

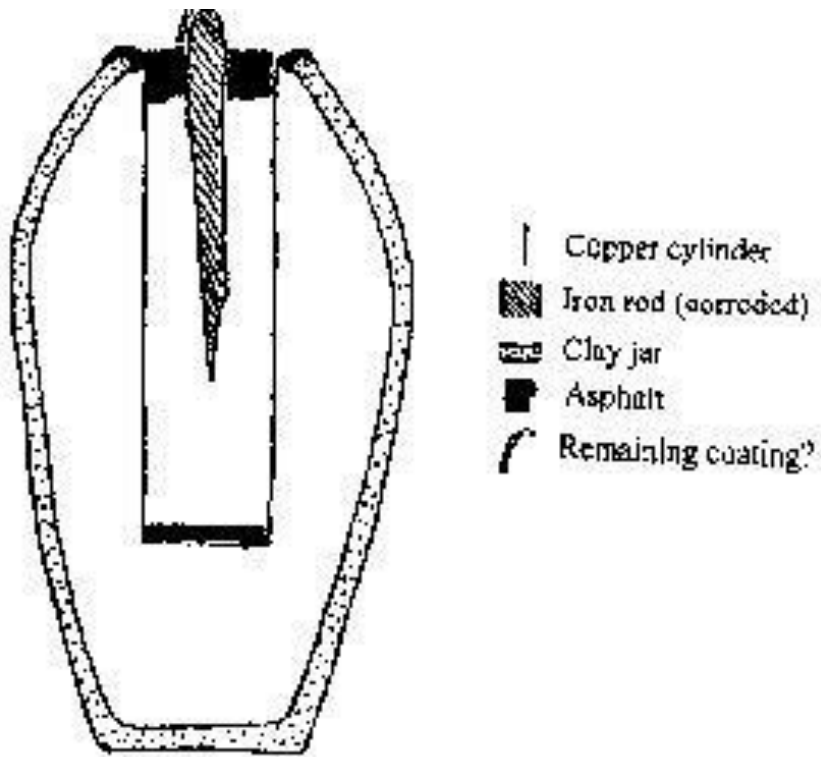
Гальванические элементы

Луиджи Гальвани 1791г.

Алессандро Вольта 1800г.

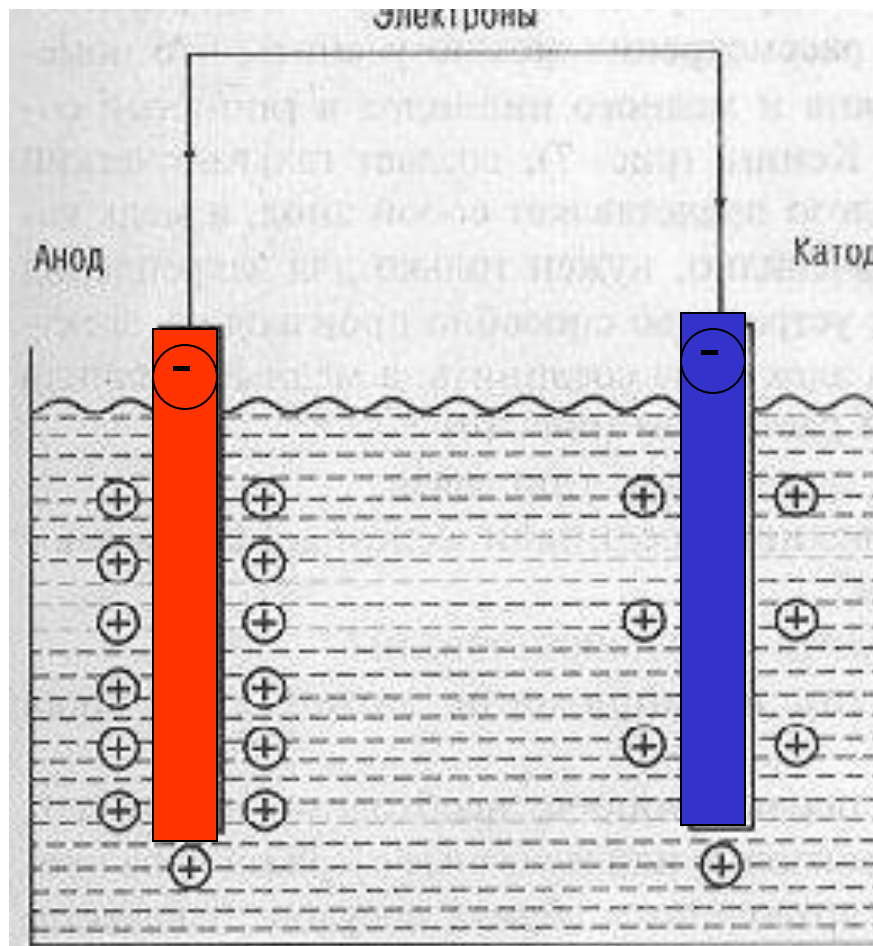
Парфянская батарея

Электрический ток 2000 лет назад???

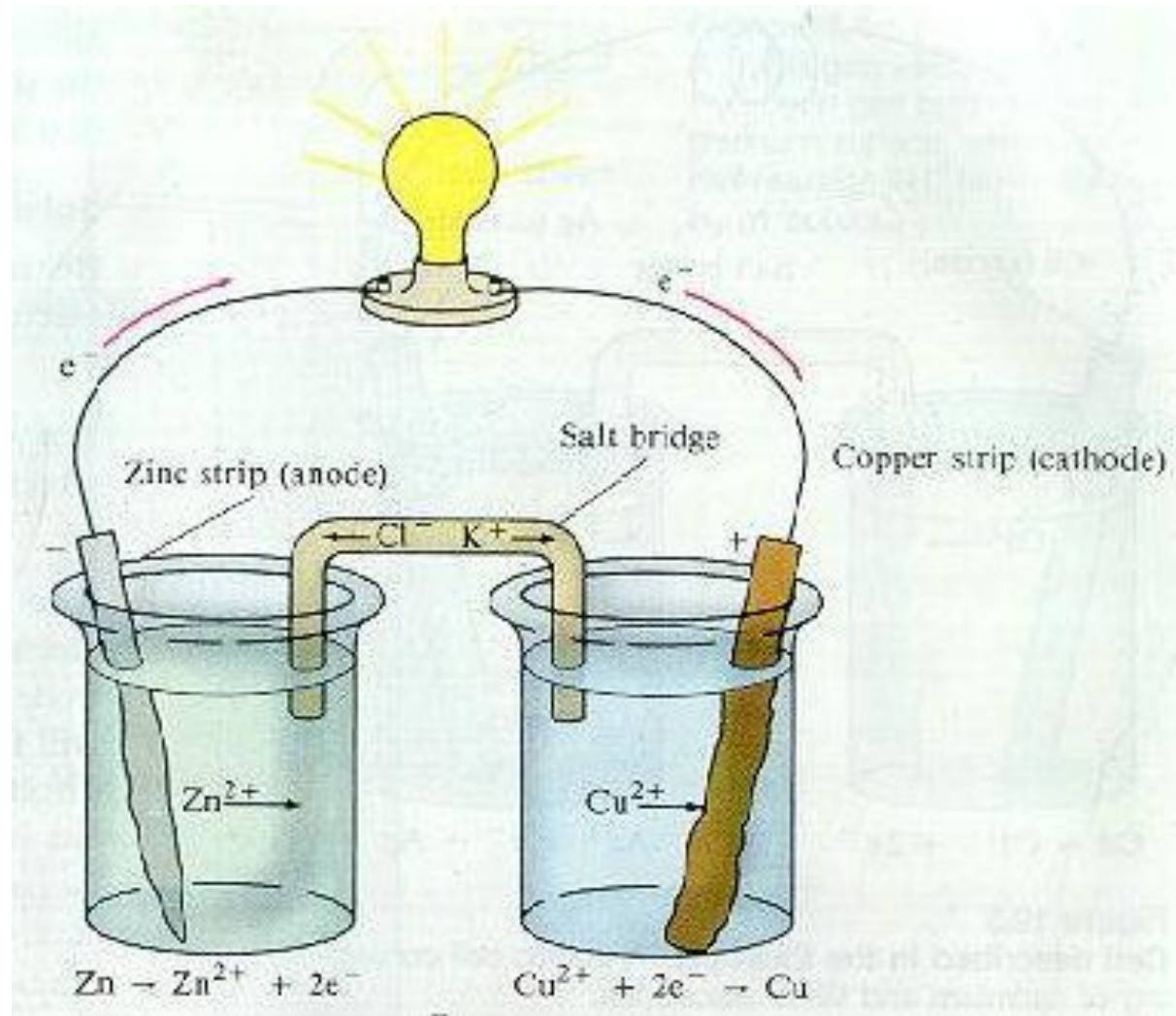


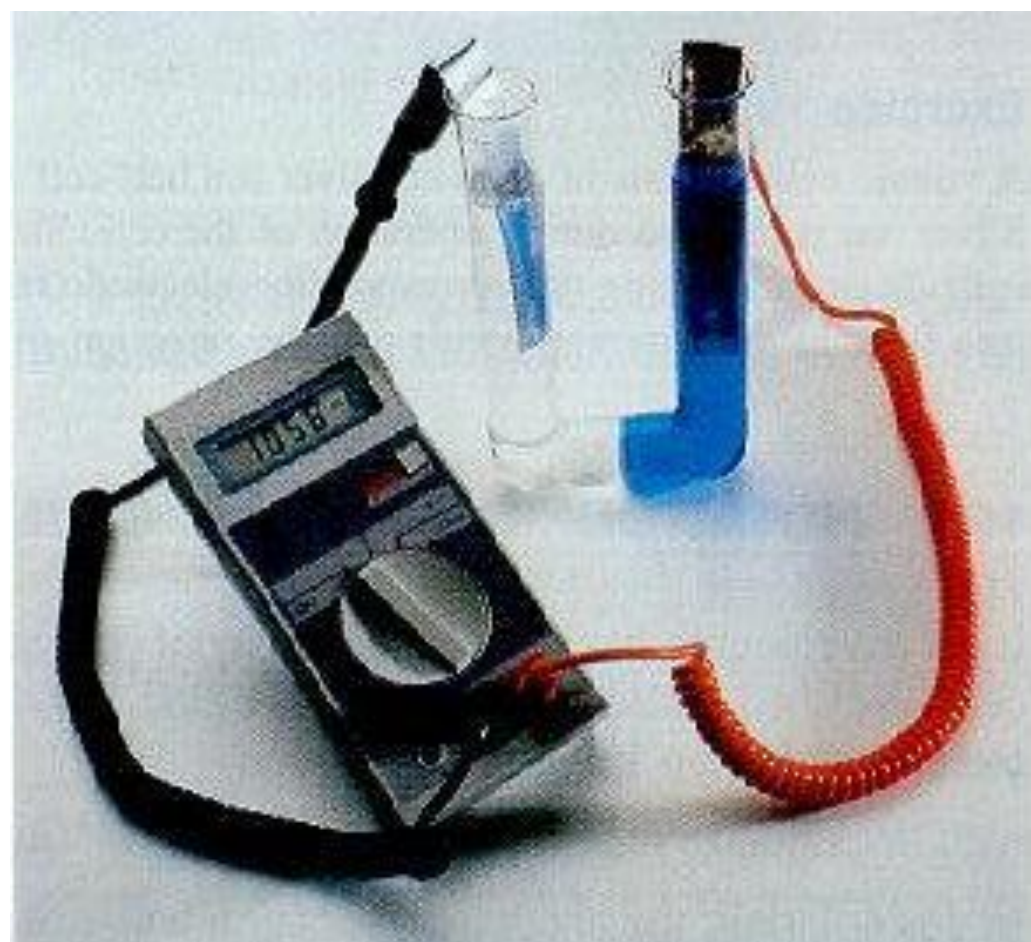
1936г., раскопки в районе Багдада

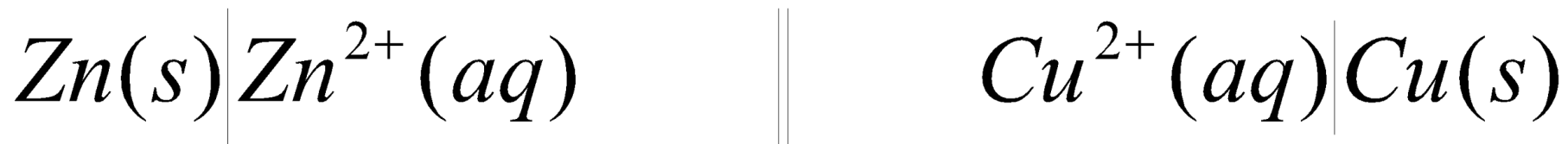
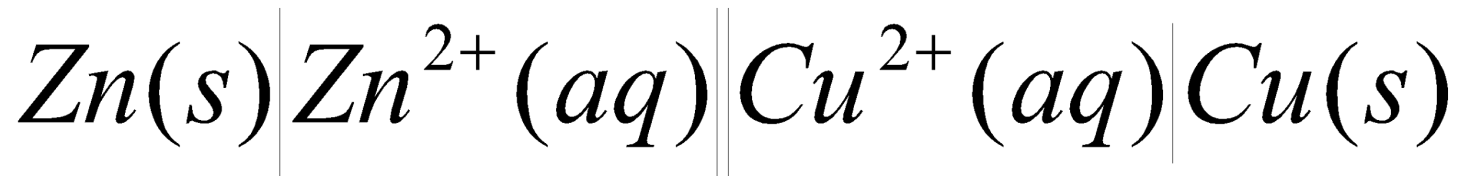
Механизм возникновения электрического тока в гальваническом элементе



A zinc-copper voltaic cell







anode

Salt bridge

cathode

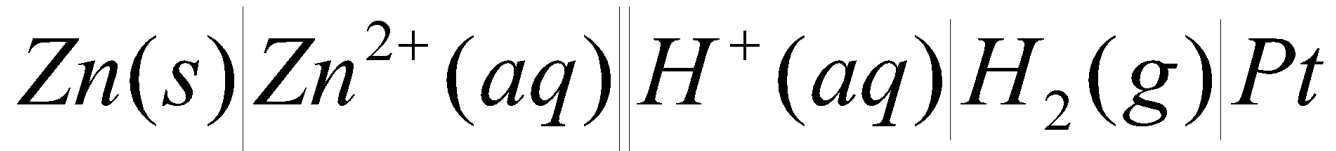
Стандартный электродный потенциал (восстановления) в водной среде при 25⁰С



$$\underline{\underline{E^0 = -0.76 \text{ В}}}$$

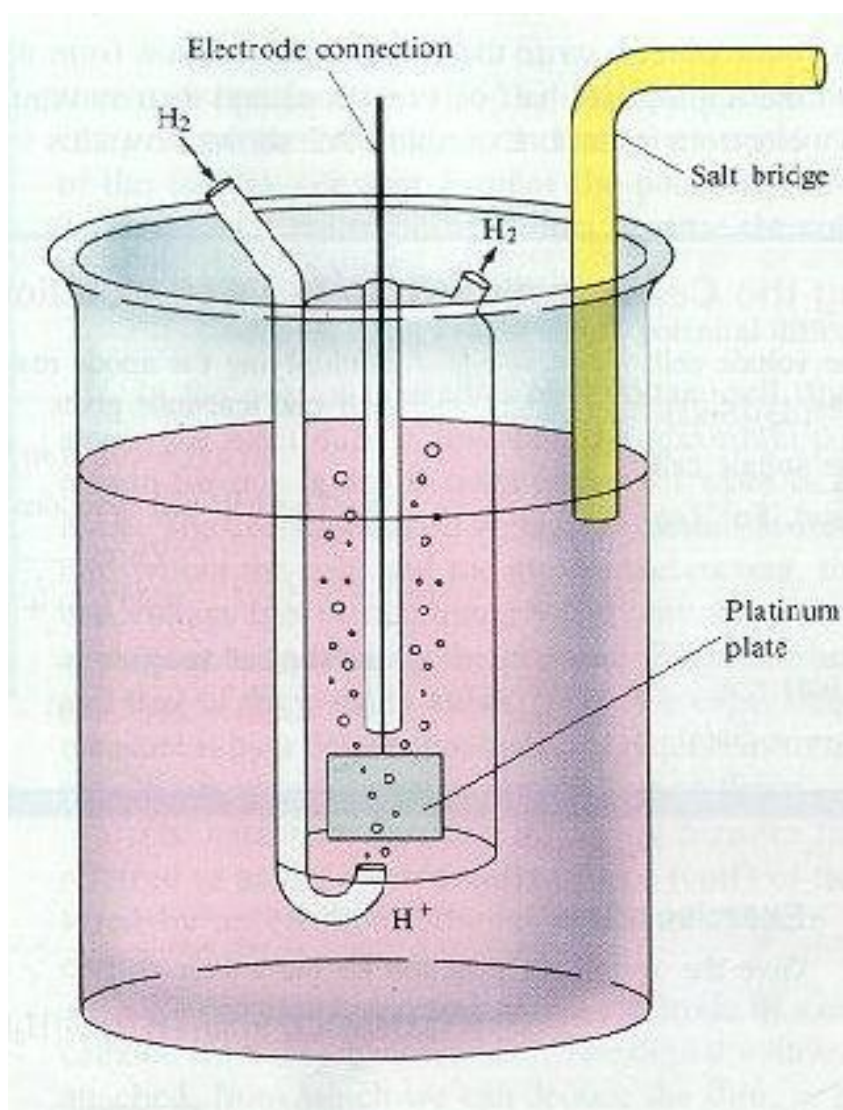
$\text{Li}^+(aq) + e^- \rightleftharpoons \text{Li}(s)$	-3.04
$\text{Na}^+(aq) + e^- \rightleftharpoons \text{Na}(s)$	-2.71
$\text{Mg}^{2+}(aq) + 2e^- \rightleftharpoons \text{Mg}(s)$	-2.38
$\text{Al}^{3+}(aq) + 3e^- \rightleftharpoons \text{Al}(s)$	-1.66
$2\text{H}_2\text{O}(l) + 2e^- \rightleftharpoons \text{H}_2(g) + 2\text{OH}^-(aq)$	-0.83
$\text{Zn}^{2+}(aq) + 2e^- \rightleftharpoons \text{Zn}(s)$	-0.76
$\text{Cr}^{3+}(aq) + 3e^- \rightleftharpoons \text{Cr}(s)$	-0.74
$\text{Fe}^{2+}(aq) + 2e^- \rightleftharpoons \text{Fe}(s)$	-0.41
$\text{Cd}^{2+}(aq) + 2e^- \rightleftharpoons \text{Cd}(s)$	-0.40
$\text{Ni}^{2+}(aq) + 2e^- \rightleftharpoons \text{Ni}(s)$	-0.25
$\text{Sn}^{2+}(aq) + 2e^- \rightleftharpoons \text{Sn}(s)$	-0.14
$\text{Pb}^{2+}(aq) + 2e^- \rightleftharpoons \text{Pb}(s)$	-0.13
$\text{Fe}^{3+}(aq) + 3e^- \rightleftharpoons \text{Fe}(s)$	-0.04
$2\text{H}^+(aq) + 2e^- \rightleftharpoons \text{H}_2(g)$	0.00
$\text{Sn}^{4+}(aq) + 2e^- \rightleftharpoons \text{Sn}^{2+}(aq)$	0.15
$\text{Cu}^{2+}(aq) + e^- \rightleftharpoons \text{Cu}^+(aq)$	0.16
$\text{Cu}^{2+}(aq) + 2e^- \rightleftharpoons \text{Cu}(s)$	0.34
$\text{IO}^-(aq) + \text{H}_2\text{O}(l) + 2e^- \rightleftharpoons \text{I}^-(aq) + 2\text{OH}^-(aq)$	0.49
$\text{Cu}^+(aq) + e^- \rightleftharpoons \text{Cu}(s)$	0.52
$\text{I}_2(s) + 2e^- \rightleftharpoons 2\text{I}^-(aq)$	0.54
$\text{Fe}^{3+}(aq) + e^- \rightleftharpoons \text{Fe}^{2+}(aq)$	0.77
$\text{Hg}_2^{2+}(aq) + 2e^- \rightleftharpoons 2\text{Hg}(l)$	0.80
$\text{Ag}^+(aq) + e^- \rightleftharpoons \text{Ag}(s)$	0.80
$\text{Hg}^{2+}(aq) + 2e^- \rightleftharpoons \text{Hg}(l)$	0.85
$\text{ClO}^-(aq) + \text{H}_2\text{O}(l) + 2e^- \rightleftharpoons \text{Cl}^-(aq) + 2\text{OH}^-(aq)$	0.90
$2\text{Hg}^{2+}(aq) + 2e^- \rightleftharpoons \text{Hg}_2^{2+}(aq)$	0.90
$\text{NO}_3^-(aq) + 4\text{H}^+(aq) + 3e^- \rightleftharpoons \text{NO}(g) + 2\text{H}_2\text{O}(l)$	0.96
$\text{Br}_2(l) + 2e^- \rightleftharpoons 2\text{Br}^-(aq)$	1.07
$\text{O}_2(g) + 4\text{H}^+(aq) + 4e^- \rightleftharpoons 2\text{H}_2\text{O}(l)$	1.23
$\text{Cr}_2\text{O}_7^{2-}(aq) + 14\text{H}^+(aq) + 6e^- \rightleftharpoons 2\text{Cr}^{3+}(aq) + 7\text{H}_2\text{O}(l)$	1.33
$\text{Cl}_2(g) + 2e^- \rightleftharpoons 2\text{Cl}^-(aq)$	1.36
$\text{MnO}_4^-(aq) + 8\text{H}^+(aq) + 5e^- \rightleftharpoons \text{Mn}^{2+}(aq) + 4\text{H}_2\text{O}(l)$	1.49

$$E^0_{cell} = E^0_{Ag} - E^0_{Cd}$$



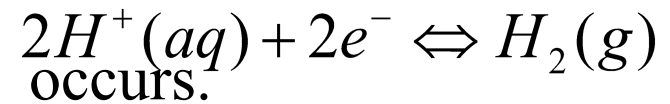
$$E^0_{Zn} = E^0_{Cathode} - E^0_{anode}$$

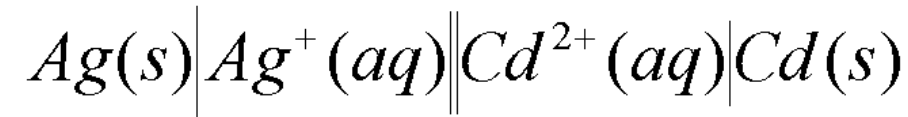
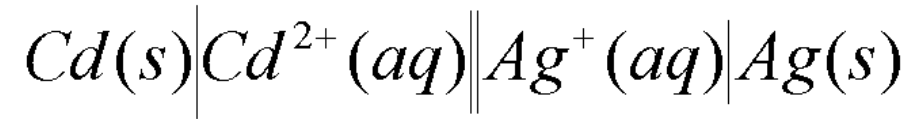
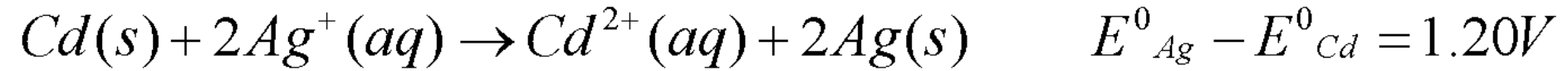
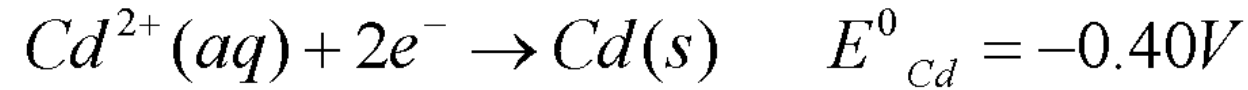
$$E^0_{Zn} = -0.76V$$



A hydrogen electrode.

Hydrogen gas bubbles over a platinum surface, where the half-reaction





Уравнение Нернста

$$\varphi = \varphi^0 + \frac{2.3RT}{zF} \lg \frac{[Ox]}{[Red]}$$

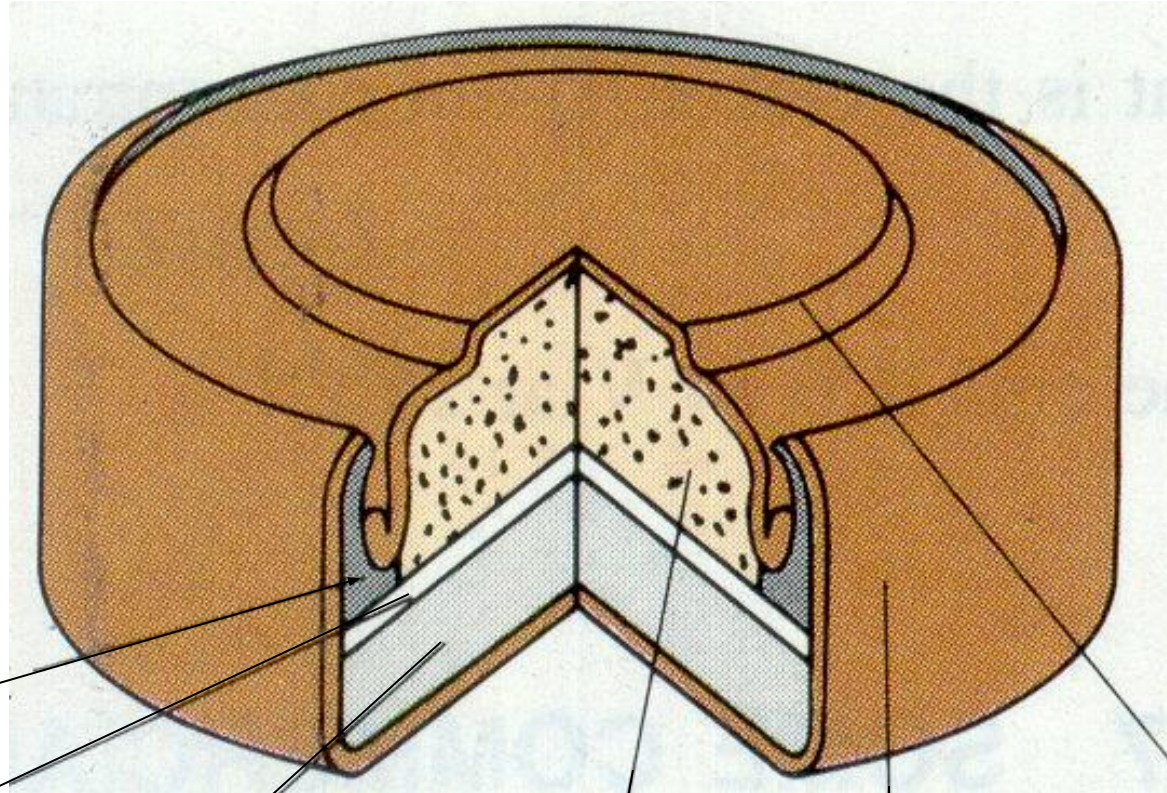
$$Zn / Zn^{2+} \quad Zn^{2+} + 2e^- \Leftrightarrow Zn \quad \varphi = \varphi^0 + \frac{0.059}{2} \lg [Zn^{2+}]$$

$$Ag / Ag^+ \quad Ag^+ + e^- \Leftrightarrow Ag \quad \varphi = \varphi^0 + 0.059 \lg [Ag^+]$$

$$Pt / Fe^{2+}, Fe^{3+} \quad Fe^{3+} + e^- \Leftrightarrow Fe^{2+} \quad \varphi = \varphi^0 + 0.059 \lg \frac{[Fe^{3+}]}{[Fe^{2+}]}$$

$$Pt / MnO_4^-, \quad MnO_4^- + 8H^+ + \quad \varphi = \varphi^0 + \frac{0.059}{5} \lg \frac{[MnO_4^-][H^+]^8}{[Mn^{2+}]}$$

$$Mn^{2+}, H^+ \quad + 5e^- \Leftrightarrow Mn^{2+} + 4H_2O$$



Gasket

Separator

Cathode ($\text{MnO}_2 + \text{KOH}$)
electrolyte

Anode (Zn powder + KOH
electrolyte)

Cell can

Anode cap

A small alkaline dry cell. The anode is zinc powder and the cathode is MnO_2 , as in the Leclanche cell; however, the electrolyte is KOH.