STANDARDS FOR SECONDARY EDUCATION

CHEMISTRY

Quality Assurance and Development Services
Ministry of Education, Youth and Sports 2004

CHEMISTRY

Content Standard No. 1
Differentiate between solids, liquids and gases.

Learning Outcomes
Third Form

1.1 Explain and illustrate the differences between solids, liquids, and gases in terms of arrangement of particles.
1.2 Explain the differences between solids, liquids, and gases in terms of kinetic energy of particles.
1.3 Describe and perform experiments to illustrate differences between solids, liquids, and gasses, to include diffusion, osmosis and Brownian motion.

Content Standard No. 2
Describe changes between states of matter

Learning Outcomes
Third Form

2.1 Describe and perform experiments to demonstrate changes in state of matter
2.2 Describe activities to show sublimation

Content Standard No. 3
Investigate types of mixtures

Learning Outcomes
Third Form

3.1 Identify different types of mixtures
3.2 Distinguish among solutions, suspensions and colloids
3.3 Classify substances as pure or impure

Content Standard No. 4
Investigate the factors that affect the solubility of solids

Learning Outcomes
Third Form

4.1 Describe and demonstrate the effect of structure and temperature on solubility of solids in water
4.2 Plot and interpret graphs based on solubility curves

Content Standard No. 5
Perform suitable separation techniques of mixtures

Learning Outcomes
Third Form

5.1 Describe and perform techniques most suitable for the separation of substances, which includes simple filtration, fractional distillation, paper chromatography, use of separating funnel and decanting
5.2 Describe industrial applications of extraction such as the extraction of sucrose from sugar cane

Content Standard No. 6
Describe the properties of sub-atomic particles and describe the first 20 elements

Learning Outcomes
Third Form

6.1 Describe properties related to relative mass and relative charge of electrons, protons and neutrons
6.2 Define atomic number, atomic mass and interpret the isotopic notation
6.3 Define the relative molecular mass, relative atomic mass, and relative formula mass based on carbon-12
6.4 Identify names and symbols of first 20 elements in the periodic table
6.5 Describe and illustrate the atomic structure of the first twenty elements

Content Standard No. 7
Explain isotopes and their uses

Learning Outcomes
Third Form
7.1 Define isotopes as elements with same protons but different neutrons and cite examples
7.2 Explain the use of radioactive isotopes in carbon dating, radiotherapy, tracers, pacemakers and energy generation

Content Standard No. 8
Analyze the arrangement of elements in the Periodic Table

Learning Outcomes
Third Form
8.1 Outline a brief history and development of the periodic table
8.2 Classify elements based on atomic number
8.3 Arrange elements based on atomic structure and oxidation state
8.4 Explain periodicity of trends across period 3 citing changes in element properties from metals to non-metals
8.5 Describe the reactivity in groups II, VII and use relative ease of electron loss or gain

Content Standard No. 9
Apply the concept of ionic bonds

Learning Outcomes
Third Form
9.1 Explain the formation of ions including valence and the octet rule
9.2 Explain ionic bond formation as electron transfer from atom to atom, citing attraction of opposite charge as the bond
9.3 Predict likelihood of atoms forming ionic compounds and discuss properties of ionic compounds
9.4 Write formulas for mono-ionic and poly-ionic compounds and name them
9.5 Draw ionic structure of compounds based on atomic structures
9.6 Calculate molecular mass and percentage composition for ionic compounds

Content Standard No. 10
Apply the concept of covalent bonds including the effect of electro negativity on bond polarity and coordinate bonds and explain ionic bonds

Learning Outcomes
Third Form
10.1 Explain covalent bond formation as sharing of electrons and discuss properties of covalent compounds
10.2 Illustrate structures of diatomic molecules, to include Cl_2, H_2, N_2, and other molecules CO_2, H_2O, NH_3, CH_4
10.3 Explain the type of bonding found in metals

Content Standard No. 11
Analyze the properties of compounds

Learning Outcomes
Third Form
11.1 Distinguish between ionic, molecular and giant molecular solids in terms of; melting point, solubility, and conductivity.
11.2 Relate NaCl structure and bonding to its properties including melting point, solubility in H_2O and conductivity.
11.3 Explain the term allotropes
11.4 Relate properties and uses to structure of carbon and sulphur.

Content Standard No. 12

Apply the concept of the Mole to derive empirical and molecular formulas, and to volumetric analysis

Learning Outcomes

Third Form

12.1 Define mole as the amount of substance containing the same # of particles as in one mole of C-12 and Avogadro's #: 6 x 10^{23} atoms.
12.2 Calculate the molar, relative molecular and relative formula masses of compounds.
12.3 Perform calculations involving the mole including conversions from, grams to moles, particles to moles and vice versa.
12.4 Use mass and percent composition to derive empirical, relative molecular mass and molecular formulae.
12.5 Identify types of chemical reactions.
12.6 Write balanced equations for ionic and molecular reactions including symbols to represent chemical reactions.
12.7 Use mole ratios from balanced equations to calculate mass or volume of reactant and products.
12.8 Derive quantities to prepare standard solutions.
12.9 Prepare bench reagents
12.10 Perform titration and use results from volumetric analysis to calculate the number of moles reacting, and ratio in which they react.
12.11 Perform titration in the lab and use results to calculate mass and mole concentration of reactants.

Content Standard No. 13

Recall the properties of acids, bases and salts, and investigate the reactions among acids, bases and salts

Learning Outcomes

Third Form

13.1 Define the following and give examples of each: acid, acid anhydride and acidic oxide
13.2 State the physical and chemical properties of acid and acid anhydride.
13.3 Identify types of acid as organic or mineral.
13.4 Identify acids as monobasic, dibasic or tribasic.
13.5 Identify the strength of various acids from experiments.
13.6 Differentiate between acid strength and concentration.
13.7 Perform reactions of non-oxidizing acids with
    (i) metals
    (ii) carbonates
    (iii) bases.
13.8 Define the following citing examples of each: base, alkali and basic oxides.
13.9 Investigate by means of experiment the reaction of bases with ammonium salts.
13.10 Define the following citing examples of each: amphoteric, neutral oxides and hydroxides.
13.11 Define salts citing examples of acid salts, basic salts, and neutral salts.
13.12 Distinguish between acid salts and normal salts citing everyday uses of salts e.g. food, laxatives etc.
13.13 Prepare samples of soluble and insoluble salts.

Content Standard No. 14

Investigate and analyze the properties, importance, preparation/extraction, and applications of metals and nonmetals.

Learning Outcomes

Third Form

14.1 Describe the physical properties of metals such as: melting point, boiling point, conductivity, luster, density, malleability, ductility and sonority.
14.2 Describe the chemical properties of metals such as: actions of oxygen, water, dilute HCl and H_2SO_4.
14.3 Explain and perform experiments involving displacement reactions and thermal stability of compounds including ease of decomposition of nitrates, carbonates, oxides and hydroxides.
14.4 Perform experiment to deduce the order of reactivity of metals.

14.5 Describe the industrial extraction of iron and aluminum and relate it to the principle of reduction
14.6 Explain by comparison the properties of metals and their alloys to their preferred use in place of the metal.
14.7 Describe and perform experiments that demonstrate the conditions needed for metals to corrode using Al and Fe as examples.
14.8 Explain the importance of metals to living systems; Mg in chlorophyll, Fe in hemoglobin and trace metals e.g. Zn
14.9 Describe the carbon, nitrogen and water cycles as important to living systems.
14.10 Describe the harmful effects of metals and non-metal to living system with reference to pollution.
14.11 Perform experiments to identify cations (Pb^{2+}, Al^{3+}, Ca^{2+}, Zn^{2+}, Fe^{3+}, Fe^{2+}, NH_4^+ and Cu^{2+}) by color and solubility of hydroxide with NaOH (aq) and NH_3(aq)
14.12 Perform experiments to identify anions (CO_3^{2-}, SO_4^{2-}, SO_4^{2-}, NO_3^-, Br^-, I^-, Cl^-) by heating compounds strongly, treating with acid, solubility of silver halide with NH_3 (aq), and precipitation with Ba^{2+} ions.
14.13 Describe the physical properties of non-metals such as: M.pt, B.pt, conductivity density, brittleness, hardness and dull appearance for H_2, Cl_2, O_2, N_2, C and S.
14.14 Describe chemical properties such as reactions with oxygen and metals, oxidizing and reducing properties for H_2, Cl_2, O_2, N_2, C and S.
14.15 Describe the industrial, lab preparation and collection of chlorine, and ammonia.
14.16 Describe the industrial preparation of sulphuric acid
14.17 Conduct experiment to identify the following gases; H_2, O_2, CO_2, NH_3, SO_2, Cl_2, NO_2, H_2O by means of color, odor, reaction with splint, moist litmus paper, lime water etc.

Content Standard No. 15
Use oxidation and reduction to deduce oxidation numbers and describe tests for oxidizing and reducing agents.

Learning Outcomes
Fourth Form
15.1 Define oxidation and reduction as loss and gain of electrons and a change in oxidation state.
15.2 Perform calculations to deduce oxidation numbers from formulae.
15.3 Identify chemical equations that are redox and non-redox reactions including their half equations.
15.4 Describe and perform experiments to test for oxidizing and reducing agents.
15.5 Perform volumetric analysis using redox reactions.

Content Standard No. 16
Perform electrolysis of salts and dilute acids and describe some industrial applications of electrolysis

Learning Outcomes
Fourth Form
16.1 Perform experiments to classify substances as conductors or insulators.
16.2 Perform experiments using metals and solutions to distinguish between metallic and electrolytic conduction.
16.3 Define the terms electrolysis, cathode, anode, cation and anion.
16.4 Classify electrolytes such as acids, salts and alkali, as being strong or weak based on availability of ions and conductivity.
16.5 Perform experiments and predict electrodes to which ions in electrolyte will migrate.
16.6 Write ionic equations for reactions at the electrodes.

16.7 Perform experiment to demonstrate effect of type of electrode and position of ions in electrochemical series as factors affecting product formation in electrolysis.
16.8 Perform experiment to show electrolysis of Conc. HCl, dil. H_2SO_4, NaCl, $CuSO_4$, using Pt, and Cu electrodes.
16.9 Define the Faraday constant
16.10 Calculate the masses and volumes of substances liberated during electrolysis.
16.11 Describe the industrial applications of electrolysis: metallic extraction and purification, electroplating and anodizing.

Content Standard No. 17
Analyze and explain rates of chemical reaction

Learning Outcomes
Fourth Form
17.1 Define reaction rate.
17.2 Explain and perform experiments to investigate the effect of factors such as Temperature, surface area, concentration and catalyst on reaction rate
17.3 Plot and interpret line graphs and make presentations on results from reaction rates experiment.

Content Standard No. 18
Investigate and analyze energy of chemical reactions

Learning Outcomes
Fourth Form
18.1 Perform and discuss simple experiments to demonstrate the transformation of energy from one form to another.
18.2 Explain fossil fuel formation.
18.3 Discuss alternative energy sources to include wind, hydro, Biogas, geothermal etc.
18.4 Perform experiments to demonstrate the differences between endothermic and exothermic changes.
18.5 Illustrate endothermic changes on energy profile diagrams including the difference for both catalyze and uncatalyzed reactions.
18.6 Perform experiments recording temperature changes to calculate energy changes for heat of solution, heat of neutralization and heat of combustion.

Content Standard No. 19
Analyze the reactions of organic compound, illustrate structural isomerism, and analyze the properties and reactions of alcohols, acids and esters.

Learning Outcomes
Fourth Form
19.1 Explain and illustrate that carbon can form branched and un-branched chains, with single and double bonds.
19.2 Write general and molecular formulae for alkanes, alkenes, alcohols and alkanoic acid.
19.3 Illustrate structures (up to four carbon atoms) and names of branched and un-branched alkanes, alkenes, alcohols and alkanoic acids.
19.4 Define and illustrate structures (up to four carbon atoms) of isomers for alkanes and alkenes.
19.5 Conduct experiments to illustrate test for unsaturation.
19.6 Describe using equations and reaction conditions, the following reactions; combustion, halogenation, hydration, and hydrogenation.
19.7 Relate the presence of the –OH group to solubility and volatility of alcohols, acids and esters.
19.8 Describe, explain and perform experiments to illustrate the following reactions of ethanol; combustion, rxn with sodium, dehydration and oxidation. Include chemical equations and reaction conditions.
19.9 Describe, explain and perform experiments to illustrate the following reactions of Ethanoic acid; condensation with alcohols, reactions with metals, oxides, hydroxides and carbonates. Include chemical equations and reaction conditions.

Content Standard No. 20
Explain the formation of carbon compounds, their uses and their effect on human consumption.

Learning Outcomes
Fourth Form
20.1 Describe the fractional distillation of petroleum and state the main uses of fractions of petroleum.
20.2 Discuss the high demand of petroleum products and importance of need for thermal and catalytic cracking of alkanes.
20.3 Describe the preparation of an ester and sample of soap.
20.4 Describe and perform activities to show the differences between reaction of soap and soapless detergent.

20.5 Describe and compare acid hydrolysis of the ester and peptide bonds in polymers.
20.6 Describe the fermentation process by which ethanol is produced from carbohydrates.
20.7 Describe the short and long term effect of alcohol on the human body.

Content Standard No. 21
Describe the formation of macromolecules and polymers and illustrate the relationship between a monomer and its polymer, and their uses.

Learning Outcomes
Fourth Form
21.1 Describe and represent the formulae of monomers and polymers formed from addition and condensation polymerization; polyalkanes, polyamides, polyester, and polysaccharides.
21.2 Illustrate an experiment to demonstrate the differences between a monomer and its polymer.
21.3 Illustrate using glucose and starch to show how monomer is linked in the structure of a polymer. -X-O-X-
21.4 State at least one use of one of the following polymers; polyalkane, polyamide, polyester, polysaccharide.

Content Standard No. 22
Discuss Chemistry applications to the sustainable use of the environment
Learning Outcomes
Fourth Form
22.1 Define Environment in terms of both physical and biotic factors.
22.2 Describe the effects of pollutants on the environment, by linking the pollutant to its source in the environment.
22.3 Distinguish among biodegradable, recyclable and toxic solid household waste citing the following as examples: food, plastics, metal, paper, asbestos, wood and paint.
22.4 Explain and evaluate methods used for solid waste disposal to include; dumping, recycling, incineration, and landfill.
22.5 Explain the process involved in sewage treatment as a means of proper waste disposal.
22.6 Describe processes used to create potable water: Boiling from rivers, water treatment plants for fresh water sources and desalination plants for salt-water sources.

Content Standard No. 23
Describe the chemical properties needed for plant growth and the use of hydroponics, and explain food preservation

Learning Outcomes
Fourth Form
23.1 Identify and explain sources of six essential elements needed for plant growth focusing on primary and secondary elements; N, P, K, Ca, P, and S
23.2 Describe the effects of the deficiency of N, P, K, Ca, P, and S on plant growth.
23.4 Explain the importance of soil as a medium for plant growth including the importance of humus and chemical fertilizer in the soil.
23.5 Describe and perform a lab experiment involving hydroponics.
23.6 Compare advantages and disadvantages of soil and hydroponics to include pest control.
23.7 Specify reasons for preserving food including; reduction of spoilage, availability out of season and for exporting.

23.8 Identify four methods of food preservation to include chemical preservation, drying, refrigeration, pasteurization, irradiation, vacuum packing, canning and bottling.
23.9 Describe the dangers associated with the use of some food preservatives to include $NaNO_3$ as suspected carcinogen and causing brain damage in children.
23.10 Describe the preservation of a local food focusing on either a fruit meat or vegetable.
23.11 Describe the preservation of local foods considering; flavor, out of season, time to preserve, possible adverse effects of the chemicals used.