ELECTROCHEMICAL CONCENTRATION CELLS **CHEM BC 2001x**

General Nernst equation for the electric potential difference in any electrochemical cell at 25°C:

$$\Delta\mathscr{E} = \Delta\mathscr{E}^\circ - \left(\frac{0.05916}{n}\right)\log_{10} Q = (\mathscr{E}^\circ_R - \mathscr{E}^\circ_L) - \left(\frac{0.05916}{n}\right)\log_{10} Q$$

Voltage of concentration cell: $\Delta\mathscr{E} = -\left(\frac{0.05916}{n}\right)\log_{10} Q = -\left(\frac{0.05916}{n}\right)\log_{10}\left(\frac{M_L}{M_R}\right)$

Concentration cells have exactly the *same* half-cell and half-reaction on each side, so $\Delta\mathscr{E}^\circ = 0$.

Example 1: **Pb(s) | Pb^{2+}(aq, M_L) || Pb^{2+}(aq, M_R) | Pb(s)** at 25°C

Reduction on the right-hand side: $Pb^{2+}(aq, M_R) + 2\,e^- \rightarrow Pb(s)$

Oxidation on the left-hand side: $Pb(s) \rightarrow Pb^{2+}(aq, M_L) + 2\,e^-$

Net overall cell reaction: $Pb^{2+}(aq, M_R) \rightarrow Pb^{2+}(aq, M_L)$

Two electrons are transferred per unit of reaction. The ion concentrations tend toward equality.

Observed cell potential difference $\Delta\mathscr{E}_{cell}$ as a function of lead ion concentrations M_R and M_L:

M_L	M_R	$Q = M_L/M_R$	$\log_{10}Q$	$\Delta\mathscr{E}_{cell}$ (volts) at 25°C
0.100	0.100	1.0	0	0.00000
0.100	1.000	0.1	–1	0.02958
0.010	0.100	0.1	–1	0.02958
0.010	1.000	0.01	–2	0.05916
0.001	1.000	0.001	–3	0.08874

Example 2: **Ag(s) | Ag^+(aq, M_L) || Ag^+(aq, M_R) | Ag(s)** at 25°C

Reduction on the right-hand side: $Ag^+(aq, M_R) + e^- \rightarrow Ag(s)$

Oxidation on the left-hand side: $Ag(s) \rightarrow Ag^+(aq, M_L) + e^-$

Net overall cell reaction: $Ag^+(aq, M_R) \rightarrow Ag^+(aq, M_L)$

One electron is transferred per unit of reaction. The ion concentrations tend toward equality.

Observed cell potential difference $\Delta\mathscr{E}_{cell}$ as a function of silver ion concentrations M_R and M_L:

M_L	M_R	$Q = M_L/M_R$	$\log_{10}Q$	$\Delta\mathscr{E}_{cell}$ (volts) at 25°C
0.100	0.100	1.0	0	0.00000
0.100	1.000	0.1	–1	0.05916
0.010	0.100	0.1	–1	0.05916
0.010	1.000	0.01	–2	0.11832
0.001	1.000	0.001	–3	0.17748