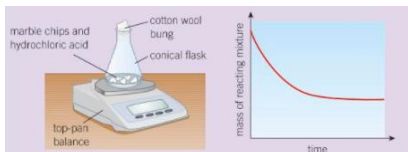


Measuring Rate

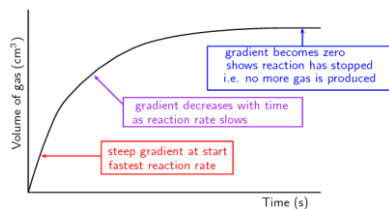
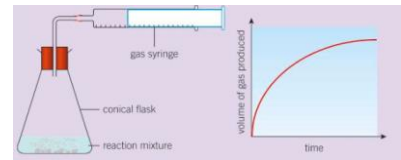
To measure the rate of a reaction you can:

- Measure how fast the reactants are used up
- Measure how fast the products are made

e.g. Measure mass lost due to gas formed



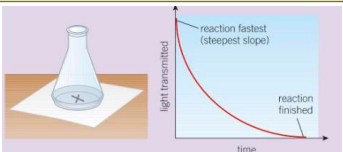
e.g. Measure volume of gas made



$$\text{Rate} = \frac{\text{volume of gas}}{\text{time}}$$

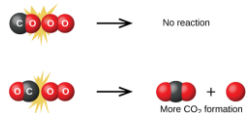
$$\text{cm}^3/\text{s}$$

e.g. Measure time for insoluble product to form



Collision theory

For a reaction to happen reactants must: **collide with enough energy** (activation energy)



A successful collision is one that leads to a reaction

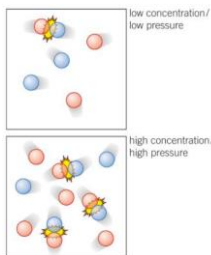
So to increase the rate of a reaction you must either

- Increase the frequency of collisions
- Increase the energy of the collisions
- Decrease the energy needed for a collision to be successful

Factors affecting rate

Concentration and Pressure

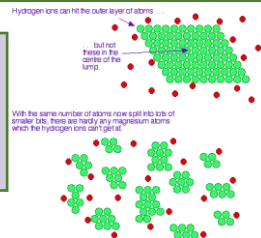
More particles in the same space.
More frequent collisions



C8 Rates and Equilibrium

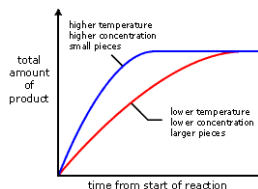
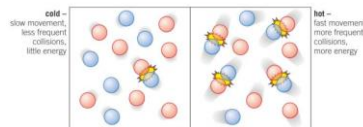
Surface area

More particles available to react.
More frequent collisions



Temperature

Particles **move faster**.
So they **collide more frequently**.
Particles collide **with more energy**.
So more of the collisions are **successful**.



Catalysts

Lower the energy needed for successful collisions. (Activation energy)
Not used up.
Biological catalysts are called **enzymes**

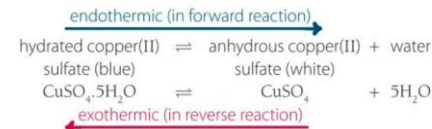


Reversible reactions

Can go in both directions.



If a reaction is exothermic in one direction it is endothermic in the other direction.



In a closed system (where nothing can get in or out) an **equilibrium** is reached where the **rate of reaction is the same in both directions**.

- 1) $A + B \rightleftharpoons C + D$ reactants only at start of reaction
- 2) $A + B \rightleftharpoons C + D$ rate of \rightarrow much greater than \leftarrow at first
- 3) $A + B \rightleftharpoons C + D$ rate of \leftarrow increases as C+D build up
rate of \rightarrow slows down as reactants get used up
- 4) $A + B \rightleftharpoons C + D$ eventually the rates of \rightarrow and \leftarrow are the same

At equilibrium:

- Rate of forward reaction = rate of reverse reaction.
- Amount of products and reactants don't change.

