# HERBERT MORRISON TECHNICAL HIGH SCHOOL

# CHEMISTRY CSEC SYLLABUS

# GRADE 11

## Section A- Principles of Chemistry Cont'd

## *8. OXIDATION – REDUCTION REACTIONS*

Students should be able to:

**8.1 investigate the action of common oxidizing and reducing substances in everyday activities;**

Action of bleach (stain removal, browning of cut fruits and rusting. Sodium sulfite or sulfur dioxide used as food preservatives.

**8.2 define oxidation and reduction;**

Loss and gain of electrons and a change in oxidation number.

**8.3 deduce oxidation number from formulae;**

**8.4 identify oxidation and reduction reactions including reactions at electrodes;**

Refer to SO A9.8.

**8.5 distinguish between oxidizing and reducing agents;**

Equations involving formulae for potassium chromate(VI), potassium manganate(VII) and household bleach are not required.

Inclusion of at least one example of a substance, which can behave both as an oxidizing and a reducing agent.

Refer to SO B3.7, C6.3.

Perform reduction and oxidation reactions with potassium manganate (VII) iron(II)sulfate, potassium chromate(VI), hydrogen peroxide and potassium iodide.

Concentrated hydrogen peroxide should be handled with care.

**8.6 perform tests for oxidising and reducing agents.**

Refer to SO C6.3.

## *9. ELECTROCHEMISTRY*

Students should be able to:

**9.1 conduct investigations leading to the classification of substances as conductors or non-conductors;**

Low voltage supplies only. Plastic and metals.

Physics – Current, electricity.

**9.2 distinguish between metallic and electrolytic conduction;**

Reference to mobile electrons in metals and mobile ions in solution.

Use simple circuits including plastic, metals or solutions.

Physics – Current, electricity.

**9.3 classify electrolytes as strong or weak based on their conductivity;**

Use of acids, salts and alkalis as examples of electrolytes.

Physics – Current, electricity.

**9.4 define electrolysis, cathode, anode, cation, anion;**

Physics – Current, electricity.

**9.5 identify ions present in electrolytes;**

**9.6 predict the electrode to which an ion will drift;**

**9.7 predict chemical reactions making use of electrochemical series;**

Consideration of gain or loss of electron and formation of cation.

**9.8 discuss the electrolysis of certain substances;**

Principles related to:

(a) Concentration of electrolyte.

b) Type of electrode (active and inert).

Position of ions in the electrochemical series with respect to the named substances. Refer to SO A8.4.

Carry out electrolysis of the following substances: dilute sulfuric acid, concentrated aqueous sodium chloride, dilute aqueous sodium chloride, aqueous copper(II)sulfate using carbon or platinum and copper electrodes. One fused halide, for example, lead (II) bromide, using inert electrodes. Draw simple line diagrams representing electrolytic cell.

Physics – Current, electricity.

**9.9 define the Faraday constant;**

Approximate value of the Faraday constant as 96 500 C mol-1 (coulombs per mole) of electrons.

Physics – Current, electricity.

**9.10 calculate the masses and volumes of substances liberated during electrolysis;**

Quantity of electricity dependent on the current and time.

Q =It.

Physics – Current, electricity.

**9.11 describe industrial applications of electrolysis.**

Reference to:

(a) metallic extraction (based on position in electrochemical series);

(b) purification;

(c) electroplating:

(d) anodising.

Refer to SO C2.3.

Physics – Current electricity.

## *10. RATES OF REACTION*

Students should be able to:

**10.1 define rate of reaction;**

The change in concentration of reactant or product with time at a stated temperature.

**10.2 identify the factors which affect the rate of reaction;**

Factors:

(a) concentration;

(b) temperature;

(c) surface area;

(d) presence or absence of a catalyst.

The danger of explosive combustion of finely divided substances, for example, flour in flour mills. Consideration of the change in rate of reaction as the reaction proceeds.

Carry out exercises varying one factor at a time while maintaining the others constant, for example:

(a) magnesium strips and dilute acid;

(b) potassium iodide and hydrogen peroxide;

(c) sodium thiosulfate and dilute acid;

(d) marble chips and dilute hydrochloric acid.

Biology- Enzymes in biological systems.

**10.3 predict the effect of factors on rates of reaction from given data;**

**10.4 interpret graphical representation of data obtained in studying rates of reaction.**

Include graphs of:

(a) Concentration (volume; mass) vs. time;

(b) Concentration

Vs 1/t5

(c) rate vs time.

## *11. ENERGETICS*

Students should be able to:

**11.1 distinguish between exothermic and endothermic reactions;**

Energy content of products and reactants.

Bond breaking being endothermic; bond forming being exothermic;

temperature change in surroundings.

Use of notation.

Perform investigations to demonstrate endothermic and exothermic changes, for example,

potassium nitrate and water, sodium hydroxide pellets and water.

Physics-Thermal energy.

**11.2 draw energy profile diagrams to illustrate endothermic and exothermic change;**

Simple energy profile diagrams including energy barrier.

Include the action of catalyst using energy profile diagrams.

Physics-Thermal energy.

**11.3 calculate energy changes from experiments or from experimental data**.

Reference to heat of solution and heat of neutralization of strong acid and strong base.

Assumptions: density and specific heat capacity of pure water;

negligible heat loss/gain from surroundings.

Refer to SO A7.10.

Carry out experiments by reacting metals with acids, volumetric analysis of alkali and acid.

Record temperature changes.

End point of thermometric titration determined from the intersection of lines from the graph obtained.

## Section B- Organic Chemistry

## *1. SOURCES OF HYDROCARBON COMPOUNDS*

Students should be able to:

**1. 1 identify natural gas and petroleum as natural sources of hydrocarbons;**

Physics-Forms of Energy.

Biology-Ecology; Natural resources.

**1. 2 list the main uses of at least three fractions obtained from the fractional distillation of petroleum;**

Uses should include fuels, petrochemicals, lubricants.

Refer to SO A2.5.

Physics-Forms of Energy.

Biology-Ecology.

**1. 3 describe cracking of petroleum fractions.**

Thermal and catalytic cracking of alkanes.

## *2. ORGANIC CHEMISTRY - AN INTRODUCTION*

Students should be able to:

**2.1 illustrate that carbon atoms can form single and double bonds, branched and unbranched chains and ring compounds;**

Carbon atoms form four bonds.

Refer to SO A5.1.

Illustrate various molecular structures using models.

**2.2 write formulae to represent simple organic compounds**;

Structures to be represented by the condensed formulae and fully displayed (structural) formulae:

**2.3 list the general characteristics of a homologous series;**

**2.4 write general and molecular formulae for members of a given homologous series;**

Alkanes, alkenes, alcohols and alkanoic (carboxylic) acid.

**2.5 deduce the homologous series given the fully displayed and condensed formulae of compounds;**

**2.6 write fully displayed structures and names of branched and unbranched alkanes and unbranched alkenes, alcohols, and alkanoic acid;**

IUPAC notation structure limited to compounds of up to 6 carbon atoms.

Use molecular models.

**2.7 define structural isomerism;**

**2.8 write the fully displayed structures of isomers given their molecular formulae.**

Limited to structural isomerism for alkanes and alkenes up to 6 carbon atoms.

## *3. REACTIONS OF CARBON COMPOUNDS*

Students should be able to:

**3.1 describe the reactions of alkanes and alkenes;**

The chemical reactions considered should be: burning and halogenation of alkanes and alkenes; hydration and hydrogenation for alkenes. Equations and conditions for reactions are required.

Demonstrate burning of appropriate hydrocarbons for example (hexane, hexene).

Physics-Forms of energy.

Biology - Ecology.

**3.2 relate the characteristic reactions of alkanes and alkenes to their structures;**

Emphasis should be placed on the dominance of substitution in alkanes and addition in alkenes.

**3.3 distinguish between alkanes and alkenes;**

Carbon-Carbon double bond (C=C) associated with unsaturation.

Test for unsaturation (burning is not acceptable). Use bromine solution or acidified potassium manganate (VII).

Skill: ORR; AI; PD.

**3.4 relate the properties of hydrocarbons to their uses;**

Alkanes as fuels and solvents and alkenes as the starting material for a wide range of polymers (for example, plastics) biogas production from decomposition of manure.

Refer to SO B4.2.

Physics - Energy.

Biology - Ecology.

**3.5 identify alcohols, acids and esters by their functional groups;**

Alcohol : R– OH,

Acid: R-COOH,

Ester: COO-R where R represents an alkyl group.

**3.6 relate the properties of alcohols, acids and to their functional groups;**

The presence of hydroxyl (- OH) groups linked to solubility and volatility.

Investigate solubility of alcohols and acids in water.

**3.7 describe the reactions of ethanol;**

Combustion, reaction with sodium, dehydration. Oxidation by reaction with potassium chromate (VI), ($KMnO_4$). Reaction with organic acids to form esters. Equations and conditions for reactions are required.

Equations for the conversion to acid are not required.

Refer to SO A8.5.

Demonstration of the principles of the breathalyser test, formation of esters and reaction of sodium with ethanol.

Physics - Forms of energy.

Biology - Ecology.

**3.8 describe the fermentation process by which ethanol is produced from carbohydrates;**

Fermentation of a suitable carbohydrate, for example, glucose.

Equation is required. Reference to wine-making and rum manufacture.

Draw line diagrams of the distillation process in the laboratory.

Refer to SOA2.5.

Prepare a sample of ethanol.

Biology - Aerobic and anaerobic respiration.

**3.9 describe the reactions of ethanoic acid;**

Condensation reactions with alcohols (ester formation) Reactions with metals, oxides, hydroxides, and carbonates. Equations and conditions of reactions are required.

Esterification with appropriate alcohols and carboxylic acids

**3.10 explain hydrolysis of esters including saponification;**

Equation for hydrolysis of an ester.

Include saponification of fats and oils.

Preparation and hydrolysis of a suitable ester, for example, ethyl ethanoate. Preparation of a sample of soap.

**3.11 compare soapy and soapless detergents;**

Compare effect on hard and soft water, environmental impact. Refer to SO C5.5, C5.6, C5.7.

A comparison of the effect of soaps and soapless detergents on hard water.

# *4. POLYMERS*

Students should be able to:

**4.1 define polymers;**

Polymers as macromolecules produced from 50 or more monomers.

**4.2 distinguish between addition and condensation as reactions in the formation of polymers;**

Addition – polyalkenes

Condensation – polyamides

polyesters

polysaccharides.

The mechanism of polymerization is NOT required.

Refer to SO B3.4.

**4.3 state at least one use of each of the following types of polymers.**

Polyalkene

Polyamide

Polyester

Polysaccharide.

A named example is required in each case, for example, polyvinyl chloride (PVC) used in pipe fittings.

Refer to SO C5.5.

## Section C- Inorganic Chemistry

# *1. CHARACTERISTICS OF METALS*

Students should be able to:

**1.1 describe the physical and chemical properties of metals;**

Physical properties melting point, boiling point, conductivity, lustre, hardness, density.

Chemical properties to include action of oxygen, water, dilute hydrochloric acid, dilute sulfuric acid.

Refer to SO A5.4.

Physical examinations and reactions of various metals, including zinc, iron, sodium, calcium, magnesium, aluminium, copper. Reaction of acids with sodium and calcium should not be attempted.

Physics - Specific latent heat, current, electricity.

**1.2 describe the reactions of metallic oxides, hydroxides, nitrates and carbonates.**

Equations are required. Reaction with dilute acid, action of heat.

Refer to SO A7.4, A6.5.

The action of dilute sulfuric acid and hydrochloric acid on metallic oxides and hydroxides. The action of heat on nitrates, carbonates and hydroxides.

## *2. REACTIVITY AND EXTRACTION OF METALS*

Students should be able to:

**2.1 discuss the reactivity of metals;**

Reactivity based on displacement reactions, reactions with oxygen, relative ease of decomposition of their nitrates, carbonates, oxides and hydroxides.

Refer to practical activities at SO C1.1 and 1.2.

**2.2 deduce the order of reactivity of metals based on experimental results or data supplied;**

Refer to practical activities at SO C1.1, 2.2.

**2.3 describe the extraction of aluminum and iron.**

Relate the principles underlying the extraction of a metal to its position in the electrochemical series; details of purification of the raw materials not required. Use of carbon or hydrogen in the extraction of iron.

## *3. USES OF METALS*

Students should be able to:

**3.1 explain why metal alloys are often used in place of the metals;**

**3.2 relate the properties of the metals (aluminum, lead, iron) and their alloys to their uses.**

Consideration of aluminum alloys, steel and solder. Reference to the use of lead in batteries. Use of metal cans as storage containers.

Physics – Current, electricity.

## *4. IMPACT OF METALS ON LIVING SYSTEMS AND THE ENVIRONMENT*

Students should be able to:

**4.1 investigate the conditions necessary for the corrosion of metals;**

Reference to iron and aluminum.

Experiments with iron and aluminium under various conditions to show that air and water are necessary for corrosion.

**4.2 explain the importance of metals and their compounds on living systems and environment;**

Organometallic compounds such as chlorophyll (containing magnesium) and haemoglobin, (containing iron). Importance of trace metals, for example, zinc.

Biology - Transport, nutrition.

**4.3 discuss the harmful effect of metals and their compounds to living systems and the environment.**

Reference to toxicity of certain metals example: Lead

(Lead compounds in car exhaust fumes, and paints, disposal of vehicular batteries), arsenic (for mining), cadmium (disposal of nickel-cadmium batteries), and mercury (disposal of thermometers in hospitals and labs, mercury content in fish). Problem of disposal of solid waste (metals).

## *5. NON-METALS*

Students should be able to:

**5.1 describe the physical and chemical properties of non-metals;**

Hydrogen, chlorine, oxygen, carbon, sulfur, nitrogen. Reactions with oxygen and metals, oxidising and reducing properties. Physical properties (melting point, boiling point, conductivity, luster, hardness, density).

Burning of sulfur and carbon conductivity of carbon and sulfur.

Biology – Photosynthesis, nitrogen cycle, Physics – Specific latent heat, current electricity.

**5.2 describe the laboratory preparation of gases;**

Preparation of O2, CO2, NH3. Relate methods of drying and collection to the properties of gas (density, solubility and reaction with drying agents).

Preparation of gases, line drawings of apparatus used.

Refer to SO A7.6.

**5.3 explain the use of gases based on their properties;**

Example: carbon dioxide in fire extinguishers, oxygen in hospitals and for welding.

Refer to SO A7.4.

**5.4 list uses of the non-metals: carbon, sulfur, phosphorus, chlorine, nitrogen, silicon and their compounds;**

Inclusion of insecticides, strengthening of plastics with fibre, jewellery, tyre manufacture, matches, phosphate and other fertilisers (NPK), bleaches, glass, ceramics.

Biology - Nutrition;

soils, fertilisers.

**5.5 discuss the harmful effects of non-metal on living systems and the environment;**

Pollution and role played by sulfur dioxide, carbon monoxide, hydrogen sulfide, oxide of nitrogen, carbon dioxide, chlorofluoro carbons, nitrates, phosphates, herbicides and pesticides; problem of disposal of solid waste (non-metal, example, plastics).

Refer to SO B3.11, B4.3.

Biology - Ecology.

**5.6 relate the unique properties of water to its functions in living systems;**

Include density changes, solvent properties, specific heat capacity, volatility.

Refer to SO B 3.11.

Physics-Specific heat capacity, density.

**5.7 discuss the consequences of the solvent properties of water;**

Hardness of water (temporary and permanent). Leaching.

Refer to SO B 3.11.

Biology – Ecology.

**5.8 describe the methods used in the treatment of water for domestic purposes;**

Boiling, filtering, chlorinating, softening.

Include equations for softening water.

Refer to SO A2.5.

Biology – Role of decomposers.

**5.9 define Green Chemistry;**

Green Chemistry is the utilization of a set of principles that reduces or eliminates the use of generations of hazardous substances in the design, manufacture and application of chemical products.

Refer to SO C4.3, C5.5.

**5.10 outline the principles of Green Chemistry**.

In-depth study of the principles is not required.

## *6. QUALITATIVE ANALYSIS*

Students should be able to:

**6.1 identify cations - Pb2+, Al3+, Ca2+, Zn2+, Fe3+, Fe2+, NH4+ ,Cu2+;**

The following criteria to be used for identification;

(a) metallic ions -colour, solubility of the hydroxides in:

(i) aqueous sodium hydroxide refer to SO A7.1;

Appropriate experimental activities based on criteria in "Content/

Explanatory Notes".

Use of Potassium Iodide.

(ii) aqueous ammonia or a suitable confirmatory test.

Use of potassium iodide identity of Pb 2+ions.

(b) ammonium ion, evolution of ammonia gas after treatment with aqueous sodium hydroxide and warming.

Ionic equations are required.

Refer to SO A6.5.

**6.2 identify anions -**

CO32-, SO42-, SO32-, NO3-, Br-, I-, Cl;

The following criteria to be used for identification:

(a) evolution and identification of gases produced when compounds containing the anions are:

(i) heated strongly,

Use criteria listed under "Content/Explanatory Notes" to conduct simple experiments.

(ii) treated with acid (dilute and concentrated);

(b) colour and solubility of the silver halide in aqueous ammonia or lead halide;

(c) colour of precipitate formed when anion reacts with a solution containing barium ions;

(d) solubility of the precipitate formed in (c), in dilute acids.

**6.3 identify gases - H2, O2, CO2, NH3, SO2, Cl2, NO2, H2O;**

The following criteria to be used for identification:

(a) colour;

(b) odour;

(c) reaction with a lighted or a glowing splint:

(i) reaction with moist litmus paper;

(ii) reaction with dry cobalt chloride paper/ anhydrous copper(II) sulfate;

(iii) reaction with acidified potassium manganate

(VII) acidified potassium dichromate (VI);

(iv) reaction with a glass rod dipped in concentrated aqueous ammonia or concentrated hydrochloric acid;

Standard laboratory tests for the gases.

Biology - Photosynthesis, respiration.

(v) hydroxide

reactions with lime water/ aqueous calcium.

Refer to SO A7.2, A8.5, A8.6.