CHEM1001 Worksheet 13 – Answers to Critical Thinking Questions

The worksheets are available in the tutorials and form an integral part of the learning outcomes and experience for this unit.

Model 1: Reduction Potentials

1. Oxidising agents are themselves reduced – the strongest oxidising agent is the most easily reduced. This is Ag^{+}(aq) as it has the most positive $E_{red}°$ value (it has the strongest attraction to electrons).

2. Reaction (1) will remain a reduction. Reaction (2) will reverse to become an oxidation, as Ag^{+}(aq) is the strongest oxidising agent.

3. Reaction (3) will remain a reduction. Reaction 4 will reverse to become an oxidation as Zn^{2+}(aq) is the stronger reducing agent. It does not matter that they are both negative as it is the *difference* between the two E^{0}_{red} values which determines the reaction.

Model 2: Voltaic Cells

1. The Zn/Zn^{2+} half reaction is proceeding as an oxidation as it has a lower E^{0}_{red} value than that for Cu^{2+}/Cu. When we flip a reduction to an oxidation, we reverse the sign of the potential.

2. The Zn electrode will erode and the Cu electrode will gain mass.

3. Oxidation takes place at anode. Reduction takes place at cathode

4. Electrons flow from the anode, the Zn metal, to the cathode. As the Zn atoms lose electrons to form Zn^{2+} ions, the electrons flow through the wire and to the cathode where they combine with Cu^{2+} to form Cu.

5. Anode is negative, cathode is positive

6. The overall charge in each compartment *must* be equalised. Cations are being made in the anode department and lost in the cathode compartment, so to balance the charges cations move from anode to cathode and anions in the other direction. You can also think of it as 'completing the circuit' – electrons flow from anode to cathode through the wire, then the negative anions flow form cathode to anode through the solution.

7. Cathode - reduction: $\mathrm{Ag^{+}(aq) + e^{-} \rightleftharpoons Ag(s)}$. Anode - oxidation: $\mathrm{Cu(s) \rightleftharpoons Cu^{2+}(aq) + 2e^{-}}$
   E^{0}_{cell} = [0.80 +(-0.34)] V = 0.46 V

8. Cathode - reduction: $\mathrm{Cu^{2+}(aq) + 2e^{-} \rightleftharpoons Cu(s)}$. Anode - oxidation: $\mathrm{Ni(s) \rightleftharpoons Ni(aq) + 2e^{-}}$
   E^{0}_{cell} = [0.34 + 0.25] V = 0.59 V

9. Cathode - reduction: $\mathrm{Ni^{2+}(aq) + 2e^{-} \rightleftharpoons}$ Ni(s). Anode -oxidation: $Zn \rightleftharpoons Zn^{2+} + 2e^{-}$
   E^{0}_{cell} = [-0.25 + 0.76] V = 0.51 V

10. $\mathrm{Ag^{+}(aq) + e^{-} \rightleftharpoons}$ Ag(s) and Zn(s) $\mathrm{\rightleftharpoons Zn^{2+}(aq) + 2e^{-}}$; E^{0}_{cell} = 1.56 V

Model 3: Nernst Equation

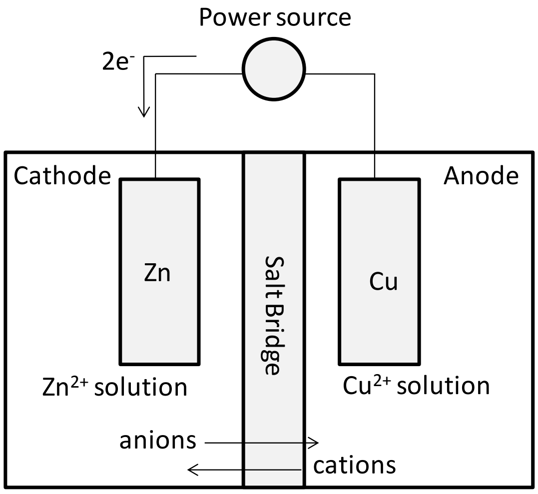
1. 1.0 V

2. The voltmeter reading goes to zero: the battery is dead.

3. Put a current through it.

Model 4: Electrolytic Cells

1. See below.



2. Oxidation: $\mathrm{Cu(s)} \rightleftharpoons \mathrm{Cu^{2+}(aq)} + 2\mathrm{e^-}$. Reduction: $\mathrm{Zn^{2+}(aq)} + 2\mathrm{e^-} \rightleftharpoons \mathrm{Zn(s)}$

3. 1.1 V from power source.

4. Zn electrodes will gain mass. Cu electrode will erode.

5. $A = Cs^{-1}$

6. 0.813 g

7. Need 0.4 V from power source. 6880 s = 115 min.