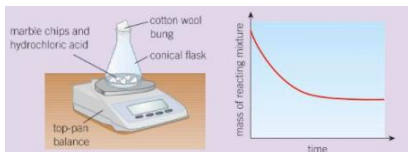


# Measuring Rate

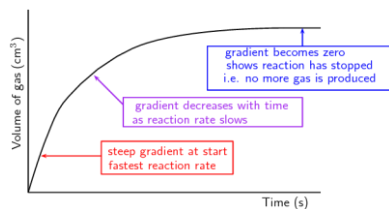
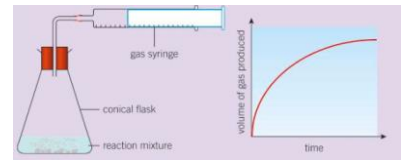
To measure the rate of a reaction you can:

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

e.g. Measure mass lost due to gas formed



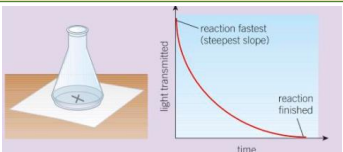
e.g. Measure volume of gas made



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

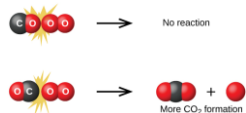
$$\text{cm}^3/\text{s}$$

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

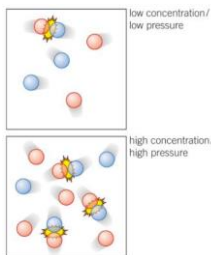
So to increase the rate of a reaction you must either

- 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

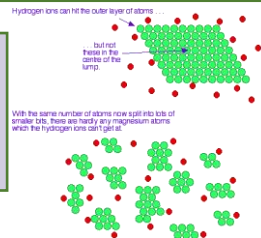
More particles in the same space.  
More frequent collisions



# C8 Rates and Equilibrium

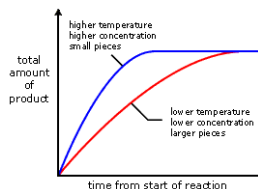
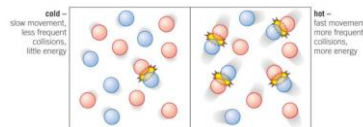
## Surface area

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**

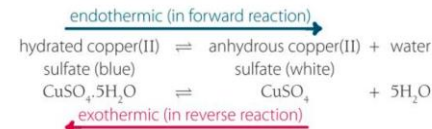


# Reversible reactions

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.

