CHAPTER	LESSON	DESCRIPTION
I. Atomic Structure	The Structure of the Atom	At the end of this activity, students should be able to describe the inner structure of the atom, define and use atomic number and mass number, compare the properties of subatomic particles, describe isotopes, explain how a mass spectrometer works, use the mass spectra of elements to determine the abundance of isotopes and define relative atomic mass and relative molecular mass.
	Development of Atomic Theory and Radioactivity	At the end of this activity, students should be able to give the main postulates of early atomic theories, describe how subatomic particles were discovered, explain how the modern atomic model was developed, explain the phenomenon of radioactivity, discuss the characteristics and origin of alpha, beta and gamma radiation, predict the process of radioactive decay and indicate the main uses of radioactive isotopes.
	Atomic Spectra	At the end of this activity, students should be able to describe light as a particular kind of electromagnetic radiation, explain the wave–like and particle–like nature of light, explain the relationships among wavelength, frequency and energy of radiation, explain the difference between continuous and line spectra, describe Bohr's model of the atom and explain the origin of spectral lines using Bohr's model.
	Electron Configuration of Atoms	At the end of this activity, students should be able to define the four quantum numbers, describe the structure of energy levels in a many–electron atom, define s, p and d orbitals, and describe their shapes, describe the rules for assigning electrons to subshells, deduce the electron configuration of an atom from its atomic number and describe the position of the element in the periodic table based on its electron configuration.
II. Bonding	Types of Bonding	At the end of this activity, students should be able to explain how elements form ions, explain the concept of the electrical charge of metal ions, and explain how the basic types of chemical bond are formed: ionic (electrovalent), covalent, multiple covalent, dative (coordinate) and metallic bonds.
	Electronegativity and Polarity	At the end of this activity, students should be able to define the concept of electronegativity, explain the electronegativity scale, describe how electronegativity changes across the periodic table, explain how the electronegativities of two elements affect the type of bonding between them and describe the variation of chemical bonding in the halides of the third period elements and the second group elements.
	Molecular Shapes	At the end of this activity, students should be able to outline the basis for determining molecular shapes using the VSEPR theory and determine the shape of simple molecules, including those containing lone electron pairs.
	Valence Bond Theory and Hybridization	At the end of this activity, students should be able to interpret covalent bonds as overlapping of atomic orbitals, define the bond, describe the main types of hybridisation, explain shapes of molecules using the concept of hybridisation of atomic orbitals and explain the formation of multiple bonds.
III. Phases and Phase Changes	States of Matter	At the end of this activity, students should be able to: describe the macroscopic properties of gases, liquids and solids, explain the properties of gases, liquids and solids in terms of the kinetic theory, describe the fourth state of matter, plasma.
	Phase Changes	At the end of this activity, students should be able to define a phase and a phase change, describe and analyze cooling and heating curves, explain phase changes in terms of the kinetic theory, define melting and boiling points, describe melting and freezing processes in terms of dynamic equilibrium, explain the process of vaporization and the existence of vapor pressure, tell the difference between vaporization and boiling, explain why boiling point depends on external pressure as well as describe sublimation and deposition.

CHAPTER	LESSON	DESCRIPTION
	Gas Laws	At the end of this activity, students should be able to describe the properties of an ideal gas, state Boyle's law, Charles's law and Avogadro's law and use them in calculations, use the ideal gas law to calculate the density of a gas and the relative molecular mass of a volatile compound and explain under what conditions real gases behave as ideal and how very low temperatures and extremely high pressures affect their behavior.
	Intermolecular Forces	At the end of this activity, students should be able to decide whether a molecule is polar or nonpolar, describe dipole–dipole interactions, describe London (dispersion) forces between induced dipoles, describe hydrogen bonding and explain the effect of intermolecular interactions on the physical properties of the substance.
	Structure of Solids	At the end of this activity, students should be able to describe the structure and properties of metallic crystals, ionic crystals, molecular crystals, macromolecular crystals and amorphous solids and identify the type of structure of a solid based on its properties.
IV. Stoichiometric Calculations	**The Mole**	At the end of this activity, students should be able to define the unit of quantity of matter, the mole, define Avogadro's number, define molar mass, calculate the number of moles in a given mass, calculate the mass given the number of moles, define the molar volume of gases and calculate volumes of gas reactants.
	Chemical Equations	At the end of this activity, students should be able to define a chemical equation and describe what it consists of, explain the difference between a stoichiometric subscript and a stoichiometric coefficient, explain how to balance chemical equations, determine stoichiometric coefficients in chemical reactions, obtain information about the qualitative and quantitative composition of a chemical compound from its molecular formula, calculate reacting masses on the basis of chemical equations and explain the concept of the limiting reactant.
	Practical Importance of the Mole	At the end of this activity, students should be able to determine the empirical formula of a chemical compound, determine the molecular formula given the empirical formula and molar mass, determine the composition of a mixture and calculate reaction yields.
	Concentration	At the end of this activity, students should be able to determine if mixture is homogeneous or heterogeneous, define saturated and unsaturated solutions and explain how to recognize the colloid solution, calculate molarity and do calculations involving molarity, calculate the concentration of ions in a solution, prepare a solution of given molarity, calculate the molarity of a solution after dilution and calculate the molarity of a solution after mixing two solutions of the same substance, explain what titration is and determine the molarity of a solution using titration and do calculations of reactant and product quantities for reactions occurring in solution and calculate the mass percent concentration.
V. Periodic Table	**The Periodic Table of the Elements**	At the end of this activity, students should be able to state the criteria for classifying the elements in the periodic table, state the group to which a given element belongs on the basis of its number of valence electrons, and vice versa, state the period to which a given element belongs on the basis of its number of electron shells, and vice versa, state the block to which a given element belongs, s, p, d or f, on the basis of its electron configuration and give the electron configuration of an element on the basis of its position in the periodic table, and vice versa.
	The Trends in the Properties of the Elements in Period 3	At the end of this activity, students should be able to know how atomic radius, ionisation energy, electronegativity, conductivity, melting point and boiling point vary across Period 3 and be able to explain what factors affect these properties.

CHAPTER	LESSON	DESCRIPTION
	Periodic Trends in the Chemical Properties of Elements	At the end of this activity, students should be able to understand how the electronegativity of elements influences the properties of their compounds, understand how the oxides of Period 3 elements form, and what their structure and their properties are, understand how the elements of Period 3 behave in the presence of water, understand how the chlorides of Period 3 elements form and what their structure is and understand the chemical properties of the chlorides of Period 3 elements.
	s-Block Elements	At the end of this activity, students should be able to write out the electron configurations of the elements in the s–block, describe the changes in the atomic radii of the s–block elements within groups and periods, describe the changes in the ionic radii of the s–block elements within groups and periods, describe the trend in the melting points of the elements in groups 1 and 2 and describe the relationship between atomic structure and the physical properties of elements.
	Chemical Properties of s-Block Elements	At the end of this activity, students should be able to describe the changes in reactivity of s–block metals within groups and periods, know what type of bonding occurs in compounds made by the s–block metals with other elements, know the reactions between the Group 1 and 2 metals and water, know the solubility of the Group 1 and 2 metal hydroxides and sulphates, know the reactions of the Group 1 and 2 metals with oxygen, know the stability of the Group 1 and 2 metal carbonates and know about the unique properties of beryllium.
	Elements of Group 17	At the end of this activity, students should be able to write the electron configuration of Group 17 elements, describe the trends in the size of atomic and ionic radii in elements of Group 17, state the direction of changes in the melting point and the boiling point in Group 17, discuss the relationship between the atomic structure and the physical properties of elements, describe the trends in the reactivity of halogens, explain why chlorine is more reactive than bromine and state whether a reaction occurs between a molecule of a particular halogen and a simple ion of another halogen.
	Reactions of Halogens	At the end of this activity, students should be able to: describe the reactions between halogens and metals, determine the water solubility of halides, describe the reactions between silver halides and ammonia solution, define photosensitive substances, explain why silver bromide forms a negative image on photographic films, describe other uses of the halogens and their compounds, describe the reactions between the halogens and concentrated sulphuric acid.
VI. Transition Metals	**Electron Configuration and Periodic Trends of Transition Elements**	At the end of this activity, students should be able to give a general description of d–block elements, relate the properties of transition metals to their electron configurations, indicate whether a certain transition metal atom or ion is paramagnetic or not, discuss general periodic trends in the d–block and explain the reactivity of transition metals in terms of standard reduction potentials.
	Oxidation States of Transition Elements	At the end of this activity, students should be able to: explain why transition elements exist in many oxidation states in their compounds, give the most common oxidation states for the 4th Period transition elements, explain the use of manganate(VII) and dichromate(VI) in redox titrations.
	Transition Metal Complexes	At the end of this activity, students should be able to describe the structure of complex ions and determine the co–ordination number of the central ion, classify ligands as uni– or multitendate, determine the charge of a complex ion, explain why transition metal complexes are usually colored, and say what affects their color, describe the reactions of complex ions in terms of ligand exchange, give examples of redox reactions promoted by changing the ligands, describe the uses of transition metal complexes, including in analytical tests and explain the biological importance of transition metal complexes.

CHAPTER	LESSON	DESCRIPTION
VII. Oxidation and Reduction	**Oxidation State**	At the end of this activity, students should be able to describe what oxidation–reduction reactions involve, calculate oxidation states, recognise redox equations, give the systematic names of inorganic compounds and polyatomic ions, specifying their oxidation states, discuss the oxidative–reductive properties of the s–block metals, discuss the oxidative–reductive properties of the elements of Group 17 and describe the oxidation states of the p–block elements in their commonest chemical compounds.
	Redox Reactions	At the end of this activity, students should be able to write a redox reaction in the form of half–equations, balance redox reactions occurring in acidic solution, using the method of half–equations, balance redox reactions occurring in alkaline solution, using the method of half–equations, know how to recognize the oxidizing agent (reducing agent) in an aqueous solution and determine the concentration of a solution using redox titration.
	Extraction of Metals, Part I	At the end of this activity, students should be able to explain and define a mineral and an ore, explain the general methods for extracting metals from their ores, explain the importance of iron to man, describe the operation of a blast furnace and discuss the chemical processes occurring during the extraction of iron and explain the basic oxygen process for making steel.
	Extraction of Metals, Part II	At the end of this activity, students should be able to describe the process of electrolysis and discuss its products, describe the general properties, uses and extraction methods for aluminium, titanium and copper and discuss economic aspects of metal extraction and recycling.
VIII. Electrochemistry	**Voltaic Cells**	At the end of this activity, students should be able to describe the structure of a voltaic cell, discuss the principles of voltaic cells, explain what emf is, use the conventional notation for cell descriptions and write the half–cell reactions and discuss the practical applications of voltaic cells.
	Standard Electrochemical Potential	At the end of this activity, students should be able to: describe the structure of a standard hydrogen electrode, calculate the emf of a cell, determine the relative oxidising and reducing ability of a chemical species on the basis of its standard reduction potential, identify an equation for a spontaneous reaction, discuss the practical applications of the calomel half–cell.
	Electrochemical Series	At the end of this activity, students should be able to estimate the oxidizing and reducing properties of chemical elements on the basis of their position in the electrochemical series, use the electrochemical series to predict the direction of displacement of metals from solutions of their salts by other metals, use the electrochemical series to identify metals that will displace hydrogen from acids, estimate the oxidizing and reducing properties of chemical species from their position in the electrochemical series, estimate the feasibility of a redox reaction using the position of the reactants in the electrochemical series and predict whether a particular substance can be used for the oxidation of another substance under standard conditions.
IX. Thermodynamics	**Enthalpy Change and Calorimetry**	At the end of this activity, students should be able to: explain what energy is and classify the various forms of energy, distinguish between a system and its surroundings, describe the energetic effects that accompany chemical and physical changes, classify reactions as exothermic or endothermic, explain the concept of enthalpy change, write and interpret thermochemical equations, define specific heat capacity and use this quantity in calculations, explain the concept of calorimetry, determine enthalpy changes from calorimetric data.
	Standard Enthalpy Change and Hess's Law	At the end of this activity, students should be able to define standard conditions, standard state and standard enthalpy change, define and use in calculations standard enthalpies of combustion and standard enthalpies of formation, explain Hess's law and use it in determining enthalpy changes and use standard enthalpies of combustion and standard enthalpies of formation in determining the standard enthalpy change of a reaction.

CHAPTER	LESSON	DESCRIPTION
	Born–Haber Cycle	At the end of this activity, students should be able to describe the formation of an ionic compound as a series of steps, explain every step in the formation of an ionic compound and the enthalpy changes involved: enthalpy of atomisation, ionisation enthalpy, electron affinity and lattice formation enthalpy, describe a Born–Haber cycle as an energy diagram linking the enthalpy of formation to the enthalpy changes of atomisation, ionisation and crystal lattice formation and use a Born–Haber cycle to calculate enthalpy changes and to predict the stability of an ionic compound.
	Enthalpy Changes in the Solution Process	At the end of this activity, students should be able to explain the properties of water in terms of the structure of the water molecule, describe the process of dissolving an ionic solid, define enthalpy of hydration and discuss the factors that affect its value, define enthalpy of solution, derive the value of enthalpy of solution from lattice formation enthalpy and enthalpy of hydration and describe how enthalpy of solution can be measured experimentally.
	Mean Bond Enthalpies	At the end of this activity, students should be able to define mean bond enthalpies, use mean bond enthalpies to predict enthalpy changes, describe the limitations in the use of mean bond enthalpies in thermochemical calculations and explain why for certain compounds the predicted values of enthalpy changes do not agree with the experimental values.
	Entropy	At the end of this activity, students should be able to use the laws of probability to explain the spontaneity of chemical and physical changes, explain the concept of entropy as a measure of disorder at the molecular level, discuss the entropy changes caused by chemical and physical processes, use standard entropy values to calculate standard entropy changes for reactions, explain how the entropy change of a system is affected by temperature, phase change or the stoichiometry of gaseous reactions, use enthalpy change and temperature to determine the enthalpy change for the surroundings and use a calculated total entropy change to predict whether a reaction is spontaneous or not.
	Free Energy	At the end of this activity, students should be able to define free energy change and use it to determine whether a reaction is feasible or not, discuss the effect of ?H° and ?S° values on free energy change, explain why most exothermic processes are spontaneous but only certain endothermic processes are spontaneous, discuss how lattice formation enthalpy, enthalpy of hydration and entropy change affect the solubility of ionic compounds in water, correlate the feasibility of a reaction with the temperature and explain dynamic equilibrium in terms of free energy change.
X. Reaction Kinetics	**Reaction Rate**	At the end of this activity, students should be able to explain the importance of the speed at which a chemical reaction occurs, define reaction rate as the change in concentration of a reactant or product over time, discuss reaction rates qualitatively using graphs and describe experimental methods for studying reaction rates: gas volume, gas pressure, mass, conductance, colorimetric, titrimetric.
	Collision Theory	At the end of this activity, students should be able to describe a chemical reaction at the microscopic level as a collision of reactant molecules, discuss the factors that govern the effectiveness of collisions, explain the course of a reaction in terms of activation energy and an activated complex, use energy diagrams to show the course of a reaction, define a reaction mechanism and give examples of chemical reactions that do not require collisions between molecules to occur.
	Effect of Concentration on the Reaction Rate	At the end of this activity, students should be able to explain how concentration affects reaction rates, discuss the effect of concentration in terms of the collision theory, explain the effect of pressure on the rate of reactions taking place in the gas phase, define the rate equation, rate constant and order of reaction, determine a rate equation from the relative rates at various concentrations of reactants, use rate equations for predicting relative and actual reaction rates and explain why the contact area affects the rate of heterogeneous reactions.

CHAPTER	LESSON	DESCRIPTION
	Effect of Concentration on the Reaction Rate	At the end of this activity, students should be able to explain what zero–order, first–order and second–order reactions are, explain how to express the rate equation for a first–order reaction using natural logarithms, explain how the half–life is related to the rate constant for first–order reactions and use graphical methods in kinetics.
	Effect of Temperature and Catalysts on the Reaction Rate	At the end of this activity, students should be able to explain how and why reaction rates depend on temperature, describe the distribution of molecular energies in gases and liquids, discuss why controlling the temperature of chemical reactions is important, define a catalyst and inhibitors, explain how catalysts work, using the activation energy concept, describe the catalytic activity of metals and elicit information about reaction rates from potential energy diagrams and the Maxwell–Boltzmann distribution curve.
	Catalysts and Enzymes	At the end of this activity, students should be able to indicate the differences between heterogeneous and homogeneous catalysis, describe the course of a reaction in the presence of a solid catalyst, explain the concept of autocatalysis and active complex theory, describe the mechanism of catalyst action, give examples of the uses of catalysts and how enzymes work.
XI. Chemical Equilibria	**Chemical Equilibrium and Equilibrium Constant**	At the end of this activity, students should be able to explain the difference between reversible and irreversible reactions, explain the dynamic character of chemical equilibrium, write equilibrium constant expressions using the appropriate reaction equations, determine the units of Kc, discuss the relationship between the magnitude of Kc and the position of chemical equilibrium and determine Kc for a reaction, knowing the equilibrium concentration of one of the reagents.
	Factors Affecting the Chemical Equilibrium	At the end of this activity, students should be able to use the reaction quotient to determine whether a given system is in chemical equilibrium, define Le Chatelier's principle, predict how the addition or removal of reactants or products will affect an equilibrium, describe, in terms of disturbed chemical equilibrium, the formation of stalagmites and stalactites, tooth decay, and the harmful effects of acid rain on trees, explain how temperature changes affect chemical equilibrium, predict the direction of a net reaction induced by a temperature change and explain why catalysts do not affect the position of equilibrium.
	Chemical Equilibrium in a Gas Phase	At the end of this activity, students should be able to explain why pressure affects reactions involving gases, convert between different units of pressure, explain how pressure changes affect chemical equilibria, define partial pressure and molar fraction, write the expression for Kp of a reaction, use the Kp constant in calculations of partial pressures at equilibrium, explain the importance of reaction conditions for industrial processes and discuss the factors that affect the outcome of the Haber process.
XII. Acids, Bases, and Salts	**Dissociation of Acids, Bases, and Salts**	At the end of this activity, students should be able to define strong and weak electrolytes and non–electrolytes, explain why solutions of electrolytes conduct electricity, define acids, bases and salts and describe their general properties, explain the dissociation of acids, bases and salts, describe the neutralisation reaction, discuss the solubility of salts and describe the precipitation process.
	Brønsted–Lowry Theory of Acids and Bases	At the end of this activity, students should be able to define acids and bases in terms of the Bronsted–Lowry theory, identify pairs of conjugated acids–bases in aqueous and non–aqueous media, describe the autoionisation of water, define the ionic product of water Kw, distinguish among neutral, acidic and alkaline solutions and calculate concentrations of ions using the ionic product equation.
	pH as the Universal Acidity Measure	At the end of this activity, students should be able to use logarithms in calculations, define pH of a solution, explain the relationship between pH and the concentrations of hydrogen and hydroxide ions, describe the pH scale, determine the pH of strong acids and bases and deduce the pH of the solution resulting from mixing an acid and a base.

CHAPTER	LESSON	DESCRIPTION
	Weak Acids and Weak Bases	At the end of this activity, students should be able to describe the dissociation of weak acids and bases, define the acid and base dissociation constants, compare the strengths of acids and bases using dissociation constants, explain the changes in subsequent dissociation constants for di– and triprotic acids, perform pH calculations for solutions of weak acids and bases and explain pKa and pKb values and use them to predict the strengths of acids and bases.
	Salts in Water Solution	At the end of this activity, students should be able to describe the dissociation of conjugate acids and bases, explain the hydrolysis of salts and describe the relation of Ka and Kb in conjugate acid–base pairs, decide whether the pH of a salt solution has a neutral, acidic or alkaline value and calculate the pH of solutions of the salts of weak acids and strong bases and of the salts of strong acids and weak bases.
	Buffers	At the end of this activity, students should be able to define acidic and alkaline buffers, describe quantitatively how buffers work, calculate the pH of a buffer solution, calculate the pH changes resulting from the addition of strong acids/bases to buffer solutions, determine the pH range of a buffer based on Ka and Kb constants and calculate the amounts of acid/base and salt required to prepare a buffer solution of specified pH.
	Acid-Base Titration	At the end of this activity, students should be able to define titration as the volumetric analytical technique, describe how to perform an acid–base titration, derive the unknown amount of acid/base from the results of an acid–base titration and explain the importance of standardisation of titrant solutions.
	Titration Curves	At the end of this activity, students should be able to describe how the pH of a solution changes upon gradual addition of the titrant, describe the characteristics of pH curves for strong acid-strong base, weak acid-strong base and weak base-strong acid titrations, explain how indicators work, choose the appropriate indicator for a given titration, discuss qualitatively pH curves with two equivalence points and indicate the limitations of acid-base titrations.
XIII. Reaction of Metal Ions in Water Solution	**Acid-Base Reactions of Metal Ions**	At the end of this activity, students should be able to define acids and bases in terms of the Lewis theory, describe the formation of aqua ions in water solution, explain the acidity (hydrolysis) reaction of hexaaqua–metal ions, define the products of the reactions of metal aqua ions with alkalis, ammonia and carbonates, explain the term amphoteric hydroxides and use the reactions of aqua complexes for the identification of metal ions.
	Ligand Exchange Reactions	At the end of this activity, students should be able to describe the stability of a complex in terms of formation constant, explain the reaction of aqua ions with ammonia and describe the structure of the resulting ammine complexes, describe metal complexes of chloride ions, explain why the complexes with multidentate ligands (chelating agents) are usually more stable than those with unidentate ligands and explain why the formation of complex ions affects the solubility of ionic compounds.
XIV. Hydrocarbons	**Petroleum As the Source of Hydrocarbons**	At the end of this activity, students should be able to understand the origin of fossil fuels, recognise the importance of crude oil, know the location of the principal deposits of crude oil in the world, understand the fractional distillation process, know the basic products from fractional distillation of crude oil and their uses, understand the terms 'cracking' and 'reforming' and be able to perform calculations involving the concepts of density and mass percentage.
	Hydrocarbons As Fuel	At the end of this activity, students should be able to understand the importance of energy in modern society, understand the difference between total and incomplete combustion of hydrocarbons, be able to work with graphs and calculations concerning hydrocarbon oxidation, understand the term 'energetic value' of a fuel and how to evaluate it and know how catalytic converters work.

CHAPTER	LESSON	DESCRIPTION
	Alkanes and Cycloalkanes	At the end of this activity, students should be able to be able to explain the unique properties of the element carbon, understand the terms ‘homologous series’ and ‘isomers’, know the basic structural features of alkanes and cycloalkanes, know how to name alkanes, alkyl groups and cycloalkanes according to the IUPAC rules and know how to draw structural formulas for alkanes and cycloalkanes and know the basic physical properties of alkanes and understand the influence of intermolecular forces on the physical properties of alkanes.
	Chemistry of Alkanes and Cycloalkanes	At the end of this activity, students should be able to understand why alkanes and cycloalkanes are chemically inert, understand the energy profile for the combustion of alkanes, know the conditions leading to homolytic fission of the C-C bond, understand the mechanism of free-radical substitution, know about the influence of the type of halogen on substitution in alkanes as well as know the basic methods for alkane and cycloalkane synthesis.
	Alkenes	At the end of this activity, students should be able to provide the names and structures of the first members of a homologous series of alkenes, state and explain the physical properties of alkenes, recall and explain the types of isomerism exhibited by alkenes and give examples and systematic names of compounds belonging to the series of alkadienes and cycloalkenes.
	Alkene Reactions	At the end of this activity, students should be able to understand the concept of electrophilic addition, understand why alkenes undergo electrophilic addition, be able to write molecular and structural equations for reactions involving alkenes, understand why addition reactions yield mixtures of isomeric alkanes, and predict their proportion in the mixture and understand the importance of addition polymerisation and be able to give examples of this type of reaction.
	Haloalkanes	At the end of this activity, students should be able to define the term ‘functional group’, build models of, construct formulae for, and correctly name haloalkanes, give examples of isomers of haloalkanes, describe the physical properties of haloalkanes, describe the methods of preparation of haloalkanes and write appropriate reaction equations, give examples of the uses of haloalkanes and discuss the environmental impact of haloalkanes.
	Reactions of Haloalkanes	At the end of this activity, students should be able to describe the properties of the C-X bond, write equations for the reactions of haloalkanes with bases, ammonia and the cyanide ion, explain the mechanism of SN1 and SN2 nucleophilic substitution reactions, give examples of elimination reactions in haloalkanes and write relevant equations and give examples of the applications of haloalkanes in organic synthesis.
	Alcohols	At the end of this activity, students should be able to describe the structure of alcohol molecule, name alcohols and draw their structural formulae, explain the phenomenon of isomerism in alcohols, explain the concept of primary, secondary and tertiary alcohols, describe the physical properties of ethanol and describe and explain the changes in the boiling points and solubility of alcohols with increasing molecular size.
	Ethanol	At the end of this activity, students should be able to investigate the physical properties of ethanol, describe the methods for obtaining ethanol, explain the most important applications of ethanol and assess the effects of alcohol on the human organism.
	Reactions of Alcohols	At the end of this activity, students should be able to describe the acidic properties of the -OH group in alcohols, describe and give examples of the elimination reactions of alcohols, the reactions between alcohols and inorganic acids, and reactions involving alcohol oxidation, explain how to distinguish primary, secondary and tertiary alcohols and explain the concept of monohydric and polyhydric alcohols.

CHAPTER	LESSON	DESCRIPTION
XV. Compounds with the Carbonyl Group	**Aldehydes and Ketones**	At the end of this activity, students should be able to define the carbonyl group, an aldehyde and a ketone and name examples of carbonyl compounds, explain the effect of the presence of a carbonyl group on the physical properties of aldehydes and ketones, design reactions for obtaining simple aldehydes and ketones and describe the occurrence of aldehydes and ketones in nature and give examples of the applications of them.
	Reactions of Aldehydes and Ketones	At the end of this activity, students should be able to define a nucleophilic addition reaction and discuss its mechanism, write equations for the addition reactions of hydrogen cyanide and hydrogensulphite, and name the products, write equations for the reduction of aldehydes and ketones with various reducing agents and name the products of these reactions, explain the differences between the behaviour of aldehydes and ketones during oxidation and describe the practical importance of these reactions, write equations for the oxidation of aldehydes and ketones using known oxidising agents and define Tollens', Fehling's and Brady's reagents and name the reactions used for identification of carbonyl compounds.
	Carboxylic Acids	At the end of this activity, students should be able to describe the general structure of carboxylic acids, name carboxylic acids according to the IUPAC rules, explain how the physical properties of carboxylic acids are a result of the structure of the carboxyl group, explain the acidic properties of carboxylic acids and discuss how the structure of an acid affects its acidic strength, describe the properties of the salts of carboxylic acids and the typical reactions of carboxylic acids, describe preparative methods for carboxylic acids and indicate the natural sources of carboxylic acids.
	Functional Derivatives of Carboxylic Acids	At the end of this activity, students should be able to describe the general structure of functional derivatives of carboxylic acids, explain nucleophilic acyl substitution reactions, describe the structure, properties, reactions and preparation of acyl chlorides, acid anhydrides, esters, amides and nitriles and explain acylation reactions.
XVI. Aromatic Compounds	**Benzene**	At the end of this activity, students should be able to describe the inconsistencies arising from the representation of the structure of benzene using C=C double bonds, explain the structure of benzene in the light of modern knowledge, understand the concepts of delocalisation and resonance and be able to take them into account when writing the structure of an organic compound, determine the resonance stabilisation energy for arenes, describe the names and structures of some polycyclic aromatic hydrocarbons and alkyl derivatives of benzene and explain the aromaticity criteria for organic compounds.
	Electrophilic Substitution	At the end of this activity, students should be able to define an electrophilic substitution reaction of the aromatic ring and describe its mechanism, write down the reaction of benzene nitration and name its products, give examples of the uses of nitro compounds, explain the Friedel-Crafts alkylation and acylation reactions of the benzene ring and design synthesis reactions for simple alkyl and acyl derivatives of benzene.
XVII. Organic Compounds of Nitrogen	**Structure and Properties of Amines**	At the end of this activity, students should be able to describe amines as functional derivatives of ammonia, name and classify amines as primary, secondary or tertiary, explain the physical properties of amines as related to their structure, explain the properties of amines as bases and discuss their strength as bases, explain the effect of a benzene ring on the strength of aromatic amines as bases and describe the structure, properties and uses of quaternary ammonium salts.
	Reactions and Preparation of Amines and Amides	At the end of this activity, students should be able to describe the alkylation of ammonia and amines, explain how primary, secondary and tertiary amides are formed by the acylation of amines, discuss the physical and acid-base properties of amides, describe the hydrolysis and reduction of amides and describe the main general preparative routes to aliphatic and aromatic amines and use them to plan syntheses.

CHAPTER	LESSON	DESCRIPTION
	Amino Acids	At the end of this activity, students should be able to explain the structure of amino acids and zwitterions, describe the structural features of amino acids found in proteins, explain the optical isomerism of amino acids, discuss physical properties in terms of zwitterions, explain and use the concept of isoelectric point and describe the general structure of peptides.
XVIII. Biologically Important Chemical Compounds	**Fats and Sugars**	At the end of this activity, students should be able to describe the structures and physical properties of animal and vegetable fats, describe the hydrolysis of fats and the addition reactions of unsaturated fats, explain the role of fats in our diet, explain the washing properties of soaps in terms of their molecular structure, describe the structure and physical properties of sugars and explain the reactions of sugars as reactions of the carbonyl and hydroxyl groups, describe the general structure and biological function of polysaccharides and explain the nutritional importance of sugars.
	Proteins and Nucleic Acids	At the end of this activity, students should be able to describe the primary, secondary, tertiary and quaternary structures of proteins, explain the nature of the interactions that give proteins a three-dimensional shape, explain the relationship between the shape of a protein molecule and its biological function, describe the denaturation of proteins, name the main building blocks of nucleic acids, explain the structure of DNA and how two strands are bonded together and explain why the two strands of DNA are complementary.
XIX. Polymers	**Polymer Types and Addition Polymers**	At the end of this activity, students should be able to classify polymers and describe their basic types: straight-chain, cross-linked, thermoplastic, thermosetting, elastomers, explain the mechanism of the addition reaction leading to polymerisation, using the example of polyethene, describe the properties of the most common addition polymers as: polypropene, PVC, polystyrene and Teflon and explain how plasticisers work.
	Condensation Polymers	At the end of this activity, students should be able to explain condensation polymerisation reactions, describe condensation polymers: polyesters and polyamides and their uses, describe composites and explain the negative environmental impact of polymers.
XX. General Topics in Organic Chemistry	**Organic Molecules**	At the end of this activity, students should be able to explain why carbon has a unique ability to form so many compounds, describe the importance of carbon compounds to life on Earth, discuss the differences between organic and inorganic chemistry, describe the general types of carbon-carbon bond, explain how bonding affects the shape of organic molecules, derive the empirical formula of an organic compound from experimental data and define and use empirical, molecular and general formulae as well as various types of structural formula.
	Naming Organic Compounds	At the end of this activity, students should be able to classify organic compounds as aliphatic, alicyclic or aromatic, define a homologous series of compounds, explain the general approach to naming organic compounds recommended by the IUPAC, identify and name parent hydrocarbons for organic molecules, build a name for an organic compound using the names of the parent hydrocarbon, alkyl groups and functional groups, apply the IUPAC rules in naming organic compounds and draw the structure of a molecule using its IUPAC name.
	Isomerism	At the end of this activity, students should be able to explain the general types of isomerism: structural isomerism (chain, positional, functional group) and stereoisomerism (geometric, optical), identify the type of isomerism in simple organic molecules, indicate the differences in physical and chemical properties of enantiomers and explain the construction and use of a polarimeter.
	Organic Reactions	At the end of this activity, students should be able to describe homolytic and heterolytic fission of a covalent bond, explain free-radical chain reactions, discuss the stability of free radicals, define electrophiles and nucleophiles, describe the formation of carbocations and discuss their stability, explain the mechanisms of: electrophilic addition, electrophilic substitution, nucleophilic substitution (SN1 and SN2) , nucleophilic elimination (E1 and E2), nucleophilic addition and nucleophilic addition-elimination and describe the most common oxidants and reductants used in organic syntheses, and give examples of specific uses of these reagents.

CHAPTER	LESSON	DESCRIPTION
	Analytical Tests in Organic Chemistry	At the end of this activity, students should be able to explain what information can be obtained from combustion tests, use the results of elementary analysis in the determination of empirical formulae, describe the chemical tests for alkenes, haloalkanes (including identification of the halogen), aldehydes, ketones, alcohols (including 1°, 2° and 3° alcohols), carboxylic acids, esters, acid anhydrides, acyl chlorides, amines and amino acids and use the information from analytical tests to identify organic compounds.
XXI. Spectrometric Techniques	**Infrared Spectroscopy, Part I**	At the end of this activity, students should be able to use information from chemical tests to determine the structure of an organic compound, describe electromagnetic radiation in terms of wavelength, frequency, energy of photons and wave number, explain the general concept of spectroscopy, define the infra-red region used in spectroscopy, explain why organic compounds absorb infra-red radiation, state the relationship between the frequency of bond vibration and the frequency of absorbed radiation, discuss the factors affecting the frequency of bond vibration and the modes of bond vibration and describe recording of an infra-red spectrum, construction of the spectrometer and sample handling.
	Infrared Spectroscopy, Part II	At the end of this activity, students should be able to use a correlation chart for infra-red spectra, indicate the most typical absorptions found in the spectra of alkanes, alkenes, alkynes, aromatic hydrocarbons, alcohols, amines, haloalkanes, aldehydes and ketones, carboxylic acids and their derivatives (esters, amides, nitriles), identify the presence and absence of functional groups using infra-red spectra, predict the infra-red absorption regions for molecules of known structure and describe the uses and limitations of infra-red spectroscopy.
	Mass Spectrometry, Part I	At the end of this activity, students should be able to: discuss the behaviour of charged particles in electric and magnetic fields, relate the deflection of a charged particle in a magnetic field to the mass and charge of the particle and the strength of the magnetic field, describe how a mass spectrometer works, explain what a mass spectrum is, explain the terms: base peak, molecular ion, fragmentation ion, relative abundance, discuss mass spectra of the elements in terms of the natural abundance of isotopes, explain the general features of mass spectra of organic compounds.
	Mass Spectrometry, Part II	At the end of this activity, students should be able to: use mass spectra to determine the relative molecular mass of a compound, discuss the stability of fragmentation ions, predict the most probable fragmentation patterns, recognise the spectra of chlorine– and bromine–containing compounds and use mass spectra for the identification of organic compounds.
	Nuclear Magnetic Resonance (NMR) Spectroscopy, Part I	At the end of this activity, students should be able to: explain how atomic nuclei behave in an external magnetic field, depending upon whether they posses nuclear spin or not, explain why a magnetic field causes the energy levels of nuclei possessing nuclear spin to split, explain the nuclear absorption of electromagnetic radiation by nuclei placed in a magnetic field, describe the construction and operation of an NMR spectrometer and how an NMR spectrum is recorded, explain the term 'chemical shift' and discuss why hydrogen atoms in organic molecules may produce more than one NMR absorption signal, explain why TMS has been chosen as a standard in NMR spectroscopy, identify equivalent and non–equivalent 1H atoms in the molecule, predict the number of absorption signals in low–resolution proton NMR spectra, as well as their relative intensity.
	Nuclear Magnetic Resonance (NMR) Spectroscopy, Part II	At the end of this activity, students should be able to: explain the coupling effect , predict the number of components in proton NMR multiplets, given the structural formula of a compound, draw conclusions about a molecular structure from the coupling pattern, state and use the n + 1 rule and describe the main types of multiplet: singlet, doublet, triplet, quartet, explain the types of coupling with non–equivalent 1H atoms, explain why there is no coupling with hydrogen atoms bonded to oxygen or nitrogen, use a chemical–shift correlation chart to obtain information about molecular structure and determine the structure of organic molecules using information provided by proton NMR spectra: the number and intensity of absorption signals, the coupling pattern and chemical shifts.

CHAPTER	LESSON	DESCRIPTION
	Determination of Molecular Structure	At the end of this activity, students should be able to: lculate and use the hydrogen deficiency index, use spectral and analytical data to draw conclusions about the structures of organic compounds.
	Absorption of Visible Light, Colorimetry	At the end of this activity, students should be able to: explain how the absorption of light produces colour, explain the origin of the colours of the inorganic compounds of s, p and d–block metals, as well as of organic compounds, describe how absorption spectra are recorded, explain the concept of colorimetry, define and use the Beer–Lambert law.
XXII. Environmental Pollution by Chemical Products	**Pollution of Air**	At the end of this activity, students should be able to describe the composition of air and the structure of the atmosphere, explain how the contemporary atmosphere evolved, explain the carbon cycle and discuss how it is disturbed by human activities, explain why the increasing concentration of atmospheric CO2 contributes to global warming, and what the probable results of a prolonged greenhouse effect would be, indicate the sources of sulphur dioxide and nitrogen oxides, explain the phenomenon of acid rain, describe the formation of photochemical smog and explain how CFCs disrupt the ozone layer.
	Pollution of Water	At the end of this activity, students should be able to explain the composition and properties of natural water: oxygen content, pH, hardness, content of ionic compounds, explain the toxic properties of heavy metals, give examples of poisoning by heavy-metal ions contained in water, discuss the positive and negative effects of using pesticides, explain the eutrophication of water by excess phosphate and describe the purification of tap water and the treatment of sewage.
	Pollution of Land	At the end of this activity, students should be able to explain the composition and disposal of solid commercial and domestic waste, discuss the benefits of and problems with the recycling of plastic, paper, glass and metals, indicate the sources of dioxins and explain the environmental impact of using nuclear energy for the production of electricity.