

Chapter 1 - Experimental chemistry

Experimental design

1. Name the most suitable apparatus for each situation

- (a) To contain about 100 cm³ of nitric acid: **beaker**
- (b) To measure 15 cm³ of sodium hydroxide solution: **measuring cylinder**
- (c) To measure the volume of carbon dioxide gas: **gas syringe**
- (d) To quickly dispense out three sets of 25.0 cm³ hydrochloric acid: **pipette**
- (e) To accurately measure the volume of alkali needed in titration: **burette**
- (f) To contain about 5 cm³ of salt solution: **test-tube**
- (g) To measure the mass of a bar of zinc: **electronic balance**

2. Precision of a non-electronic instrument is half of its smallest reading.

Instrument	Smallest reading	Precision
measuring cylinder	1 cm ³	0.5 cm ³
burette	0.1 cm ³	0.05 cm ³
thermometer	1 °C	0.5°C
electronic balance	0.01g	0.01g
digital stopwatch	0.01s	0.01s

Methods of purification and analysis

1.Name the most suitable separation technique for each situation

- (a) Obtaining an insoluble solid from a mixture of the solid and a solution: **filtration**
- (b) Obtaining a soluble solid from a mixture of the solid in a solution. This solid does not decompose in heat. : **evaporation to dryness**
- (c) Obtaining a soluble solid from a mixture of the solid in a solution. This solid decomposes in heat. : **crystallisation**
- (d) Obtaining the pure solvent (or water) from a solution: **simple distillation**
- (e) Separating different liquids with different boiling points: **Fractional distillation**
- (f) Separating different liquids with different solubilities: **Paper chromatography**

2. Describe the procedure of crystallisation.

- Heat solution until saturated.
- Leave solution to cool for crystals to form.
- Filter to obtain crystals.
- Wash crystals with a small amount of cold distilled water.
- Dry the crystals.

3.

(a) The best way to test for the purity of a solid substance is to: **check if it has a fixed melting point**

- (b) The best way to test for the purity of a liquid substance is to: **check if it has a fixed boiling point**
- (c) Impure substances or mixtures have **a range** of melting point and boiling points.

Chapter 2 - Kinetic Particle Theory

1. Describe the arrangement and movement of particles in each state.

(a) solid:

movement: It is vibrating about fixed positions

arrangement: It is very closely packed in an orderly manner

(b) liquid:

movement: It slides over one another

arrangement: It is quite closely packed in a disorderly manner

(c) gas:

movement: It is moving randomly in all directions at high speeds

arrangement: It is very far apart in a disorderly manner

Chapter 3 - Atomic structure

	proton	neutron	electron
relative mass	1	1	1/1840
relative charge	+1	0	-1
location	nucleus	nucleus	electron shells

- (a) Define the term proton (atomic) number: **The number of protons in an atom.**
- (b) Define the term isotopes: **Isotopes are atoms of the same element with the same number of protons but different number of neutrons**
- (c) Define the term nucleon (mass) number: **The total number of protons and neutrons in the nucleus of an atom.**

Chapter 4 - Bonding and Structure and properties of materials

1. A metal atom tends to **lose** electrons
 2. Metals are found on the **left side** of the periodic table
 3. A non-metal tends to **gain or share** electrons
 4. Non-metals are found on the **right side** of the periodic table
 5. Atoms gain, lose or share electrons during a reaction in order to **achieve a stable electronic configuration**
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6. Ionic bonding occurs between **metal and non-metal**
 7. The metal atom **loses** electrons to form a **positive** ion while the non-metal atom **gains** electrons to form a **negative** ion.

8. Ionic compounds form a **giant ionic lattice structure**.
9. Ionic compounds have **high** melting points and boiling points.
10. This is because a **large amount of energy** is required to overcome the **strong electrostatic forces of attraction** between the **oppositely-charged ions**.
11. Ionic compounds cannot conduct electricity in the **solid state**.
12. This is due to the **absence of mobile charge carriers**
13. Ionic compounds can conduct electricity in the **molten and aqueous states**.
14. This is due to the **presence of mobile ions**
15. Ionic compounds are usually soluble in water, and insoluble in organic solvents.

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16. Covalent bonding occurs between **non-metal and non-metal**.
 17. It involves the **sharing** of electrons between **non-metal atoms**
 18. Covalent substances can form simple covalent molecules
 19. Simple covalent compounds have **low** melting and boiling points.
 20. This is because a **small amount of energy** is required to overcome the **weak intermolecular forces of attraction** between **molecules**
 21. Covalent substances **cannot** conduct electricity in **all states**.
 22. This is due to the **absence of mobile charge carriers**
 23. Simple covalent molecules are usually soluble in organic solvents and insoluble in water.

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24. Metals and alloys have **high** melting and boiling points.
 25. Metals and alloys conduct electricity in **all states**.
 26. This is due to **the presence of mobile electrons**.
 27. Pure metals are **malleable and ductile**.
 28. This is because pure metals have a **regular** structure made up of atoms of **the same size**.
 29. The layers of atoms can easily **slide over one another** when enough force is applied.
 30. Alloys are a **mixture** of a metal with **other** elements.
 31. Alloys have an **irregular** structure made up of **different** sizes. The layers of atoms **cannot** easily **slide over one another** when a force is applied.
 32. Thus, alloys are **harder and stronger** than pure metals.

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33. Bronze is a mixture of **copper and tin**
 34. Brass is a mixture of **copper and zinc**
 35. Steel is a mixture of **iron and carbon**

substance	element	compound	mixture
made up of	only one type of atom	2 or more types of atoms chemically combined	2 or more elements and/or compounds not chemically combined
formed by	naturally occurring	chemical reaction	physical mixing

ratio of constituents	-	fixed	variable
properties	-	different properties from its constituent elements	same properties as its constituents
m.p and b.p.	fixed	fixed	a range

Chapter 5 - Formulae and equation writing

group	1	2	13	15	16	17
charge of ion formed	1+	2+	3+	3-	2-	1-

Name of ion	Chemical formula
Hydroxide ion	OH^-
Nitrate ion	NO_3^-
Carbonate ion	CO_3^{2-}
Sulfate ion	SO_4^{2-}
Phosphate ion	PO_4^{3-}
Ammonium ion	NH_4^+

- List all the diatomic elements: (HON17):
 H_2 , O_2 , N_2 , F_2 , Cl_2 , Br_2 , I_2

prefix	mono-	di-	tri-	tetra-
no. of atoms	1	2	3	4

Chapter 6 - Mole concept and Stoichiometry

1. Define relative atomic mass: **The average mass of an atom of an element compared to 1/12 of a carbon-12 atom.**
2. Define relative molecular mass: **The average mass of a molecule of a substance compared to 1/12 of a carbon-12 atom.**

3. What does "1 mole of particles" mean? **6.02×10^{23} particles**

Chapter 7 - Acids and bases

- An acid is a substance that produces H^+ ions in solution
- An alkali (soluble base) is a substance that produces OH^- ions in solution
- Reactions:
 1. Acid + base $\rightarrow$ salt + water (neutralisation)
 2. Acid + metal $\rightarrow$ salt + hydrogen
 3. Acid + carbonate $\rightarrow$ salt + water + carbon dioxide
 4. Base + ammonium salt $\rightarrow$ salt + water + ammonia gas

Chapter 8 - Oxidation and reduction

define..	oxidation	reduction
In terms of oxygen	gain	loss
In terms of hydrogen	loss	gain
In terms of electrons	loss	gain
In terms of oxidation state	increase	decrease

Chapter 9 - Periodic Table

- The elements in the periodic table is arranged in order of **increasing proton number**
- Elements in the same group in the periodic table have the same **number of valence electrons**
- Elements in the same period in the periodic table have the same **number of electron shells**

property	group 1 metals	other typical metals
hardness	Soft, easily cut	Hard
melting point	Relatively low	High
density	Relatively low	High
electrical conductivity	Good	Good

Group 17 element	colour	State at r.t.p
Fluorine	Pale yellow	Gas

Chlorine	Greenish-yellow	Gas
Bromine	Reddish-brown	Liquid
Iodine	Purplish-grey	Solid
Astatine	Shiny black	Solid

Group 1 metals: **Alkali Metals**

Group 17 metals: **Halogens**

Group 18 elements: **Noble gases**

Why are group 18 elements unreactive? **They have fully-filled valence shells.**

Chapter 10 - Reactivity series

1. Metal + water → metal hydroxide + hydrogen
2. Metal + steam → metal oxide + hydrogen
3. Metal + acid → salt + hydrogen

Rusting:

- Iron can undergo rusting.
- Rusting requires **water and oxygen**
- We can prevent rusting by placing a barrier around iron such as by **painting, grease and oil**
- We can also prevent rusting using sacrificial protection by attaching a more reactive metal to the iron. So that the other metal will corrode first before the iron rusts.

Chapter 11 - Chemical Energetics

- An exothermic reaction releases energy to the surroundings which causes the temperature of the surroundings to increase.
- An endothermic reaction absorbs energy to the surroundings which causes the temperature of the surroundings to decrease.

Chapter 12 - Rate of reactions

Factors that affect the rate of reaction:

- Concentration
 - Pressure
 - Particle size
 - Temperature
1. When concentration is increased, there are **more reactant particles** per unit volume.
 - This leads to an increase in the frequency of **effective collisions**
 - Thus, the rate of reaction **increases**

2. When pressure is increased, the reactant particles are **closer together**.
 - This leads to an increase in the frequency of **effective collisions**
 - Thus, the rate of reaction increases
3. When particle size of the solid reactant is decreased, the **exposed surface area** of reactant particles increases.
 - This leads to an increase in the frequency of **effective collisions**
 - Thus, the rate of reaction **increases**
4. When temperature is increased, the reactant particles **move faster**
 - This leads to an increase in the frequency of **effective collisions**
 - Thus, the rate of reaction **increases**

Chapter 13 - Fuels and crude oil

1. Three non-renewable sources of energy are:
 - natural gas (mainly methane)
 - crude oil / petroleum
 - coal
 2. Crude oil is a mixture of **hydrocarbons** which can be separated by **fractional distillation** to yield various fractions.
 3. These fractions can be used as fuels and source of chemicals.
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4. Biofuels such as bioethanol from **sugarcane** is a renewable source of energy.
 5. Biofuels are also more environmentally sustainable because the carbon dioxide emitted during combustion of biofuels is offset by the carbon dioxide **absorbed** by the sugarcane during **photosynthesis**

Chapter 14 - Hydrocarbons

Homologous series:

A homologous series is a group of compounds with:

- same general formula
- similar chemical properties
- same functional group
- show a gradation in physical properties

prefix	meth-	eth-	prop-	but-
no. of C atoms	1	2	3	4

homologous series	alkane	alkene	alcohol	carboxylic acid
suffix	-ane	-ene	-ol	-oic acid

alkane general formula: C_nH_{2n+2}

alkene general formula: C_nH_{2n}

Define unsaturated:

Contains a carbon-carbon double bond

Describe a reagent you can use to differentiate between an alkane and an alkene:

- reagent: aqueous bromine
- observation with alkane: aqueous bromine remains reddish-brown
- observation with alkene: aqueous bromine turns from reddish-brown to colourless

Describe polyunsaturated:

Contains many carbon-carbon double bonds

Describe the reagents and conditions used to manufacture margarine from vegetable oils:

- reagent: hydrogen
- conditions: high temperature, nickel catalyst

Chapter 15 - Alcohols and Carboxylic acids and Polymers

alcohol general formula: $C_nH_{2n+1}OH$

carboxylic acids general formula: $C_nH_{2n+1}COOH$

Define polymer:

A very large organic molecule built up from many small units called monomers.

Addition polymerisation:

- Molecules with **a carbon-carbon double bond** can undergo addition polymerisation.
- Two uses of poly(ethene):
- Plastic bags
- Clingfilm

Recycling plastic:

- physical method: **melting small pieces of plastic waste into small pellets which can then be reused**
- chemical method: **cracking of plastic waste into fuel**

Chapter 16 - Maintaining Air Quality

nitrogen	oxygen	other gases
78%	21%	1%

pollutant	sources	effects
carbon monoxide	incomplete combustion of fossil fuels	toxic to humans, can lead to loss of consciousness and death
sulfur dioxide	-combustion of fossil fuels -volcanic eruptions	-breathing difficulties -forms acid rain which can corrode buildings , affect plants and aquatic life
nitrogen oxides	-vehicle combustion engines -lightning activity	-breathing difficulties -forms acid rain which can corrode buildings , affect plants and aquatic life

greenhouse gas	sources	effects
carbon dioxide	combustion of fossil fuels	effects of global warming and climate change: - changes in rainfall patterns - heat waves - ocean warming and ocean acidification - glacial retreat and melting of polar caps
methane	waste gases from cattle	effects of global warming and climate change: - changes in rainfall patterns - heat waves - ocean warming and ocean acidification - glacial retreat and melting of polar caps