Lecture 22.3 Concentration Cells (Nernst Equation)

Note Title

ox. react plate red.

$Cu_{(s)} \mid Cu^{2+}_{(aq)}\ (0.100M) \parallel Cu^{2+}_{(aq)}\ (1.00M) \mid Cu_{(s)}$

copper copper

net cell reaction

conc. ↓ 1 : 1 conc ↑

$Cu_{(s)} + Cu^{2+}_{(aq)}(1.00M) \longrightarrow Cu^{+2}_{(aq)}(0.100M) + Cu_{(s)}$

1.0 → 0.55M 0.1M → 0.55M

cell stops operating.

1 : 1

$Conc._{Avg} = \frac{0.100 + 1.00}{2}$

$Conc_f = 0.55M$

Initially: Entropy.

$V_1\ [Cu^{+2}] = 0.100M$ ∴

$V_2\ [Cu^{+2}] = 1.00M$ ∴

Finally:

$V_1\ [Cu^{+2}] = 0.55M$ ∴

$V_2\ [Cu^{+2}] = 0.55M$ ∴

$S_i < S_F$ Spontaneous!

Conc. Cells are driven by increase in entropy.

Nernst Equation: $E_{cell} = \underbrace{E^\circ_{cell}}_{0} - \frac{0.0592}{n} \log Q$

$E^\circ_{cell} = E^\circ_{cathode\ Cu} - E^\circ_{anode\ Cu} = 0$ ... true for conc. cells

$E_{cell} = -\frac{0.0592}{n} \log Q = -\frac{0.0592}{2} \log\left(\frac{0.100M}{1.00M}\right)$

$E_{cell} = 0.0296 Volts = 29.6\ mV$

Appl. of Conc. cell: Ion sensitive electrode.

$Cu_{(s)} \mid Cu^{2+}_{(aq)}\ (?M) \parallel Cu^{+2}_{(aq)}\ (1.00M) \mid Cu_{(s)}$

- tap water
- lake water
- unknown

e⁻ → 0.040V → e⁻

Nernst Eq.: $E_{cell} = -\frac{0.0592}{n} \log Q$

$0.040V = -\frac{0.0592}{2} \log\left(\frac{?}{1.00M}\right)$ ... solve for ? = 0.0445M.