Chemistry Knowledge Organiser
Energy changes (Trilogy Science)

Energy changes in reactions

Energy is **conserved** in chemical reactions.

If a reaction transfers energy to the surroundings the product molecules must have less energy than the reactants, by the amount transferred.

Exothermic reactions

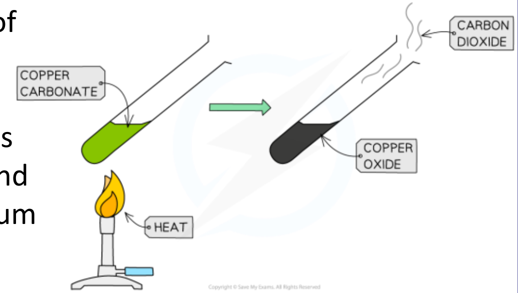
Gives out energy to the surroundings so the temperature of the surroundings increases.

Examples of exothermic reactions include combustion, many oxidation reactions and neutralisation.

Uses of exothermic reactions include **self heating cans** and **hand warmers**.

Endothermic reactions

Takes in energy from the surroundings so the temperature of the surroundings decreases.



Examples of endothermic reactions include thermal decompositions and the reaction of citric acid and sodium hydrogencarbonate.

Uses of endothermic reactions include some **sports injury packs**.

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Measuring temperature changes

Key steps in a method to investigate the effect of changing the mass of sodium carbonate powder on the highest temperature reached

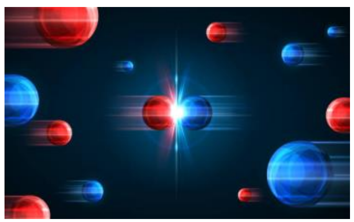
- measure volume of (hydrochloric) acid
- with a measuring cylinder
- pour (hydrochloric) acid into a suitable container eg polystyrene cup
- measure the initial temperature (of hydrochloric acid)
- with a thermometer
- add a known mass of sodium carbonate
- measured with a balance
- stir
- measure the highest temperature reached
- repeat with different masses of sodium carbonate
- repeat the whole investigation

Energy change reactions are either done in a **polystyrene cup** or an **insulated beaker** to **reduce heat transfer** between the reaction mixture and the surroundings.

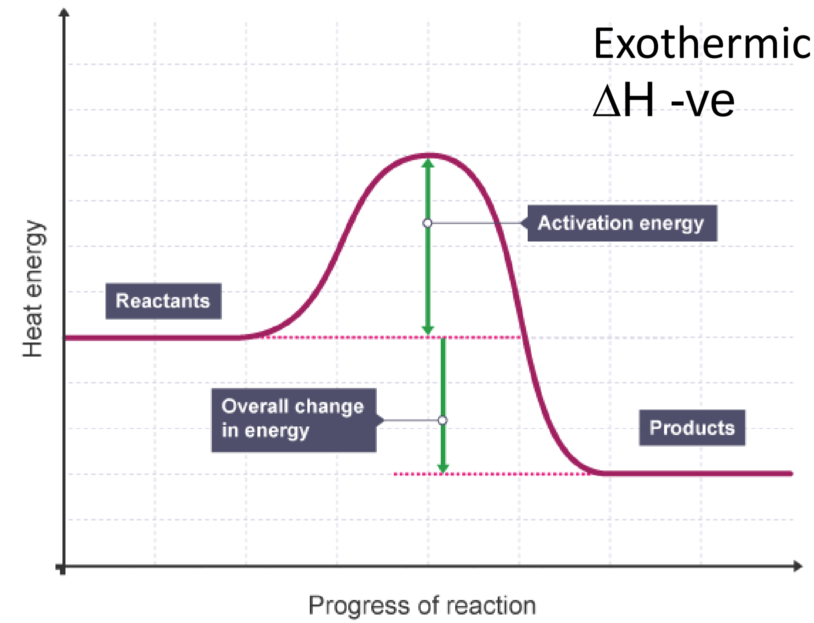
If different metals are reacted with acid the **more reactive** the metal the **higher the temperature increase**.

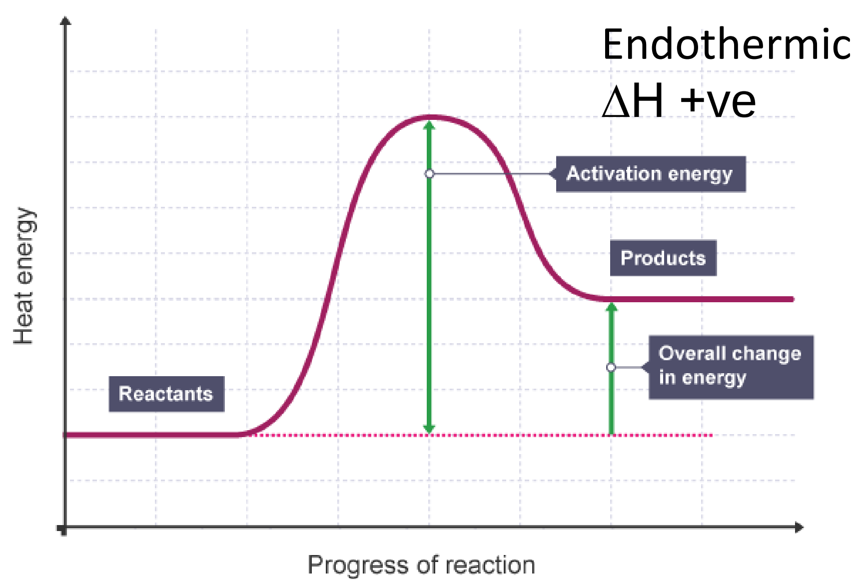
Activation energy

The **minimum** energy particles must have to **react** when they collide.



Reaction profiles





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Bond energy calculations (higher)

Bonds are an attractive force between atoms so:

Breaking bonds **takes in** energy (endothermic)

Making bonds **releases** energy (exothermic)

ΔH = Sum of bonds broken – Sum of bonds made

Reactants → Products

Bonds broken Bonds broken

Approach to calculations:

1. Draw out the displayed formula of the reactants and products
2. Count the number of bonds of each type in all the reactants taking into account the balancing numbers in front of the formulae
3. Substitute in the bond energy values for the type of bond and calculate the total
4. Repeat steps 2 and 3 for the products
5. Substitute the values calculated into the ΔH equation above.

If the energy needed to break the bonds Is less than the energy released when the new bonds are formed, then the energy change will be negative, and the reaction is exothermic.

Bond energy calculations example (higher)

Calculate the overall energy change for the reaction.

Use **Figure 7** and **Table 3**.

Figure 7 shows the displayed formula equation for the reaction.

Figure 7

$$4\,\mathrm{H{-}N(H){-}H} + 3\,\mathrm{O{=}O} \longrightarrow 2\,\mathrm{N{\equiv}N} + 6\,\mathrm{H{-}O{-}H}$$

Table 3 shows some bond energies.

Table 3

Bond	N—H	O=O	N≡N	O—H
Bond energy in kJ/mol	391	498	945	464

Bonds broken

Sum of bonds broken = (12 x N-H) + (3 x O=O)

Sum of bonds broken = (12 x 391) + (3 x 498)

Sum of bonds broken = 6186

Bonds formed

Sum of bonds formed = (2 x N-N) + (12 x O-H)

Sum of bonds formed = (2 x 945) + (12 x 464)

Sum of bonds formed = 7458

ΔH = 6186 - 7458 = **-1272 kJ/mol**