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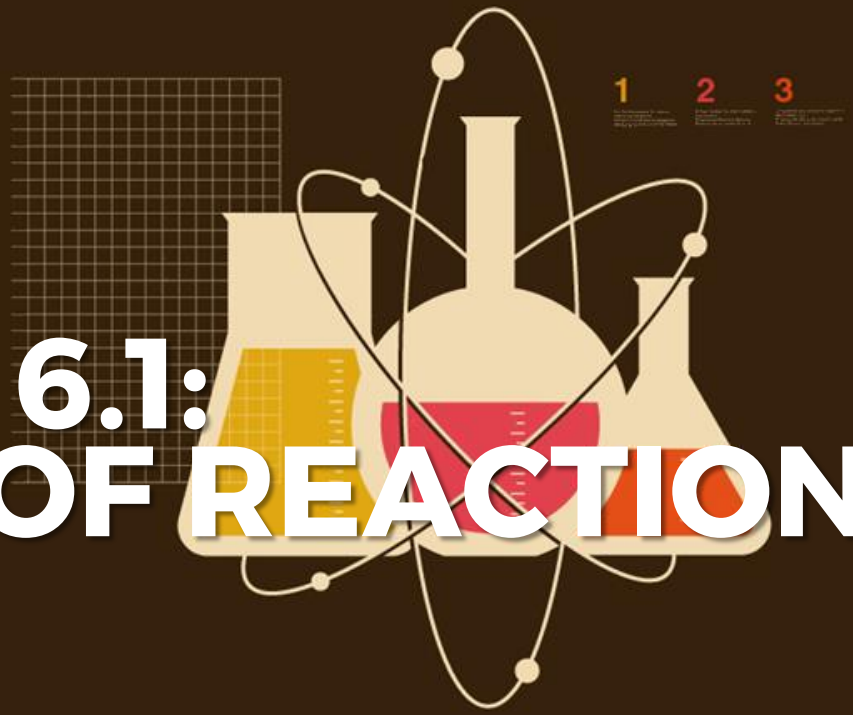


TOPIC 6.1: RATE OF REACTION

THE ABOUT

CHAPTER ANALYSIS

TIME

- Relatively okay chapter
- 5 key concepts

- Size of reactant particles
- Concentration of reactants
- Pressure applied
- Temperature of mixture
- Use of catalysts

EXAM

- Very much interlinked with Energy Changes
- Energy profile diagram is commonly tested

WEIGHTAGE

- Light overall weightage
- Constitute to **3%** of marks for past 5 year papers

KEY CONCEPT

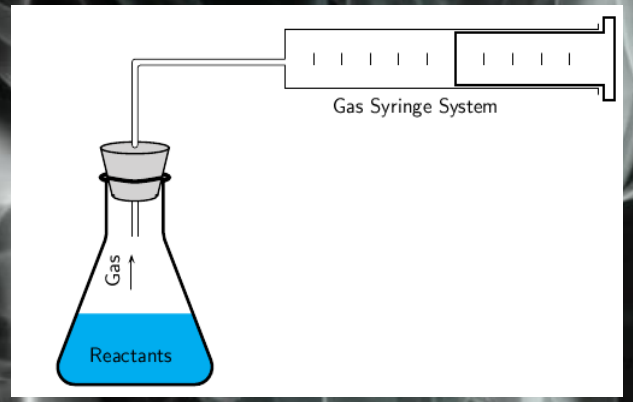
MEASURING RATE OF REACTION

VOLUME OF GAS COLLECTED

CHANGE IN MASS

CHANGE IN PRESSURE

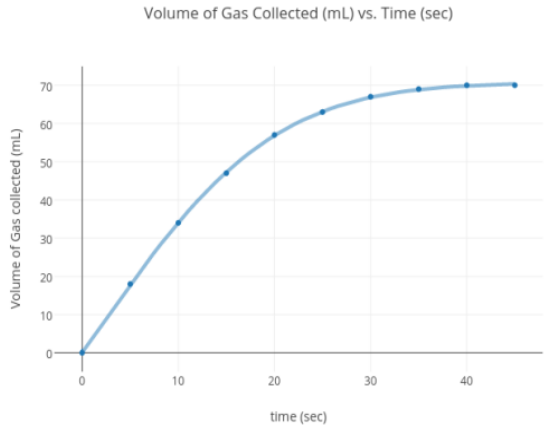
Set up:



CALCULATING RATE OF REACTION

VOLUME OF GAS FORMED

The rate of reaction graph measures the volume of gas produced as time passes.



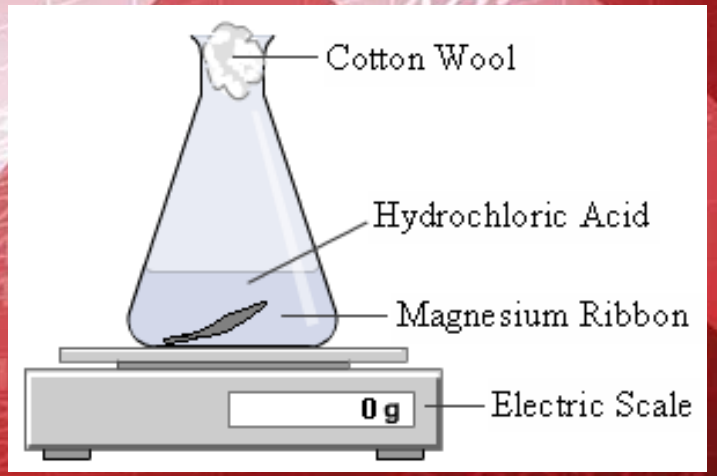
As the reaction progresses, the gradient of the graph becomes gentler, showing that the volume of gas produced per unit time is decreasing.

This shows that the rate of reaction is falling.

At the end of the reaction, the gradient of the graph reaches zero and no more gas is produced.

This shows that the reaction is complete and no further reaction is occurring.

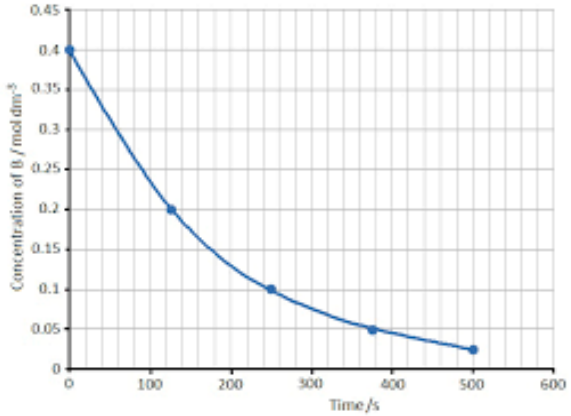
Set up:



CALCULATING RATE OF REACTION

CHANGE IN MASS

As the reaction progresses, reactants are used up and hydrogen gas produced escapes from the flask, the mass of the set-up decreases over time.



Comparing the product-time graph observed earlier and this graph, the variation in the gradient of the graphs are similar.

The gradient of the graph is the steepest at the start of the reaction and gradually becomes gentler before finally decreasing to zero when the reaction is complete.

KEY CONCEPT

CONDITIONS FOR SUCCESSFUL REACTION

RATE OF REACTION FACTORS

- Size of reactant particles
- Concentration of reactants
- Pressure applied
- Temperature of mixture
- Use of catalysts

2 CONDITIONS FOR EFFECTIVE COLLISION

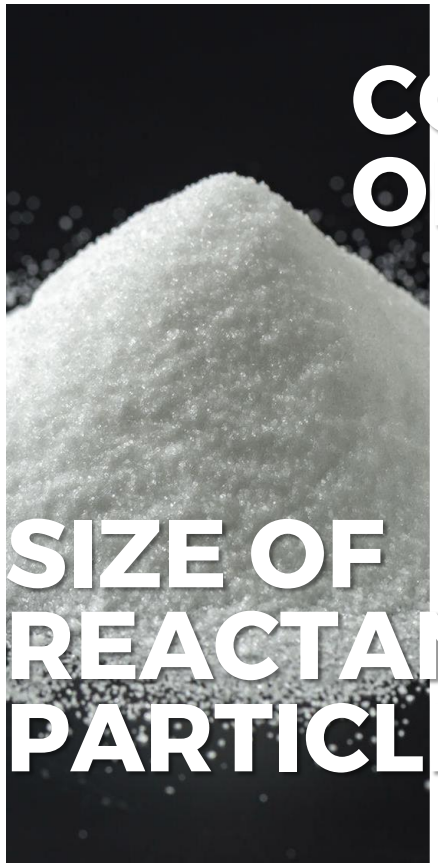
1) SUFFICIENT ENERGY
2) RIGHT ORIENTATION

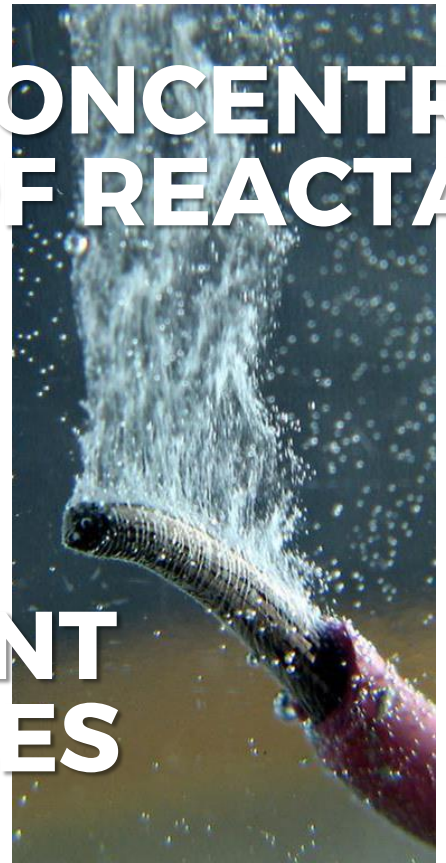
Reactions occur when there are **effective collisions** between reacting particles.

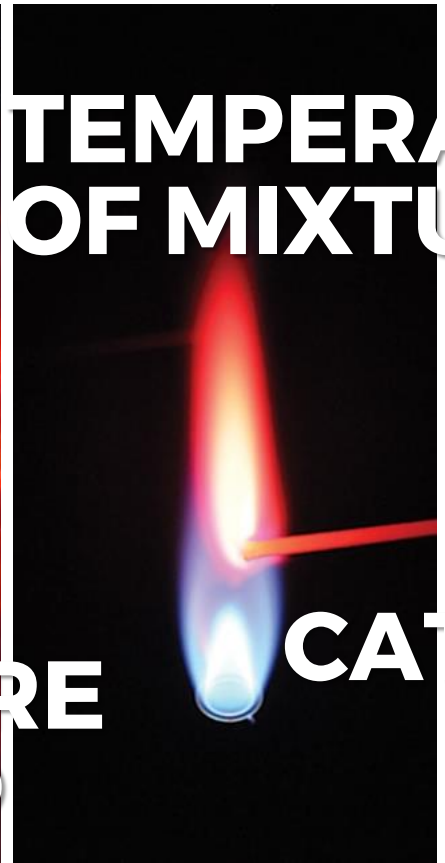
In an effective collision, reactants would need to collide with sufficient energy and in the right orientation to form products.

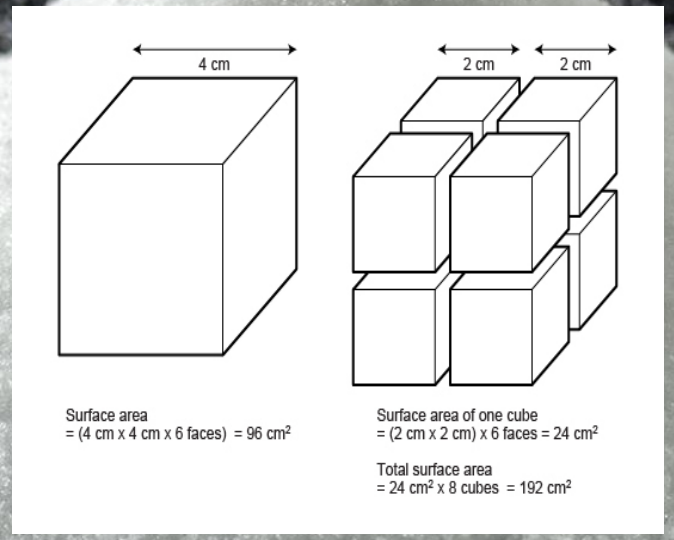
Both conditions have to be fulfilled before an effective collision takes place and products can be formed.

5 FACTORS THAT AFFECT RATE OF REACTION







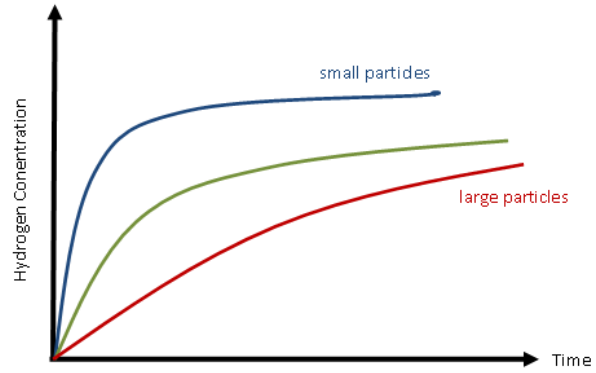


SIZE OF REACTANT PARTICLES

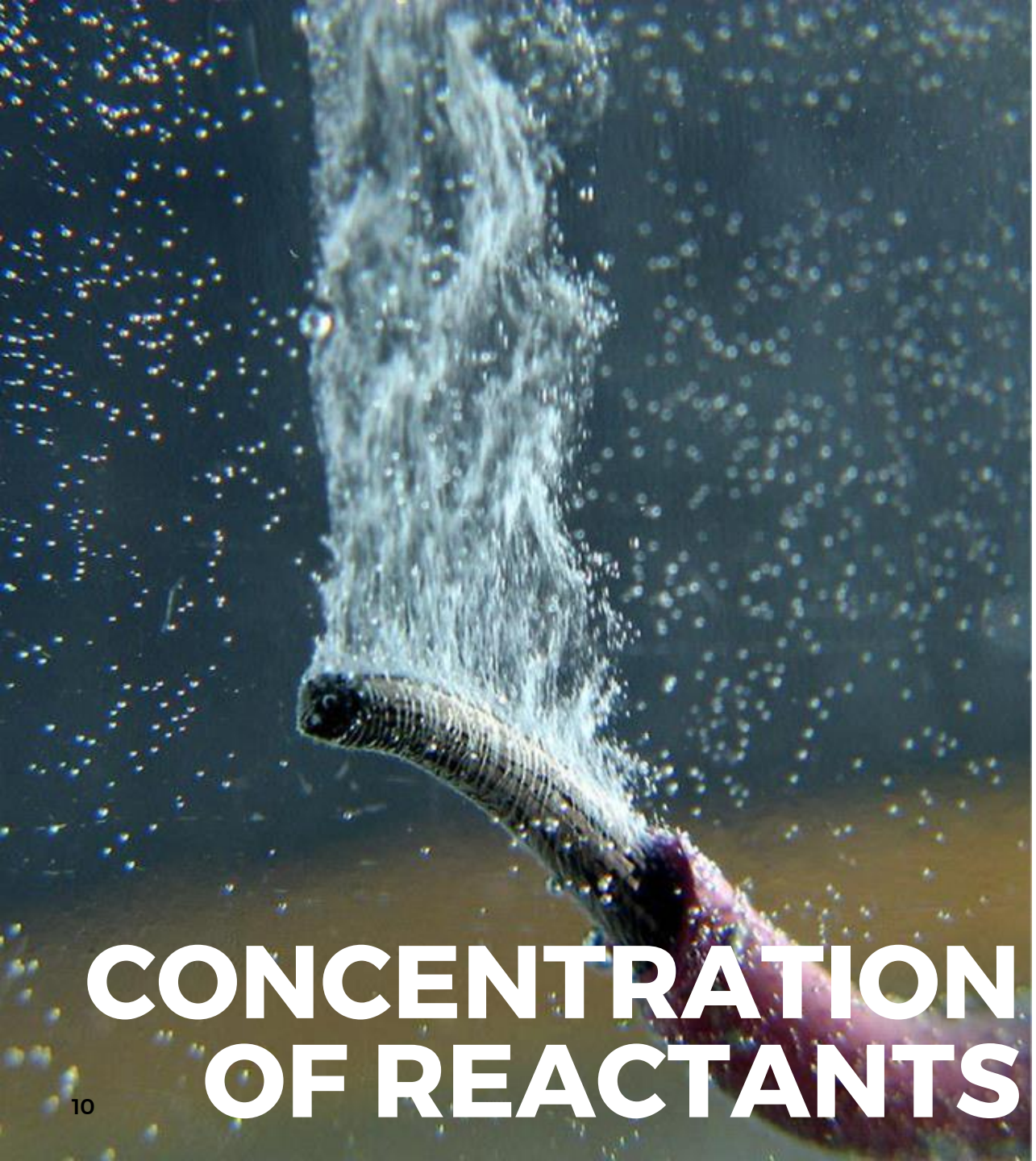
SIZE OF REACTANT PARTICLES

The **smaller the size of the particles**, the **faster the rate of reaction.**

The reason is that having a smaller particle size means that the total surface area for interaction between reacting particles is greater.



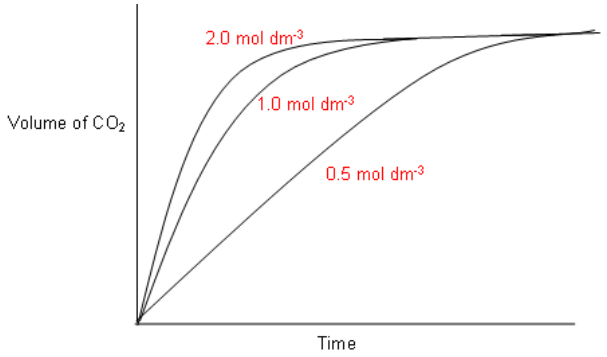
The frequency of effective collisions in Reaction 1 is higher than 2 because of the greater total surface area that is exposed for interaction between reactants.



CONCENTRATION OF REACTANTS

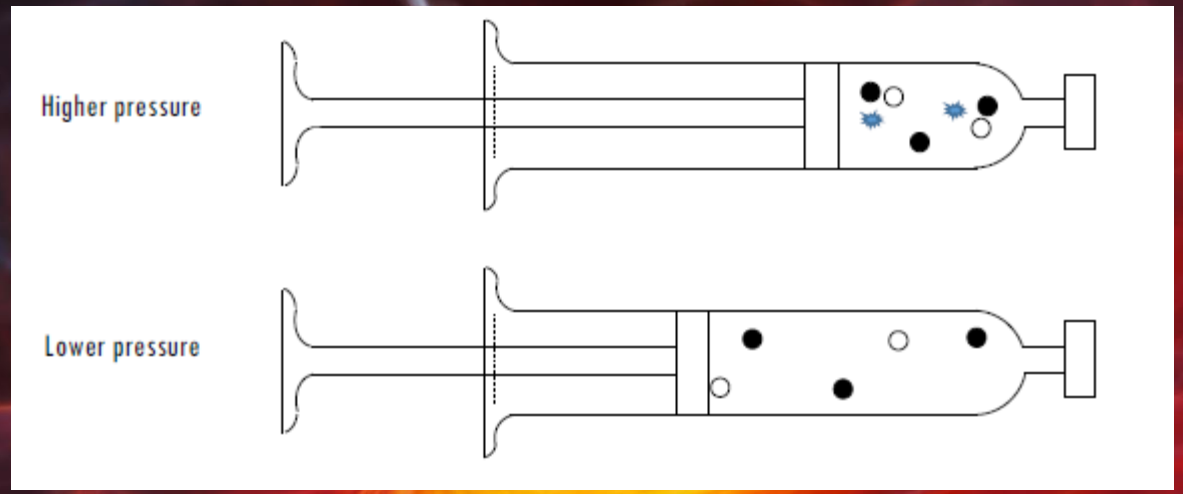
CONCENTRATION OF REACTANTS

A **higher concentration** means that within the same volume of reactants, there is a **higher number of reacting particles.**



For the reaction with 2 moldm^{-3}, the initial gradient of the graph is steeper compared to the rest, indicating a higher reaction rate.

However, the volume of CO_2 produced for three reactions are the same. If the number of moles of the limiting reagent used in the reactions is the same, volume of CO_2 produced from the reactions will be the same.



PRESSURE APPLIED

PRESSURE APPLIED

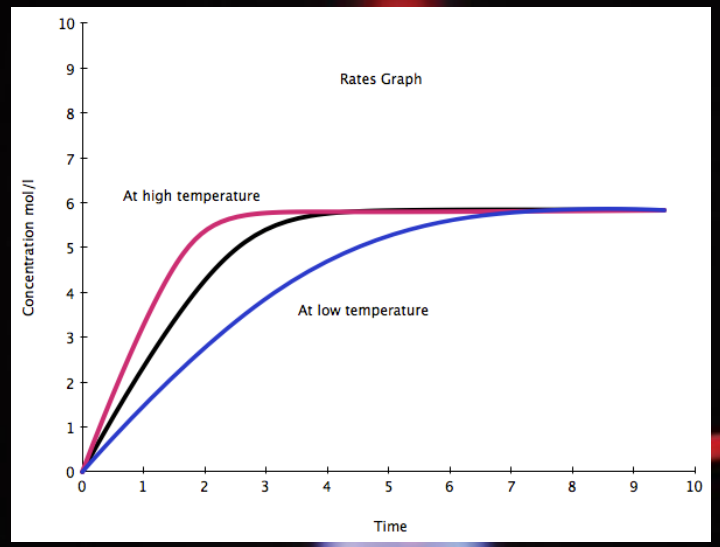
The **higher the pressure, the higher the rate of reaction.**

At a higher pressure, the reactants are brought closer together due to the decrease in volume.

This means there are **more reactants per unit volume**. This would result in the rate of reaction to increase.

For the set-up at higher pressure, as there are more reactant particles per unit volume compared to the set-up at lower pressure, the reacting particles are closer together as well.

As a result, there would be more collisions between reactants and thus leading to a higher frequency of effective collisions.



TEMPERATURE OF SYSTEM

TEMPERATURE OF SYSTEM

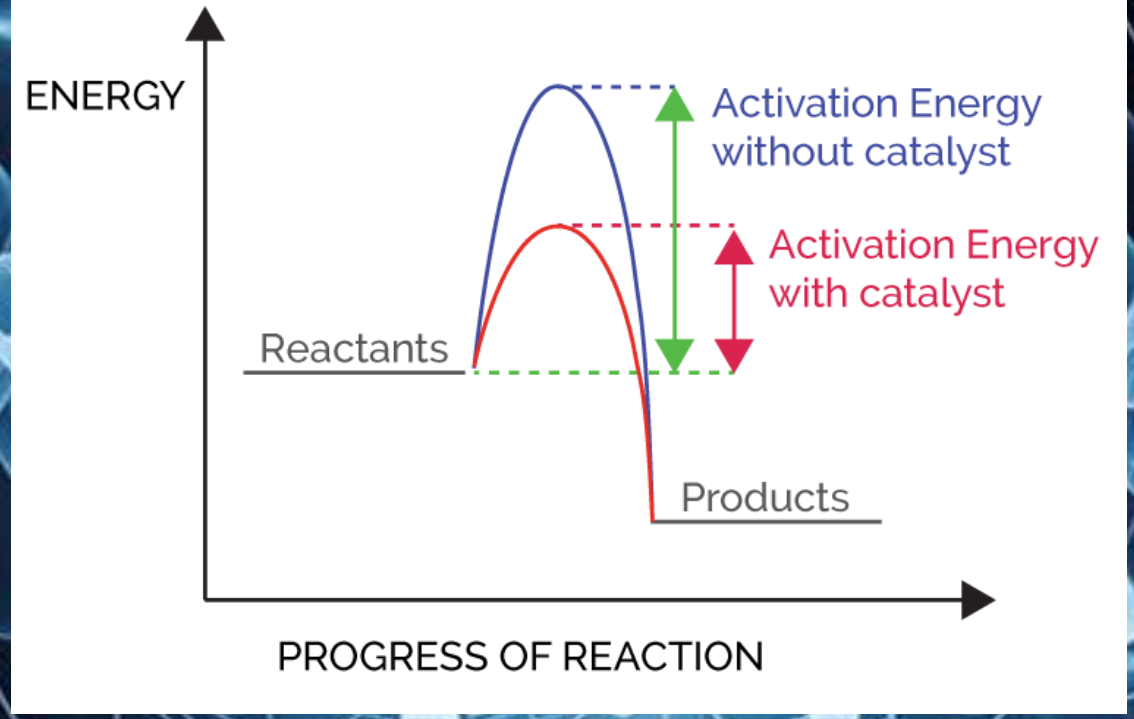
When the temperature of a system is increased, the average kinetic energy of the particles in the system increases too.

A higher temperature of a system means that:

1) Reactant particles have **higher kinetic energy and move faster**

2) The **fraction of reactant particles** in the system that have energy **more than or equal to the activation energy** is higher

These two factors would increase the **frequency of effective collisions** and resulting in an increase in the rate of reaction.



USE OF CATALYSTS

USE OF CATALYSTS

A catalyst provides an **alternative reaction pathway** that allows a **lower activation energy barrier.**

As less activation energy is required, a **higher number of reacting particles will have sufficient kinetic energy** to overcome the activation energy barrier for reaction. Hence, it is more likely to be an **effective collision**.

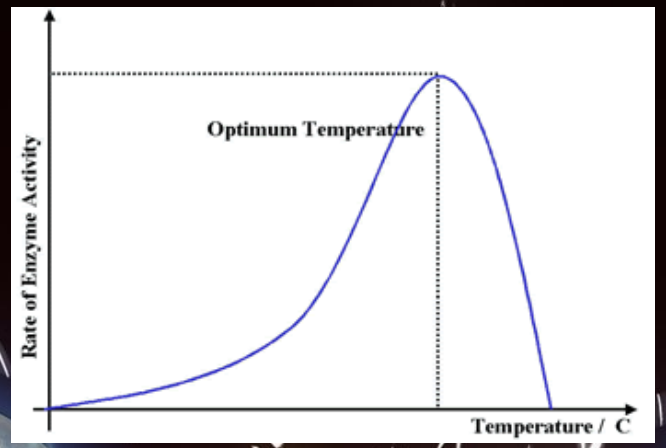
CHARACTERISTICS OF CATALYSTS

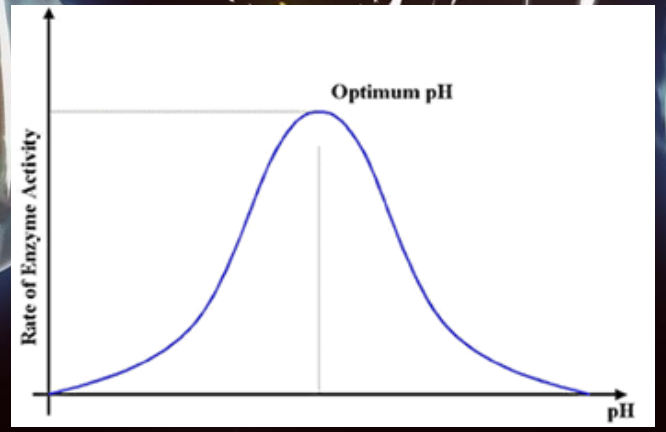
1) A catalyst **changes the rate of reaction without being chemically altered.**

2) **The yield from the reaction is not altered** by catalyst.

3) The purpose of catalysts are to **speed up the rates of reactions** and only a **small amount of the catalyst is required**.

4) Many catalysts are **transition metals** due to variable oxidation states.





BIOLOGICAL CATALYST - ENZYMES

ENZYMES

Living organisms contain enzymes which are biological catalysts. They help to **speed up the rate of chemical reactions** in living organisms.

Many important biological processes are driven by chemical reactions that utilise enzymes, examples are respiration and photosynthesis.

CHARACTERISTICS OF ENZYMES

1. Enzymes are **highly specific** as each enzyme has a unique structure
2. Enzymes are **highly selective** and is only has able to bind a particular substance
3. Enzymes being catalysts, **lower the activation energy** of a reaction
4. Enzymes are also **highly sensitive to temperature and pH changes**

Easy game here if you take bio~

Try it yourself! (TYS Question)

6. How is the activation energy for a reaction between two gases changed when it is carried out either in the presence of a catalyst or when the temperature is increased?

(N2019/P1/Q18)

	change in activation energy	
	addition of catalyst	increase in temperature
A	decreases	decreases
B	decreases	stays the same
C	increases	decreases
D	increases	stays the same

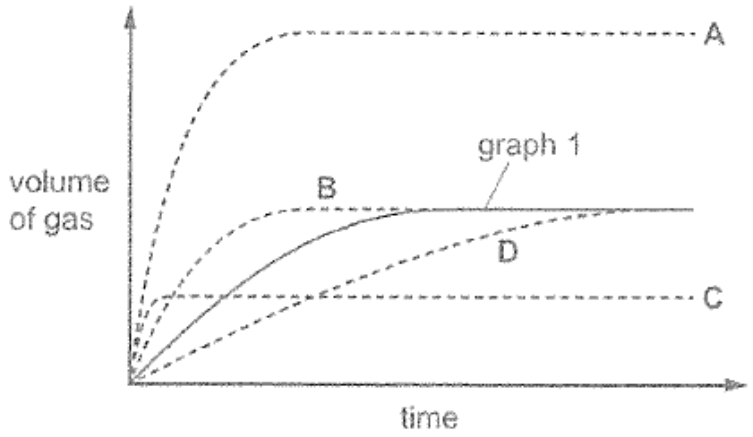
( )

Answer:

6. **B**
A catalyst speeds up the rate of reaction by providing an alternative pathway with a lower activation energy. An increase in temperature does not change the activation energy of the reaction.

Try it yourself! (TYS Question)

7. A sample of 0.5 g of magnesium ribbon is reacted with an excess of 1 mol/dm^3 hydrochloric acid.
The volume of hydrogen produced over time is measured.
The results are plotted to give graph 1.
Which graph would be produced when 0.5 g of magnesium ribbon is reacted with an excess of 2.0 mol/dm^3 hydrochloric acid under the same conditions? (N2020/P1/Q17)



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Answer:

7. **B**
A higher concentration of acid will speed up the rate of reaction. The volume of gas produced remains the same as acid is in excess.

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