Heat Energy Change Notes

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During any chemical reaction the temperature of the reaction changes. The amount of energy that is transferred as heat, when bonds are broken or are formed, depends on what kinds of bonds are broken and what kinds of bonds are made.

In a chemical reaction:

The bonds in the reactant molecules are broken.

The bonds in the product molecules are made.

The difference between the energy needed to break bonds, and the energy released when new bonds form, determines the type of reaction. A reaction is either:

1. **Endothermic.**
2. **Exothermic**

Exothermic: a reaction which gives out heat energy to its surroundings so the temperature of the reaction mixture and the surroundings goes up.

Making chemical bonds gives energy out so is exothermic.

Exothermic reactions are ΔH negative.

In an exothermic reaction, more heat energy is given out making bonds than is required to break bonds.

Endothermic: a reaction which takes in heat energy from its surroundings.

Breaking chemical bonds requires energy to be put in so is endothermic.

Endothermic reactions are ΔH positive.

In an endothermic reaction, less energy is given out making bonds than is required to break bonds.

Delta – stands for "change in" → ΔH ← H – stands for "heat energy"

Energy Level Diagrams

An energy level diagram shows the energy in the reactants and products, and the difference in energy between them.

Exam note: A lot of exam questions involve energy level diagrams. Many ask you to complete one or read from one. So please be very familiar with these.

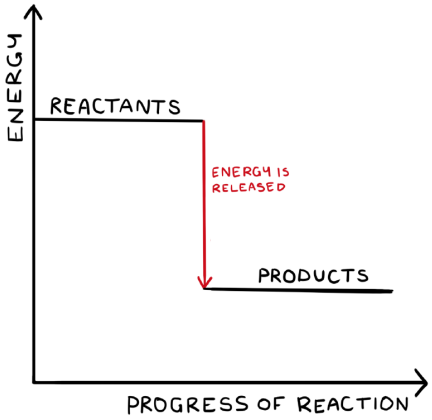
Exothermic Reaction Energy Level Diagram

The figure to the right shows the energy level diagram for an exothermic reaction.

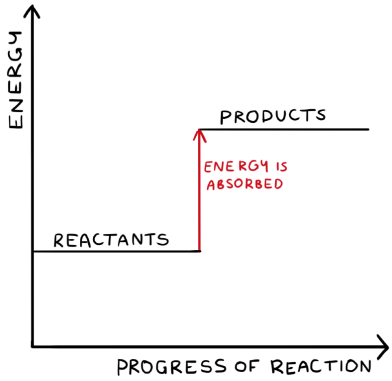
We can see that the energy level decreases in an exothermic reaction.

This is because energy is given out to the surroundings.

So, the line for the products is always lower than the reactants.



Endothermic Reaction Energy Level Diagram



The figure to the left shows the energy level diagram for an endothermic reaction.

We can see that the energy level increases in an endothermic reaction.

This is because energy is taken in from the surroundings.

So, <u>the line for the products is always higher than the reactants</u>.

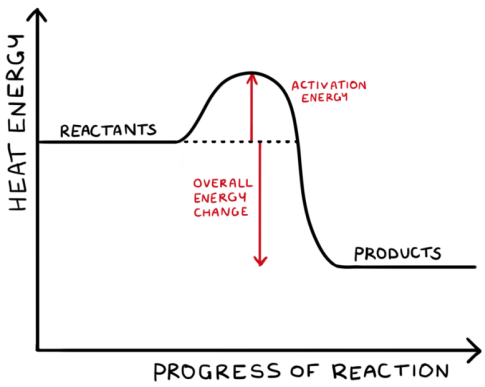
Exam note: Being able to tell the difference between these two reaction profiles is a key skill. But questions tend to focus more on reaction profiles. These include activation energy and gentle curves.

Reaction Profiles

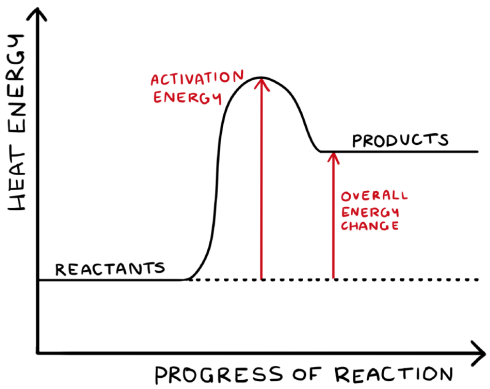
A reaction profile shows how the energy of the reactants and products changes during a reaction so it is very much like an energy level diagram. But these include the activation energy which is the minimum energy needed for a reaction to start. The activation energy is shown as a 'cleat hump' along the line which:

- starts at the energy of the reactants.
- is equal to the difference in energy between the top of the 'hump' and the reactants.

<u>The overall change in energy in a reaction is the difference between the energy of the reactants and products</u>.



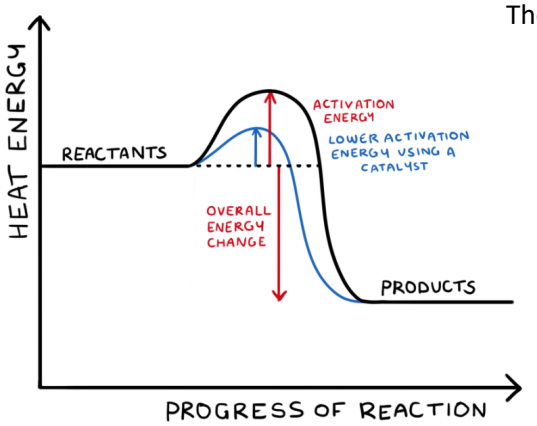
Exothermic reaction profile



Endothermic reaction profile

In the exams we could also be asked about the effect of a catalyst on a reaction profile. This is very similar to catalysts in rates of reaction. It's the exact same let's be fair here, so learn it once and you have learned it for both 😊

<u>A catalyst is a substance that speeds up a chemical reaction and can be obtained chemically unchanged at the end of the reaction</u>. A catalyst lowers the activation energy and provides an alternative reaction pathway so that more of the collisions have sufficient energy to overcome the activation energy and more of the collisions result in a reaction.



The figure shows the effect of a catalyst on the reaction profile

Biological catalysts

<u>Enzymes are biological catalysts</u>. For example, yeast contains a number of enzymes that catalyse fermentation of carbohydrates such as glucose:

$$C_6H_{12}O_6\ (aq) \rightarrow 2C_2H_5OH\ (aq) + 2CO_2\ (g)$$

Conditions: yeast, 25-35 °C, no O_2.

Use: to make beer and wine and in baking to make bread rise.