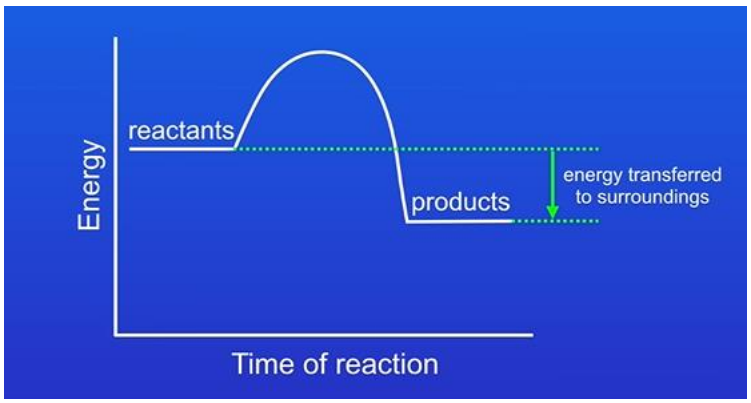
Exothermic and endothermic reactions:

Exothermic reactions:

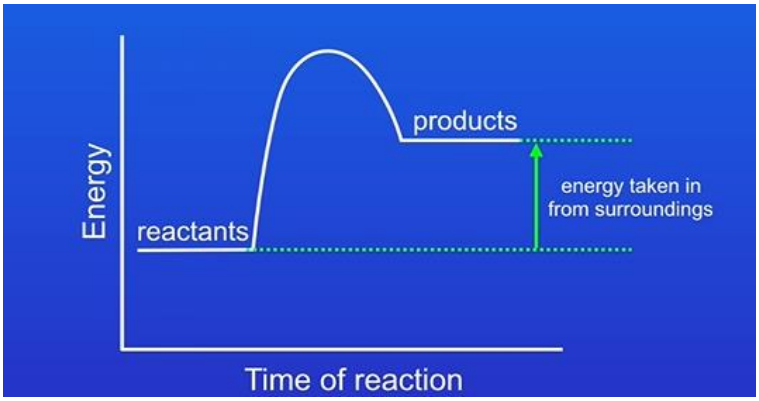
- Energy transferred to the surroundings
- Temperature of substance decreases
- Temperature of surroundings increases
- Examples can include oxidation and neutralisation reactions



- Energy of products have less energy than the reactants
- Exothermic reactions can include hand warmers and self heating cans

Endothermic reactions:

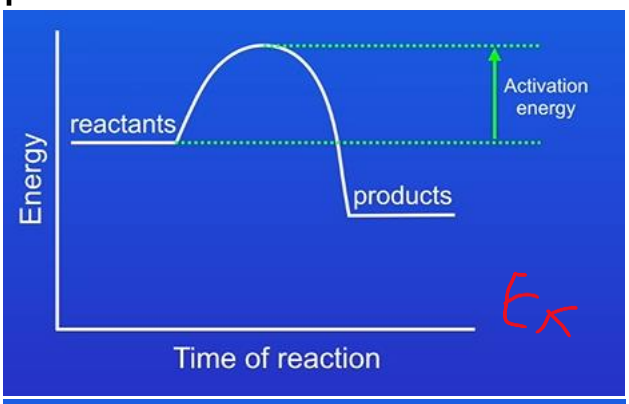
- Reactions which take in energy from the surroundings
- Temperature of surroundings decreases
- Temperature of reaction increases
- Examples can include thermal decomposition

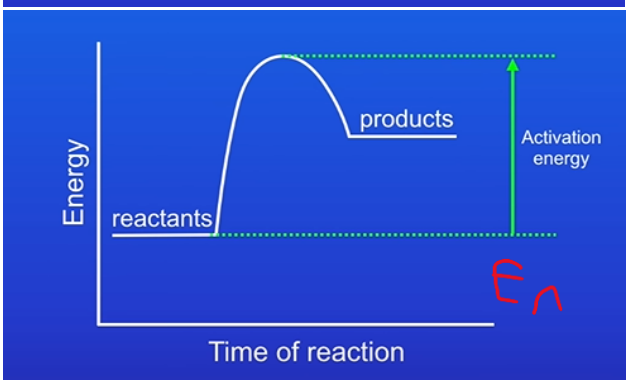


- The products have more energy than the reactants

Energy profile diagrams:

- A reaction can only happen when the particles collide with each other
- Activation energy can be represented from the peak to the reactants:





Bond energy calculations:

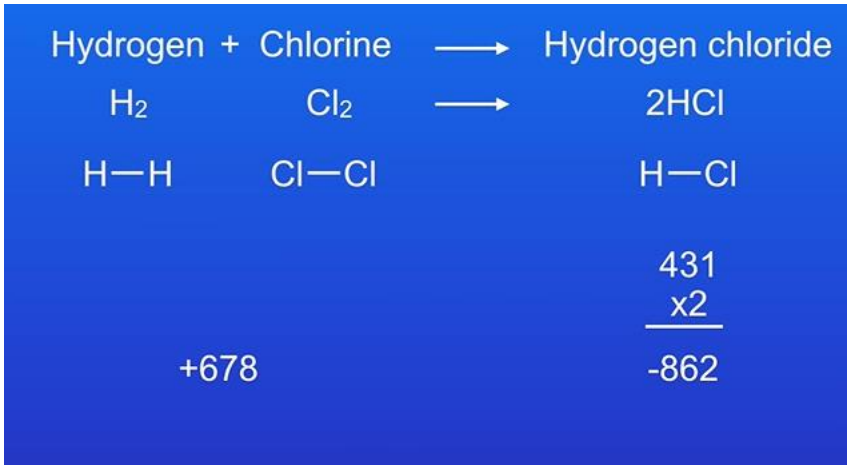
Exothermic reactions have a negative energy change because energy has been lost

Endothermic reactions have a positive energy change because energy has been gained

Bonds:

- Breaking a bond requires energy so it is **endothermic**
- Making bonds release energy so it is **exothermic**

How to calculate bond energy:



678 – 862 = -184kJ

Required practical changes:

Independent variable is the volume of sodium hydroxide solution

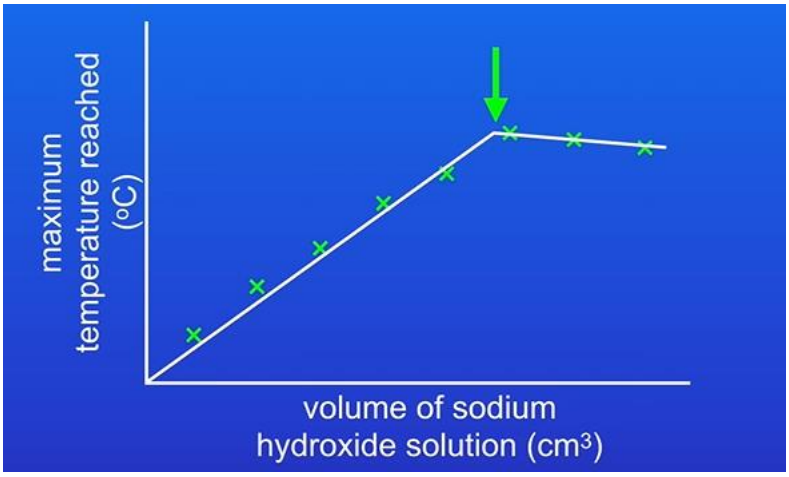
Dependent variable is the maximum temperature reached

Control variables are the volume of the hydrochloric acid and the concentration of both the hydrochloric acid and the sodium hydroxide solution

How to perform:

1. Start by using a measuring cylinder to measure 30cm^3 of dilute hydrochloric acid
2. Transfer acid to polystyrene cup inside a beaker. Beaker stops cup from falling over
3. Use a thermometer to measure the initial temperature of the acid and record it in a table
4. Use a measuring cylinder to measure 5cm^3 of sodium hydroxide solution
5. Transfer sodium hydroxide solution to the cup
6. Fit a plastic lid over the cup with a hole for the thermometer
7. Stir the solution with the thermometer

8. We record the temperature of the solution when it stops increasing as it is an exothermic reaction
9. We repeat experiment using 10cm^3 of sodium hydroxide solution
10. We carry out experiment several more times and increase the volume of sodium hydroxide solution by 5cm^3 until we reach maximum volume
11. We repeat experiment two times to calculate a mean



- As we increase volume, temperature is increasing because it's reacting
- As we further increase the volume, the temperature decreases because there isn't enough hydrochloric acid

We use a polystyrene cup because it reduces heat loss through the sides and the bottom

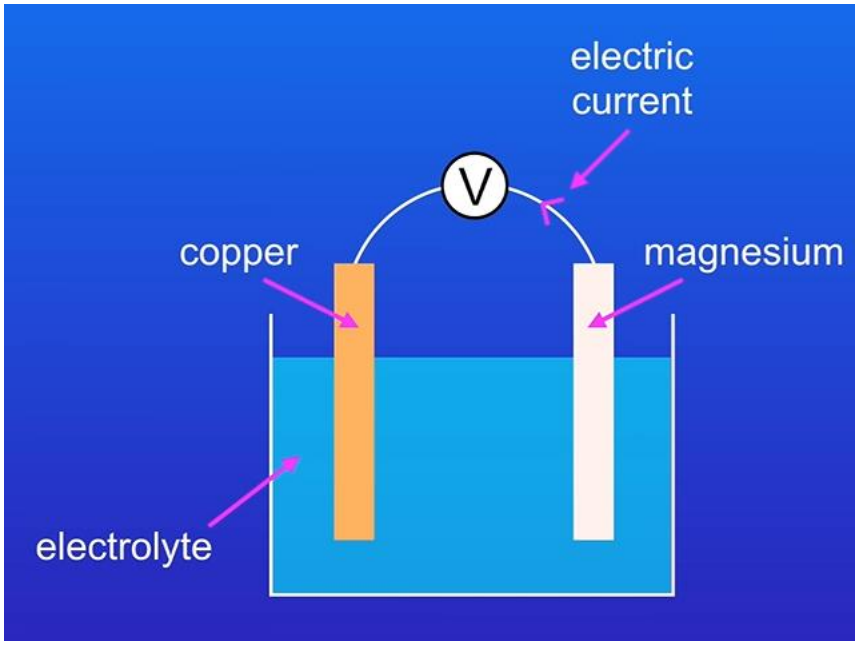
We use a lid on the top to reduce heat loss to the air

Cells and batteries:

If we place two different metals into an electrolyte, we can produce electricity

An electrolyte is a solution that can conduct electricity

Cells:



- The two metals have a potential difference because it's in an electrolyte which can allow a current to flow through

- It can only produce electricity for a certain period of time
- The chemicals become used up and run out which means the reaction stops making the battery unable to work
- Cells can only produce electricity when the metals have different reactivities
- The greater the reactivity of the metals, the greater the potential difference produced by the cell and the electrolyte also affects the potential difference

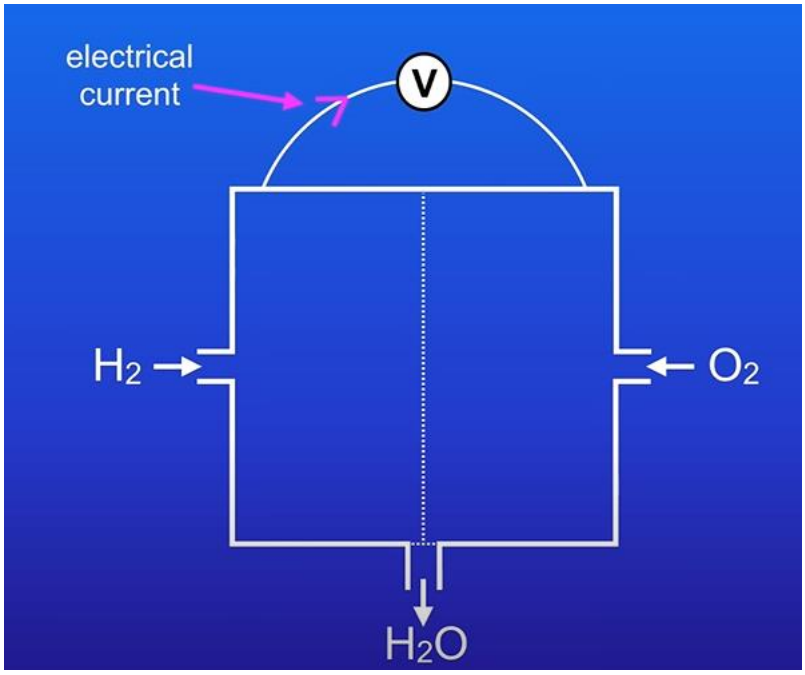
Batteries contain two or more cells and produce larger potential difference

Rechargeable batteries:

- Alkaline batteries run out because the reactants run out
- Alkaline batteries have a reaction that is not reversible so it is not rechargeable

- Rechargeable batteries have reversible reactions when we apply an electrical current so there are rechargeable

Fuel cells:



Negative electrode

$2H_2 \longrightarrow 4H^+ + 4e^-$

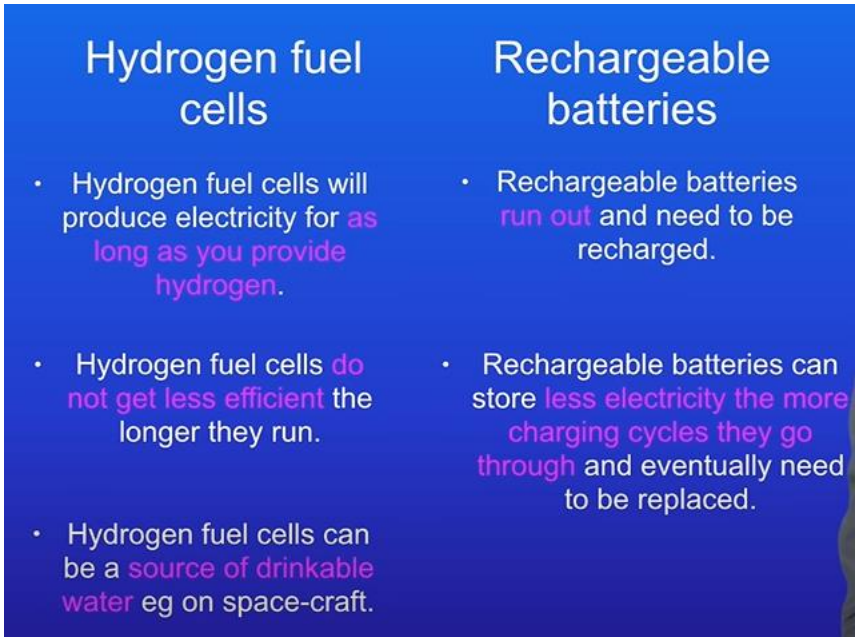
Positive electrode

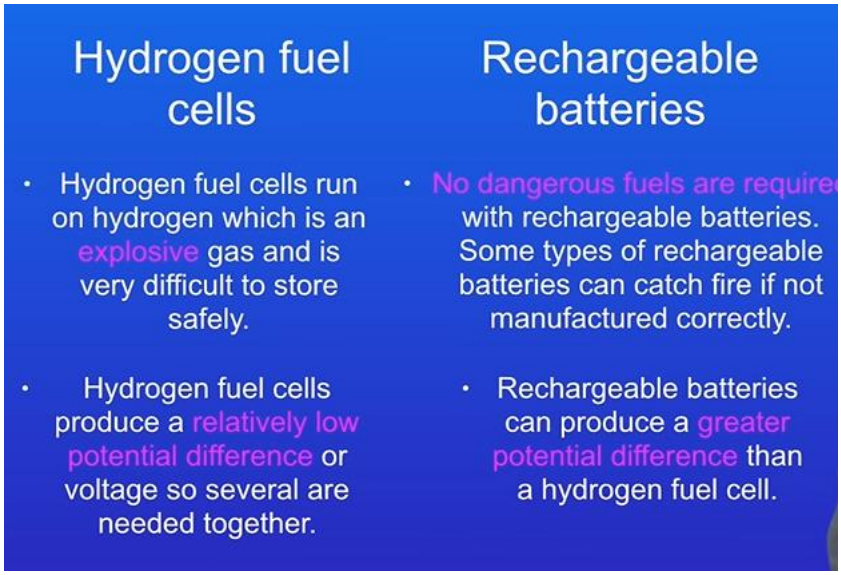
$O_2 + 4H^+ + 4e^- \longrightarrow 2H_2O$

Overall equation

$2H_2 + O_2 \longrightarrow 2H_2O$

The hydrogen is being oxidised.


Hydrogen fuel cells
Hydrogen fuel cells will produce electricity for as long as you provide hydrogen.
Hydrogen fuel cells do not get less efficient the longer they run.
Hydrogen fuel cells can be a source of drinkable water eg on space-craft.
Rechargeable batteries
Rechargeable batteries run out and need to be recharged.
Rechargeable batteries can store less electricity the more charging cycles they go through and eventually need to be replaced.


Hydrogen fuel cells
Hydrogen fuel cells run on hydrogen which is an explosive gas and is very difficult to store safely.
Hydrogen fuel cells produce a relatively low potential difference or voltage so several are needed together.
Rechargeable batteries
No dangerous fuels are require
with rechargeable batteries. Some types of rechargeable batteries can catch fire if not manufactured correctly.
Rechargeable batteries can produce a greater potential difference than a hydrogen fuel cell.