AIR

- Mixture of elements and compounds
- Can be separated into its main components by fractional distillation by liquid air
- Nitrogen -> 78%, Oxygen - 21%, Co2- 0.03%, Noble gases(argon) -> 0.97%

Air pollutants

Carbon monoxide

- Odourless and colourless gas, neutral gas
- Incomplete combustion of carbon containing substances due to the lack of oxygen
- Binds with haemologbin in the blood to form carboxyhaemoglobin, preventing transport of oxygen to rest of the body causing death

Sulfur dioxide

- Acidic gas
- Complete combustion of sulfur containing fossil fuels
- Volcanic eruptions
- Irritates eyes and lung
- Causes breathing difficulties
- Reacts with rain and oxygen to form sulfuric acid(acid rain->pH4 or less)
- $2So2(g) + 2H20(l) + O2(g) = 2H2SO4$

Nitrogen oxide

- Acidic gas
- Internal combustion engines due to high temperatures causing nitrogen and oxygen to react together
- Lighting activity
- Irritates eyes and lungs
- Causes breathing difficulties
- Reacts with rain and oxygen to form nitric acid
- $4NO2(g) + 2H2O(l) + O2 = 4HNO3$

Unburned Hydrocarbons

- Internal combustion engines due to incomplete combustion of fuels
- Cancer-causing

Methane

- Bacterial decay of plant matter, animal waste and rubbish
- Global warming

Ozone

- Reaction between nitrogen dioxide and unburned hydrocarbons in presence of light
- Breathing difficultes

- Rain reacting with carbon dioxide forms dilute carbonic acid
- Acid rain corrodes metals/limestones in buildings and reduces pH in water killing fishes and aquaculture

ENERGY CHANGES

Exothermic

- A chemical reaction where energy in the form of heat is released to the surroundings and may increase the surrounding temperature
- Egs. condensation, freezing, metal displacement, neutralization, combustion

Endothermic

- A chemical reaction where energy is taken in from the surroundings and may decrease the temperature of the surroundings
- Egs. dissolving ammonium nitrate in water, boiling, melting

MOLE

Mol

- Volume divide by 24 (FOR GAS*)
- Mass divide by molar mass
- Molar Concentration times Volume (Mol/dm3 X dm3)

Mass concentration (g/dm3)

- Mass divide by volume

Molar concentration (mol/dm3)

- Mass concentration divide by molar mass

Molar mass -> g/mol

Atomic Structure

- nucleon/mass -> neutron + proton
- Proton = atomic number

Neutron -> 0, 1
Proton -> 1+ , 1
Electron -> 1- , 1/1840

Isotopes

- Atoms of the same element, with the same number of proton and electron but different number of neutron
- Similar chemical reactions as number of valence electrons is same
- Different physical properties as mass number is different

Metallic atoms

- 1,2, or 3 valence electrons
- Loses its valence electrons to form a fully filled valence electrons to form a positively charged ion

Non-metallic atom

- 5, 6 or 7 valence electrons
- Gains electrons to form a fully filled valence electron to form a negatively charged ion

Ion

- Formed when gaining or loseing electron

SPEED OF REACTION!

Factors

- Temperature (increase)
- Surface area (smaller)
- Pressure (higher)
- Concentration (more)

Effect

- The more/higher the pressure/concentration, the more reacting particles per unit volume. The reacting gaseous particles are closer together, the frequency of effective collisions increases, more product formed and speed of reaction increases. The higher the concentration/pressure of gaseous reactants, the faster the speed of reaction.
- The smaller solid reactant particles, the larger the exposed surface area. There is more exposed surface area for other reactant particles to collide into. The frequency of effective collisions increases, more products are formed and speed of reaction increases. The smaller reactant size particles, the larger the exposed surface area, the faster the speed of reaction.
- As temp increases, more particles have energy greater than the activation energy and reacting particles gain more energy, moving faster. The frequency of effective collisions increases, more products are formed and speed of reaction increases. The higher the temp, the faster the speed of reaction.

Collision

- The higher the concentration of reactants, the greater the number of reactant particles in a given volume. OR A solid reactant that is smaller in particle size has greater exposed surface area. OR At higher pressure, the gas molecules are forced closer together. More frequent collisions between reactant particles can occur leading to greater frequency of effect collisions, increasing speed of reaction.

Experiments

Concentration

- Using a measuring cylinder, measure 50cm3 of 1mol/dm3 HCl in a beaker. Add 2cm magnesium ribbon into HC in beaker and start stopwatch. Once magnesium completely dissolved, stop stopwatch and record time taken. Repeat 3 times with 50cm3 of 2 mol/dm3 HCl using fresh magnesium ribbon. Record time taken in a table. The shorter the time taken, the faster speed of reaction.

Surface area

- Measure 2g of CaCO3 powder into conical flask. Add 100cm3 of 1mol/dm3 into flask. Co2 is produced and collected by gas syringe. Start stopwatch immediately and stop timing when 50cm3 of Co2 is produced. Repeat using 2g of CaCO3 lumps. (conclusion)

Temp

- 50cm3 of HCl is measured and placed in small beaker. Add strip of magniesum into small beaker w HCl at 20 degrees.Start stopwatch immediately and stop when magnesium ribbon fully disappeared. Record time taken and repeat with different temp at 30, 40, 50, 60 degrees of HCl. (conclusion)

Steeper the gradient, faster the speed of reaction.

The speed of reaction is highest at beginning. The gradient of graph is largest as blah blah. The speed of reaction decreases with time as blah. The gradient decreases. The reaction has stopped and no more products formed. The graph is horizontal and gradient is 0.

FUELS

- Petroleum (crude oil) ->mixture of hydrocarbons
- Natural gases (methane mainly 70%-90%)

Fractional distillation of crude oil

- In the furnace at the bottom of the fractional column, petroleum is heated into a vapour. The vapour is pumped into a huge fractionating column where fractions are separated by their boiling points. Hot vapour rises up the column and begins to condense and cool. The lighter fractions have lower boiling points and are collected at the top of the fractionating column as gases as the first fraction. Heavier fractions have higher boiling points and are collected at the lower sections of the fractionating column with bitumen as residue.

Peter Pan Never Kick Dog Leg Before

Petroleum (fuel for cooking and heating)
Petrol (fuel for vehicles)
Naphtha (feedstock for petrochemicals)
Kerosene (fuel for aircraft engines)
Diesel oil (fuel for engines in buses)
Lubricating oil (for lubricating machines, making waxes and polishes)
Bitumen (paving road surfaces)

Boiling point increases as it goes down

Homologous series

- Same general formula
- Similar chemical properties
- Gradation in physical properties

1. Meth
2. Eth
3. Prop
4. But

Alkanes

- Homologous series of hydrocarbon containing carbon-carbon single covalent bonds
- CnH2n+2
- Saturated compounds

Physical properties

- Insoluble in water, soluble in organic solvents

Undergoes combustion and substitution

Combustion (same as alkenes)

- Alkanes burn in air(oxygen) to produce co2 + water vapour. Reaction is highly exothermic

Substitution

- React with halogens in the presence of ultraviolet light
- Eg, Methane + Chloride = chloromethane + Hydrogen chloride is produced

Alkenes

- Homologous series of hydrocarbon that contain one or more carbon-carbon double bonds
- CnH2n
- Unsaturated compounds

Undergoes hydrogenation, bromination, polymerisation

Hydrogenation

- Heating (200degrees)
- Nickel catalyst
- Vegetable oil → margraine
- Ethene to ethane

Bromination

- Room temp

Polymerisation

- High temp and pressure, catalyst

Alcohol

- $C_nH_{2n+1}OH$
- Includes oxygen, carbon and hydrogen

Oxidation

- Heat
- Purple acidified potassium managaate (VII) turns colorless
- Alcohol + oxygen -> carboxylic acid + water

Production of ethanol

- Hydration of alkene
- Fermentation of glucose
- Yeast is added to glucose solution in flask at temp of 37degrees in absence of oxygen to produce ethanol solution and carbon dioxide gas. Pure ethanol is obtained by fractional distillation.

Carboxylic acid

- $C_nH_{2n+1}COOH$
-

Experimental design

Measuring volume

- Gas syringe (for gases only)
- Measuring cylinder (21.0cm3)
- Burette (23.65cm3)
- Pipette (25.0cm3)

Gas collection

- Displacement of water (used to collect gases that are insoluble in water, eg. h2, o2, co2, CO
- Upward delivery (used to collect gases that have lighter density than air eg. h2, ammonia)
- Downward delivery (used to collect gases that have higher density than air eg. sulfur dioxide, chlorine)

Crystallisation

- Heat the mixture till saturated
- Allow saturated mixture to cool and crystals fill form slowly
- Filter to collect crystals
- Wash crystals with distilled water and dry with filter paper

KINETIC PARTICLE THEORY

Solid

- The particles are very closely packed together in an orderly arrangement. They are vibrating about in their fixed positions. They have very strong forces of attraction between them.
- Fixed Volume and fixed shape cannot be compressed.

Liquid

- The particles are closely packed together but not in an orderly arrangement. Particles slide over one another. Strong forces of attraction between particles. Fixed volume but no fixed shape, cannot be compressed.

Gas

- Particles very far apart in random arrangement. Particles sliding past one another at very high speeds. Weak forces of attraction between particles. No fixed volume and no fixed shape.

Solid to liquid -> melting
Liquid to gas -> boiling
Solid to gas -> sublimation

Gas to liquid -> condensation
Liquid to solid -> freezing
Gas to solid -> vapor deposition

Element

- A pure substance that cannot be broken down by chemical methods into 2 or more simpler substances
- Fixed melting and boiling point

Compound

- A pure substance made up of 2 or more different elements chemically combined together.
- Fixed melting and boiling point
- Can be separated by chemical methods

Mixture

- An impure substance with 2 or more substances that are not chemically combined together.
- No fixed melting or boiling point
- Broken down by physical methods

Ionic bonding

- High melting and boiling point as large amount of energy is required to overcome strong electrostatic forces of attraction between oppositely-charged ions
- Able to conduct electricity in molten and aqueous state due to free mobile ions but not in solid state as ions are held in fixed position due to strong electrostatic forces of attraction.
- Soluble in water, insoluble in organic solvent

Covalent bond

- Low melting and boiling point due to small amount of energy required to overcome weak intermolecular forces of attraction between molecules
- Cannot conduct electricity in any state as there is no free mobile charges and electrons
- Insoluble in water, soluble in organic solvent

ACID

- Dissociates in water to form H+ ions
- Can conduct electricity in aqueous state
- Tastes sour
- Ph <7
- Turns blue litmus paper red

- Acid + alkali -> salt + water
- Acid + Metal -> Salt + Hydrogen
- Acid + carbonate -> salt + water + co2

Alkali

- Metal oxide/metal hydroxide Dissociates in water to form OH- ions
- Tastes bitter
- pH >7
- Turn moist red litmus paper blue

- Acid + Alkali -> Salt + water
- Acid + ammonium -> Salt + water + ammonia

QA

- Sodium hydroxide
  Zinc + Lead -> ppt dissolves in excess forming a colorless solution
  Ammonium -> no ppt gives off ammonia on warming
- Aqueous ammonia
  Zinc -> dissolves in access forming a colorless solution
  Calcium -> no ppt

Test for sulfur dioxide

- Bubble the gas into acidified potassium manganate
- Turns the acidified purple potassium manganate into colorless.

Test for chlorine

- Turns blue litmus paper red and is then bleached.

Redox

- Oxidation
  Gains oxygen, loses hydrogen and electrons. Oxidation state increases
- Reduction
  Loses oxygen, gains hydrogen and electrons. Oxidation state decreases

Oxidizing agent

- Oxides others, reduces itself (acidified potassium manganate VII test -> turns from purple to colorless)

Reducing agents

- Reduces others, oxidies itself (potassium iodine test -> turns from colorless to brown)

METAL

- Good conductor of electricity and heat
- High density
- High melting and boiling point
- Malleable (can be hammered into shapes)
- Ductile (drawn into wires without breaking)

Metal + water -> metal hydroxide + hydrogen

Metal + steam -> metal oxide + hydrogen

Metal + acid -> salt + hydrogen

Haematite-> contains iron (III) oxide, silicon dioxide, clay
Coke -> carbon
Limestone -> calcium carbonate

1. Production of carbon dioxide
   Coke burns in hot air. A Lot of heat is produced. Carbon dioxide is produced.
   $C(s) + O2 (g) \rightarrow CO2 (g)$
2. Production of carbon monoxide
   Carbon dioxide burns in more coke to form carbon monoxide
   $CO2 (g) + C (s) \rightarrow 2CO(g)$
3. Reduction of iron (III) oxide
   Carbon monoxide reduces iron (III) oxide to form molten iron which runs down to the bottom of the furnace where it is tapped off.
   $Fe2O3 (s) + 3CO (g) + 2Fe(l) + 3CO2 (g)$
   Carbon dioxide, nitrogen and carbon monoxide escapes through top of furnace as waste gases
4. Removal of impurities
   Limestone decomposes at high temp to form carbon dioxide and calcium oxide
   $CaO (s) + SiO2(s) \rightarrow CaSiO3(l)$

Calcium oxide reacts with silicon oxide to form calcium silicate (slag).
$CaO (s) + SiO2 \rightarrow CaSiO3 (l)$

Recycling

- Conserves our supply of fossil fuels
- Reduces air pollution
- Less land will be mined

Group 1 (Alkali metals)

- Soft can be cut with knife
- Low mp, bp and density
- Mp decreases, density increases
- Reactivity increases

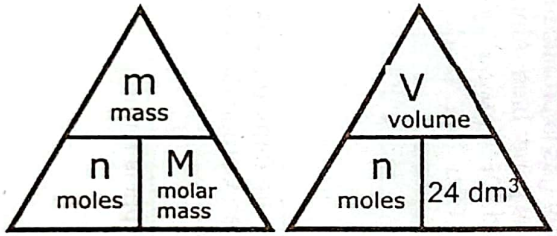
Group VII (halogens)

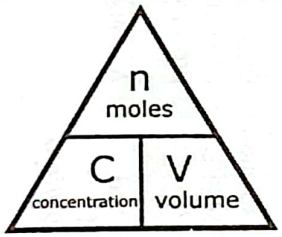
- Diatomic molecules
- Low mp, bp
- Mp, bp increases down the grp
- Color of halogens become darker \

Group 0 (Noble gases)

- Monoatomic colorlesss gas

Practical Summary Notes

<table>
<tr><th></th><th>Titration</th><th>Gravimetric</th><th>Chemical Energetic</th><th>Rate of reaction</th></tr>
<tr><td>Data recording</td><td>• Burette: 2 decimal places
• 2nd decimal place is either '0' or '5'</td><td>• Electronic Balance: 2 decimal places</td><td>• Thermometer: 1 decimal place
• 2nd decimal place is either '0' or '5'</td><td>• Stopwatch: nearest seconds
• No decimal place</td></tr>
<tr><td>Units</td><td>• cm^3</td><td>• g</td><td>• °C</td><td>• min or s</td></tr>
<tr><td>Concept(s) that is/are usually involved</td><td colspan="2">Mole Concept
Formulae
 

Steps:
1. Balanced equation
2. No. of moles
3. Mole ratio
4. Solve

All final answers to be given to 3 significant figures.</td><td>Temperature change =
Final Tempt – Initial Tempt

If
• Final T> Initial T
• Temperature change (+ value) → Exothermic reaction

If
• Final T< Initial T
• Temperature change (- value) → Endothermic reaction</td><td>Rate of reaction

Collision theory

Increase in temperature
Increase in concentration
Decrease in particle size (powder)
→ Increase in rate of reaction

decrease in temperature
decrease in concentration
increase in particle size (granules/ blocks)
→ Decrease in rate of reaction</td></tr>
</table>

Qualitative Analysis

Common Tests Carried Out

	Test	Observation
(a)	Add about 1 cm depth of **P** into a boiling tube. Add aqueous sodium hydroxide slowly with shaking, until no further change is seen. ***(test for cation)*** Add a further 1 cm depth of aqueous sodium hydroxide and gently heat the mixture. ***(test for ammonium ion)*** Test the gas evolved with damp red litmus paper.	A _(colour)_ ppt is formed, soluble/insoluble in excess NaOH. A pungent gas is produced, turns moist red litmus paper blue. Ammonia gas is produced.
(b)	Add about 1 cm depth of **P** into a boiling tube. Add aqueous sodium hydroxide slowly with shaking, until no further change is seen. ***(test for cation)*** Add alumium foil to the boiling tube and gently heat the mixture. ***(test for nitrate ion)*** Test the gas evolved with damp red litmus paper.	A _(colour)_ ppt is formed, soluble/insoluble in excess NaOH. A pungent gas is produced, turns moist red litmus paper blue. Ammonia gas is produced.
(c)	To a test-tube, add 1 cm depth of solution **P** followed by an equal volume of dilute nitric acid. ***(test for carbonate ion)***	Bubbles are formed gives white ppt with limewater. Carbon dioxide gas is produced.
(d)	To the sample of the mixture of **P** and nitric acid, add an equal volume of aqueous barium nitrate. ***(test for sulfate ion)***	A white ppt is formed.
(e)	To the sample of the mixture of **P** and nitric acid, add an equal volume of aqueous silver nitrate. ***(test for chloride ion)***	A white ppt is formed.

(f)	To a test-tube, add 1 cm depth of solution **P** followed by two pieces of magnesium ribbon/ zinc granules. ***(bubbles will be formed → test for hydrogen gas)*** Acid + metal → salt + hydrogen	- Bubbles are formed, extinguish a lighted splint with a pop sound. Hydrogen gas is produced. - A _(colour)_ solid is formed. - _(colour)_ solution turns _(colour)_.
(g)	To a test-tube, add 1 cm depth of solution **P** followed by an equal volume of **hydrogen peroxide**. ***(bubbles will be formed → test for oxygen gas)*** (H_2O_2 test oxygen)	Bubbles are formed, relights a glowing splint. Oxygen gas is produced.

When answering conclusions and evidence questions:

Example:

Consider the results of the experiments you have performed. Give two conclusions about the ions and gases involved in these reactions.

Give evidence to support each of your conclusions.

Conclusion 1: *when writing your answer, please either give the chemical formula of the ion (eg Cu^{2+}) or spell out the name of the ion (eg copper(II) ion).*

Please do not give answers such as ***copper; copper ion Cu(II) ions*** *which are in accurate or inappropriate.*

Evidence: *when writing the evidence, please give the test conducted followed by the results.*

Example:

Test conducted

When sodium hydroxide is added to the solution P, a blue ppt is formed, insoluble in excess sodium hydroxide.

Results of test