mVuli ACADEMY

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	No. of Digital Lessons		No. of ePages	Films & Animations	Simulations Games & 3D objects	Illustrations	Photos & Slideshows
Upper Primary	Mathematics	127	1 099	700	473	876	69
	Science	80	635	489	210	1 288	313
Lower Secondary	Mathematics	136	1 320	897	609	320	103
	Physics	111	970	746	352	874	528
	Biology	101	903	413	144	655	1 171
	Chemistry	99	821	1 058	175	525	1 118
Upper Secondary	Mathematics	112	1 077	675	470	419	204
	Physics	119	1 055	928	393	902	465
	Biology	99	977	487	107	699	615
	Chemistry	100	889	1 354	303	1 176	304
	TOTAL	**1 084**	**9 746**	**7 747**	**3 236**	**7 674**	**4 891**

CONTENTS OF THIS SECONDARY CHEMISTRY PACKAGE

CHAPTER	LESSON	DESCRIPTION
I. Life Processes and Cell Functions	**Animal and Plant Cells**	This lesson explores the similarities and differences between animal and plant cells. Students will learn about the cell membrane, cytoplasm, and nucleus in both animal and plant cells. They will also explore the functions of chloroplasts and cell walls in plant cells and specialized animal cells. The lesson also details levels of organization, including the way animal and plant cells form tissues, tissues form organs, and organ systems form the complex levels of organization in the human body.
	Human Organ Systems	This lesson describes key functions of the human organ systems. Students will learn major organs that belong to each system and functions of specific organs.
	Life Processes	Description: This lesson details seven life processes required by living organisms: respiration, nutrition, excretion, growth, sensitivity, movement, and reproduction. Students learn how these life processes distinguish living things from non-living things.
	Specialized Cells	This lesson describes ways in which cells are specially adapted to their functions. Students will explore examples of specialized cells in both animals and plants. They will also learn some of the features of the red blood cell, cilia cell, sperm cell, and other specialized cells.
	Structure of Flowering Plants	This lesson describes the four main plant organs: the stem, leaves, roots, and flower. Students will learn that the male sex cells, called pollen grains, fertilize female sex cells, called ova. They will also learn ways in which seeds develop after fertilization and are dispersed by plants.
II. Humans as Organisms	**Absorption and Waste**	This lesson describes how the products of digestion are absorbed into the bloodstream and transported throughout the body. Students will learn the role of the kidneys in the removal of waste as well as the process of solid waste remove in humans.
	Adolescence	This lesson describes physical and emotional changes that occur during puberty. Students will learn some of the key changes take place in girls and boys during adolescence.
	Breathing	This lesson discusses the role of lung structure in gas exchange. Students will learn the role of the lungs and the structure of the lungs. They will also learn about the mechanism of breathing and the differences between inhaled and exhaled air.
	Development of the Fetus	This lesson describes the development of a baby from cell division to birth. Students will learn about implantation, the role of the placenta, the stages of development of the fetus, and the stages of birth.
	Digestion	This lesson outlines the principles of digestion, including the role of enzymes in breaking large molecules into smaller ones. Students will learn how food is used as fuel during respiration to maintain the body's activity and as a raw material for growth and repair. They will also learn how to describe the role of the main organs of the human digestive system.
	Drugs and Health	In this lesson, students will learn the main types of legal and illegal drugs. Students will review the dangers of the most commonly abused drugs, and consider how drug abuse can affect human health.
	Fighting Disease	This lesson describes how the growth and reproduction of bacteria and the replication of viruses can affect human health. Students will learn how the body's natural defenses can be enhanced by immunization and medications.

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	Human Reproduction	This lesson covers the male and female reproductive systems. Students will learn about the human sex organs, about the stages of the menstrual cycle, and about how fertilization takes place in humans.
	Human Respiration	This lesson describes the difference between the two types of respiration: aerobic respiration and anaerobic respiration. Students will learn how to summarize aerobic respiration and anaerobic respiration in word equations. They will also learn how substances involved in respiration are transported through the bloodstream and how energy is obtained from respiration.
	Nutrition	This lesson defines a balanced diet and provides examples of good sources of carbohydrates, proteins, fats, vitamins, minerals, and fiber. Students will learn the importance of each of these nutrients, as well as how vital water is to human health.
	Smoking	This lesson covers the effects of smoking on the human body. Students will learn about the chemicals found in cigarette smoke and the health problems associated with them. They will also learn how smoking affects a fetus.
	The Skeleton and Movement	This lesson describes the role of the skeleton and joints. Students will learn the principle of antagonistic muscle pairs and how movement is produced in the body.
III. Green Plants as Organisms	**Factors Affecting Photosynthesis**	This lesson explores factors that affect photosynthesis, including light, water, temperature, and carbon dioxide. Students will learn about the importance of these factors as well as how to test for them.
	Photosynthesis and Food Production	This lesson explains the important role of plants as food and as oxygen producers. Students will learn about photosynthesis, including what plants need for photosynthesis and how the process can be summed up in an equation.
	Plant Growth	This lesson details what plants need to be healthy, including the minerals nitrates, phosphates, and potassium. Students will learn the role of roots and root hairs in absorbing water and minerals from the soil. They will also learn how nutrients can be added to soil that lacks them.
	Respiration in Plants	In this lesson, students will learn the importance of the products of plant respiration and the key role of water in a plant's life processes. The lesson describes aerobic respiration in plants, including the word equation for plant respiration. It also describes how photosynthesis and respiration are related.
IV. Variation, Classification, and Inheritance	**Causes of Variation**	This lesson explores environmental and inherited causes of variation. Students will learn examples of human variation that can be attributed to genetic and to environmental factors. They will also learn the main causes of variation in plants.
	Classification	In this lesson, students will learn how to classify organisms into taxonomic groups. They will also learn examples of organisms from each taxonomic group.
	Inheritance	This lesson defines inherited characteristics and explains the role genes play in inheritance. Students will explore several examples of inherited characteristics, as well as the usefulness of selective and cross-breeding techniques.
	Variation	The lesson defines the term species, and explores the nature of variation between organisms. Students will learn about variation between species and within a species, including human variation. They will also learn the difference between continuous and discontinuous variation.

CHAPTER	LESSON	DESCRIPTION
	Properties of Non-Metals	In this lesson students will learn how to describe the appearance, state at room temperature, magnetic properties, and thermal and electric conductivity of non-metals. They will also learn other properties of non-metals, such as strength and density.
	Separating Mixtures	This lesson explores several ways in which mixtures can be separated into their parts. Students will learn how distillation, filtration, evaporation, and chromatography can be used to separate different types of mixtures.
	Solids, Liquids, and Gases	This lesson explores the states of matter of solids, liquids, and gases. Students analyze the properties of each state, and learn how the particle theory explains the differences between the states. They also observe experiments to learn what happens when substances change from one state of matter to another.
VII. Changing Materials	**Chemical Reactions**	This lesson focuses on the roles of reactants and products in a chemical reaction. Students will learn that virtually all materials, including those in living systems, are formed by chemical reactions. They will also explore several different types of chemical reaction, and learn how some chemical reactions are useful to humans and others are harmful.
	Geological Changes	This lesson describes three ways in which the weathering of rock takes place: physical, chemical, and biological. Students will learn how the forces generated by expansion, contraction, and the freezing of water can cause weathering. They will also learn how gases dissolved in precipitation can break down rocks. Then they will see examples of how plants and animals can cause weathering, and learn the types of materials that make up soil.
	Physical Changes in Materials	This lesson describes how mass is conserved when physical changes take place. Students learn how a material's temperature changes as it is heated or cooled enough to melt, boil, condense, or freeze. Students will also learn what energy transfers occur during changes of state and how materials expand and contract as they change temperature.
	Rock Formation	In this lesson students will learn the processes by which igneous, sedimentary, and metamorphic rocks are formed. They will see how the mode of rock formation affects the texture and mineral content of the rock. They will also learn characteristics and examples of each type of rock. The lesson ends with a discussion of how rocks are commonly used for building and other purposes.
	Solutions	This lesson details what happens when one substance dissolves in another. Students will learn how solubility varies with temperature, what a saturated solution is, and the differences between the solubility of solutes in different solvents. They will also learn how solvents and solutes are used in everyday life.
	The Effects of Combustion	This lesson describes how fossil fuels form. Students will learn the effects of fossil fuels on the environment, including global warming and acid precipitation. They will also see how the amount of pollution from combustion can be reduced.
VIII. Patterns of Behavior	**Acid Reactions**	This lesson explains how acids react with metals, bases, and carbonates, and describes the products of these reactions. Students will also learn how acids can corrode metal and cause the chemical weathering of rocks.
	Acids and Bases	This lesson describes the properties of acids and bases. Students will learn how to use indicators and the pH scale to classify solutions as acidic, basic, or neutral. They will also learn everyday examples of acids and bases.
	Displacement Reactions	This lesson explains displacement reactions. Students will learn examples of displacement reactions between metals and solutions of a salt or another metal. They will also learn the order of metals in the reactivity series and how metals are extracted from their ores.

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	Neutralization	This lesson explains the process of neutralization. Students will learn how to make salts using a neutralization reaction and some everyday applications of neutralization.
	The Reactivity of Metals	This lesson describes the reactivity of metals with oxygen, water, and acids. Students will learn that substances are produced by these reactions. They will also learn how to name the products of these reactions.
IX. Electricity	**Electric Current**	This lesson explores how the current in a circuit depends on the number of cells and the number and nature of other components. Students will learn that current is not 'used up' by components. They will also see that the resistance of wires depends upon their material, length, and thickness.
	Electrical Circuits	This lesson begins by describing the source of static electricity. Then students learn how to measure current and voltage. They also explore how energy is transferred from batteries and other sources to the components in electric circuits. Students demonstrate their understanding by interpreting and drawing electric circuit diagrams.
	Electromagnets	This lesson describes how an electric current in a wire produces a magnetic field. Students will learn how electromagnets are constructed, and what factors affect their strength. They will also learn some uses of electromagnets, including electric bells, relay switches, and appliances.
	Magnets	In this lesson, students will learn what it means for an object to be magnetic. They will explore magnetic fields and how they affect magnetic materials. Students will also explore how magnets interact with each other.
	Series and Parallel Circuits	This lesson details how to design and construct series and parallel circuits. As students analyze and build circuits, they learn how current flows in different types of circuits and what causes a short circuit.
X. Forces and Motion	**Balanced and Unbalanced Forces**	In this lesson, students will learn how unbalanced forces change the speed or direction of motion of objects. They will also see that balanced forces do not cause a change in the motion of an object. Students will explore several examples of these balanced and unbalanced forces in action.
	Force and Rotation	This lesson shows how levers can make work easier. Students learn how forces cause objects to turn around the pivot of a lever. They then learn the three basic types of levers, how to draw force arrows on diagrams that show how levers work, and everyday examples of levers.
	Friction	This lesson describes how frictional forces such as air resistance affect motion. Students will learn how the balance between frictional forces affects the movement and direction of an object. They will explore the concepts using specific examples.
	Pressure	This lesson explores the concept of pressure. Students will learn the quantitative relationship between force, area, and pressure. They will then learn how to solve problems for force, area, or pressure. In addition, they will learn applications of increased and decreased pressure.
	Speed	This lesson describes how to determine the speed of a moving object. Students will learn how to use the triangular relationship between speed, distance, and time to solve problems. They will also learn units of speed and how to show speed data in graphical form.

CHAPTER	LESSON	DESCRIPTION
	Torque	This lesson introduces the principle of torque. Students will learn how to measure torque and balance torques. Advanced students will find opportunities for calculating torque.
	Weight	In this lesson, students will learn the difference between weight and mass. They will see how the weight of an object results from the gravitational attraction between the object and the Earth. Students will learn how to measure mass and weight. They will also explore how the weight of an object depends on its mass, the mass of the Earth, and how far the object is from the center of the Earth.
XI. Light and Sound	**Color**	This lesson describes how white light can be dispersed to give a range of colors. Students will learn how colored filters affect white light. They will also learn how to describe the appearance of colored objects in white light and other colors of light.
	Hearing	This lesson explains how sound travels and how sound is caused by vibration. Students will learn how sound causes the ear drum to vibrate and why different people have different audible ranges. They will also learn the effects of loud sounds on the ear.
	Light	In this lesson, students will learn that light traveling in a uniform medium moves in a straight line at a finite speed. They will observe the difference between opaque and transparent objects. They will also see what happens during eclipses of the sun and moon. They will learn the difference between the speed of light and sound, and consider how that difference affects our perception of events. They will also explore how we see objects.
	Reflection	This lesson helps students understand how mirrors work and how they are used. Students will learn what path light follows when it is reflected and how a periscope works. They will also learn to draw a reflection diagram, and describe how light is reflected off different types of surfaces.
	Refraction	This lesson explains that light travels at different speeds in different materials, depending on the density of the materials. Students will learn the principle of refraction: how a light ray bends when it passes from one medium to another. They will explore several examples of refraction and learn how to draw a refraction diagram.
	Sound	This lesson compares the ways in which sound and light travel, including their speeds. Students will learn how to explain the relationship between the loudness of a sound and the amplitude of the vibration causing it. They will also explain the relationship between the pitch of a sound and the frequency of vibration causing it.
XII. The Earth and Beyond	**Satellites**	This lesson focuses on satellites. Students will learn about the moon and other natural satellites of planets. Then they will explore artificial satellites and probes to learn about their various purposes and processes, including weather monitoring, communication and navigation, observation of the Earth, and observation of outer space.
	The Night Sky	This lesson explains why the sun and other stars are light sources. Students will learn how the planets and other bodies can be seen by reflected light in the night sky. They will also become familiar with some of the major constellations and the Horsehead Nebula.
	The Rotating Earth	This lesson describes how the movement of the Earth causes the apparent daily movement of the sun and stars. Students will learn how long it takes the Earth to orbit the sun. They will also explain the phenomena of the seasons.
	The Solar System	In this lesson students will learn how to describe the relative positions of the Earth, sun, and planets in the solar system. They will describe the movements of the planets around the sun and relate these to gravitational force. They will also learn to explain how the movement of the earth causes the apparent movement of other bodies.

CHAPTER	LESSON	DESCRIPTION
XIII. Energy Resources and Energy Transfer	**Energy Conservation**	This lesson explains what is meant by the conservation of energy. Students will learn how energy is always conserved, and how energy can be given out as useful energy and wasted energy.
	Energy Resources	This lesson covers different forms of energy resources. Students will learn how to describe a variety of energy resources, and classify them as renewable or non-renewable. They will also learn how to compare the strengths and weaknesses of different energy resources.
	Generating Electricity	This lesson describes how electricity is generated. Students will learn the differences between renewable and non-renewable energy sources in terms of electricity generation.
	Heat and Temperature	This lesson describes the difference between temperature and heat. Students will learn how differences in temperature can lead to the transfer of energy.
	The Sun's Energy	This lesson describes the sun's role as the ultimate source of most of the Earth's energy. Students will learn the sun's role in the formation of fossil fuels and explain how the sun's energy is transferred to renewable energy resources.
	Transfer of Energy	In this lesson, students will learn how energy can be transferred and stored. They will be able to describe how heat energy is transferred directly by radiation and indirectly by conduction, convection, and evaporation.

CHAPTER	LESSON	DESCRIPTION
I. States of Matter	**Basic Properties of Matter**	At the end of this activity, students should be able to: explain what matter is and describe its structure, specify the state of matter for various substances, define density, measure or calculate the volume of solids and liquids, calculate the density of a substance given its mass and volume, name the basic properties of solids, liquids and gases and discuss the differences between them.
	Gases	At the end of this activity, students should be able to: describe the structure of gases – name the characteristic properties of gases and describe them using the concept of particles (occupying a space of any shape, mixing, compressibility, expansibility, pressure) – explain what influences the pressure of a gas – describe the relationship between the size of gas particles and the density of the gas.
	Liquids	At the end of this activity, students should be able to: represent the structure of liquids and describe their characteristic properties using the particle concept – explain the importance of the ability of liquids to change shape – explain the purpose of a hydrometer – calculate the density of a liquid after measuring its volume and mass.
	Solids	At the end of this activity, students should be able to: illustrate the structure of solids and describe their characteristic properties using the concept of particles – determine the hardness of a solid body on the basis of its behaviour in relation to Mohs' hardness scale for minerals – describe the differences in the structure of matter in its different physicalstates (distance between particles, forces of attraction, energy of particles, mobility of particles).
	Changes of State	At the end of this activity, students should be able to: give definitions of individual changes of state and the temperatures at which they occur – describe the progress of a change of state using the concept of particles – give examples of changes of state that occur in nature and in everyday life.
	Physical Changes Accompaying Heating and Cooling	At the End of This Activity, Students Should Be Able to: draw the heating curve and cooling curve for a substance and describe them in detail – show the changes in volume and density undergone by most substances during heating or cooling – explain the concept of thermal expansion of bodies and what causes it – describe the changes in the volume and density of water in the three basic states of matter, and explain why ice has a lower density than liquid water – give examples of how the knowledge of thermal expansion of bodies is applied.
	Diffusion and Dissolving	At the end of this activity, students should be able to: describe the phenomenon of diffusion – demonstrate the process of diffusion between substances in different states of matter – name the factors that affect the rate of diffusion and explain the relationship between them – indicate examples of diffusion in the immediate surroundings – describe the process of dissolution and define the terms solvent, solute and solution – name the factors that affect the process of dissolution and describe their effect.
	Gas Laws. Part I	At the end of this activity, students should be able to: name the units used to express gas temperatures and pressures – discuss the relationship between the pressure, temperature and volume of gas – quote Boyle's law and Charles's law – solve calculation problems requiring a knowledge of the gas laws: Boyle's law and Charles's law.
	Gas Laws. Part II	At the end of this activity, students should be able to: discuss the relationship between the volume of a gas and its temperature – quote Gay-Lussac's law – do calculations requiring the application of Gay-Lussac's law – define isobaric, isochoric and isothermal changes and name the gas laws that govern these changes – write the equation describing the relationship among pressure, volume and temperature of a gas – transform the equation of state according to the problem to be solved.

CHAPTER	LESSON	DESCRIPTION
II. Elements, Compounds and Mixtures	**Elements**	At the end of this activity, students should be able to: discuss the different types of matter – explain the difference between a pure substance and a mixture – discuss the different types of pure substance – write the symbols of the most important elements – discuss the properties of metals and nonmetals – name the properties of metals that make them different from nonmetals – the properties of metalloids.
	Chemical Compounds	At the end of this activity, students should be able to: define a chemical compound – define a molecule – define a molecular formula – indicate the difference between a molecular formula and an empirical formula – determine the empirical formula based on the percentage composition of a compound – demonstrate, using an example, that the properties of a chemical compound are different from those of the elements that compose it.
	Mixtures	At the end of this activity, students should be able to: discuss the different types of mixture – establish whether a mixture is homogeneous or heterogeneous – define a solution – say what decantation and sedimentation involve – say what centrifugation and evaporation involve – say what crystallisation involves – say what chromatography involves – discuss the uses of chromatography.
III. Atomic Structure	**Early Atomic Theories**	At the end of this activity, students should be able to: give the main postulates of Dalton's atomic theory – discuss the atomic model proposed by Dalton – discuss the atomic model proposed by Thomson – discuss and interpret the experiment using gold foil – discuss the Rutherford model of the atom – discuss the component particles of the atom (electron, proton, neutron).
	The Structure of the Atom	At the end of this activity, students should be able to: say what information can be obtained from the atomic number – determine the number of protons and the total number of electrons in an atom on the basis of the atomic number – determine the composition of atomic nuclei, given the atomic number and the mass number – explain the term isotope – discuss the similarities and differences between hydrogen isotopes – calculate the percentage abundance of a given isotope.
	Relative Atomic Mass	At the end of this activity, students should be able to: give a definition of atomic mass unit – explain the terms atomic mass and molecular mass – find atomic masses of elements in the periodic table – calculate the atomic mass of an element taking into account its isotopic composition – calculate the isotopic composition of an element on the basis of its atomic mass – explain why it is useful to know the atomic masses of elements.
	Continuous and Line Spectra	At the end of this activity, students should be able to: explain the phenomenon of light – describe and interpret an experiment involving the passing of white light through a prism – discuss the electromagnetic spectrum – describe the atomic spectrum of hydrogen – describe atomic spectra of other elements – discuss the application of flame tests.
	The Bohr Model of the Atom	At the end of this activity, students should be able to: discuss the Bohr model of the atom – define atomic energy levels – discuss the ground state and excited states of the hydrogen atom – explain the formation of the spectral lines in the atomic spectrum of hydrogen – discuss the process of ionization.
	The Electron Configuration of an Atom	At the end of this activity, students should be able to: state the arrangement of electrons in the individual subshells of an atom – write the electron configuration of an atom, knowing its atomic number – give the principles of the classification of elements in the periodic table – determine which group and period a given element belongs to on the basis of its electron configuration – determine the electron configuration of an element knowing its position in the periodic table – describe the formation of positive and negative ions.

CHAPTER	LESSON	DESCRIPTION
IV. Bonding	**Ionic Bonding. Part I**	At the end of this activity, students should be able to: explain how ionic compounds are formed using the example of sodium chloride – describe the structure of sodium chloride in the solid state – compare the properties of sodium, chlorine and sodium chloride – solve simple problems concerning ionic bond formation.
	Ionic Bonding. Part II	At the end of this activity, students should be able to: discuss the nature of ionic bonds – predict the type of ion formed by Group 1 and 2 metals and the more important Group 16 and 17 nonmetals – describe the structure of an ionic crystal lattice – name the characteristic properties of ionic compounds and explain how they arise.
	Covalent Bonding. Part I	At the end of this activity, students should be able to: discuss the formation of covalent bonds – indicate which elements form covalent bonds – explain the terms: Lewis dot-and-cross diagrams, structural formula and molecular formula – name the non-metals that occur in nature in the form of diatomic molecules – illustrate simple diatomic molecules using molecular formulae, structural formulae and Lewis diagrams – explain how multiple bonds are formed.
	Covalent Bonding. Part II	At the end of this activity, students should be able to: give the definition of valence – write down the formula for a molecule, knowing the valences or ionic charges – give examples of diatomic and polyatomic molecules – know that carbon atoms can form single, double or triple bonds with one another.
	Simple and Giant Molecular Solids	At the end of this activity, students should be able to: describe the structure of the crystal lattice of covalent compounds – define the terms simple molecular solid and giant molecular solid – give some examples of simple and giant molecular solids – describe the properties of elements and compounds forming simple molecular solids and giant molecular solid crystals – explain why certain giant molecular solids conduct electricity, and give examples of such solids.
	Allotropes	At the end of this activity, students should be able to: explain the phenomenon of allotropy – give examples of elements that occur in different allotropic forms – describe the allotropic forms of carbon, oxygen and sulphur – describe the physical properties of diamond and graphite – give examples of the uses of graphite and diamond – discuss the role of ozone in nature.
	Metallic Bonding	At the end of this activity, students should be able to: identify metals – describe the characteristic physical properties of metals – describe the position of metals in the periodic table and recall their electron configurations – describe the nature of metallic bonding based on the 'electron sea' model – explain how the properties of metals arise from their inner structure.
	Alloys	At the end of this activity, students should be able to: define alloys – give examples of iron, aluminium, copper and tin alloys – describe some uses of steel, brass, bronze and Duralumin – explain why alloys have different properties from pure metals.
V. Representing Chemical Reactions	**Chemical and Physical Change**	At the end of this activity, students should be able to: explain what a physical change and a chemical change involve – give examples of physical changes and chemical changes – discuss the methods for representing a chemical change – define the terms: reactant and product and identify them in a chemical equation.
	Chemical Equations	At the end of this activity, students should be able to: describe how the number of molecules and the number of atoms in a molecule are indicated – write down a simple chemical reaction using symbols for elements and formulae for compounds – balance simple chemical equations using stoichiometric coefficients – explain how the physical states of reactants are indicated in chemical equations – give the definition of a stoichiometric coefficient.

CHAPTER	LESSON	DESCRIPTION
	Reaction Types	At the end of this activity, students should be able to: explain the following reaction types: combination, decomposition, displacement, precipitation, neutralisation, oxidation reaction and reduction reaction, exothermic reaction, endothermic reaction, reversible reaction and irreversible reaction – name the type of reaction, given a chemical equation.
VI. Quantitative Aspects of Chemical Reactions	**Atomic and Molecular Mass**	At the end of this activity, students should be able to quote the law of conservation of mass and explain it on the basis of the particularity of matter, explain the terms: atomic mass and molecular mass, read the atomic masses of elements from the periodic table, calculate the molecular masses of chemical compounds, obtain information about the quantitative composition of chemical compounds from their molecular formulae, and use the different ways of representing the composition of substances.
	The Mole	At the end of this activity, students should be able to: the unit of quantity of matter – the mole – Avogadro's number – the molar mass – calculating the number of moles – interpreting molecular formulae in terms of moles – empirical formulae – calculating the percentage composition of a chemical compound.
	Using the Mole Concept	At the end of this activity, students should be able to: write a chemical equation using the molar interpretation – solve simple problems using the mole concept – calculate the mass of products or reactants in a chemical reaction – calculate the volumes of gaseous products – solve simple problems using the concept of molarity – calculate the molarity of an acid or base using acid-base titration.
VII. Acids, Bases and Salts	**Properties of Acids**	At the end of this activity, students should be able to: explain the properties of acids – name a few uses of acids – describe the structure of acids – give the definition of dissociation and understand this process – describe the dissociation of weak and strong acids.
	Properties of Bases	At the end of this activity, students should be able to: give the definition of a hydroxide – describe the properties of bases – describe the uses of bases – determine the structure of bases – give a definition of dissociation – define the terms 'strong' and 'weak' bases and describe their behaviour in water.
	Indicators and pH	At the end of this activity, students should be able to: state the purpose of indicators – determine the pH of a solution using an indicator – determine the acidity or alkalinity of a solution using the pH scale – indicate the colours corresponding to alkaline, neutral and acidic solutions on the pH scale – identify strong and weak acids and strong and weak alkalis on the basis of the pH value of their solutions – discuss the applications of pH measurements.
	Neutralisation Reactions	At the end of this activity, students should be able to: explain what neutralization involves and how it is carried out – determine the molecular formula of a salt – name salts – balance equations for neutralization reactions – discuss the practical applications of neutralisation reactions.
	Salts	At the end of this activity, students should be able to: give examples of salts occurring in nature – give examples of some uses of salts – discuss the dissociation of salts and specify the types of ion present in a solution of a salt – describe the reaction between a metal and an acid at the macroscopic and microscopic levels – discuss precipitation reactions, using appropriate examples – classify some common salts as soluble or insoluble – describe the thermal decomposition of carbonates.
	Reactions of Acids and Bases	At the end of this activity, students should be able to: discuss reactions between nonmetal oxides and water – discuss reactions between bases and nonmetal oxides – discuss reactions between acids and metal oxides – discuss reactions between carbonates or hydrogencarbonates and acids – discuss reactions between acids and a solution of ammonia.

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	Acid-Base Titration	At the end of this activity, students should be able to: describe the principles of titration and how it is carried out – discuss the aims of titration – calculate the mass of a solute – determine the concentration of a solution by titration – calculate the mass of solute in a titrated sample.
VIII. Water and Water Solutions	**Properties of Water**	At the end of this activity, students should be able to: describe the structure of the water molecule – explain the process of formation of hydrogen bonds – describe the process of dissolution of ionic compounds (electrolytic dissociation) – list methods for detecting the presence of water – explain what distilled water is – discuss the effect of the presence of other substances in water on water's freezing and boiling points.
	Solubility in Water	At the end of this activity, students should be able to: define the terms: saturated solution, solubility, crystallisation, solubility curve – describe the dissolution of gases, liquids and solids in water and discuss the effect of various physical factors on this process – use a solubility curve to find the number of grams of a solute that will be dissolved at a specific temperature and perform simple calculations using the data obtained from this graph.
	Natural Waters	At the end of this activity, students should be able to: explain what hard water is, the causes and types of water hardness – describe the methods for eliminating temporary and permanent hardness from water – name the main water pollutants and the sources of this pollution – describe methods for removing water pollution caused by petroleum and petroleum products – name the main processes carried out during water treatment – describe the main steps in wastewater purification.
	Colloids. Washing in Water	At the end of this activity, students should be able to: explain what colloids are – name the properties that distinguish colloids from other types of mixture (true solutions and suspensions) – list the types of colloid and give examples of them – explain what emulsifying agents are and what coagulation involves – explain how soap and detergents remove dirt – describe the behaviour of soap and detergents in hard water.
IX. The Periodic Table and Chemical Properties of the Elements	**The Periodic Table**	At the end of this activity, students should be able to: give the criteria for the classification of the elements in the periodic table – state the group in which a given element occurs on the basis of the number of its valence electrons, and vice versa – state the period in which a given element occurs on the basis of the number of electron shells, and vice versa – determine whether a given element is a metal, a metalloid or a nonmetal from its position in the periodic table – give examples of similarities in the properties of elements within a given main group – give examples of periodic changes in the properties of elements that occur in the same period.
	Noble Gases	At the end of this activity, students should be able to: write the electron configuration of the first three elements of Group 18 – describe the trends in the melting points, boiling points and densities in Group 18 – state the relationship between their atomic structure and the properties of the noble gases – account for the chemical inertness of the noble gases – give an example of a compound of a noble gas – give examples of the uses of the noble gases.
	Alkali Metals	At the end of this activity, students should be able to: describe the electron configuration of the alkali metals – describe the trends in the melting points and the boiling points of Group 1 elements – describe the trends in the density of Group 1 elements – explain the relationship between the atomic structure and the properties of the alkali metals – describe the trends in the reactivity of the alkali metals – describe the trends in the atomic radii of the Group 1 metals.

CHAPTER	LESSON	DESCRIPTION
	Reactions of Alkali Metals	At the end of this activity, students should be able to: describe the electron configuration of alkali metals – write equations for the reactions of alkali metals with water, the halogens and oxygen – know the relationship between the structure of the halides of alkali metals and their properties – know the relationship between the structure of the oxides of alkali metals and their properties – describe the uses of alkali metal compounds.
	Alkaline Earth Metals. Group 2	At the end of this activity, students should be able to: describe the electron configuration of Group 2 metals – write equations for the reactions of the alkaline earth metals with water and oxygen – describe the relationship between the structure of the Group 2 elements and their chemical and physical properties – compare the reactivity of the metals of Groups 1 and 2 of the periodic table.
	Halogens. Group 17	At the end of this activity, students should be able to: represent the electron configuration of the elements of Group 17 – explain the formation of halogen molecules – compare the solubility of halogens in water and in hexane and give reasons for the differences – describe the trends in the melting points and boiling points in Group 17 – describe the relationship between the atomic structure and the physical properties of the elements – mention the uses of halogens and their compounds.
	Reactions of the Halogens	At the end of this activity, students should be able to: account for the high reactivity of the halogens – describe the trend in the reactivity with increasing atomic number of the halogens within the group – explain why chlorine is more reactive than bromine – write equations for reactions of halogens with metals and hydrogen – account for the acidic character of hydrogen halides – mention the most important properties and applications of hydrochloric acid – predict whether a molecule of a given halogen will react with a simple ion of another halogen.
	Transition Elements	At the end of this activity, students should be able to: describe the position of the transition elements in the periodic table – give examples of transition elements – describe the basic physical properties of transition elements – name the properties that are characteristic of transition elements – give examples of transition elements used as catalysts.
X. Reactivity of Metals	**The Reactivity Series**	At the end of this activity, students should be able to: explain what the reactivity series of metals is and what can be predicted from it – determine the reactivity of a metal from its position in the reactivity series – describe how metals react with hydrochloric acid, cold water, steam and oxygen – state which metals displace hydrogen from acids on the basis of the reactivity series – explain what noble metals are and what chemical properties they have in common.
	Reactions Involving Metals	At the end of this activity, students should be able to: use the reactivity series to predict the direction of displacement of metals by other metals from solutions of their salts – know that metal ores occur in the Earth's crust – know how metals are extracted from their ores – know that the method for the extraction of a particular metal from its ore depends on the reactivity of this metal – explain what the process of corrosion involves – name the factors that influence the rate of corrosion of iron – explain how to prevent corrosion.
	Electrochemical Cells	At the end of this activity, students should be able to: define a voltaic cell; - explain the structure and the principles of a voltaic cell – give an example of a chemical reaction that occurs in a cell – write equations for half-reactions in a voltaic cell – discuss the principles of a fuel cell – discuss the practical applications of voltaic cells and fuel cells.

CHAPTER	LESSON	DESCRIPTION
XI. Electrolysis	Conductivity of Electrolytes	At the end of this activity, students should be able to: know why some substances conduct an electric current in the molten state or in aqueous solutions – know what electrolytes are – explain how to distinguish between an electrolyte and a non-electrolyte – give examples of electrical conductors – determine which ions are present in a molten salt – specify which ions are present in a solution of an electrolyte.
	Electrolysis	At the end of this activity, students should be able to: say what electrolysis is and how it is carried out describe the apparatus for carrying out electrolysis identify the cathode and anode in an operating electrolyzer determine the products of electrolysis of typical molten salts and typical aqueous solutions write equations for the electrode reactions that occur during the electrolysis of typical solutions.
	Applications of Electrolysis and Calculations Connected with Electrolysis	At the end of this activity, students should be able to: describe how the electrolysis of brine proceeds , explain what electroplating involves, name the uses of electrolysis, calculate the quantity of product prepared by an electrolysis, calculate the time during which electric current must be applied to yield a given amount of a product by electrolysis.
XII. Organic Chemistry	Alkanes	At the end of this activity, students should be able to: indicate which compounds are classed as organic compounds, on the basis of their chemical formulae, explain the terms: hydrocarbons, saturated hydrocarbons, alkanes and homologous series, give the names and formulae of the individual members of the homologous series of alkanes containing from 1 to 10 carbon atoms.
	Isomerism of Alkanes	At the end of this activity, students should be able to: define the terms isomerism and isomers, explain what alkyl groups are and give the names of alkyl groups corresponding to individual members of the homologous series of alkanes, name simple isomers of straight chain alkanes that have one substituent or several substituents of the same type, and isomers that have different substituents, explain why straight chain alkanes are characterised by higher boiling and melting points than their branched isomers.
	Alkenes	At the end of this activity, students should be able to: explain the term unsaturated hydrocarbons or alkenes, give the names and formulae of simple alkenes and isomers that differ in the position of the double bond, describe the addition reactions of bromine and hydrogen to alkenes, discuss the rules of nomenclature for brominated derivatives of alkenes.
	Alcohols	At the end of this activity, students should be able to: explain what alcohols are, give names and formulae for common monohydric alcohols, describe the methods for obtaining ethanol, and discuss its uses, describe the reaction between ethanol and sodium, and the dehydration reaction, give examples of dihydric and trihydric alcohols.
	Carboxylic Acids	At the end of this activity, students should be able to: explain what carboxylic acids and esters are, give the names and formulae of common carboxylic acids, discuss the chemical properties of carboxylic acids (acidity of aqueous solutions), write down the reactions of ethanoic or methanoic acid with magnesium, copper(II) oxide and carbonates, give examples of higher fatty acids, discuss the structure of soaps, write down the reaction for esterification and specify the conditions under which it proceeds.
XIII. Chemical Reactions	Endothermic and Exothermic Reactions	At the end of this activity, students should be able to: describe the phenomenon of energy transfer in a chemical reaction, define exothermic and endothermic reactions, identify exothermic and endothermic reactions, draw energy diagrams, do simple calculations associated with energy transfer during a chemical reaction.
	Reversible Reactions and Chemical Equilibrium	At the end of this activity, students should be able to: know what irreversible and reversible processes are, give examples of reversible and irreversible processes, explain the state of dynamic equilibrium, know what factors affect equilibrium, apply Le Chatelier's principle in reversible reactions

CHAPTER	LESSON	DESCRIPTION
	Reaction Rate	At the end of this activity, students should be able to: define reaction rate as the change of concentration of reactants or products with time, give examples of fast and slow reactions, draw a graph showing changes of concentration with time, find reaction rates from given experimental data, describe the basic methods for the determination of reaction rates, describe the economic importance of reaction rates.
	Factors Affecting Reaction Rate	At the end of this activity, students should be able to: explain the collision theory give the factors affecting chemical reaction rates propose methods for increasing a reaction rate define a catalyst.
	Catalysts	At the end of this activity, students should be able to: define catalysts, explain the concept of activation energy, explain the mechanism of catalyst action, give examples of applications of catalysts, identify the benefits of using catalysts in industry.
	Enzymes – Biological Catalysts	At the end of this activity, students should be able to: explain how to significantly increase the reaction rate, define enzymes and give examples of them, describe the action of enzymes and their importance in everyday life, explain the process of fermentation, define biotechnological process, give an example of biotechnological process.
XIV. Useful Products From Organic Sources	**Fossil Fuels and Crude Oil**	At the end of this activity, students should be able to: understand the role of fossil fuels, know the origin of fossil fuels, know the location of the main deposits of fossil fuels in the world, understand the fractional distillation process.
	Cracking and Combustion of Hydrocarbons	At the end of this activity, students should be able to: know and understand the cracking process, understand what octane rating means, know the products from the complete and the incomplete combustion of hydrocarbons.
	Polymers	At the end of this activity, students should be able to: define the terms - monomer, polymer, polymerization, describe the structures of polymers and classify them according to the structure of macromolecules, define a copolymer, indicate everyday objects that are made of plastic, mention the basic properties of polymers, explain the terms thermoplastics and thermosetting plastics, describe the uses of at least three different polymers.
	Environmental Impact of Oil Products	At the end of this activity, students should be able to: know how to identify the products from the complete combustion of hydrocarbons, understand the origin of unwanted industry-related effects in the atmosphere, know what we could do to combat the greenhouse effect, acid rains, increasing amounts of plastic litter, understand the difference between total and incomplete combustion of hydrocarbons.
XV. Useful Products from Rocks	**Metals from Metal Ores**	At the end of this activity, students should be able to: mention the most important chemical elements which make up the Earth's crust, give the names of minerals that contain iron, aluminum, titanium and copper and write their chemical formulas, predict, on the basis of the reactivity series of the metals, whether a given metal can displace another metal from its compounds, discuss the methods for metal extraction from ores.
	Iron	At the end of this activity, students should be able to: describe the method for the extraction of iron in a blast furnace, explain the production process for steel, describe the corrosion of iron and steel, describe methods for the protection of iron and steel against corrosion.
	Aluminum	At the end of this activity, students should be able to: name the ores of aluminum, describe the process of extracting aluminum from bauxite, using aluminum as an example, discuss the phenomenon of passivation, mention the most important uses of aluminum, explain how aluminum is recycled and indicate the benefits of this process.

CHAPTER	LESSON	DESCRIPTION
	Copper and Titanium	At the end of this activity, students should be able to: name the minerals that contain copper and titanium, discuss methods for the extraction and refining of copper, describe the method for the extraction of titanium, explain why titanium and copper do not corrode, state the uses of copper and titanium.
	Industrial Uses of Limestone	At the end of this activity, students should be able to: name the types of rock that contain calcium carbonate, describe the reactions that occur in limestone in the presence of carbon dioxide and water, explain what quicklime and slaked lime are and how they are prepared, explain the terms mortar, cement, concrete and glass, describe the methods of preparation and applications of these materials.
	Sulfur and Sulfuric(VI) Acid	At the end of this activity, students should be able to: name the principal minerals that contain sulfur, discuss the properties of sulfur, describe the methods for the extraction and the combustion reactions of sulfur, discuss the process for manufacturing and the hygroscopic properties of sulfuric(VI) acid, discuss the uses of sulfur and sulfuric(VI) acid, describe the effect of sulfur dioxide on living organisms and on the process of corrosion.
XVI. Useful Products from Air	**Air**	At the end of this activity, students should be able to: name the constituents of clean air, name the pollutants of air, their sources and environmental impact, explain the terms 'acid rain' and 'smog', discuss the preparation of oxygen and nitrogen from air, describe the properties of oxygen and its applications.
	Ammonia and Nitric Acid	At the end of this activity, students should be able to: describe the properties of nitrogen, and its uses, describe the properties of ammonia and the method for its synthesis on an industrial scale, describe the properties of nitric(V) acid and the steps in its preparation from ammonia, give the definition of reaction yield and be able to use it in simple calculations.
	Fertilizers	At the end of this activity, students should be able to: discuss the structure of soil, name the basic elements essential for plants and discuss their effect on plants, give natural and artificial sources of these elements, describe the processes for preparing basic artificial fertilizers containing nitrogen, phosphorus and potassium, describe the effect of fertilizers on water basins or reservoirs, and ways of preventing the pollution of surface water with fertilizers.
XVII. Food and Drugs	**Carbohydrates**	At the end of this activity, students should be able to: give the definitions of carbohydrates, mono-, di- and polysaccharides, describe the structures of glucose, fructose, sucrose, starch, cellulose and glycogen, describe the properties of these compounds and give reactions for their identification, discuss the importance of carbohydrates in the diet.
	Proteins	At the end of this activity, students should be able to: describe what amino acids, polypeptides and proteins are, discuss the spatial structure of proteins, explain the phenomenon of denaturation and name the factors that cause it, describe the color reactions used for the detection of proteins.
	Fats	At the end of this activity, students should be able to: describe the structure of a fat molecule, classify fats according to their physical state, origin and structure, describe the reactions of saponification and the hardening of oils, give the uses of fats.
	Food and Drugs	At the end of this activity, students should be able to: explain what vitamins are and classify them as water-soluble or fat-soluble, mention some sources of vitamins, discuss methods for protecting food against the adverse effect of bacteria and oxygen, explain the terms: avitaminosis, hypervitaminosis, antivitamin, functional food, antibiotics.

CHAPTER	LESSON	DESCRIPTION
XVIII. Chemistry and the Earth	The Structure of the Earth	At the end of this activity, students should be able to: define the relative positions of the Earth, Moon and Sun in the Universe, name the layers of the Earth, describe the properties of the main layers within the Earth, compare the abundance of elements in the Earth's crust and in the whole of the Earth, specify the sources of information used to determine the structure of the inner part of the Earth, describe how density, pressure and temperature vary with depth from the surface, specify the position of the magnetic poles of the Earth.
	Tectonic Plates	At the end of this activity, students should be able to: say what tectonic plates are and describe their properties, explain why tectonic plates shift, explain what happens in places where the edges of tectonic plates meet, describe what divergent, convergent and transform boundaries are, give evidence for the expansion of the ocean floor, present the evidence for the changes in the Earth's magnetic field in the past, say how continents move, give the evidence for continental drift.
	Tectonic Movements, Earthquakes and Volcanoes	At the end of this activity, students should be able to: explain how volcanoes form, explain why earthquakes occur and describe where they occur most often, show the location of volcanoes on the Earth, using a map with the tectonic plates marked on it, show the location of seismic zones on the Earth, using a map with the tectonic plates marked on it, describe the effect of the processes involving tectonic plates on the formation of volcanoes and earthquakes, describe the applications of the Richter scale.
	Igneous Rocks	At the end of this activity, students should be able to: explain what minerals are, what rocks are composed of and what is the difference between a rock and a mineral, explain which chemical compounds are the principal components of magma, explain how igneous rocks are formed and classify them according to the form of their crystals, distinguish between intrusive and extrusive rocks, give examples of the most common igneous rocks and explain the differences between them, list the characteristic properties of igneous rocks, know the applications of igneous rocks.
	Sedimentary Rocks. Part I	At the end of this activity, students should be able to: explain what weathering is and list the factors that influence this process, name and describe the types of rock weathering, give examples of physical, chemical and biological weathering, explain what erosion involves and give examples of different forms of erosion, name the ways in which weathered rocks are transported, discuss rock transportation by water, wind and glaciers, explain the origin of sediments on sea and ocean floors.
	Sedimentary Rocks. Part II	At the end of this activity, students should be able to: explain how sedimentary rocks were formed, account for the order in which rock layers are arranged, explain how fossils were formed, determine the age of rock layers on the basis of the fossils found in them, give examples of the most common sedimentary rocks and explain the differences between them, name the characteristic properties of sedimentary rocks, describe the principal component of limestone rocks.
	Metamorphic Rocks and Circulation of Rock Material	At the end of this activity, students should be able to: explain how metamorphic rocks are formed, give examples of the most common metamorphic rocks, mention the characteristic properties of metamorphic rocks, discuss the 'rock cycle', recognize the basic types of rock on the basis of their characteristic properties.
	The Atmosphere	At the end of this activity, students should be able to: explain how the Earth's atmosphere evolved before reaching its present composition, describe the approximate percentage composition of the atmosphere at present, discuss the structure of the atmosphere, describe the process of formation of radicals by the break-up of a covalent bond, explain how chlorine radicals can deplete the ozone layer, explain the effect of the ozone-hole expansion on human health, explain how the ozone layer is formed, describe the causes of the greenhouse effect, and what impact it could have on the living conditions on Earth.

CHAPTER	LESSON	DESCRIPTION
	Oceans	At the end of this activity, students should be able to: explain how the oceans were formed, explain the origin of salts in the oceans, list the characteristic properties of sea water, list the most abundant ions in sea water, discuss the concentration of salts in oceans, discuss salinity balance, discuss the role of the oceans in maintaining the composition of the atmosphere, discuss the economic importance of the oceans.
XIX. Laboratory Techniques and Analytical Tests	**Handling Liquids**	At the end of this activity, students should be able to: explain the purpose of a graduated cylinder, pipette and burette and describe how they are used, describe how to transfer a liquid from a bottle to a beaker, carry out a temperature measurement and determination of the pH and odour of a liquid, determine the age of rock layers on the basis of the fossils found in them, heat a liquid in a test-tube in a safe way.
	Handling Solids. Heating	At the end of this activity, students should be able to: describe how solids are stored, give guidelines on how to correctly transfer solids from containers, and how to weigh and crush solids, explain what decantation, filtration and evaporation involve and why these techniques are used, discuss the structure of the Bunsen burner and its safe use.
	Gases: Handling and Laboratory Tests	At the end of this activity, students should be able to: describe the set-up used for collecting gases, prepare equipment for measuring the volume of gases evolved from various chemical reactions, describe methods for obtaining oxygen, hydrogen and carbon dioxide in a chemistry lab and for the identification of these gases, discuss how to use indicator paper when investigating gases.
	Testing for Ions	At the end of this activity, students should be able to: explain what a flame test involves, give the flame colors characteristic of lithium, sodium, potassium, barium, calcium, copper and lead, and be able to distinguish between these metals on the basis of their flame colours, describe simple methods for detecting ammonium, carbonate, sulfate(VI), sulfate(IV) and halide ions.
XX. Safety in the Chemical Laboratory	**Safety in the Chemical Laboratory**	At the end of this activity, students should be able to: recognise the types of hazardous substance on the basis of the hazard symbols, read the hazards involved in contact with a given substance and the guidelines for handling on the basis of the R and S symbols, specify appropriate personal protective equipment, discuss the principles for the safe conduct of experiments, describe the procedure in an emergency.

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.