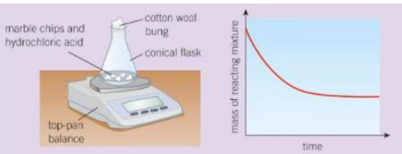
Rate of reaction and reversible reactions

Measuring Rate

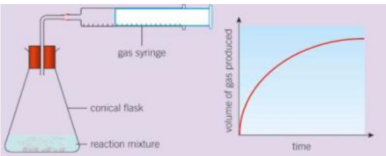
To measure the rate of a reaction you can:

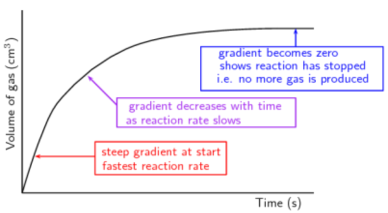
- **Measure how fast the reactants are used up**
- **Measure how fast the products are made**
- **Rate = change in mass/ volume ÷ time**

e.g. Measure mass lost due to gas formed



e.g. Measure volume of gas made

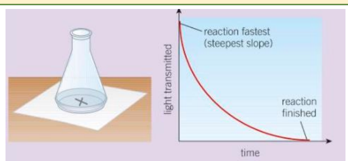




Rate = volume of gas ÷ time

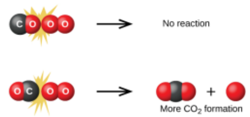
cm^3/s

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

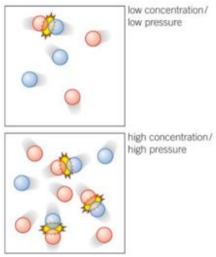
So to increase the rate of a reaction you must either

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

Factors affecting rate

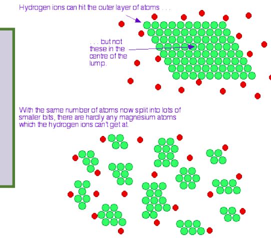
Concentration and Pressure

More particles in the same **volume**. **More frequent collisions**



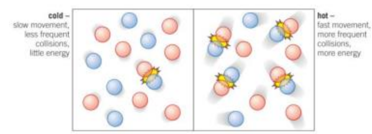
Surface area

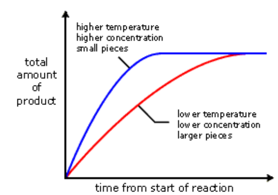
More particles available to react. **More frequent collisions**



Temperature

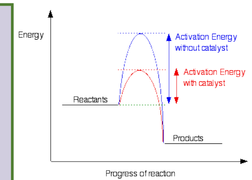
Particles gain energy and so **move faster**.
So particles **collide more frequently**.
Particles collide **with more energy**.
So more of the collisions are **successful**.





Catalysts

Speed up reactions but are not used up. Provide an alternate route of lower activation energy. Lower the energy costs for industry.



Reversible reactions

Can go in both directions. Do not go to completion.

$$A + B \rightleftharpoons C + D$$

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

endothermic (in forward reaction)
hydrated copper(II) sulfate (blue) ⇌ anhydrous copper(II) sulfate (white) + water
$CuSO_4.5H_2O \rightleftharpoons CuSO_4 + 5H_2O$
exothermic (in reverse reaction)

In a **closed system** (where no reactants or products can get in or out) an **equilibrium** is reached where the **rate of reaction is the same in both directions.**

At equilibrium:

- Rate of forward reaction = rate of reverse reaction.
- The concentration of products and reactants stays the same