ²⁺ + 2e ⁻	→ Cu(s)	0.34
	AgCl(s) + e ⁻	→ Ag(s) + Cl ⁻	0.22
	AgBr(s) + e ⁻	→ Ag(s) + Br ⁻	0.10
	2H ⁺ + 2e ⁻	→ H ₂ (g)	0.00
	Pb ²⁺ + 2e ⁻	→ Pb(s)	-0.13
	Sn ²⁺ + 2e ⁻	→ Sn(s)	-0.14
	Ni ²⁺ + 2e ⁻	→ Ni(s)	-0.25
	Fe ²⁺ + 2e ⁻	→ Fe(s)	-0.44
	Cr ³⁺ + 3e ⁻	→ Cr(s)	-0.74
	Zn ²⁺ + 2e ⁻	→ Zn(s)	-0.76
	2H ₂ O + 2e ⁻	→ H ₂ (g) + 2OH ⁻ (aq)	-0.83
	Al ³⁺ + 3e ⁻	→ Al(s)	-1.66
	Mg ²⁺ + 2e ⁻	→ Mg(s)	-2.36
	Na ⁺ + e ⁻	→ Na(s)	-2.71
	Ca ²⁺ + 2e ⁻	→ Ca(s)	-2.87
	K ⁺ + e ⁻	→ K(s)	-2.93
	Li ⁺ + e ⁻	→ Li(s)	-3.05

Increasing strength of oxidising agent

Increasing strength of reducing agent

10. Resistance of a conductivity cell filled with 0.1 mol L⁻¹ KCl solution is 100 Ω. If the resistance of the same cell when filled with 0.02 mol L⁻¹ KCl solution is 520 Ω. calculate the conductivity and molar conductivity of 0.02 mol L⁻¹ KCl solution. The conductivity of 0.1 mol L⁻¹ KCl solution is 1.29 S/m.

⇒ The cell constant is given by the equation :

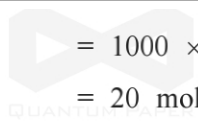
$$\text{cell constant} = G^* = \text{conductivity} \times \text{resistance}$$

$$= 1.29 \text{ S/m} \times 100 \text{ } \Omega = 129 \text{ m}^{-1} = 1.29 \text{ cm}^{-1}$$

$$\text{conductivity of } 0.02 \text{ mol L}^{-1} \text{ KCl solution} = \text{cell constant/resistance}$$

$$= \frac{G^*}{R} = \frac{129 \text{ m}^{-1}}{520 \text{ } \Omega} = 0.248 \text{ S m}^{-1}$$

$$\text{Concentration} = 0.02 \text{ mol L}^{-1}$$



$$= 1000 \times 0.02 \text{ mol m}^{-3}$$

$$= 20 \text{ mol m}^{-3}$$

$$\text{Molar conductivity} = \wedge_m = \frac{\kappa}{c}$$

$$= \frac{248 \times 10^{-3} \text{ S m}^{-1}}{20 \text{ mol m}^{-3}}$$

$$= 124 \times 10^{-4} \text{ S m}^2 \text{ mol}^{-1}$$

$$\text{Alternatively, } \kappa = \frac{1.29 \text{ cm}^{-1}}{520 \Omega} = 0.248 \times 10^{-2} \text{ S cm}^{-1}$$

$$\text{and } \wedge_m = \kappa \times 1000 \text{ cm}^3 \text{ L}^{-1} \text{molarity}^{-1}$$

$$= \frac{0.248 \times 10^{-2} \text{ S cm}^{-1} \times 1000 \text{ cm}^3 \text{ L}^{-1}}{0.02 \text{ mol L}^{-1}}$$

$$= 124 \text{ S cm}^2 \text{ mol}^{-1}$$

