Rates of Reaction

Rate of reaction states the amount of chemical used or made in a given time.
e.g. 25.2 cm^3 hydrogen s^{-1} or 0.00255 moles iodine $dm^{-3}min^{-1}$
It is important to name the chemical because different chemicals will not change in the same way although the changes are linked by the chemical equation

Simple Collision Theory

Collision Theory of Reaction Rates

It is assumed that particles must collide in order to react. This idea is used to explain how various factors influence rate of reaction.

The effect of Concentration

If concentration is increased, there are more particles in the same volume so collisions are more likely-reaction rate will increase. If a gas is involved, **pressure** of the gas is important because pressure is proportional to concentration -a higher pressure means greater concentration and a faster reaction.

The effect of Temperature

Absolute temperature measures the average kinetic energy of the particles. At higher temperature, the particles move faster so are more likely to collide making hotter reactions faster. However, experiments show that reactions are much more sensitive to temperature than this explanation would suggest-other factors are involved.

Activation Energy

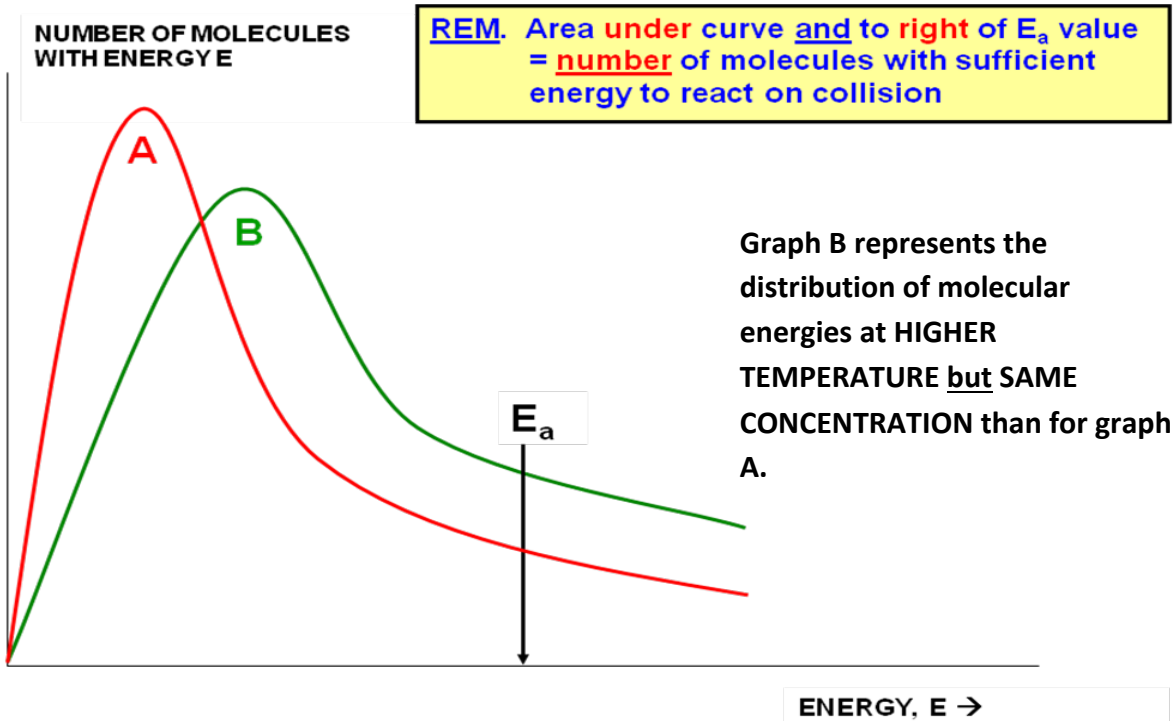
Is the minimum amount of energy needed for particles to react- if less energy is available the reaction cannot happen - the collisions will not be effective.

The Bolzmann distribution

The particles in a sample of gas travel at different speeds, so they have different kinetic energies. The Boltzman Distribution is a graph which shows this.

Points to note:-

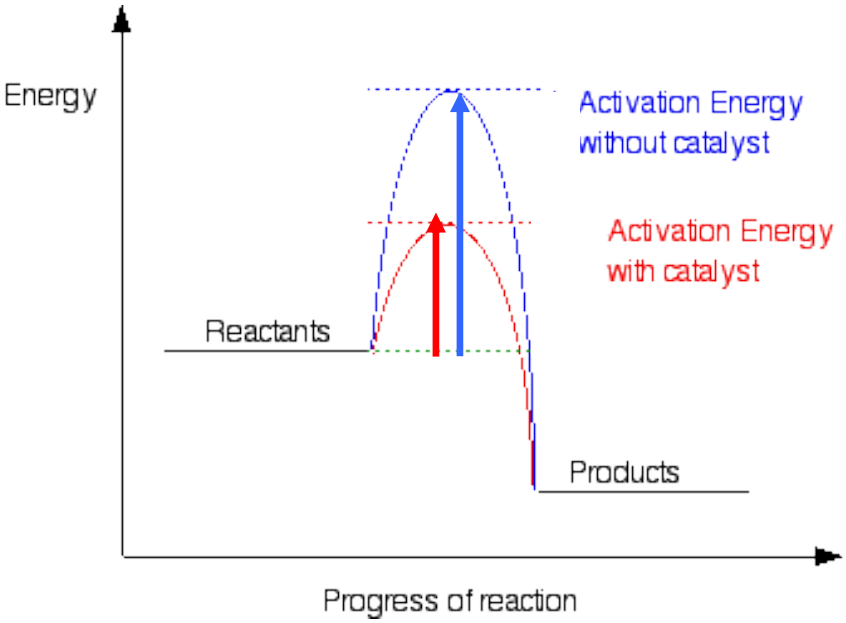
1. The curves are not symmetrical, even at low temperature some molecules will have a high energy.
2. At higher temperature, the curve is flatter and the peak is at a higher energy value.
3. A small increase in temperature causes a small change in the average molecular energy but a large increase in the number of particles having high molecular energy



Rate of reaction is very sensitive to temperature because activation energy is usually much higher than average energy. Raising the temperature by 10K will increase the average energy by a few % but may double the number of molecules having enough energy to react.

Catalysts

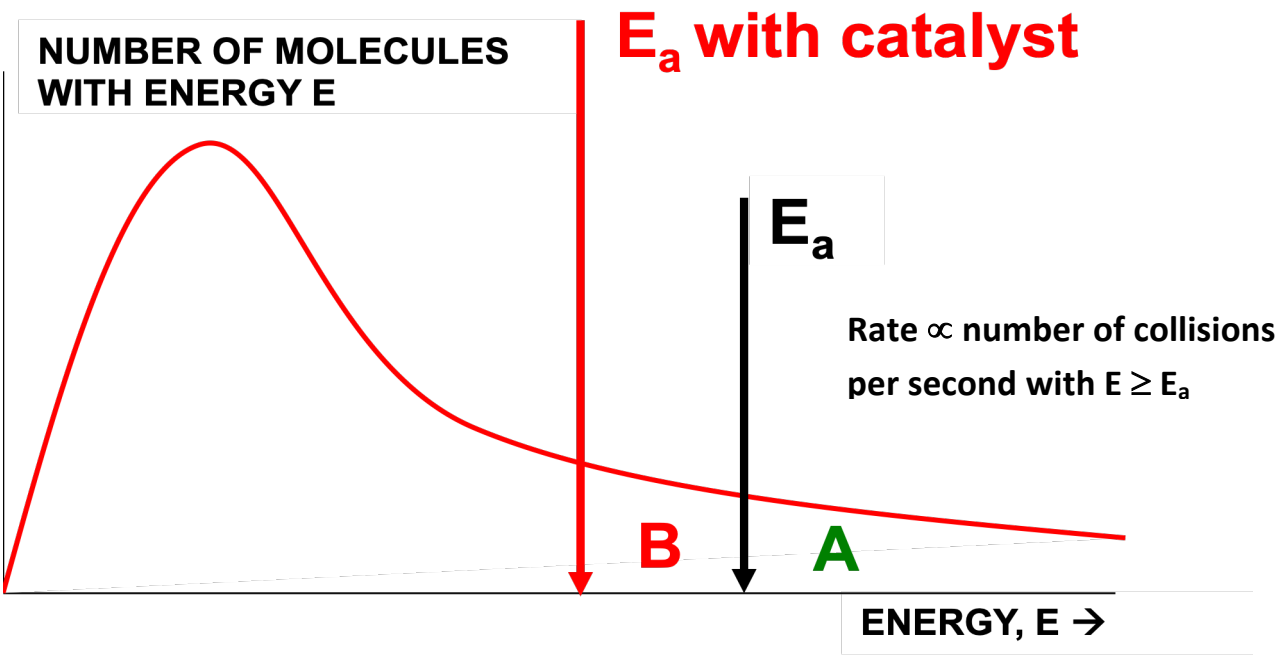
A **Catalyst** increases the rate of a reaction but is not itself used up. Catalysts work by providing an alternative route for the reaction which has a lower activation energy. This means that more molecules have energy > Ea so there are more effective collisions.



Catalysts

1. Affect the conditions that are needed, often requiring lower temperatures and reducing energy demand and CO_2 emissions from burning fossil fuels.
2. Enable different reactions to be used, with better atom economy and with reduced waste.
3. Are often enzymes, generating very specific products, and operating effectively close to room temperatures and pressures.
4. Have great economic importance
    - Iron in ammonia production
    - Ziegler-Natta catalyst in poly(ethene) production
    - Platinum/palladium/rhodium in catalytic converters

Catalysis and Bolzmann distribution



Without catalyst, rate ∝ area A but with catalyst, rate ∝ area (A+B)