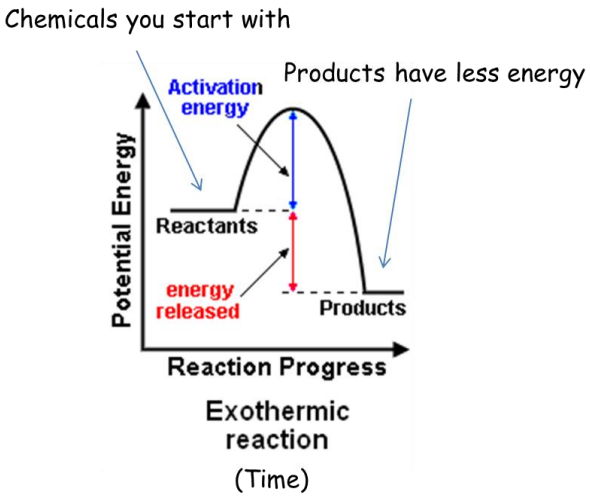
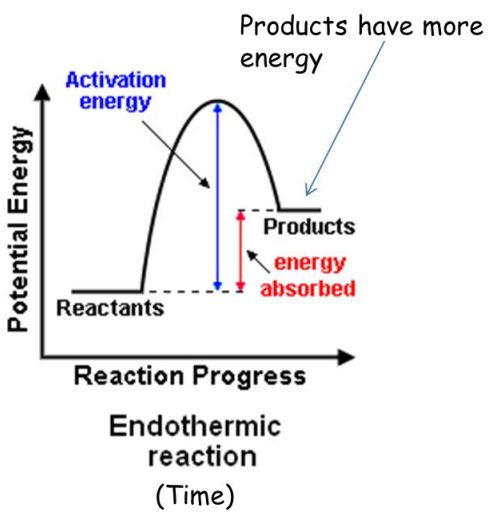
Energy changes

Exothermic reaction



Endothermic reaction



An exothermic reaction is one that transfers energy to the surroundings so the temperature of the surroundings increases.

An endothermic reaction is one that takes in energy from the surroundings so the temperature of the surroundings decreases.

Law of Conservation of Energy

- Energy cannot be created or destroyed, just transferred.
- During chemical reactions energy used to break chemical bonds between atoms in the reactants, when new bonds are formed to make the products energy is released.
- If overall energy is released to the surroundings the reaction is exothermic.
- If overall energy is absorbed from the surroundings the reaction is endothermic.

Exothermic	Endothermic
Combustion (burning)	Citric acid + sodium hydrogen carbonate
Neutralisation (acid + base)	Thermal Decomposition (splitting up a substance using heat)
Oxidation	
Hand Warmers	
Self Heating Cans	

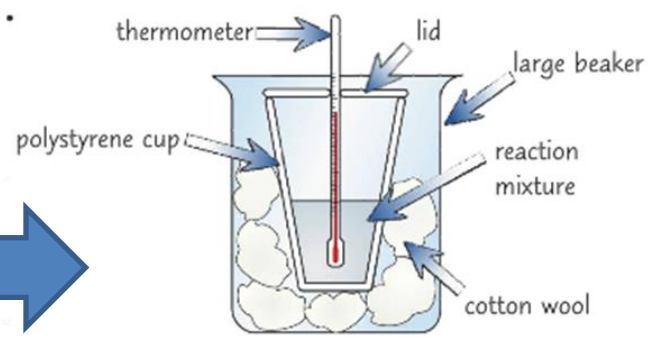
Investigating Energy Changes

- The experiment must be designed to stop heat energy entering or exiting.
- Lid prevents heat escaping by convection.
- Cotton wool and polystyrene cup prevent heat escaping by conduction/radiation.

Method

1. Add one of the reactants to the polystyrene cup. Measure and record the temperature with a thermometer.
2. Add the second reactant. Record the temperature every 30 seconds and record the maximum/minimum temperature.
3. Calculate the temperature change from the results.
4. Repeat, discard anomalies and calculate the mean.

Q. Explain how you could investigate how the concertation of acid effected the temperature rise when magnesium and hydrochloric acid were reacted together.



Energy Changes Separate Science Chemistry

To calculate bond energy

1. Add together the bond energies for all the bonds in the **reactants** – this is the 'energy in'.
2. Add together the bond energies for all the bonds in the **products** – this is the 'energy out'.
3. Calculate the energy change = energy in – energy out.

Worked example – an exothermic reaction

Hydrogen and chlorine react to form hydrogen chloride gas:

H–H + Cl–Cl → 2 × (H–Cl)

Bond	Bond Energy (kJ/mol)
H–H	436
Cl–Cl	243
H–Cl	432

1. Energy in = 436 + 243 = 679 kJ/mol
2. Energy out = 2 × 432 = 864 kJ/mol
3. Energy change = in – out = 679 – 864 = **–185 kJ/mol**

The energy change is negative, showing that energy is released to the surroundings in an **exothermic** **reaction**.

Worked example – an endothermic reaction

Hydrogen bromide **decomposes** to form hydrogen and bromine:

2 × (H–Br) → H–H + Br–Br

Bond	Bond Energy (kJ/mol)
H–Br	366
H–H	436
Br–Br	193

1. Energy in = 2 × 366 = 732 kJ/mol
2. Energy out = 436 + 193 = 629 kJ/mol
3. Energy change = in – out = 732 – 629 = **+103 kJ/mol**

The energy change is positive, showing that energy is taken in from the surroundings in an **endothermic** **reaction**.

Exothermic Reactions
A reaction is exothermic overall if less energy is absorbed when bonds are broken than released when the bonds are made.

Endothermic Reactions
A reaction is endothermic overall if more energy is absorbed when bonds are broken than released when the bonds are made.

During a chemical reaction:
•• energy must be supplied to break bonds in the reactants – endothermic – these have + energy change values as energy has entered the reaction.
•• energy is released when bonds in the products are formed – exothermic – these have – energy change values as energy has exited the reaction.

Energy Change = Break - Make

Explaining energy changes in terms of bonds…
Endothermic Reactions
If more energy was needed to break the bonds than was released when the bonds were formed the reaction is endothermic.
Exothermic Reactions
If more energy was released when the bonds were formed than was needed to break the bonds the reaction is exothermic.

Questions:
1. What happens to energy in reactions?
2. Compare exothermic and endothermic reactions.
3. Explain how you could investigate how the concertation of acid effected the temperature rise when magnesium and hydrochloric acid were reacted together.
4. Explain why reactions are exothermic or endothermic in terms of bonds made and bonds broken.