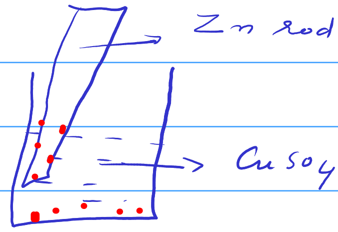
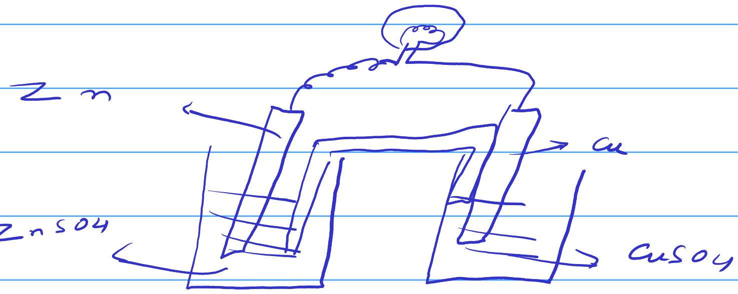
$Zn \rightarrow Zn^{2+} + 2e^-$

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

$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$





LHS

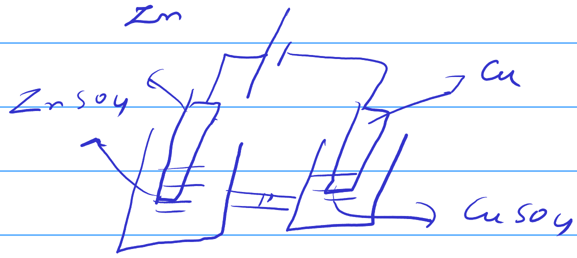
$Zn \rightarrow Zn^{2+} + 2e^-$

RHS

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

$Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$

Electrolytic cell

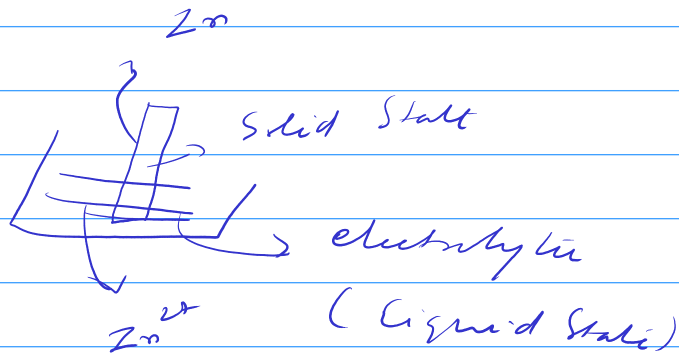


$2e^- + Zn^{2+} \rightarrow Zn$

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

$Zn^{2+} + Cu \rightarrow Zn + Cu^{2+}$

Representation



$Zn \mid Zn^{2+}$

interface b/w two phases

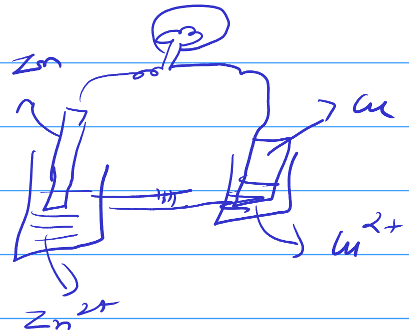
Oxidation half cell $\parallel$ Reduction half cell

Salt bridge

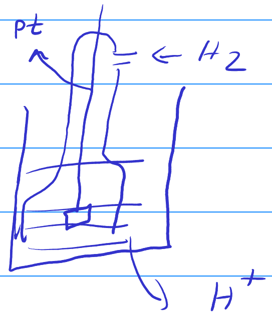
Oxidation half cell	Reduction half cell

Phase of lower oxidation state | Phase of higher oxidation state || Phase higher oxidation state | Phase of lower oxidation state

$$Zn_{(s)} \mid Zn^{2+}_{(aq)} \parallel Cu^{2+}_{(aq)} \mid Cu_{(s)}$$



eg: 1 H_2 electrode



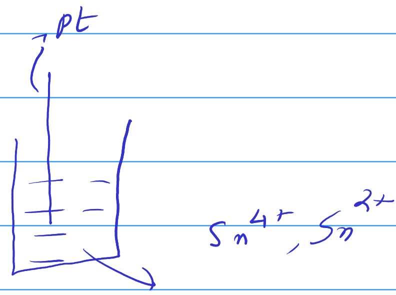
if anode $H_{2(g)} \rightarrow 2H^+ + 2\bar{e}$

$$Pt_{(s)} \mid H_{2(g)} \mid H^+_{(aq)}$$

if Cathode $2H^+ + 2\bar{e} \rightarrow H_{2(g)}$

$$H^+_{(aq)} \mid H_{2(g)} \mid Pt_{(s)}$$

eg: 2



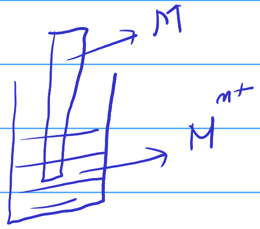
if anode $Sn^{2+} \rightarrow Sn^{4+} + 2\bar{e}$

$$Pt_{(s)} \mid Sn^{2+}_{(aq)}, Sn^{4+}_{(aq)}$$

if Cathode $Sn^{4+} + 2\bar{e} \rightarrow Sn^{2+}$

$$Sn^{4+}_{(aq)}, Sn^{2+}_{(aq)} \mid Pt_{(s)}$$

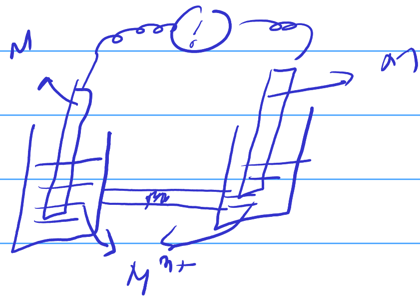
Origin of electrode Potential



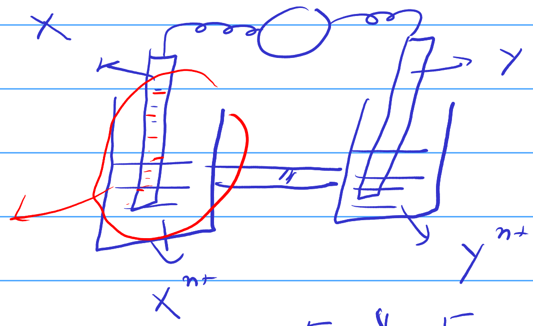
① $M_{(s)} \rightarrow M^{n+} + ne^-$

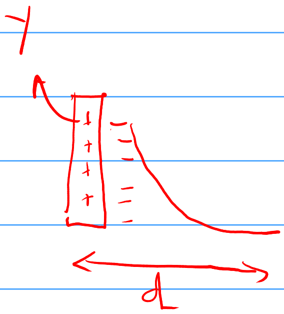
② $M^{n+} + ne^- \rightarrow M_{(s)}$

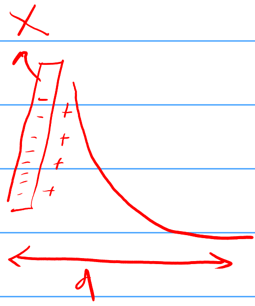
$M^{n+} + ne^- \rightleftharpoons M$



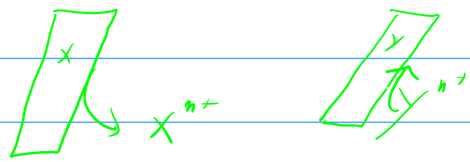
$X_{(s)} \rightarrow X^{n+}_{(aq)} + ne^-$







$E_Y > E_X$



E_{cell} → Potential difference between two half cell

$$E_{cell} = E_{cat} - E_{anode}$$

Potential of electrode depends on

- → Metal electrode
- → Concentration of electrolyte
- → temperature

Standard reduction Potential

condition

- → Electrolyte Concentration 1 M
- → 1 atm gas pressure if involved
- → temp - @ 25 °C

Metal having high E° → std reduction potential to will ~~undergo~~ Undergo reduction

Metal having low E° will Undergo Oxidation

E° —— Cathode E°

$$E^\circ_{cell} = E_{cathode} - E_{anode}$$

E° —— anode

$$Zn \rightarrow Zn^{2+} + 2e^-$$

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

$$Zn + Cu^{2+} \rightarrow Cu + Zn^{2+}$$

$n = 2$

$$\Delta G^\circ_{cell} = \Delta G^\circ_{cathode} - \Delta G^\circ_{anode}$$

$$-nFE^\circ_{cell} = -nFE^\circ_{cathode} - (-nFE^\circ_{anode})$$

$$E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode}$$

Std Hydrogen electrode:

→ Potential is zero for a wide range of temp

→ @ 1M H^+, 1 atm gas H_2

E^0_{SHE} = Zero

$Zn_{(s)} \mid Zn^{2+}_{(aq)} \parallel H^+_{(aq)} \mid H_{2(g)} \mid Pt_{(s)}$

$E_{cell} = 0.76\ V$

$E_{Zn^{2+}/Zn} = -0.76$

$$E^0_{cell} = \underbrace{E^0_{cath}}_{= 0} - \underbrace{E^0_{ano}}_{=}$$

$$0.76 = \underbrace{E^0_{SHE}}_{= 0} + E^0_{Zn^{2+}/Zn}$$

$E^0_{Zn^{2+}/Zn} = -0.76$

Oxidizing agent

	E^0
$\frac{1}{2}F_2 + 1\bar{e} \rightarrow F^-$	2.87 V
$Cr^{6+} + 3\bar{e} \rightarrow Cr^{3+}$	1.1
$Ag^+ + 1e \rightarrow Ag$	0.8 V
$Fe^{3+} + 1\bar{e} \rightarrow Fe^{2+}$	0.77 V
$Cu^{2+} + 2\bar{e} \rightarrow Cu$	0.34
$Sn^{4+} + 2\bar{e} \rightarrow Sn^{2+}$	0.4 V
$2H^+ + 2\bar{e} \rightarrow H_{2(g)}$	0
$Cd^{2+} + 2\bar{e} \rightarrow Cd_{(s)}$	−0.4 V
$Zn^{2+} + 2\bar{e} \rightarrow Zn$	−0.76 V
$Li^+ + 1e \rightarrow Li$	~~−3~~ −3.1 V

Reducing agent

Significance of electrochemical Series:-

(i) relative Oxidizing / reducing power of Certain element

(ii) relative activity:-

~~Zn~~ Cu^{2+} solution Can not be Stored in Zn Container

$$E^0_{Cu^{2+}/Cu} > E^0_{Zn^{2+}/Zn}$$

(iii) Calculate Std reduction Potential of Unknown reaction

① $Ce^{3+} + 3\bar{e} \rightarrow Ce$ $\quad n = 3 \quad E^0 = -2.48\,V$

② $Ce^{4+} + 1\bar{e} \rightarrow Ce^{3+}$ $\quad n = 1 \quad E^0 = 1.61\,V$

$Ce^{4+} + 4\bar{e} \rightarrow Ce$ $\quad E^0 = ?$

in reactions (1) & (2) n is different

they are not same so we can not deal with E^0 directly

you have deal with ΔG

$$\cancel{Ce^{3+}} + 3e^- \longrightarrow Ce$$

$$Ce^{4+} + 1e \longrightarrow \cancel{Ce^{3+}}$$

$$Ce^{4+} + 4e^- \longrightarrow Ce$$

$$\Delta G^0_{Ce^{4+}/Ce} = \Delta G^0_{Ce^{3+}/Ce} + \Delta G^0_{Ce^{4+}/Ce^{3+}}$$

$$+nFE^0_{Ce^{4+}/Ce} = +nFE^0_{Ce^{3+}/Ce} + nFE^0_{Ce^{4+}/Ce^{3+}}$$

$$+4E^0_{Ce^{4+}/Ce} = 3E^0_{Ce^{3+}/Ce} + 1E^0_{Ce^{4+}/Ce^{3+}}$$

$$E^0_{Ce^{4+}/Ce} = \frac{3 \times -2.48 + 1.61}{4} \quad -1.45V$$

$$= \frac{-7.44 + 1.61}{4} = \frac{-5.83}{4} = \cancel{-1.43}$$