Reaction Feasibility

We can use the equations along with the standard electrode potential values to predict reaction feasibility.

Consider the magnesium, copper cell

$Mg^{2+}_{(aq)} + 2e^- \rightleftharpoons Mg_{(s)}$ $E^\theta = -2.37$ V LHS Rev

$Cu^{2+}_{(aq)} + 2e^- \rightleftharpoons Cu_{(s)}$ $E^\theta = +0.34$ V RHS

Calculate the standard cell potential for this system

$+0.34 - -2.37 = +2.71$ V

The standard cell potential is positive so the reaction is feasible.

The reaction that is happening is

$Mg_{(s)} + Cu^{2+}_{(aq)} \rightarrow Mg^{2+}_{(aq)} + Cu_{(s)}$

E.g. Will the following reaction occur?

Silver metal reacting with zinc ions

$2Ag_{(s)} + Zn^{2+}_{(aq)} \rightarrow 2Ag^+_{(aq)} + Zn_{(s)}$

$Ag^+_{(aq)} + e^- \rightleftharpoons Ag_{(s)}$ $E^\theta = +0.80$V Rev

$Zn^{2+}_{(aq)} + 2e^- \rightleftharpoons Zn_{(s)}$ $E^\theta = -0.76$V

$-0.76 - 0.80 = -1.56$ V not feasible

E.g. Will the following reaction occur?

$Fe^{2+}_{(aq)} + Ag^+_{(aq)} \rightarrow Fe^{3+}_{(aq)} + Ag_{(s)}$

$Ag^+_{(aq)} + e^- \rightleftharpoons Ag_{(s)}$ $E^\theta = +0.80$V

$Fe^{3+}_{(aq)} + e^- \rightleftharpoons Fe^{2+}_{(s)}$ $E^\theta = +0.77$V Rev

$+0.80 - 0.77 = +0.03$ V

feasible

Limitations of this method 1.0M , 298K , 100kPa

Standard cell potentials are calculated under strict conditions. If these conditions are changed we cannot predict reaction feasibility with certainty.

E.g. $Zn_{(s)} + Cu^{2+}_{(aq)} \rightarrow Zn^{2+}_{(aq)} + Cu_{(s)}$

★ $Cu^{2+}_{(aq)} + 2e^- \rightleftharpoons Cu_{(s)}$ $E^\theta = +0.34V$ RHS

$Zn^{2+}_{(aq)} + 2e^- \rightleftharpoons Zn_{(s)}$ $E^\theta = -0.76V$ LHS

Standard cell potential = +0.34 − −0.76 = +1.10V

The reaction is feasible under standard conditions

However, changing the conditions will shift the position of equilibrium and so change the value of E^θ.

Increasing the concentration of the solutions will shift the equilibrium right making E^θ more positive.

Changing the temperature or pressure of gases will also have an effect on the value of E^θ and so the reaction feasibility.