

**Federal Democratic Republic of Ethiopia**  
**Ministry of Education**

**Minimum Learning Competencies**

**Chemistry, Grades 9 to 12**

**2009**

**Minimum Learning Competencies (MLCs) of Chemistry for Grade 9 and 10**

<i>Area of Competency</i>	<i>Grade 9</i>	<i>Grade 10</i>
<b>I. Substances</b>	<ul style="list-style-type: none"> <li>• Describe Dalton’s and Modern Atomic theory</li> <li>• Compare and contrast Dalton’s and Modern Atomic theory</li> <li>• Write the charges and the masses of the three fundamental subatomic particles</li> <li>• Explain the terms- atomic number, mass number, atomic mass and isotopes</li> <li>• Determine the number of protons, number of electrons, and number of neutrons from atomic number and mass number</li> <li>• Name the five atomic models and state Bohr’s postulates</li> <li>• Explain Energy levels, Valence electrons, and electron configuration</li> <li>• Write the ground state electron configuration for given elements and represent them diagrammatically</li> <li>• Define chemical bonding and explain why atoms form chemical bonds with other atoms</li> <li>• Define ionic bond, describe its formation and explain the general properties of ionic compounds</li> <li>• Define covalent bond, describe its formation and explain the general properties of covalent compounds</li> <li>• Make models of molecules to show single, double and triple bonds using balls and sticks of locally available materials</li> <li>• Give examples of simple ionic and covalent compounds and draw their electron dot structures</li> <li>• Explain polarity of covalent molecules and distinguish between polar and non polar molecules</li> <li>• Explain coordinate covalent ( dative ) bond formation using examples</li> <li>• Define metallic bonding and describe thermal and electrical conductivity of metal in relation to metallic bond</li> <li>• Define intermolecular forces, explain dipole-dipole and</li> </ul>	

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	<p>dispersion forces and illustrate using examples</p> <ul style="list-style-type: none"> <li>• Explain the effects of hydrogen bond and dispersion forces on the properties of substances</li> <li>• Name and give examples for the three physical states of matter</li> <li>• State kinetic theory of matter , explain and compare the properties of the three physical states of matter in terms of kinetic theory</li> <li>• State and explain Boyle’s law, Charles’ law, combined gas law, Avogadro’s law and Graham’s law of diffusion and do calculations to which the laws apply</li> <li>• Perform activities to show the changes in temperature, pressure and volume of gases to illustrate Boyle’s and Charles’ laws</li> <li>• Explain the terms evaporation, condensation, vapor pressure, boiling point, heat of vaporization and heat of condensation</li> <li>• Explain the terms- melting, fusion, sublimation, melting point, freezing point, heat of fusion and heat of solidification</li> <li>• Carry out activities to demonstrate the concepts of vapor pressure and to determine the boiling points of water and ethanol</li> <li>• Describe phase changes and explain temperature changes associated to phase changes</li> <li>• Demonstrate an experiment to show phase changes using ice, liquid water and water vapor</li> <li>• Demonstrate Scientific inquiry skills:- observing, predicting, classifying, comparing and contrasting, making model, communicating, measuring, asking questions, interpreting data, drawing conclusions, applying concepts, relating causes and effects and making generalizations</li> </ul>	
<p><b>II. Chemical Reactions</b></p>	<ul style="list-style-type: none"> <li>• Define Chemical reaction and give examples</li> <li>• State the laws of definite proportion and the law of</li> </ul>	<ul style="list-style-type: none"> <li>• Explain what an Electro chemistry is</li> <li>• Define electrical conductivity and differentiate</li> </ul>

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	<p>conservation of mass and illustrate with examples</p> <ul style="list-style-type: none"> <li>• Demonstrate the law of conservation of mass using simple experiment</li> <li>• Balance chemical equations using the inspection and the Least Common Multiple ( LCM ) methods</li> <li>• Discuss energy changes in chemical reactions, distinguish between exothermic and endothermic reaction and illustrate using diagram</li> <li>• Appreciate the importance of chemical changes in the production of new substances and energy'</li> <li>• Identify four types of chemical reactions and give examples</li> <li>• Deduce mole ratios from balanced chemical equations</li> <li>• Solve mass-mass problems based on the given chemical equations</li> <li>• State Avogadro's principle, solve Volume-Volume and mass-volume problems based on balanced chemical equations</li> <li>• Determine excess and deficient (limiting substances) in a reaction.</li> <li>• Describe the percentage, actual and theoretical yields of a chemical reaction</li> <li>• Calculate the percentage yield of a reaction from the given information</li> <li>• Define redox reaction, the terms oxidation and reduction in terms of electron transfer and give examples</li> <li>• Define oxidation number and determine the oxidation number of an element in a given formula( in a molecular, an ion or a compound )</li> <li>• Describe oxidizing and reducing agents and distinguish between them</li> <li>• Analyze a given redox reaction by specifying the substance reduced, the substance oxidized, the oxidizing agent and the reducing agent</li> <li>• Distinguish between redox and non-redox reaction</li> <li>• Explain the reaction rate and describe an activity to illustrate it</li> </ul>	<p>electrolytic conductivity from metallic conductivity</p> <ul style="list-style-type: none"> <li>• Define terms like Electrolysis, Electrode, Cathode, anode, Anion, Cation, Electrolyte, non-electrolyte, strong electrolyte and weak electrolyte, half reaction and cell reaction</li> <li>• Confirm by performing simple experiments on metallic and electrolytic conductivity</li> <li>• Describe electro chemical cell</li> <li>• Draw labeled diagram of electrolytic cell and represent electrode reactions by ionic half-reactions for fused electrolytes</li> <li>• Perform an activity to show electrolysis of molten electrolytes</li> <li>• Explain voltaic cell</li> <li>• Explain the difference between voltaic cell and electrolytic cell</li> <li>• Describe the difference types of voltaic cell</li> <li>• Describe how voltaic cells can be used to make commercially useful batteries</li> <li>• Describe selected industrial applications of electrolysis</li> </ul>

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	<ul style="list-style-type: none"> <li>• Describe how collision, activation energy and proper orientation a chemical reaction to occur</li> <li>• List and explain the factors that affect reaction rate and describe briefly an activity to illustrate each</li> <li>• Define reversible reaction, irreversible reactions and chemical equilibrium</li> <li>• Describe the characteristics of chemical equilibrium</li> <li>• Write an expression of equilibrium constant of a reversible reaction</li> <li>• State the Lechatlier’s principle and explain factors affecting chemical equilibrium</li> <li>• Demonstrate scientific enquiry skills:- observing, inferring, predicting, classifying, comparing and contrasting, communicating, measuring, asking questions, designing skills, interpreting data, drawing conclusions, applying concepts, relating causes and effects and problem solving</li> </ul>	
<p><b>III. Classification In Chemistry</b></p>	<ul style="list-style-type: none"> <li>• Describe Periodicity</li> <li>• State the modern periodic law</li> <li>• Define the terms Period and Group</li> <li>• Explain the relation ship between the electronic configuration structure of the modern periodic table</li> <li>• Identify and explain the three classes and the four blocks of the elements of the periodic table</li> <li>• Tell the number of the main groups and sub groups and give specific names for the main group elements</li> <li>• Tell the number of periods and classify them as short, long and incomplete based on the number of elements they contain</li> <li>• Predict from the given atomic number of an element its position in the periodic table</li> <li>• Deduce the properties of an element from its position in the periodic table.</li> <li>• Explain the general trends in properties of elements down a group and across a period of the periodic table</li> <li>• Make a model to demonstrate the trends in properties of</li> </ul>	<ul style="list-style-type: none"> <li>• Classify inorganic compounds in to oxides, acids, bases and salts</li> <li>• Define oxides and classify them in to acidic oxides, basic oxides, neutral oxides, Amphoteric oxides and peroxides</li> <li>• Define acidic oxides, give examples and explain their properties and methods of preparation</li> <li>• Define Amphoteric oxides, give examples and explain their properties</li> <li>• Define neutral oxides, give examples and explain their properties.</li> <li>• Define acids and bases in terms of Arrhenius, Bronsted-Lowry and Lewis and give examples.</li> <li>• Classify acids and bases on the number of ionizable (replaceable) hydrogen ion (<math>H^+</math>) and based on the number of elements they are composed of.</li> </ul>

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<i>Area of Competency</i>	<i>Grade 9</i>	<i>Grade 10</i>
	<p>elements in the periodic table</p> <ul style="list-style-type: none"> <li>• Appreciate the importance of the classification in the study of chemistry</li> <li>• Demonstrate the scientific enquiry skills:- observing, inferring, predicting, classifying, comparing and contrasting, making models, communicating, measuring, asking questions, interpreting illustrations, drawing conclusions, applying concepts and problem solving.</li> </ul>	<ul style="list-style-type: none"> <li>• Explain the general properties of acids and bases</li> <li>• Distinguish between Strong and weak acids; concentrated and diluted acids</li> <li>• Distinguish between Strong and weak bases; concentrated and diluted bases</li> <li>• Use the necessary precautions while working with acids and bases</li> <li>• Define PH and POH, describe the PH scale and identify a given PH labeled solution as acidic, basic or neutral</li> <li>• Show the mathematical relationship between PH and POH</li> <li>• Calculate the PH, POH, <math>H^+</math> ion concentration, <math>OH^-</math> ion concentration of a solution when the necessary variables are given.</li> <li>• Perform an activity to determine the PH of some common substances using universal indicator or PH meter</li> <li>• Explain methods of preparing acids and bases and describe the uses of the three common laboratory acids and the three common laboratory bases</li> <li>• Conduct simple experiment to prepare acids and bases in the laboratory</li> <li>• Define salts and give examples</li> <li>• Classify salts as acidic, basic, and normal salts</li> <li>• Explain properties of salts</li> <li>• Explain methods of preparing salts</li> <li>• List some important salts and explain their uses</li> <li>• Describe the chemical tests for some salts ( Sulfates, chlorides, nitrates, and carbonates )</li> <li>• List essential nutrients elements</li> <li>• Describe the functions of nitrogen, phosphorus and potassium</li> <li>• Define fertilizers and describe their importance</li> </ul> <p>List some common inorganic compounds that are used as pesticides</p>

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<p><b>IV. Organic Chemistry</b></p>		<ul style="list-style-type: none"> <li>• Narrate the historical development of organic chemistry</li> <li>• Classify organic compounds</li> <li>• Define the term functional group</li> <li>• Define homologous series and state its characteristics</li> <li>• Define the terms hydrocarbons, structural formula, condensed structural formula and cis-trans isomerism</li> <li>• Write the general formulas for alkanes, alkenes and alkynes</li> <li>• Write the molecular formula, condensed structural formula and names of the first ten members of alkanes, alkenes and alkynes</li> <li>• Give the IUPAC names for branched alkanes, branched alkenes, branched alkynes, cyclo alkanes and cyclo alkenes</li> <li>• Write the possible structural isomers of the alkanes- <math>C_4H_{10}</math>, <math>C_5H_{12}</math> and the alkenes- <math>C_4H_8</math> and <math>C_5H_{10}</math></li> <li>• Write cis-trans isomers for the given alkenes</li> <li>• Explain the physical and chemical properties of alkanes, alkenes alkynes homologous series</li> <li>• Explain why alkenes and alkynes undergo addition reaction but not substitution reaction</li> <li>• Describe the laboratory and industrial preparation of methane, ethane and ethyne</li> <li>• Prepare methane, ethane ethyne in a laboratory</li> <li>• Performa a project on the production of biogas from cow dung</li> <li>• Define aromatic hydrocarbons</li> <li>• Draw and explain the structure of benzene</li> <li>• Describe the main physical properties and chemical reactions of benzene</li> <li>• Carry out test tube reactions of benzene with               <ul style="list-style-type: none"> <li>a) <math>KMnO_4</math></li> <li>b) <math>Br_2/CCl_4</math></li> <li>c) Conc. <math>H_2SO_4</math></li> </ul> </li> </ul>

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<i>Area of Competency</i>	<i>Grade 9</i>	<i>Grade 10</i>
		<ul style="list-style-type: none"> <li>• List the natural sources of hydrocarbons and tell their formation</li> <li>• Explain the fractional distillation of petroleum, discuss fractionally distilled petroleum products and their uses</li> <li>• Tell the composition of coal</li> <li>• Explain destructive distillation of coal</li> <li>• Classify alcohols based on the number of hydroxyl ( OH ) groups</li> <li>• Classify monohydric alcohols in to primary, secondary and tertiary alcohols, write the general formula of monohydric alcohols and give some examples form each of them</li> <li>• Write the molecular formulas and names of the first six members of monohydric alcohols</li> <li>• Give the IUPAC names for given alcohols</li> <li>• Describe the physical properties of alcohols</li> <li>• Explain the industrial and laboratory preparation of ethanol</li> <li>• Explain the general methods of preparation of alcohols</li> <li>• Performa an activity of preparing locally distilled alcohol ( Katikalla )</li> <li>• Explain the chemical reactions of alcohols such as oxidation, reaction with active metals, esterification and dehydration</li> <li>• Write the general structural formulas of aldehydes, Ketones, carboxylic acids and esters and give the structures and names of common members each group</li> <li>• Discuss the uses of organic compounds in the manufacture of industrial products like beverages, pharmaceuticals, fuels, soaps and detergents and dry cleaning agents</li> <li>• Discuss the uses of organic compounds in the manufacture of agricultural products like pesticides, herbicides and urea</li> </ul>

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		<ul style="list-style-type: none"> <li>• Conduct an experiment to prepare soap from naturally existing ester(fats or oils )</li> </ul>
<b>V. Chemistry and Industry</b>		<ul style="list-style-type: none"> <li>• Define and classify natural resources</li> <li>• Explain the importance of natural resources in the manufacturing of industrial products</li> <li>• Describe the chemical properties and extraction methods of aluminum, iron and copper</li> <li>• Describe the chemical properties and industrial production of nitrogen, phosphorus, sulfur and chlorine</li> <li>• Mention the important steps in the production of glass, ceramics, Cement, Sugar, Paper and pulp and tanneries</li> <li>• Describe different methods of food processing and preservation</li> <li>• Explain how different industrial by products pollute air, water and land.</li> </ul>

**Chemistry Grades 11 & 12 Minimum Learning Competencies**

<i>Area of Competency</i>	<i>Grade 11</i>	<i>Grade 12</i>
<p><b>1. Fundamental Concepts in Chemistry.</b></p>	<p><b>The students should be able to:</b></p> <ul style="list-style-type: none"> <li>• Define chemistry &amp; describe the major fields of chemistry;</li> <li>• Describe the SI units &amp; their prefixes ; &amp; write the names &amp; symbols of derived SI units;</li> <li>• Identify causes of uncertainty in measurement;</li> <li>• Explain systematic &amp; random errors;</li> <li>• Define precision &amp; accuracy &amp; analyses a given data in terms of precision &amp; accuracy;</li> <li>• Define significant figures, determine the number of significant figures in a calculated result &amp; use the scientific notation in writing very large or very small numbers;</li> <li>• Define scientific method, describe its major steps &amp; use it in solving problems;</li> <li>• Demonstrate some experimental skills in chemistry &amp; describe the procedures of writing laboratory report.</li> </ul>	
<p><b>2. Structure of substance &amp; periodic table.</b></p>	<ul style="list-style-type: none"> <li>• Narrate historical development of atomic nature of substance;</li> <li>• State postulates of Dalton’s &amp; modern atomic theories;</li> <li>• Discuss the discovery of electron &amp; describe the properties of cathode rays;</li> <li>• Define the terms : radioactivity, radioactive decay &amp; radioisotope;</li> <li>• Describe the common types of radioactive emission;</li> <li>• Describe the alpha scattering experiment;</li> <li>• Describe makeup of the nucleus;</li> <li>• Explain atomic number &amp; mass number; &amp; define atomic mass &amp; isotope;</li> <li>• Tell the number of protons, electrons &amp; determine the number of neutrons from the given atomic number &amp; mass number of an element;</li> <li>• Calculate the relative atomic mass of naturally occurring isotopic elements;</li> <li>• Characterize electromagnetic radiation in terms of wave length, frequency &amp; calculate the wave length &amp;</li> </ul>	

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	<p>frequency of the electromagnetic radiation;</p> <ul style="list-style-type: none"> <li>• Explain that light has both wave &amp; particle nature &amp; the emission spectra of atoms consist of series of lines;</li> <li>• State Bohr's assumption of energy of electron in hydrogen atom ;</li> <li>• Calculate the radius of electron orbit, the electron velocity &amp; the energy of an electron using Bohr model;</li> <li>• Explain that atoms emit or absorb energy when they undergo transition from one state to another;</li> <li>• Explain that the spectrum of hydrogen demonstrates the quantized nature of the energy of its electron;</li> <li>• Explain the short coming of Bohr's theory;</li> <li>• State Hinesburg's uncertainty principle &amp; describe the significance of electron probability distribution;</li> <li>• Explain the quantum numbers <math>n, l, m_l</math> &amp; <math>m_s</math> ;</li> <li>• Write all possible sets of quantum numbers of electrons in an atom;</li> <li>• Describe the shapes of orbital designated by s,p,and d;</li> <li>• Explain Aufbau principle Pauli exclusion principle &amp; Hundi's rule;</li> <li>• Write ground state electron configuration of elements with the periodicity of elements;</li> <li>• Classify elements as representative, transition &amp; inner-transition;</li> <li>• Explain the general trends in atomic radius, ionization energy,electronaffinity,electro-negativity &amp; metallic character of elements within a period &amp; a group of the periodic table;</li> <li>• Write the advantages of periodic classification of elements;</li> <li>• Describe the reason why atom form chemical bonds;</li> <li>• Define chemical bonding &amp; describe the types of chemical bonding &amp; the mechanisms of bonding process;</li> <li>• Define ionic bonding &amp; explain the formation of ionic bonding;</li> <li>• Give examples of ionic compounds &amp; describe their properties;</li> </ul>	

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<i>Area of Competency</i>	<i>Grade 11</i>	<i>Grade 12</i>
	<ul style="list-style-type: none"> <li>• Define lattice energy;</li> <li>• Calculate the lattice energy of ionic crystals from a given data using the methods of Born-Haber cycle;</li> <li>• Discuss the limitation of Octet rule;</li> <li>• Describe ionic bonding using Lewis electron dot symbols;</li> <li>• Define Covalent bonding &amp; explain the formation of Covalent bonding;</li> <li>• Give examples of covalent molecules &amp; describe their properties;</li> <li>• Draw Lewis structures of some covalent molecules;</li> <li>• Define resonance &amp; draw resonance structures of some covalent molecules &amp; polyatomic ions;</li> <li>• Discuss the exceptions to the Octet rule in covalent bonding;</li> <li>• Illustrate the formation of coordinate covalent bonding using examples.</li> <li>• Distinguish between polar &amp; non-polar covalent molecules;</li> <li>• Describe the properties of covalent molecules;</li> <li>• Define intermolecular force &amp; name the different types of intermolecular forces;</li> <li>• Explain dipole-dipole interaction &amp; give examples of them;</li> <li>• Define hydrogen bonding &amp; explain the effects of it on the properties of substances;</li> <li>• Explain dispersion forces &amp; give examples of them;</li> <li>• Define metallic bonding &amp; explain the properties of metals related to the concept of bonding;</li> <li>• Name two chemical bond theories;</li> <li>• Explain the VBT &amp; distinguish between the Lewis model &amp; valence bond model;</li> <li>• Discuss the overlapping of orbital in covalent bond formation;</li> <li>• Explain hybridization &amp; show its process involved in some covalent molecules;</li> <li>• Draw hybridization diagram for the formation of</li> </ul>	

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	<p>sp,sp<sup>2</sup>,sp<sup>3</sup>,sp<sup>3</sup>d,sp<sup>3</sup>d<sup>2</sup> hybrids;</p> <ul style="list-style-type: none"> <li>• Discuss the hybridization involved in compounds containing multiple bonds;</li> <li>• Explain the MOT &amp; describe molecular orbital using atomic orbital &amp; bonding &amp; anti-bonding orbital;</li> <li>• Write the electron configuration of simple molecules using molecular orbital model;</li> <li>• Define bond order of some simple molecules &amp; their stability using bond order;</li> <li>• Describe the Valence Shell Electron Pair Repulsion(VSEPR) theory;</li> <li>• Define the bonding pairs &amp; non-bonding pairs of electron;</li> <li>• Describe how electron pair arrangement of molecules can be predicted from the number of electron pairs;</li> <li>• Explain the term dipole moment with the help of a diagram;</li> <li>• Predict the geometrical shapes of some simple molecules on the basis of hybridization &amp; the nature of electron pairs;</li> <li>• Explain that the VSEPR theory is used to explain the molecular parameters like bond angle &amp; polarity of the molecule;</li> <li>• Construct models to represent shapes of some simple molecules;</li> <li>• Define crystal, name four types of crystalline solids, give examples &amp; describe their properties;</li> <li>• Mention the types of attractive forces that exist within each type of crystalline solids.</li> </ul>	
<p><b>3.Chemical Reaction</b></p>	<ul style="list-style-type: none"> <li>• Define chemical kinetics &amp; reaction rate;</li> <li>• Perform an activity to measure rate of reaction;</li> <li>• Solve problems related to the rate of reaction;</li> <li>• List five factors that affect the reaction rate &amp; explain how they affected by giving examples;</li> <li>• Define catalyst, positive catalyst &amp; negative catalyst;</li> <li>• Distinguish between homogeneous &amp; heterogeneous</li> </ul>	<p><b>The students should be able to:</b></p> <ul style="list-style-type: none"> <li>• Define the terms mixture, homogenous &amp; heterogeneous mixtures, solute , solvent, solution;</li> <li>• Distinguish between homogeneous &amp; heterogeneous mixtures;</li> <li>• Explain different types of solutions &amp; give</li> </ul>

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	<p>catalysts, biological &amp; non-biological catalysts &amp; homogeneous &amp; heterogeneous reactions</p> <ul style="list-style-type: none"> <li>• Perform an activity to show the effect of nature of reactant on surface area, concentration, temperature &amp; catalyst on the reaction rate;</li> <li>• State collision theory &amp; transition state theory, &amp; describe how these theory can be used to explain change in reaction rate;</li> <li>• Define activation energy, activated complex, rate law, order of reaction rate construct &amp; half-life;</li> <li>• Sketch &amp; label the energy profiles of reactions which are exothermic &amp; endothermic;</li> <li>• Determine reaction order &amp; calculate rate constants from a given experimental data;</li> <li>• Explain the zero, 1<sup>st</sup> &amp; 2<sup>nd</sup> order reaction using concentration verses time curve;</li> <li>• Calculate the half-lives of zero, 1<sup>st</sup>, &amp; 2<sup>nd</sup> orders from experimental data;</li> <li>• Explain reaction mechanism, molecularity of a reaction, &amp; rate determining step &amp; give specific examples to illustrate rate determining step;</li> <li>• Explain the relationship between the reaction pathway &amp; the rate law &amp; use rate law to suggest possible reaction mechanism for a reaction;</li> <li>• Explain reversible &amp; irreversible reactions;</li> <li>• Define dynamic equilibrium, discuss how chemical equilibrium is established &amp; explain its characteristics;</li> <li>• State the law of mass action;</li> <li>• Define equilibrium constant, write its expression involving concentration for chemical reactions &amp; calculate it;</li> <li>• Write the equilibrium constant expression involving partial pressure for chemical reactions &amp; calculate it;</li> <li>• Show relationship between <math>K_c</math> &amp; <math>K_p</math>;</li> <li>• Distinguish between homogeneous &amp; heterogeneous equilibrium reaction;</li> <li>• Define reaction quotient &amp; use equilibrium quotient to</li> </ul>	<p>examples for each;</p> <ul style="list-style-type: none"> <li>• Define heat of solution, salvation energy &amp; hydration energy;</li> <li>• Explain the solution process &amp; how heat of solution is influenced by the interparticle interaction forces;</li> <li>• Explain formation of saturated &amp; supersaturated solutions;</li> <li>• Define rate of dissolution &amp; discuss the factors that affect it</li> <li>• Define solubility &amp; describe the factors that affect it;</li> <li>• Conduct an experiment to determine solubility of table salt &amp; sugar;</li> <li>• State Henry's law &amp; use it to calculate concentration of gaseous solute in a solution;</li> <li>• Define concentration of a solution, mass percentage of a solute in a solution, mole fraction, molarity, molality, equivalent mass, number of equivalents &amp; normality;</li> <li>• Calculate the mass percentage &amp; mole fraction of a solute in a solution;</li> <li>• Prepare molar, normal &amp; molal solutions of different substances;</li> <li>• Calculate molarity, normality &amp; molality of a solution from a given information;</li> <li>• Explain dilution process &amp; calculate the volume or concentration changes during dilution of solution;</li> <li>• Do calculations involving solutions to determine the number of moles, masses or volumes of reactants and products in ionic reactions;</li> <li>• Analyze ionic reactions and write net ionic equations;</li> <li>• List the important properties of solvents that are affected by the formation of a solution;</li> <li>• State Raoult's law;</li> </ul>

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	<p>predict the direction of the reaction &amp; position of equilibrium;</p> <ul style="list-style-type: none"> <li>• Calculate the equilibrium concentrations of a given initial concentrations;</li> <li>• List factors that affect chemical equilibrium;</li> <li>• State Le-chatlier principle &amp; use it to explain the effect of changes in temperature, pressure, concentration &amp; presence of catalyst of a reaction.</li> </ul>	<ul style="list-style-type: none"> <li>• Explain the changes in the colligative properties of solvent when a certain solute is added;</li> <li>• Describe the Vant Hoff's factor;</li> <li>• Calculate the vapor pressure, the boiling point &amp; the freezing point of a solvent after a certain amount of solute is added;</li> <li>• Define osmosis &amp; osmotic pressure of a solution;</li> <li>• Calculate the osmotic pressure of a solution;</li> <li>• Compare &amp; contrast change in colligative properties of electrolytic &amp; nonelectrolytic solution ;</li> <li>• Define acid &amp; base by Arrhenius , Bronsted-Lowry &amp; Lewis concepts &amp; give examples of each;</li> <li>• Define chemical thermodynamics, systems, state functions, path function and non-function;</li> <li>• Give examples of systems, classify them into open, closed and isolated systems and explain them;</li> <li>• Distinguish between intensive and extensive properties;</li> <li>• Explain internal energy, heat and work in relation to the concepts of thermodynamics;</li> <li>• State and explain first law of thermodynamics;</li> <li>• Calculate change in internal energy of a system from a given information;</li> <li>• Define enthalpy change , standard state, standard molar enthalpy of combustion, standard molar enthalpy of formation and standard molar enthalpy;</li> <li>• Carry out an activity to measure standard molar enthalpy of neutralization;</li> <li>• State Hess's law and apply it to solve problems on enthalpy changes of chemical reactions;</li> <li>• Explain bond energy and calculate it in a</li> </ul>

Minimum Learning Competencies Grades 9–12

<i>Area of Competency</i>	<i>Grade 11</i>	<i>Grade 12</i>
		<p>given chemical reaction ;</p> <ul style="list-style-type: none"> <li>• Calculate the standard enthalpy changes of a reaction from given enthalpy changes of reactants and products;</li> <li>• Explain entropy and entropy changes;</li> <li>• Calculate the entropy change from the given standard entropies of substances;</li> <li>• State and explain the second law of thermodynamics;</li> <li>• Calculate the entropy changes from the given enthalpy change of the system and absolute temperature;</li> <li>• Explain free changes and standard free change;</li> <li>• Calculate the standard free energy change from a given standard free energies of reactants and products;</li> <li>• Describe the relationship between standard free change, standard enthalpy change and standard entropy change of a reaction;</li> <li>• Determine the spontaneity of a reaction;</li> <li>• Define redox reactions, oxidation and reduction;</li> <li>• Describe the oxidizing &amp; reducing agents;</li> <li>• Identify the species that are oxidized &amp; reduced in a given redox reaction;</li> <li>• Balance a given redox reaction using oxidation number method &amp; ion-electron method;</li> <li>• Distinguish between molten electrolytes and aqueous electrolytic solutions;</li> <li>• Draw labeled diagram of an electrolytic cell;</li> <li>• Define preferential discharge &amp; explain factors that affect it;</li> <li>• Describe the reactivity of a metal from its position in the activity series;</li> <li>• Describe the effect of nature of the ions,</li> </ul>

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		<p>concentration of the ions, types of the electrodes on the electrolysis of aqueous solutions of dilute sulphuric acid and sodium hydroxide , on the electrolysis of dilute and concentrated solutions of sodium chloride and on the electrolysis of dilute sulphuric acid, dilute sodium hydroxide , concentrated &amp; dilute sodium chloride and copper sulphate solutions respectively;</p> <ul style="list-style-type: none"> <li>• State Faraday’s first &amp; second law of electrolysis and write mathematical expression of them;</li> <li>• Do calculations related to Faraday’s first and second law of electrolysis;</li> <li>• Mention industrial applications of electrochemistry;</li> <li>• Define voltaic cell, salt bridge, electrode potential and cell potential;</li> <li>• Draw, label and construct Zn-Cu voltaic cell;</li> <li>• Measure the cell potential of Zn-Cu cell using voltmeter;</li> <li>• Explain how standard electrode potential is measured and calculate cell potential;</li> <li>• Decide whether a given redox reaction is spontaneous or not;</li> <li>• Explain the effect of concentration on cell potential;</li> <li>• Mention different types of voltaic cells and give examples of each;</li> <li>• Distinguish between primary and secondary cells;</li> <li>• Identify the cathode, anode and electrolyte of a given voltaic cell;</li> <li>• Compare and contrast electrolyte and voltaic cells;</li> <li>• Explain metallic corrosion in terms of redox reaction , its negative effects and different</li> </ul>

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		<p>methods of prevention;</p> <ul style="list-style-type: none"> <li>• Describe the forms of occurrence of metals ;</li> <li>• Define metallurgy &amp; explain the major steps in metallurgical processes;</li> <li>• Explain the chemical properties, the manufacture and uses of sodium ;</li> <li>• Explain the chemical properties , the manufacture and uses of calcium;</li> <li>• Explain the chemical properties , the manufacture and uses of tin;</li> <li>• Explain the chemical properties , the manufacture and uses of lead;</li> <li>• Explain the chemical properties , the manufacture and uses of zinc;</li> <li>• Explain the chemical properties , the manufacture and uses of chromium;</li> </ul>
<p><b>4. Carboxylic acids, Esters, Fats, Oils and Polymers</b></p>	<ul style="list-style-type: none"> <li>• Write the general formula of saturated monocarboxylic acid;</li> <li>• Write the molecular formulas and names of the first six members of saturated monocarboxylic acids &amp; give their structural formulas;</li> <li>• Give examples for monocarboxylic, dicarboxylic and tricarboxylic acids &amp; name some branched carboxylic acids;</li> <li>• Explain the general methods of preparation of saturated monocarboxylic acids &amp; the industrial and laboratory preparation of acetic acid;</li> <li>• Conduct an experiment to prepare acetic acid in the laboratory;</li> <li>• Explain why “Tella” or “Tej” turns sour;</li> <li>• Describe physical properties and chemical reactions of saturated monocarboxylic acids;</li> <li>• Name and write structural formulas of some fatty acids;</li> <li>• List common sources of esters;</li> <li>• Write the general formulas of esters and the molecular</li> </ul>	<ul style="list-style-type: none"> <li>• Define monomer and polymer;</li> <li>• Classify polymers into synthetic and natural polymers give examples for each;</li> <li>• Explain polymerization and mention two types of polymerizations;</li> <li>• Explain how addition &amp; condensation polymerization take place;</li> <li>• Give examples of addition polymers and tell their monomers;</li> <li>• Give examples of condensation polymers and tell their monomers;</li> <li>• Explain the common uses of addition &amp; condensation polymers;</li> <li>• Describe thermoplastics and thermo set polymers &amp; give examples of each;</li> <li>• Describe natural rubber and tell its monomers;</li> <li>• Explain vulcanization;</li> <li>• Explain the use of natural rubber;</li> <li>• Give three examples of synthetic rubbers &amp;</li> </ul>

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	<p>formulas &amp; names of the first six members of esters;</p> <ul style="list-style-type: none"> <li>• Explain the method of preparation of esters;</li> <li>• Describe physical properties and chemical reactions of esters;</li> <li>• Define fats and oil;</li> <li>• Write the general formula of fats and oil and the structures for some common triglycerides;</li> <li>• Describe physical properties of fats and oil;</li> <li>• Explain rancidity and hardening of oil;</li> <li>• Define soap and detergent;</li> <li>• Explain saponification and the cleaning action of soap ;</li> <li>• Prepare soap;</li> </ul>	<p>explain their uses;</p> <ul style="list-style-type: none"> <li>• Compare and contrast synthetic and natural rubber;</li> <li>• Define carbohydrate;</li> <li>• Describe monosaccharide, draw its structure and give examples;</li> <li>• Describe disaccharide, draw its structure and give examples;</li> <li>• Describe polysaccharide, draw its structure and give examples;</li> <li>• Explain the difference between starch, glycogen and cellulose;</li> <li>• Define amino acid, peptide and protein;</li> <li>• Describe the structure of amino acids;</li> <li>• Explain how proteins are formed;</li> <li>• List types of proteins;</li> </ul>

