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Combined Science CC13-15 Groups, Rates and Energy Changes

The Periodic table

Alkali metals | Halogens | Noble gases | Transition metals

1	2											3	4	5	6	7	0
H																	He
Li	Be											B	C	N	O	F	Ne
Na	Mg											Al	Si	P	S	Cl	Ar
K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr
Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe
Cs	Ba	La	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn
Fr	Ra	Ac	Rf	Db	Sg	Bh	Hs	Mt	?	?	?						

Elements arranged in order of atomic number	*Elements with similar properties are in columns called groups*	Elements in the same group have the same number of outer shell electrons and elements in the same period (row) have the same number of electron shells.

Group 1

Alkali metals		
	Soft and easily cut	Low melting and boiling points.
	Very reactive with oxygen, water and chlorine	Only have one electron in their outer shell. Form +1 ions.
	Reactivity increases down the group	Negative outer electron is further away from the positive nucleus so is more easily lost.

Metal	Reaction with water	Word equation
Lithium	Fizzing	Lithium + water → lithium hydroxide + hydrogen
Sodium	Fizzing more vigorously than lithium	Sodium + water → sodium hydroxide + hydrogen
Potassium	Fizzes and burns with a lilac flame	Potassium + water → potassium hydroxide + hydrogen

Group 7

Halogens		
	Consist of molecules made of a pair of atoms	Have seven electrons in their outer shell. Form -1 ions.
	Melting and boiling points increase down the group (gas → liquid → solid)	Increasing atomic mass number.
	Reactivity decreases down the group	Increasing proton number means an electron is less easily gained as outer shell is further away from nucleus, therefore the attraction force is weaker.

Halogen	Colour at room temperature	State at room temperature
Chlorine	Yellow-green	Gas
Bromine	Red-brown	Liquid
Iodine	Dark purple	Solid

With metals	Forms a metal halide	Metal + halogen → metal halide e.g. Sodium + chlorine → sodium chloride	e.g. NaCl metal atom loses outer shell electrons and halogen gains an outer shell electron
With hydrogen	Forms a hydrogen halide	Hydrogen + halogen → hydrogen halide e.g. Hydrogen + bromine → hydrogen bromide	Dissolve in water to form acidic solutions.
With aqueous solution of a halide salt	A more reactive halogen will displace the less reactive halogen from the salt	Chlorine + potassium bromide → potassium chloride + bromine	**(HT) These are redox reactions. The halogen gains electrons and the halide ion from the compound loses electrons.**

Group 0

Noble gases		
	Unreactive, do not form molecules	This is due to having full outer shells of electrons.
	Boiling points increase down the group	Increasing atomic number.

Helium	*Used in balloons*	Due to being less dense than air, which means balloons will float.
Neon	*Used in signs*	Glows when electricity flows through it.
Argon	*Used in filament light bulbs*	Stops the heated filament reacting with oxygen. Bulbs filled with unreactive argon instead.

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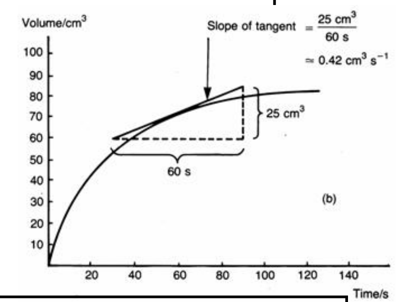
Rates of reaction

Calculating rates of reactions

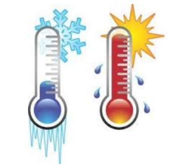
Rate of chemical reaction	*This can be calculated by measuring the quantity of reactant used or product formed in a given time.*	Rate = $\frac{\text{quantity of reactant used}}{\text{time taken}}$ Rate = $\frac{\text{quantity of product formed}}{\text{time taken}}$

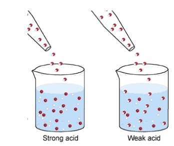
Quantity	Unit
Mass	Grams (g)
Volume	cm^3
Rate of reaction	Grams per cm^3 (g/cm^3) HT: moles per second (mol/s)

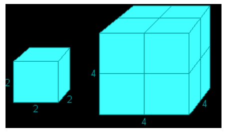


Factors affecting rates

Factors affecting the rate of reaction	
Temperature	*The higher the temperature, the quicker the rate of reaction.*
Concentration	*The higher the concentration, the quicker the rate of reaction.*
Surface area	*The larger the surface area of a reactant solid, the quicker the rate of reaction.*
Pressure (of gases)	*When gases react, the higher the pressure upon them, the quicker the rate of reaction.*



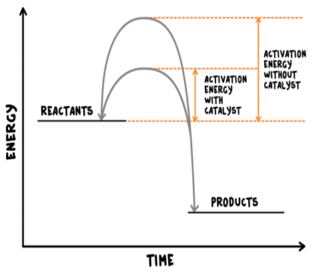




Collision theory and activation energy

Collision theory	*Chemical reactions can only occur when reacting particles collide with each other with sufficient energy.*	Increasing the temperature increases the frequency of collisions and makes the collisions more energetic, therefore increasing the rate of reaction. Increasing the concentration, pressure (gases) and surface area (solids) of reactions increases the frequency of collisions, therefore increasing the rate of reaction.
Activation energy	*This is the minimum amount of energy colliding particles in a reaction need in order to react.*	

Catalysts



If a catalyst is used in a reaction, it is not shown in the word equation.

Catalyst	A catalyst changes the rate of a chemical reaction but is not used in the reaction.
Enzymes	These are biological catalysts.
How do they work?	Catalysts provide a different reaction pathway where reactants do not require as much energy to react when they collide.

Heat energy changes in chemical reactions

Heat energy changes	Occur in the following: - Salts dissolving in water - Neutralisation reactions - Displacement reactions - Precipitation reactions
Exothermic reactions	Heat energy is given out as bonds are being formed.
Endothermic reactions	Heat energy is taken in as bonds are being broken.

Bond energy calculation

Calculate the overall energy change for the forward reaction
$N_2 + 3H_2 \rightleftharpoons 2NH_3$

Bond energies (in kJ/mol): H-H 436, H-N 391, N≡N 945

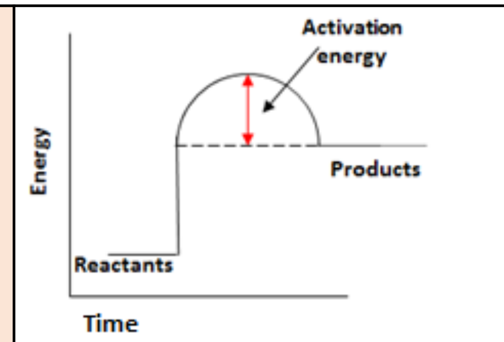
Bond breaking: 945 + (3 x 436) = 945 + 1308 = 2253 kJ/mol

Bond making: 6 x 391 = 2346 kJ/mol

Overall energy change = 2253 - 2346 = -93kJ/mol

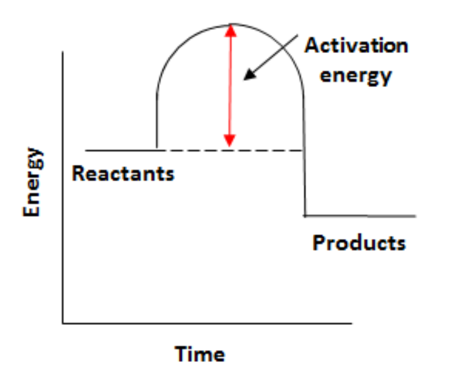
Therefore reaction is exothermic overall.

Endothermic



Products are at a higher energy level than the reactants. As the reactants form products, energy is transferred from the surroundings to the reaction mixture. The temperature of the surroundings decreases because energy is taken in during the reaction.

Exothermic



Products are at a lower energy level than the reactants. When the reactants form products, energy is transferred to the surroundings. The temperature of the surroundings increases because energy is released during the reaction.