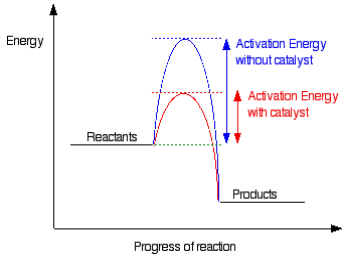
Speed of reaction = how fast or how slow a reaction is - do an experiment to measure change over a period of time (equations): - amt of reactant used up / time taken - amt of product obtained / time taken - vol of gas produced / time taken Experiment notes: H2 is given off: use gas syringe - H2 is very light and the change is minimal leading to unreliable results CO2 given off: mass change - CO2 is a heavier gas Cotton wool: allow gas to escape and prevent solution from splashing Graphs of mass- does not reach zero	Collision theory: - for a reaction to take place, there must be a collision between reactant particles, some are unsuccessful. - a successful collision is one where the colliding particles have enough energy to react (minimum activation energy) Catalyst (usually transition metals / oxides): = a substance that speeds up a chemical reaction, without being used up itself - change the speed of reaction, not the yield of product obtained - small amounts → significant effects Industry use: reduce fuel bills if the reaction is fast enough at lower temperature note: catalysts lower the activation energy of a reaction
Factors: 1. Particle size - the smaller the size, the faster the reaction - smaller particle size = larger total surface area for collision of the particles = higher frequency of collision = higher frequency of effective collision application: coal dust burns faster than large pieces of coal = powdered coal is used in modern coal-burning power stations - explosions can occur if the air contains too much coal dust (sparks from machinery causes explosion) = remove dust by spraying water 2. Concentration - the higher the concentration, the faster the reaction - higher concentration = greater number of reactant particles in a unit volume = higher frequency of collision = higher frequency of effective collision	3. Pressure - the higher the pressure, the faster the speed of reaction - higher pressure = particles are closer together = higher frequency of collision = higher frequency of effective collision 4. Temperature - the higher the temperature, the faster the reaction - higher temperature = particles possess more ke = move at higher speeds and collide with each other with greater force = greater number of particles with the minimum activation energy = higher frequency of collision = higher frequency of effective collision

Heat of reaction (energy change) Enthalpy change: the amount of energy absorbed or released in a chemical reaction carried out under constant pressure **ΔH = HEAT ABSORBED DURING BOND BREAKING- HEAT RELEASED DURING BOND FORMING**	Exothermic reactions - gives out heat to the surroundings (feels hot) Characteristics: - temp of surroundings increase - products have less energy than reactants - **negative ΔH** (temp increases rapidly after the reaction begins as heat energy is given off to the environment, temp falls gradually after reaction is complete and returns to room temp) *the total amount of energy absorbed in breaking the bonds in the reactants is LESS THAN the total amount of energy released from bond forming in the products	Endothermic reactions - takes in heat from surroundings (feels cold) Characteristics: - temp of surroundings decrease - products have higher energy than reactants - **positive ΔH** (temp decreases rapidly after the reaction begins as heat energy is taken in from the environment, temp gradually increases after reaction is complete and returns to room temp) *the total amount of energy absorbed in breaking the bonds in the reactants is MORE THAN the total amount of energy released from bond forming in the products
Energy profile diagram  * catalyst reduces the activation energy needed Catalyst: speeds up the rate of reaction while remaining chemically unchanged at the end of the reaction	Examples (exothermic) - Nuclear fission; large atomic nucleus, such as uranium, is split into 2 or smaller particles - Combustion; use of oxygen to burn fuel - Neutralisation; free moving aq hydrogen and hydroxide ions come together and form bonds - Respiration; use of oxygen to burn glucose C6H12O6 + 6 O2 -> 6 CO2 + 6 H2O + energy - Converting anhydrous salt to hydrated salt; CuSO4 + H2O -> CuSO4.5H2O - Haber process; manufacture ammonia - Contact process; 2 SO2 + O2 ->2 SO3 (physical process) - condensation, freezing, dissolving of anhydrous salt/acids	Examples (endothermic) - Thermal decomposition of carbonate and nitrate salts - Dissolving crystals of potassium or ammonium salts in water - Photography; light falls on silver bromide and agitate an electron in Br- and causes it to move to Ag+ causing the compound to break up and form dark areas on the film 2AgBr (underlight) -> Br2 + 2Ag (redox) - Photosynthesis; 6 CO2 + 6 H2O -> C6H12O6 + 6 O2 (physical process) - evaporation, melting, dissolving some ionic compounds

Redox reaction
- a reaction where both reduction and oxidation takes place concurrently

O		R
+	S	-
-	H	+
+	O	-
-	E	+

S: oxidation state
H: hydrogen
O: oxygen
E: electrons

Explanation:

Oxidation
- increase in oxidation state*
- lose hydrogen
- gain oxygen
- loss of electrons

Reduction
- decrease in oxidation state*
- gain hydrogen
- lose oxygen
- gain in electrons

* it is (oxidised/reduced) as the oxidation state of __ (increase/decrease) from (+/-)__ in __ to (+/-)__ in __

Oxidising agent (OA): a substance that causes another substance to be oxidised while itself being reduced

Reducing agent (RA): a substance that causes another substance to be reduced while itself being oxidised

OA	Test for RA	RA	Test for OA
oxygen, ozone		hydrogen	
halides* Iodine solution	Brown to colourless (I- ions) **oxidizing power of halogens decreases down the group**	sulfur dioxide, hydrogen sulfide	
copper(II) oxide**	**low reactive metal + O2 (easily lose O2 to other compounds)**	Carbon, CO	
Acidified KMnO4	Purple to colourless	metals***	**reducing ability of group I metals increases down the group**
Acidified K2Cr2O7	Orange to green	Acidified FeSO4	Green to yellow or orange or brown (Fe3+ ions)
Fresh FeCl3	Yellow to green (Fe2+ ions)	Acidified KI	Colourless to brown (I2 aq)
H2O2	**ALSO RA**	Conc HCl	Cl2 formed