Exothermic & Endothermic reactions:

Energy is conserved so is either stored by an object or transferred to the environment

Exothermic:

Transfers energy 2 surroundings as heat (so temp increases)
E.g. combustion, neutralisation & oxidation reactions
Uses: hand warmers oxidise iron to release energy

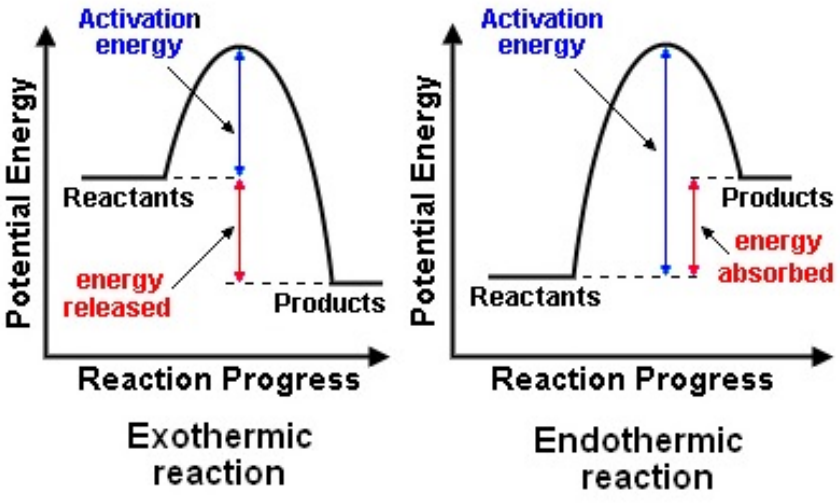
Endothermic:

Absorb energy from surroundings (so temp decreases)
E.g. thermal decomposition
Uses: sports injury packs for cooling

Reaction profiles:

Exothermic:
Reactants have a higher energy than products (initial temp rise = activation energy)
Activation energy = minimum energy needed to initiate a reaction (for particle collisions)

Endothermic:
Products have higher energy than reactants



Bond energies:

Breaking bonds = endothermic (energy is supplied)
Creating bonds = exothermic (energy is released)

Exothermic: energy released is greater than energy needed to break bonds

Bond energy calculations:

Reactants - products = overall energy change (left-right) after finding sum of the bond energies
Numerical values = points of comparison (energy needed during breaking & forming bonds of 2 elements = very similar so need exact value)

Bond energy is either absorbed to break one mole of bonds, or released when one mole of the bonds is made.

The calculation can be tabulated, as shown below:

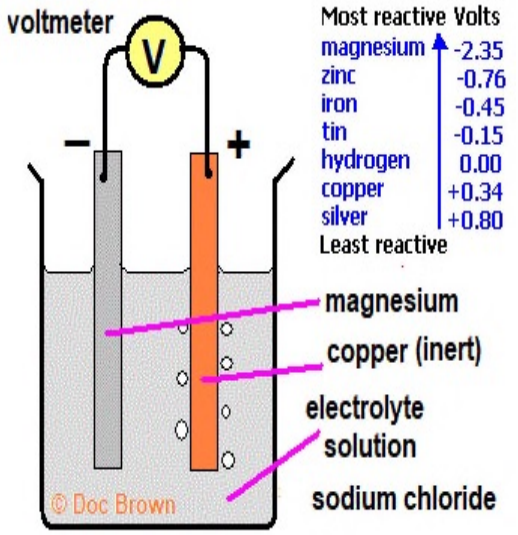
Bond	Bond energy in kJ/mol
C–H	412
O=O	496
O–H	463
C=O	743

Breaking bonds			Making bonds		
Bonds	Energy in kJ		Bonds	Energy in kJ	
4 × C–H	4 × 412	+1648	2 × C=O	2 × –743	–1486
2 × O=O	2 × 496	+992	4 × O–H	4 × –463	–1852
	Total	+2640		Total	–3338
Overall energy change = 2640 – 3338 = –698 kJ (exothermic)					

Cells & Batteries:

Electrochemical cell = 2 electrodes (metals) + an electrolyte in a system

Reaction between electrodes & electrolyte = create charge differences between the electrodes which are then connected to a circuit & voltage is read



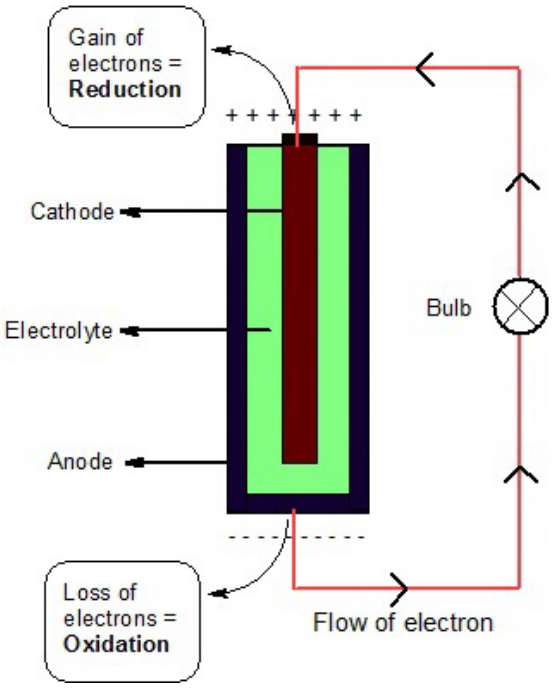
Different electrodes react different = charge difference
Bigger charge difference = bigger voltage produced
Electrolyte used affects voltage (ions react with the electrodes differently)

Battery formed by: connecting >2 cells in series, voltages combine = bigger voltage overall

Non-rechargeable batteries:

Reactions = irreversible (the ions in the electrolyte & electrodes get used up), if ONE of the reactants is used up the reaction STOPS = cell wont be charged

E.g. alkaline batteries which have to be replaced



Rechargeable cells: reaction is reversed by connecting it to an external electrical current

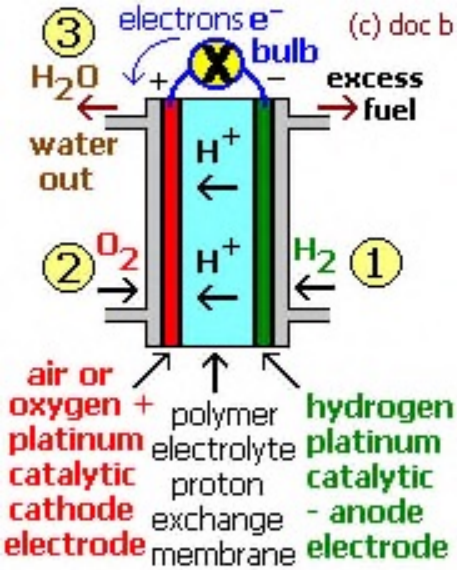
Fuel cells:

A cell supplied with fuel & oxygen which uses the reaction energy to product electricity efficiently

Fuel enters cell= becomes oxidised = PD set up

Hydrogen-oxygen fuel cell: produces H20 & releases energy, they involve a REDOX reaction:

1. Electrolyte = acid, Electrodes = carbon
2. Hydrogen goes into negative electrode, Oxygen into positive electrode (opposite to electrolysis!!!!)
3. Hydrogen loses electrons = H+ ions are formed at the anode = oxidation & they move to the cathode
4. Oxygen loses electrons at the cathode & they react with the H+ ions, making H20 = reduction
5. Electrons flow through a circuit from the anode->cathode = electrical current formed
6. Hydrogen + oxygen -> water



Hydrogen fuel cells in vehicles:

Conventional fossil fuels = finite & polluting

Pros of hydrogen fuel cells:
Less pollutants,
Rechargeable,
Store more energy than electrical batteries

Cons of hydrogen fuel cells:
Gas = hard to store as explosive
Made from hydrocarbons/electrolysis = energy intensive process originating from fossil fuels