

REACTION RATES

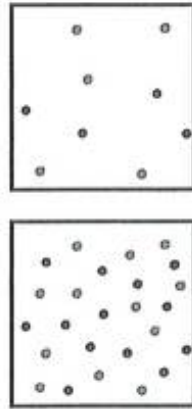
COLLISION THEORY

- Reactions happen when reactant particles collide with enough energy (known as the **activation energy**)
- Particles must also be correctly orientated for a collision to lead to a reaction
- When the **concentration of solutions** or the **pressure of gases** is increased, particles are closer and collide more often – so the rate of reaction increases

Activation energy is the minimum energy required for a reaction to happen.



In most collisions, particles do not have enough energy (or have the wrong orientation) and so there is no reaction.



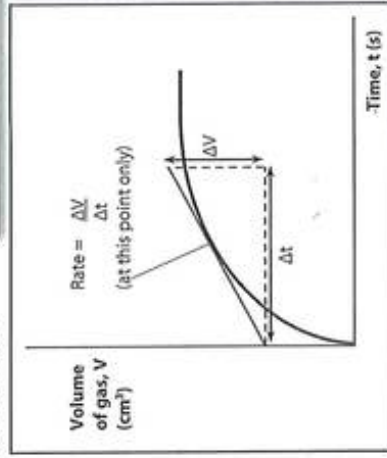
- High pressure or concentration**
- Frequent collisions
 - Fast reaction
- Low pressure or concentration**
- Collisions are rare
 - Slow reaction

MONITORING REACTIONS

To investigate rates, measure a property such as volume of gas, pH or mass over time. Plot a graph of the property against time, e.g.

Practical

Gas volume can be measured by displacing water from a measuring cylinder or burette, using a gas syringe, or counting bubbles.



The rate of reaction at any time is the **gradient** of the graph at that time.

Since the gradient changes, the graph is a curve.

The rate at a particular time is the gradient of the **tangent** to the curve at that point.

EXAM TIP

You may be asked to draw a graph like this, or given one and asked to explain it.

The graph shows the **distribution of energy** among a set of gas particles.

Most particles in a very cold gas have low energy.

As the gas heats up, the range of energies increases, and more particles have higher energies.

The area under the curve between any two energies is the total number of particles in that range of energies.

It is useful to mark an activation energy for a reaction on the graph. The area under the curve to the right of this shows how many particles have enough energy to react. As temperature increases so does this area – explaining why reactions go faster at higher temperatures.

Higher temperature causes an increase in **both** the frequency of collisions and the proportion of collisions that lead to a reaction. Since **two** factors are changed, a small increase in temperature can cause a big increase in the rate of reaction.

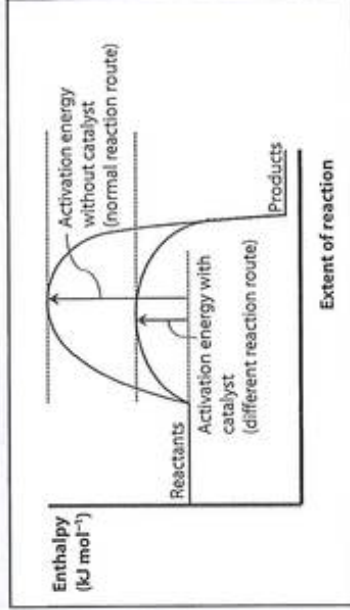
CATALYSTS

Catalysts increase the rate of a chemical reaction without any changes to their chemical composition or amount.

They do this by providing a **different route** for a reaction with a **lower activation energy**.

Reducing the activation energy means a larger proportion of particles have enough energy to become a product when they collide, so more product is formed per second.

EXAM TIP
Catalysts do not change the position of equilibrium because they affect the rate of forwards and backwards reactions **equally**.



Homogenous catalysts are in the same state as the reactants (e.g. when the catalyst and all the reactants are in the same solution)

Heterogenous catalysts are in a different state (e.g. when gases react over a solid catalyst)

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