6.2 – Collision Theory

6.2.1 - Describe the kinetic theory in terms of the movement of particles whose average energy is proportional to temperature in Kelvin

All particles – whether they are in a liquid, gaseous or solid state – move in some way. These types include **vibration**, **rotation** and **translation**. The amount of energy the particle possesses determines the velocity is travels at.

However, we do not measure the energy of each individual particle, but instead find the average energy. The measurement for this is **temperature**, conventionally expressed in Kelvin. Particles at a higher temperature possess more energy, and therefore move faster.

We look at this kinetic theory in terms of gaseous particles. According to this theory, the properties of gases include:

- They are continuously moving
- Do not have any intermolecular forces
- Transfer, but do not lose, energy when the collide
- Their energy depends entirely on the absolute temperature they are at.

6.2.2 - Define the term activation energy, E_a

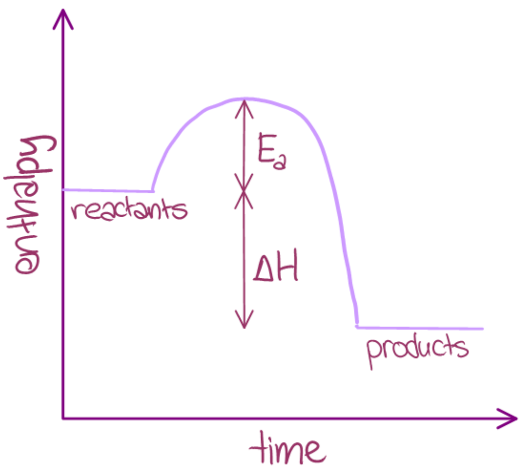
The kinetic energy required to break the bonds of the reactant particles, initiating a chemical reaction and hence allowing it to progress.

6.2.3 - Describe the collision theory

For a reaction to occur, there are three conditions that must be met

- The reactant particles must collide

- They must collide at the correct orientation so that the reactive parts come into contact
- They must collide with sufficient energy to break their bonds



This minimum kinetic energy is the **activation energy**. Other factors may be changed that will allow for more collisions or greater kinetic energy, which speeds up the reaction. This is because there are more frequent collisions and more particles with sufficient kinetic energy.

6.2.4 - Predict and explain, using the collision theory, the qualitative effects of particle size, temperature, concentration and pressure on the rate of a reaction

Particle Size

Increasing the surface area of the reactant particles in a reaction will **increase the reaction rate**. This is because more particles are able to come into contact with other particles and increase the frequency of collisions.

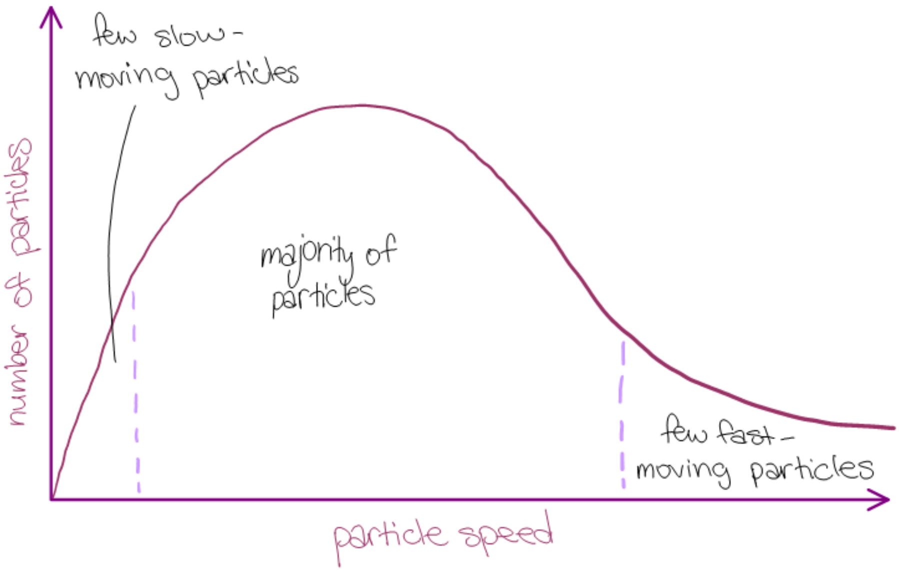
Temperature

Increasing the temperature will **increase the rate of reaction**. This is because the aver particle speed increases, giving each particle more kinetic energy when it collides. As a result, the colliding particles are <u>more likely to overcome the activation energy</u> and be able to react. Also, at higher speeds, the **frequency of collisions will increase**, giving the particles more chance to react.

Concentration and Pressure

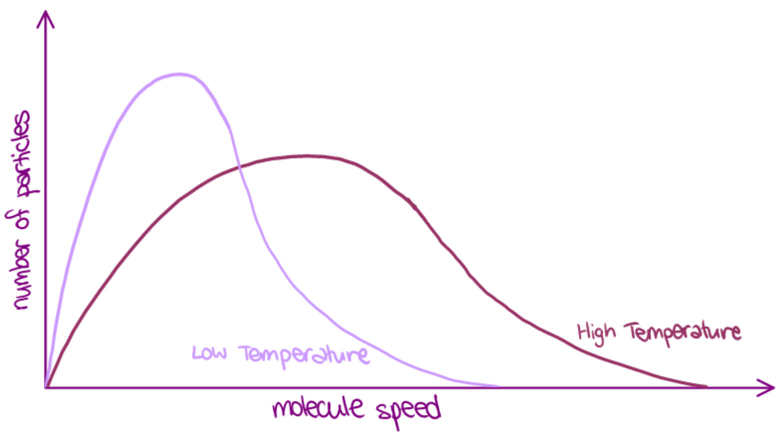
Increasing the concentration also increases the number of particles that are available to react per unit area, <u>increasing the frequency of collisions</u>. Increasing the pressure has the same effect. As a result, the **rate of reaction increases**.

The Maxwell-Boltzmann Diagram:



6.2.5 - Sketch and explain qualitatively the Maxwell-Boltzmann energy distribution curve for a fixed amount of gas at different temperatures and its consequences for changes in reaction rate

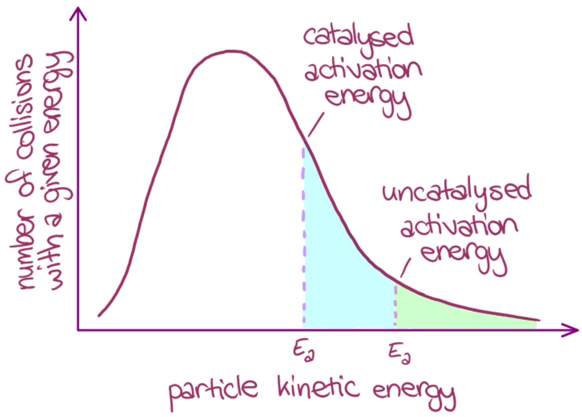
The area under the curve is constant and does not change with temperature. Not all of the particles have the same kinetic energy, hence a measurement of the temperature gives the **average kinetic energy**. In any state, the particles will still be distributed according to the curve.



The curve flattens out with increasing temperature

6.2.6 - Describe the effect of a catalyst in a reaction

A catalyst is a substance that increases the rate of reaction by providing an alternative reaction pathway with a **lower activation energy**. This means that the number of particles that are at or above the activation energy will increase, allowing more of them to react.



6.2.7 - Sketch and explain Maxwell-Boltzmann curves for reactions with and without catalysts