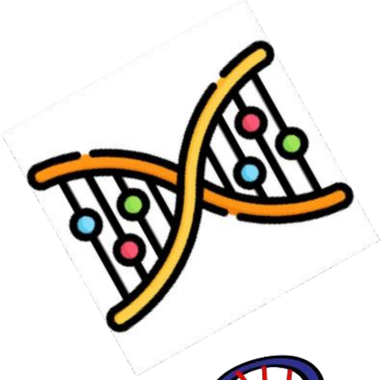

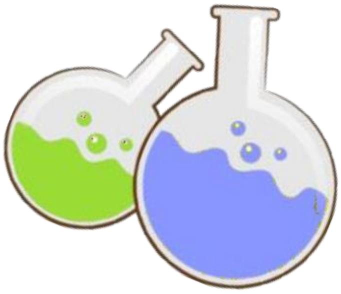

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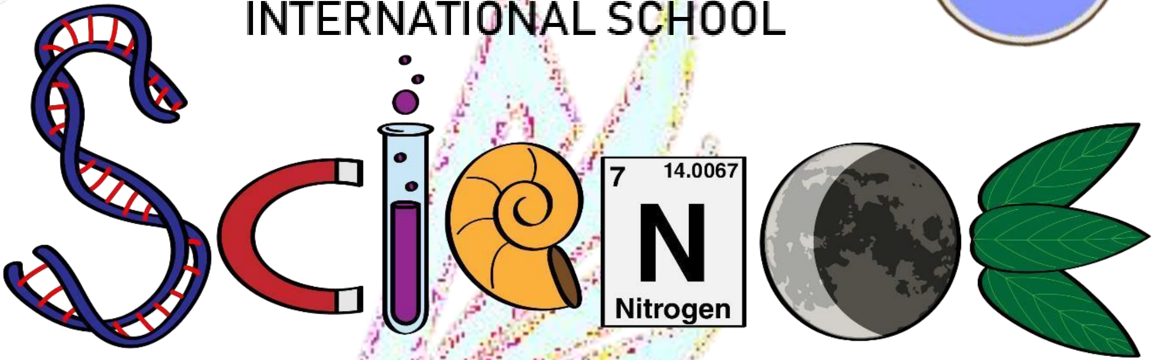


Science Department

2023/2024

Year 8
Summary notes unit 8

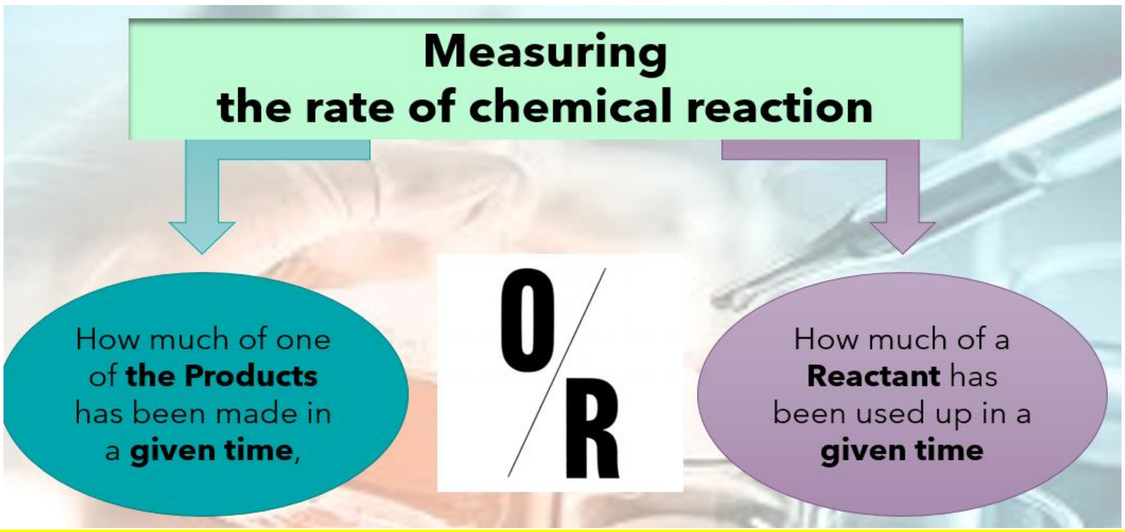
Name: ....
....

Class: ....

Rate of reaction

Definition:

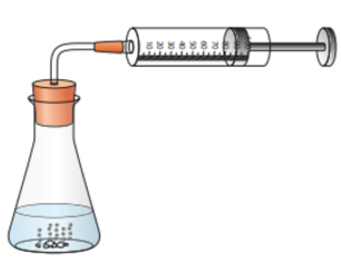
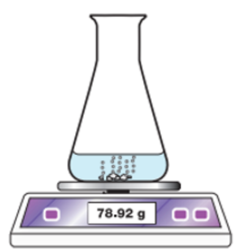
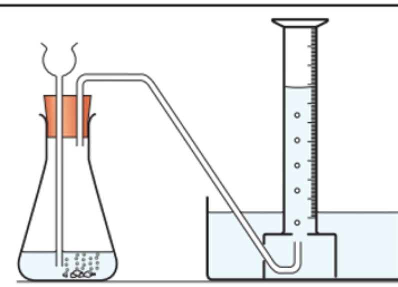
- **Rate of reaction:** how fast or how slow a chemical reaction occurs.
- Example : the reaction between magnesium and hydrochloric acid; gas is given off in form of bubbles
- At the start of the reaction, a lot of bubbles were given off quickly. As the reaction came to an end, fewer bubbles were produced. Eventually, no more bubbles were produced.



Three different method to calculate the how much of the products has been made in a given time:

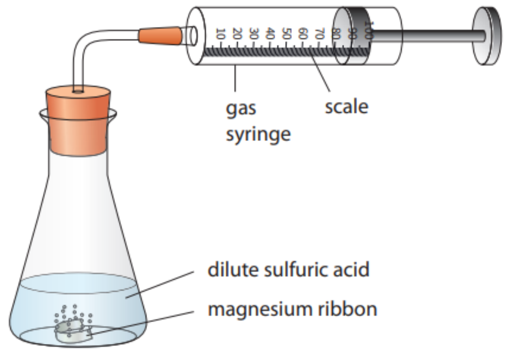
1- **Measuring the volume of gas released in a given time:**
   a. Gas syringe (cm^3)
   b. Gas over water (cm^3)

2- **Measuring the mass loss** as the reaction proceed during a given time (in g)
   Using top pan balance

			
Method	Gas syringe	Top pan balance	Gas over water

Example:

To collect the gas, you can attach a syringe to the top of a flask so that no hydrogen can escape, as shown in the diagram. You can use the scale on the syringe to measure the volume of gas produced at different times during the reaction.



1 Write the word and symbol equations for the reaction of magnesium with sulfuric acid.

2 This table shows the results obtained from an experiment using the apparatus shown above.

Time in s	Total volume of hydrogen gas produced in cm^3
0	0
30	10
60	20
90	26

Time in s	Total volume of hydrogen gas produced in cm^3
120	40
150	48
180	54
210	60

Time in s	Total volume of hydrogen gas produced in cm^3
240	64
270	66
300	66
330	66

How can you tell from the table that the reaction has finished at 270 seconds?

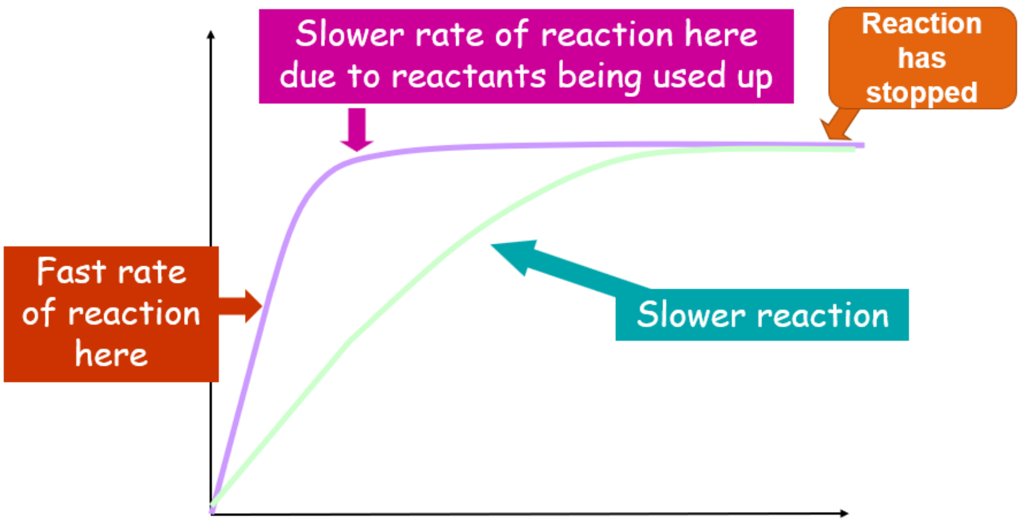
Answers:

magnesium + sulfuric acid → magnesium sulfate + hydrogen

$$Mg + H_2SO_4 \rightarrow MgSO_4 + H_2$$

2-Because there is no further increase in the volume of the gas given off after 270 seconds

RATE OF REACTION GRAPH

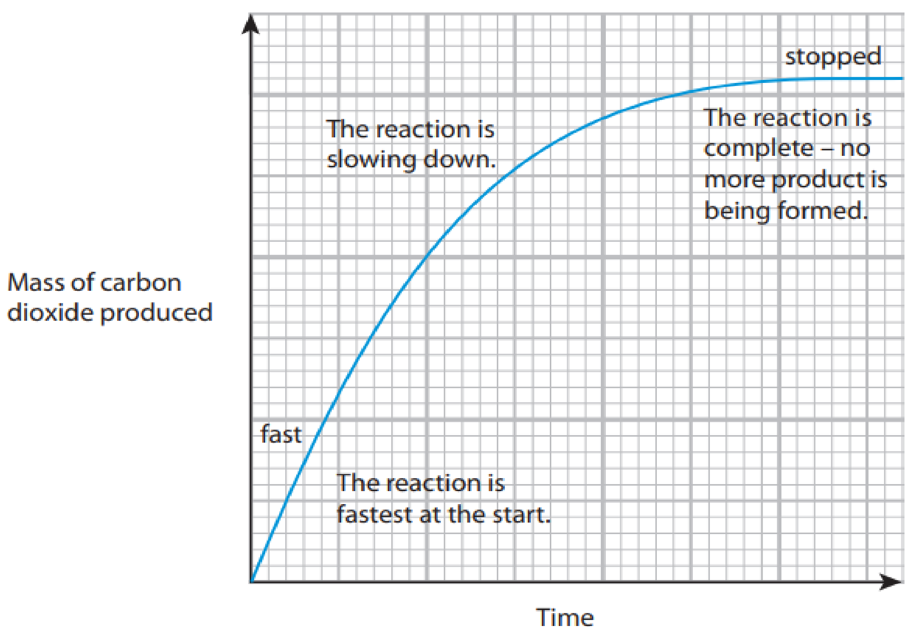


$$\text{Rate of reaction} = \frac{\text{amount of product formed/reactant used up}}{\text{time}}$$

(in g/s or cm^3/s)

Using The Graph:

- The slope or gradient of the line tells you how quickly the reaction is taking place.
- **The steeper the slope, the faster the reaction.**

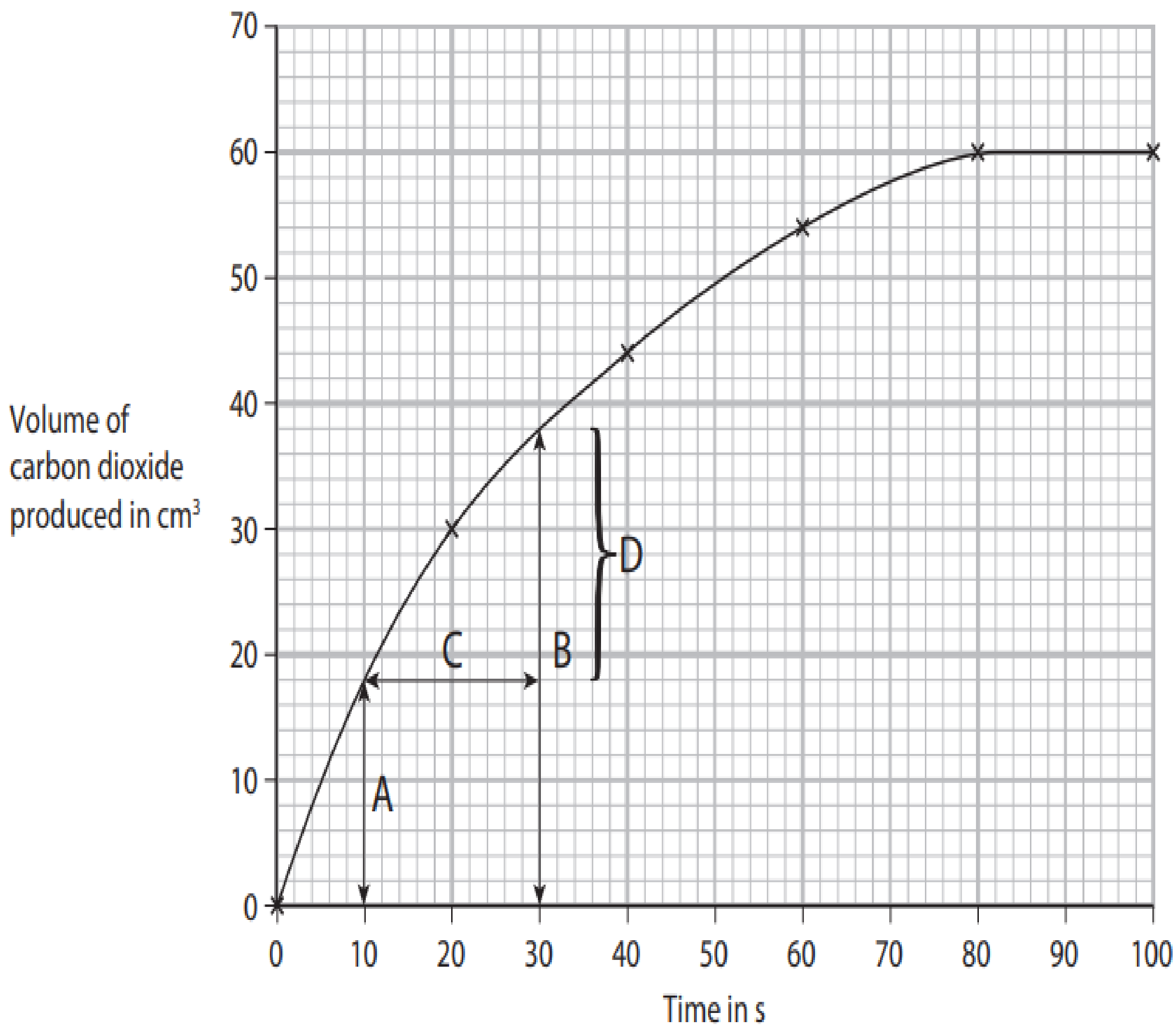


- **The line is steepest at the start of the reaction**. This is when the reaction is fastest.
- As the slope of the line **becomes less steep**, the reaction is **slowing down**.

- When the line levels out, it shows that no more carbon dioxide is being lost. This means that the reaction has ended.

How to calculate the rate of reaction from the graph:

- The graph below shows the rate of reaction between copper carbonate and hydrochloric acid. You can use a graph like this to measure and compare the rates of reaction at different times during the reaction. You can use the graph to find out the average volume of carbon dioxide gas given off per second in the period between 10 seconds and 30 seconds.



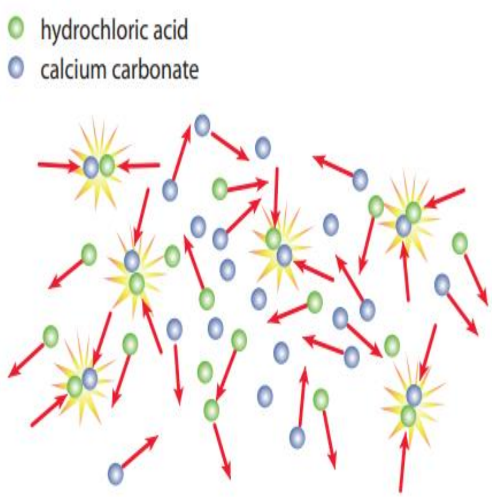
- To do this you should draw a line at 10 seconds on **the horizontal axis** up to where it meets the line of the graph, labelled A.

- Then draw another line at **30 seconds** up to the point here it meets the graph, **labelled B**.
- **Draw line C** between A and B as shown. The distance of C represents the time taken, in this case 20 seconds.
- **The line D** shows you how much carbon dioxide was produced in this time, in this case 20 cm3. If 20 cm3 of carbon dioxide is produced in 20 seconds. Then on average the rate of reaction over this period of time is 20 cm3 in 20 seconds or 1 cm3 per second.

Collision theory:

❖ **For a chemical reaction to take place, the particles of the reactants involved have:**

- **to collide with one another**
- **with enough energy**
- **and in the proper orientation to react together.**



Why does the rate of reaction changes?

- At the start of the reaction there are a lot of particles that have not reacted. Collisions happen frequently.
- As the particles react, the number of particles that have not reacted gets lower and lower. The chance of two unreacted particles colliding

with each other decreases. **This means that the rate of reaction is slower**

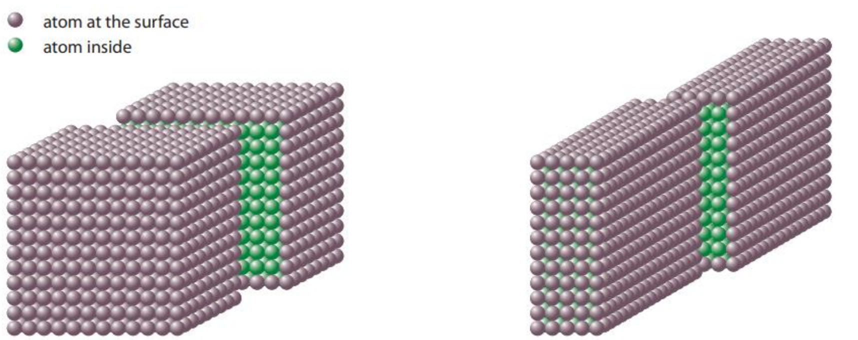
- Eventually, all the particles have reacted. There are no more collisions. **The reaction has finished.**

Factors affecting (increase) the rate of reaction:

1- **Increasing Surface Area**
2- **Increasing temperature**
3- **Increasing Concentration of reactants.**
4- **Using Catalyst.**

I. Surface Area and rate of reaction:

- Small pieces of solids always react faster than larger pieces.
- Each time you cut a solid into smaller pieces, you increase the total surface area.
- **Increasing the total surface area, increases the rate of reaction.**



Only the magnesium atoms on the surface of the block can react with oxygen in the air.

In magnesium ribbon, more of the atoms are on the surface and can react with the air.

Example:

- Iron powder has larger surface area than iron wool which in turn is lager than an iron nail

➢ **Explain the effect of surface on the rate of reaction using collision theory**

The larger the surface area, the more particles are available to collide and the faster the rate of reaction.

Question:

- **Explain the difference, using the collision theory, between using small pieces of calcium carbonate versus large pieces.**

$$CaCO_3 + HCl \rightarrow CaCl_2 + CO_2 + H_2O$$

Big Piece of Ca CO3	VS	Small Piece of CaCO3
• Small surface area. • Less particles of CaCO3 exposed to HCL. • **the complete reaction is slower**		• Big Surface Area. • More particles of CaCO3 exposed to particles of HCL • Reaction started very fast and quickly and then slows down as there are fewer particles left to react. • **the complete reaction is fast.**

II. Temperature and the rate of reaction:

- If you change the temperature of the reactants in a reaction, the rate of reaction will change.
- If you mix hydrochloric acid with a solution of sodium thiosulfate (a salt), the mixture becomes cloudy. This is because sulfur is produced. Sulfur is insoluble in water, so it forms a precipitate.
- The precipitate is opaque – so, when you can no longer see through the solution, you know the sulfur has been formed.

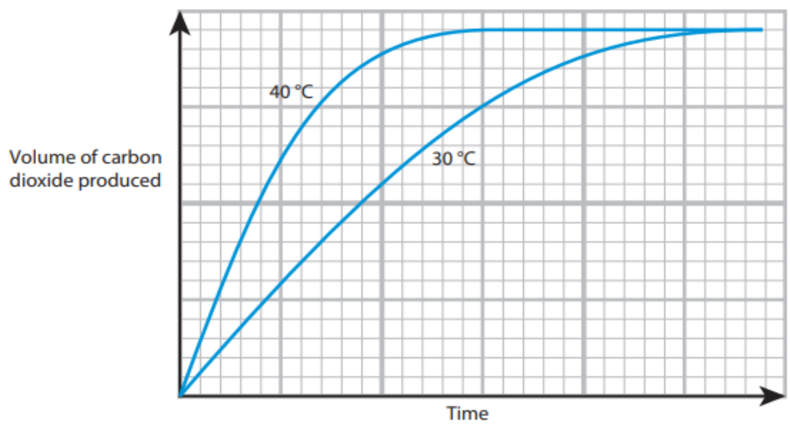
- Measure rate of reaction easily by measuring how long it takes for the sulfur precipitate to be formed
- changing the temperature of the solution , you can investigate the effect of temperature on reaction rates.

Temperature ∝ Rate of Reaction

- **The higher the temperature, The greater the rate of reaction**
- The faster the reaction and less time is taken for the reactant to be used u

Typical graph shows:

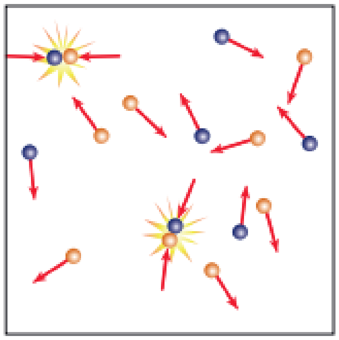
Here is a graph of some typical results for the rate of reaction between marble chips, calcium carbonate, and hydrochloric acid. This was carried out as in the previous topic.

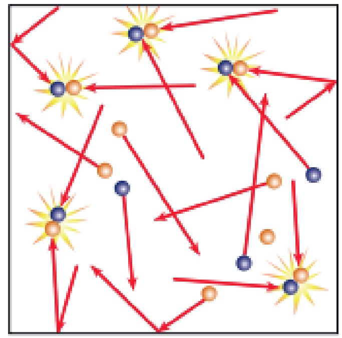


You can see from the graph that you do not get any more of the product (carbon dioxide gas) at the higher temperature. You get the same volume of gas but in less time.

- **Explaining the effect of temperature on the rate of reaction:**

  Particles move all the time. When the temperature of the reaction is increased, the particles move faster. They collide more often, and with more energy.


Reaction at 30 °C


Reaction at 40 °C

The higher the temperature the faster the rate of reaction.

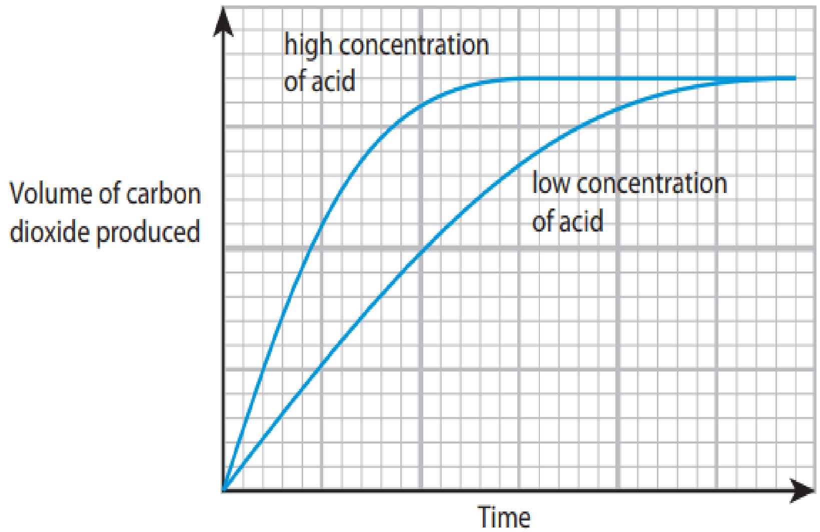
III. Concentration of reactants and the rate of reaction:

- **The higher the concentration of an acid, the faster the rate of reaction**.
- Note that there is a big difference between concentration and volume.
- The table below shows 5 solutions where prepared with the same volume of acid 50 cm^3 but different concentration.

Solution	Acid in cm^3	Water in cm^3	
A	10	40	least concentrated
B	20	30	↓
C	30	20	
D	40	10	
E	50	0	most concentrated

Typical graph shows:

- This graph shows the rate of reaction between marble chips and diluted hydrochloric acid.



Same volume of gas is collected but much quicker in the high concentration

Explaining the effect of concentration:

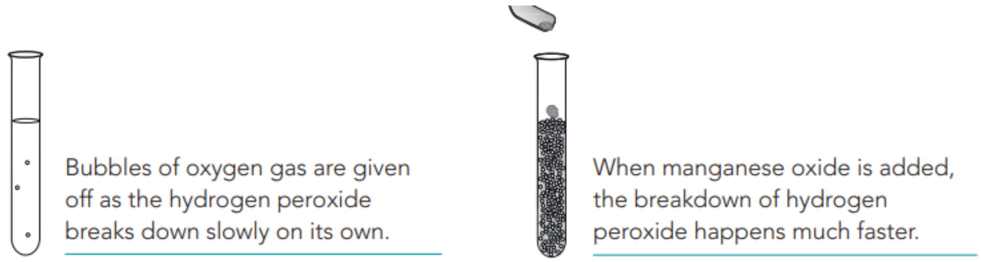
- The higher the concentration of hydrochloric acid, the more hydrochloric acid particles there are in a given amount of space. This means that there will be more frequent collision between hydrochloric acid particles and calcium carbonate particles.

IV. Catalyst:

- Substance that is used to speed up the reaction without being used up.
- A catalyst is unchanged by the reaction and the same catalyst can be used over and over again.

Using catalysts:

- Many cars have catalytic converters fitted to their exhaust systems. These have catalysts inside that speed up reactions that help to get rid of harmful gases produced in the engine.
- **The manganese oxide** act as a catalyst when added to hydrogen peroxide. It made the reaction happen faster than if the hydrogen peroxide was left to break down on its own. However, at the end of the reaction the manganese oxide (insoluble) was still there and can be removed easily from the solution by filtration and used again in another test tube.



Biological catalysts:

- Hydrogen peroxide is formed as a waste product in many reactions in the cells of plants and animals.
- It is poisonous and if it is not broken down into harmless water and oxygen quickly, it will kill living cells.
- All living cells have an enzyme, called **catalase**, which speeds up the breakdown of hydrogen peroxide.

biological washing powders:

- Some washing substances (powders, liquids or gels) contain enzymes.
- The enzymes they contain help to break down stains such as food and blood.