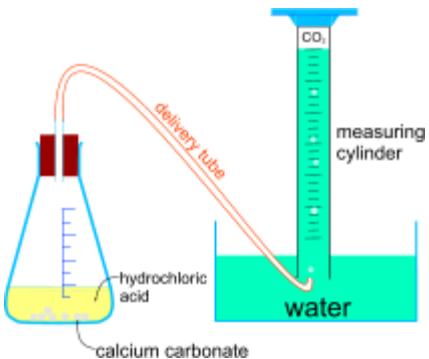


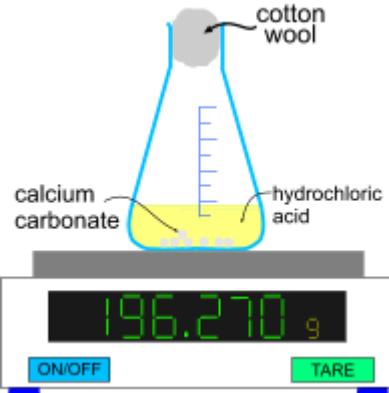
## Rates of reaction

The rate of a reaction is the speed at which products are produced or reactants are used up.



When a gas is produced the rate of reaction may be measured by measuring the volume of gas produced in a certain time or by measuring the change in mass with time:

Mass decreases because gas ( $\text{CO}_2$ ) escapes



In an experiment the variables that you should consider controlling to make it a fair test are:



Volume of solution	Concentration of solutions
Total volume of reaction mixture	Temperature
Mass of a solid	Surface area of solids
Rate of stirring	

## Collision Theory

Reactions can only occur when two particles COLLIDE. Not all collisions result in reaction. For a collision to result in a reaction the collision must have sufficient ENERGY (above the *activation energy*). Collisions which result in reaction are called *successful collisions*.

The factors which affect the rate of a chemical reaction

### Concentration

- higher concentration → faster rate of reaction
- higher concentration - more particles in a certain volume
- the particles are closer together
- particles collide more **frequently**.
- more successful collisions **per unit time**.

### Pressure

Changing the pressure only affects the reaction rate if the reactants are in the gas phase.

Increasing the pressure of a gas is the same effect as increasing the concentration (the particles are forced closer together and therefore collide more **frequently**.)

### Surface area

- more finely divided (smaller pieces) **solid** reactant = larger surface area
- higher surface area → faster rate of reaction
- more particles are exposed on the surface
- particles collide more **frequently**
- more successful collisions **per unit time**.

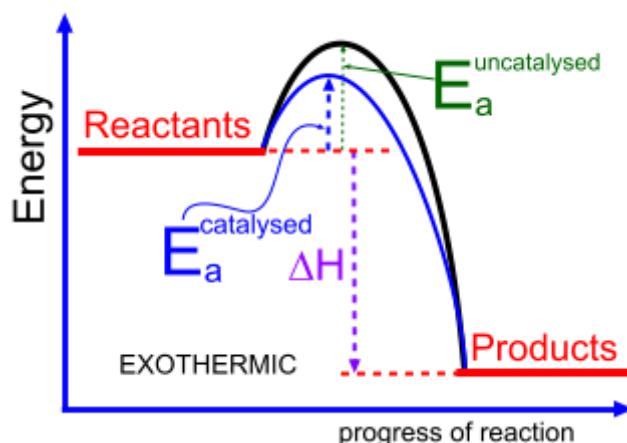
### Temperature

- higher temperature → faster rate of reaction
- higher temperature - particles have more kinetic energy
- particles move faster.
- particles collide more **frequently**.
- more particles have energy greater than or equal to the activation energy
- greater proportion of the collisions are successful
- more successful collisions **per unit time**.

### Catalyst

- speeds up a chemical reaction, but is unchanged at the end of the reaction.
- provides an alternative pathway of lower activation energy.
- more particles have energy greater than or equal to the activation energy
- greater proportion of the collisions are successful
- more successful collisions **per unit time**

You must include the idea of **time** in these answers – collide **more frequently** and not just collide more!



Hydrogen peroxide decomposition:  
 $2\text{H}_2\text{O}_2(\text{aq}) \rightarrow 2\text{H}_2\text{O}(\text{l}) + \text{O}_2(\text{g})$

To test whether substance is a catalyst – does it speed up reaction – gas given off more quickly? Is it used up? Filter off solid, wash with distilled water, dry and re-weigh – is mass the same? Same mass at end = catalyst.