Redox and Electrode Potentials

Electrochemical Cells

- Electrochemical cells can be made from two different metals dipped in salt solutions of their own ions and connected by a wire.
- Redox process
- Electrons flow through the wire from the more reactive metal to the less reactive metal.
- A voltmeter in the external circuit shows the voltage between the two half-cells. This is the cell potential (emf).
- Electrode potentials
  - Which direction each reaction goes in depends on how easily each metal loses electrons (i.e. how easily it's oxidised).
  - How easily a metal is oxidised is measured using electrode potentials.
  - Easily oxidised
    - very negative electrode potential
  - Harder to oxidise
    - less negative electrode potential

Redox Reactions

- Oxidation
  - loss of electrons
- Reduction
  - gain of electrons
- Oxidising agent
  - accepts electrons and gets reduced
- Reducing agent
  - donates electrons and gets oxidised
- Half-equations
  - A redox reaction is made up of an oxidation half-reaction and a reduction half-reaction.
- Oxidation numbers
  - The oxidation number of an element tells you the total number of electrons it has donated or accepted.

Standard Electrode Potentials

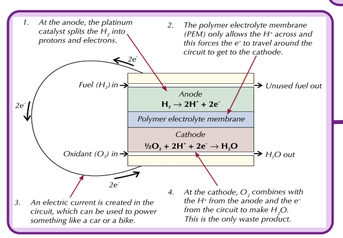
- Factors affecting the electrode potential
  - Half cell reactions are reversible
  - affected by changes in temperature, pressure and concentration
  - changing the equilibrium position changes the cell potential
  - Standard conditions are used to measure electrode potential.
- Measuring standard electrode potentials
  - The standard electrode potential of a half-cell is the voltage measured under standard conditions when the half-cell is connected to a standard hydrogen electrode.
  - Hydrogen cell
    - 0V
  - Standard conditions
    - Any solutions of ions must have a concentration of 1.00 moldm^-3
    - The temperature must be 298K
    - The pressure must be 100kPa
  - The hydrogen electrode must be on the left.

Energy Storage Cells

- Recharging energy storage cells
  - Can be recharged because the reactions are reversible.
  - A current is supplied to force the electrons to flow in the opposite direction around the cell.
- Benefits of electrochemical cells
  - They can be cheap.
  - Have relatively high power densities.
- Risks of electrochemical cells
  - The production of the cell involves the use of toxic chemicals, which need to be disposed of once the cell has reachedthe end of its life span.
  - The chemicals are highly flammable.

Fuel Cells

- A fuel cell produces electricity by reacting a fuel with oxygen. The fuel is oxidised at the anode and the oxidant is reduced at the cathode.
- Hydrogen-oxygen fuel cells



Electrochemical Series

- An electrochemical series is basically a big long list of electrode potentials for different electrochemical half-cells.
- Half life equations are writen as reduction reactions.
- The more negative electrode potential goes in the direction of oxidation (backwards).
- The one with the more postive electrode potential goes in the direction of reduction (forwards).
- Electrochemical series and reactivity
  - Metals
    - The more reactive a metal is, the more it wants to lose electrons to form a positive ion.
    - More reactive metals have more negative standard electrode potentials.
  - Non-metals
    - The more reactive a non metal is, the more it wants to gain electrons to form a negative ion.
    - More reactive non-metals have more positive standard electrode potentials.
- Calculating cell potentials

$$E^\ominus_{cell} = E^\ominus_{reduced} - E^\ominus_{oxidised}$$

This is the standard electrode potential of the half-cell which goes in the direction of reduction (the one with the more positive electrode potential).

This is the standard electrode potential of the half-cell which goes in the direction of oxidation (the one with the more negative electrode potential).

- Predicting the direction of reactions
  - the more negative electrode potential goes backwards
  - Ecell = +ve
  - Problems
    - conditions are not standard
    - reaction kinetics are not favourable (rate of reaction slow/high activating energy)