

FORM THREE

12.0.0 GAS LAWS (15 lessons)

12.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

- state Boyle's and Charles' laws
- carry out calculations involving the gas laws
- use combined gas law in calculations
- state Graham's law of diffusion
- explain diffusion in liquids and gases in terms of kinetic theory
- relate the rate of diffusion to the relative molecular mass of a gas.

12.2.0 Content

12.2.1 Boyle's law and Charles' law

- Boyle's law, Charles' law and combined gas laws
- Explanation of the laws (use graphs to illustrate)
- Calculations involving gas laws

Note: Use of SI units should be emphasised

12.2.2 Grahams' law of diffusion

- Graham's law of diffusion; experiments illustrating diffusion of bromine gas, dissolving of copper(II) sulphate crystals or potassium manganate(VII) crystals in water. Explain diffusion in terms of kinetic theory.
- Relationship between rate of diffusion and density or relative molecular mass of a gas (illustrate with ammonia and hydrogen chloride)
- Calculations on diffusion

13.0.0 THE MOLE: FORMULAE AND CHEMICAL EQUATIONS (40 Lessons)

13.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

- define the mole
- relate the mole to the relative atomic mass
- convert mass into moles and vice versa
- determine the empirical and molecular formulae of compounds from experimental results and given data
- explain the terms concentration, molarity and dilution of a solution
- define and prepare molar solution
- prepare molar solutions
- carry out titrations and calculations involving molar solutions
- write correct full formulae and ionic equations of reactions with state symbols
- define molar gas volume and atomicity of gases
- state Avogadro's and Gay - Lussac's laws and carry out related calculations.

13.2.0 Content

13.2.1 The mole as a basic unit

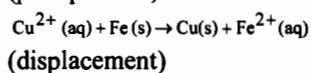
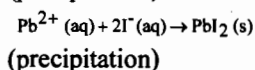
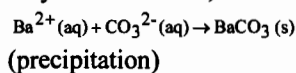
- The mole as a basic unit. Molar mass
- Relative atomic mass (reference to carbon - 12) the mole as a number of particles (illustrated using 'counting by weighing' experiments)
- Conversion of mass in grams to moles and vice versa (consider atoms, molecules and compounds)

13.2.2 Determination of formulae:

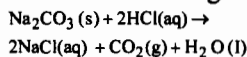
- Empirical and molecular formulae; quantitative determination of composition of magnesium oxide and copper(II) oxide

13.2.3 Molar solutions

- Preparations of molar solutions. Molarity of a solution.
- Concentration and dilution
- Stoichiometry of chemical reactions. (Use of ionic and full formulae equations in calculation of reacting quantities). Reactions that may be considered;

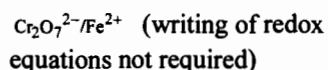


- Evolution of gas by action of an acid on solids e.g.



- Acid/base titrations (use of pipette fillers recommended). (Use balanced ionic and full formulae equations in calculation of reacting quantities.)

- Redox titration involving acidified $\text{MnO}_4^-/\text{Fe}^{2+}$ and



13.2.4 Molar gas volume

- Molar gas volume and atomicity of gases
- Avogadro's and Gay-Lussac's laws and related calculations

13.3.0 Project

Carrying out Counting by weighing experiments

14.0.0 ORGANIC CHEMISTRY I (HYDROCARBONS) (25 Lessons)

14.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

- define a hydrocarbon
- name and draw the structures of simple hydrocarbons (alkanes, alkenes and alkynes).
- state the features of a homologous series
- draw and name isomers of simple hydrocarbons containing not more than five carbon atoms
- describe the general methods of preparing alkanes, alkenes and alkynes
- explain the physical and chemical properties of alkanes, alkenes and alkynes
- state the uses of alkanes, alkenes and alkynes.

14.2.0 Content

14.2.1 Alkanes

- Definition of a hydrocarbon
- General formula: occurrence, nomenclature (consider straight chain alkanes of up to ten carbon atoms); fractional distillation of crude oil.
- Isomerism (butane and pentane)
- Preparation of methane and ethane
- Trends in physical properties (melting point, boiling point, density and solubility in water and in organic solvents)
- Chemical properties: burning and substitution reactions with chlorine or bromine

- (details of reaction mechanism not required)
- Uses of alkanes
- 14.2.2 Alkenes**
- General formula, nomenclature (consider straight chain alkenes of up to six carbon atoms)
 - Isomerism (butene and pentene)
 - Preparation of ethene; trends in physical properties (melting point, boiling point, solubility in water and non-polar solvent)
 - chemical properties (combustion, addition of chlorine, bromine, hydrogen, hydrogen halides, and ethene). (details of mechanism not required)
 - Test for unsaturation (use acidified potassium manganate (VII) or bromine water)
 - Uses of alkenes

- 14.2.3 Alkynes**
- General formula, nomenclature (consider straight chain alkynes of up to six carbon atoms)
 - Isomerism (butyne)
 - Preparation of ethyne; trends in physical properties (melting point, boiling point, density solubility in water and non-polar solvents)
 - chemical properties (combustion and addition reactions with chlorine, hydrogen, bromine, hydrogen halides).
 - Uses of alkynes

15.0.0 NITROGEN AND ITS COMPOUNDS (30 lessons)

15.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

- describe the isolation of nitrogen from air
- describe the laboratory preparation of nitrogen and state its properties and uses
- describe the laboratory preparation, and state the properties and uses of the oxides of nitrogen
- describe the laboratory preparation of ammonia and state its properties and uses
- explain the difference in chemical reactions of ammonia gas and its aqueous solution
- describe the industrial manufacture of ammonia
- calculate the percentage of nitrogen in nitrogen containing fertilizers
- describe the preparation and manufacture of nitric acid
- describe and explain the reactions of both dilute and concentrated nitric acid
- state the uses of nitric acid
- identify the products formed when different nitrates are heated
- explain the pollution effects of nitrogen compounds in the environment.

15.2.0 Content

15.2.1 Isolation of nitrogen gas from air

- Isolation of nitrogen gas from air; laboratory and in industry.

15.2.2 Laboratory preparation of nitrogen gas

- Laboratory preparation of nitrogen gas
- Properties
 - inert character
 - burning magnesium and sulphur in nitrogen gas
- uses of nitrogen gas

15.2.3 Oxides of nitrogen (nitrogen (I) oxide, nitrogen(II) oxide, nitrogen(IV) oxide)

- Laboratory preparations
- Properties and uses of the oxides.

15.2.4 Ammonia

- Laboratory preparation and properties of ammonia gas (relate method of collection to the properties of the gas):
- Solubility in water
 - reaction of aqueous ammonia (NH_4OH) with cations.
 - reaction with air/oxygen (catalysed and uncatalysed), copper(II) oxide and hydrogen chloride,
- manufacture of ammonia by Haber process. (state optimum conditions only)
- uses of ammonia
- Fertilizers: mention of various nitrogen containing fertilizers, (sulphates, nitrates and phosphate), amount of nitrogen in various fertilizers.

15.2.5 Nitric acid

- Laboratory preparation and manufacture of nitric acid
- Reaction of dilute nitric acid with; metals, carbonates, hydroxides and oxides
- Reaction of concentrated nitric acid as an oxidizing agent; iron(II) solution, Sulphur and copper metal

- Uses of nitric acid

15.2.6 Action of heat on nitrates

- Effects of heat on nitrates of sodium, potassium, copper, lead and silver (silver nitrate may be considered theoretically due to its cost)
- Test for nitrates

15.2.7 Pollution effects of nitrogen compounds in the environment

16.0.0 SULPHUR AND ITS COMPOUNDS (25 lessons)

16.1.0 Specific Objectives

By the end of this topic, the learner should be able to:

- describe the allotropes of sulphur
- describe the extraction and state the properties and uses of sulphur
- describe the preparation and state the properties and uses of sulphur(IV) oxide (sulphur dioxide) and sulphur(VI) oxide (sulphur trioxide)
- carry out tests to distinguish between sulphite and sulphate ions
- explain the preparation and manufacture of sulphuric acid and state its uses
- distinguish between the reactions of dilute and concentrated sulphuric acid
- describe the preparation and state properties of hydrogen sulphide
- explain environmental pollution caused by sulphur containing compounds.

- 16.2.0 Content**
- carbonates
 - metal hydroxides
 - metal oxides
- 16.2.1 Occurrence and extraction of Sulphur**
- Extraction by Frasch process
 - Allotropes of sulphur
 - Physical and chemical properties of sulphur
 - Uses of sulphur
- 16.2.2 Sulphur(IV) oxide (sulphur dioxide)**
- Preparation (relate method of collection to properties of the gas)
 - Properties (acid character, bleaching action, reducing action e.g. test with potassium chromate(VI) and combination with oxygen to form sulphur(VI) oxide (Sulphur trioxide). oxidizing action e.g. with magnesium and hydrogen sulphide)
 - Test for sulphate and sulphite ions
 - Uses of sulphur(IV) oxide
- 16.2.3 Manufacture of Sulphuric acid**
- Contact process (state optimum conditions only) e.g. Kel Chemical Ltd in Thika, and East Africa Heavy Chemicals, Webuye
 - Pollution control in contact process
- 16.2.4 Properties of Sulphuric acid**
- Reaction of concentrated sulphuric acid as;
 - dehydrating agent (sucrose, ethanol, hydrated copper(II) sulphate)
 - oxidizing agent (copper, zinc, sulphur and carbon)
 - displacement reaction (sodium chloride solid, potassium nitrate solid)
 - Reactions of dilute sulphuric acid with:
 - metals
- 16.2.5 Hydrogen sulphide**
- Preparation and physical properties
 - Chemical properties (reducing action)
- Note:** Only theoretical treatment is required
- 16.2.6 Pollution of atmosphere by compounds of sulphur (hydrogen sulphide and oxides of sulphur)**
- 17.0.0 CHLORINE AND ITS COMPOUNDS (20 Lessons)**
- 17.1.0 Specific Objectives**
- By the end of this topic, the learner should be able to:
- a) describe and explain the laboratory preparation of chlorine
 - b) state and explain the properties and uses of chlorine
 - c) describe and explain the preparation of hydrogen chloride gas
 - d) state and explain the properties and uses of hydrogen chloride gas
 - e) explain the effect of a solvent on the properties of hydrogen chloride
 - f) describe the industrial manufacture of hydrochloric acid
 - g) explain environmental pollution caused by chlorine and chlorine containing compounds.

17.2.0 Content

17.2.1 Chlorine

- Preparation of chlorine by reaction of concentrated hydrochloric acid with manganese(IV) oxide or any other suitable oxidizing agent (relate method of collection to its properties)
- Physical properties
- Chemical properties
Reactions of chlorine with;
 - hydrogen
 - metals (magnesium and iron)
 - non-metals phosphorous (caution!)
 - Reducing agents (hydrogen sulphide, sulphites and ammonia)
 - Water and alkali solutions (both dilute and concentrated)
 - Bromides and iodides (displacement reactions)
 - Bleaching action
- Test for chlorides in dry solids and aqueous solution
- Uses of chlorine

17.2.2 Hydrogen Chloride

- Preparation of hydrogen chloride gas by reaction of sodium chloride with concentrated sulphuric acid (relate method of collection to properties of the gas)
- Properties (physical and chemical)

17.2.3 Effect of solvent on the properties of hydrogen chloride

- Reactions of aqueous hydrogen chloride
Compare the properties of aqueous hydrogen chloride and a solution of hydrogen chloride in methylbenzene

- acid nature; litmus, reaction with metals, bases, carbonates and hydrogen carbonates
- redox reaction with potassium manganate (VII) to produce chlorine
- Test for hydrogen chloride gas with ammonia

17.2.4 Uses of hydrogen chloride gas

- Industrial manufacture of hydrochloric acid (e.g. Pan Paper, Webuye)
- Uses of hydrochloric acid

17.2.5 Pollution of environment by chlorine and its compounds e.g. CFC, DDT etc

17.3.0 Projects

- determination of chlorine content of various bleaching powders and liquids
- investigation of water purification and treatment.