Electrochemistry:

E.E $\underset{\text{Galvanic}}{\overset{\text{Electrolytic}}{\rightleftharpoons}}$ C.E → Interconversion of electrical energy & chemical energy.

Oxidation

→ Add of O

$C + O_2 \rightarrow CO_2$

→ Removal of H

$NH_3 \rightarrow N_2 + H_2$

→ Loss of $\bar{e}$s

$Fe^{+2} \longrightarrow Fe^{+3} + \bar{e}$

↳ Increase in Oxidation state

Reduction:

→ Add of H

$H_2 + Cl_2 \longrightarrow HCl$

→ Removal of O

$H_2O \longrightarrow H_2 + O_2$

→ Gain of $\bar{e}$s

$Fe^{+3} + \bar{e} \longrightarrow Fe^{+2}$

↳ Decrease in Oxidation state.

Oxidizing Agent

→ Gain of $\bar{e}$

→ Oxidation state ↓

→ Non metal

Reducing Agent.

→ loss of $\bar{e}$

→ Oxidation state ↑

→ Metal.

eg:

$\overset{0}{Na} + \frac{1}{2}\overset{0}{Cl_2} \longrightarrow \overset{+1\ -1}{NaCl}$

R.A O.A

$Zn + \overset{+2}{Cu}SO_4 \longrightarrow \overset{+2}{Zn}SO_4 + \overset{0}{Cu}$

R.A O.A

Lowest O. state ← Element → Highest O. state

R.A ——→ Between ←—— O.A

O.A ⇄ R.A

$\overset{0\ -2}{H_2S}$ $\overset{+4}{H_2SO_3}$ $\overset{+6}{H_2SO_4}$ → now it has loose all of its $\bar{e}$s now it can only gain

Rule of Oxidation Number:

↳ Apparent charge of element in compound.

↳ Oxidation state is variable except I, II & III

→ Elements:

- Free state: Na^{0}, Zn^{0}, Cu^{0}
- Homoatomic: S_8, Cl_2, H_2, O_2

- IA: +1
- IIA: +2
- IIIA: +3

- IVA:

$\overset{-4}{C}H_4$ $\quad$ $\overset{-2}{C}H_3-OH$ $\quad$ $H-\overset{0}{C}-H$ $\quad$ $H-\underset{+2}{\overset{+4}{C}}(=O)-OH \rightarrow CO_2$

- VA:

H_3N (−3) $\quad$ HNO_3 (+3) $\quad$ N_2O_5 (+5)

- VIA:

H_2S (−2) $\quad$ SO_2 (+4) $\quad$ H_2SO_4 (+6)

- VIIA:

→ F (−1)

HCl (−1) $\quad$ $HClO$ (+1) $\quad$ $HClO_2$ (+3) $\quad$ $HClO_3$ (+5) $\quad$ $HClO_4$ (+7)

$K_2Cr_2O_7$

$2K + 2Cr + 7O = 0$

$2(+1) + 2Cr + 7(-2) = 0$

$2 + 2Cr - 14 = 0$

$2Cr = 12$

$Cr = \frac{12}{2} = +6$

Oxygen:

- N. Oxide (−2): Na_2O
- P. oxide (−1): Na_2O_2
- S. oxide (−½): KO_2
- Suboxide: (+2)(+1), O_2F_2 / O_8F_2

Hydrogen

- Metal (−1): NaH
- Nonmetal (+1): HCl

Conduction:

Electrolytic	Electronic
→ due to ion	→ due to electron
→ T↑ condu↑	→ T↑ conduction↓
→ Chemical change	→ No chemical change.

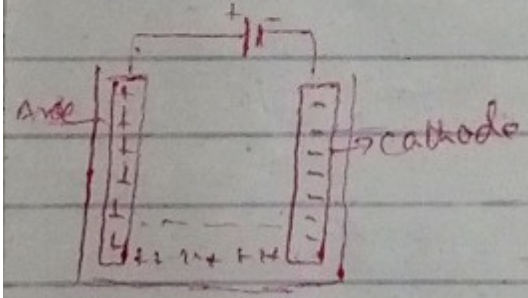
Electrode:

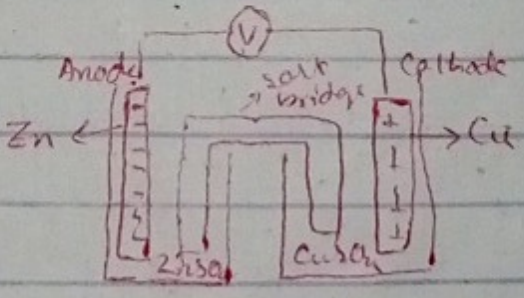
Wire / Rod / Metal by which current enter or leave reaction.

Inert Electrode	Active Electrode.
→ Don't participate in rx	→ Participate in reaction.
i.e: graphite / platinium.	ie: Zinc & copper.

Electrochemical Cells:

Electrolytic	Galvanic
→ Electrical → Chemical E	→ Chemical E → Electrical E
→ Non-Spontaneous	→ Spontaneous
→ No salt Bridge	→ Salt Bridge
→ Battery	→ No Battery.
→ Single compartment	→ two compartments
→ Anode (+ive) oxidation	→ Anode (-ive) oxidation
→ Cathod (-ive) Reduction	→ Cathode (+ive) reduction





• Down / Nelson	→ Ni-Cd
	→ Dry cell

Function Of Salt Bridge:

→ Circuit completion.
→ Electrical neutrality maintain
→ Donot ~~dec~~ charge accumulation.
→ Allow ion to move but not solution to mix.

Electrolysis

→ Calling a nonspontaneous reaction at the expense of electricity.

Fused Salts

Molten Salt

$2NaCl \longrightarrow 2Na^+ + 2Cl^-$

Anode:

$2Cl^- \longrightarrow Cl_{2(g)} + 2e^-$

Cathode:

$2e^- + 2Na^+ \longrightarrow 2Na_{(s)}$

Aqueous Solutn

$2NaCl \longrightarrow 2Na^+ + 2Cl^-$

$H_2O \longrightarrow H^+ + OH^-$

Anode:

$2Cl^- \longrightarrow Cl_2 + 2e^-$

Cathode:

$2e^- + 2H^+ \longrightarrow H_2$

H^+ → winner. → Na, Mg, Al (IA, IIA, IIIA) Above elements in E.C.S

H^+ → Cu^{+2}, Ag^+, Au^{+3} → Winner Below Element in E.C.S

OH^- ← winner. ← X^- (Cl^-, Br^-, I^-, F^-)

OH^- → winner → $SO_4^{-2}, PO_4^{-3}, NO_3^-$

$CuSO_4 \longrightarrow Cu^{+2} + SO_4^{-2}$

$H_2O \longrightarrow H^+ + OH^-$

Anode:

$2OH^- \longrightarrow O_2 + 2H_2O + 2e^-$

Cathode:

$Cu^{+2} + 2e^- \longrightarrow Cu$

Electrode Potential

↳ Ability of electrode to loose or gain electrons.

Standard Electrode Potential:

↳ Electrode potential under standard conditions.

→ T = 25C°/298K

↳ P = 1 atm

↳ Solution → 1 molar solution.

→ **SHE:** (standard Hydrogen Electrode)

↳ standard to find potential of other elements

↳ Arbitrarily.

$E_{R.P} = 0.00V$ → Ability to gain ēs is 0.

$E_{O.P} = 0.00V$ → Ability to loose is 0.

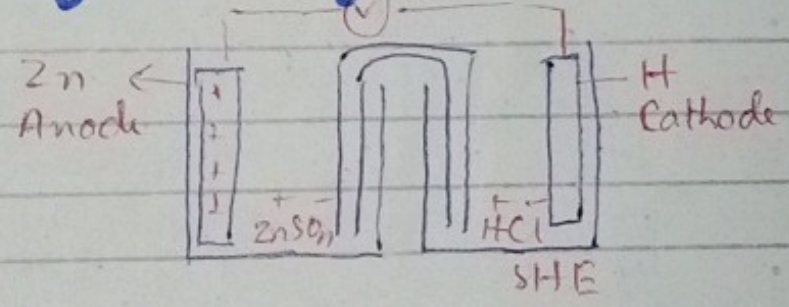
• Measurement Of R.P of Zn:

Anode: (oxidation)

$Zn \longrightarrow Zn^{+2} + 2\bar{e}$

Cathode (reduction)

$2H^+ + 2e \longrightarrow H_2$



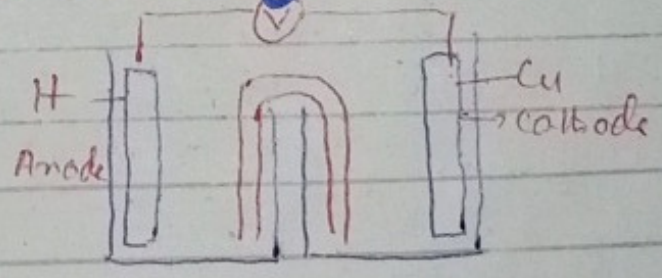
Measurement OD R.P of Cu:

Anode: (oxidation)

$H_2 \longrightarrow 2H^+ + 2\bar{e}$

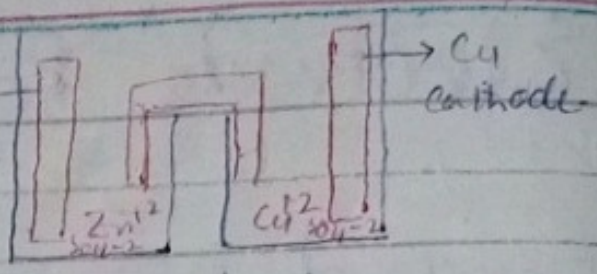
Cathode (Reduction)

$Cu^{+2} + 2\bar{e} \longrightarrow Cu$



SHE
- → Above element Anode: Li, Zn } Anode (oxidation)
- → Below element Cathode: H, Cu, F } cathode (Reduction)

Zn – Cu:



Anode:

$Zn \longrightarrow Zn^{+} + 2e^{-}$ $E_{O.P} = +0.76$

Cathode:

$Cu^{+2} + 2e \longrightarrow Cu$ $E_{R.P} = +0.34$

$E^{\circ}_{cell} = E^{\circ}_{O.P} + E^{\circ}_{R.P}$

$= 0.76 + 0.34$

$= 1.10\,V$

A^{+1}/A $E_{R.P} = -0.4$

B^{+1}/B $E_{R.P} = -0.2$

∴ Invert the sign of small value (+0.4)

$E^{\circ}_{cell} = 0.4 - 0.2$

$= 0.2$ → we need to make value +ve

A^{+1}/A $E_{R.P} = 0.76$

B^{+1}/B $E_{O.P} = 0.34$

$= 0.76 + 0.34$

$= 0.110$ (In this case we don't need to change sign as value is already +ve)

Electrochemical Series

Li $E_{R.P} = -3.01$ strong reducing agent

Na

Mg

Zn

H $E_{R.P} = 0$

Cu

F $E_{R.P} = +2.87$ strong oxidizing agent

Top to bottom:

- → Reduction Potential ↑
- → Reactivity ↓
- → Reducing power ↓
- → Oxidizing power ↑
- Ability to lose e⁻ ↓
- Cation formation difficult
- Ability to gain e⁻ ↑
- Anion formation Easy
- Above element → more reactive
- Above element can replace below element from compound

W.O.F is incorrect?

a: $Na + HCl \longrightarrow NaCl + H_2$

b: $Mg + HCl \longrightarrow MgCl_2 + H_2$

c: $Zn + CuSO_4 \longrightarrow ZnSO_4 + Cu$

d: $Cu + ZnSO_4 \longrightarrow CuSO_4 + Zn$