

## ICATS CONTESTS

### SCIENCE: COURSE OUTLINE AND LEARNING OUTCOMES

#### GRADE 9-10

#### 1. BRANCHES OF BIOLOGY

##### Cell Biology:

- Describe the structure and function of a eukaryotic cell, including the major organelles.
- Understand the difference between prokaryotic and eukaryotic cells.
- Explain the cell cycle and its importance in growth and repair.

##### Genetics:

- Define basic genetics terms, including genes, alleles, and chromosomes.
- Explain the principles of Mendelian inheritance and solve Punnett squares for simple genetic traits.
- Understand the concept of genetic variation and its role in evolution.

##### Ecology:

- Identify and describe different ecosystems and biomes.
- Explain the interdependence of living organisms in an ecosystem and the role of biodiversity.
- Understand ecological concepts such as food chains, food webs, and the carbon cycle.

##### Human Anatomy and Physiology:

- Explore the structure and function of the major human organ systems, including the circulatory, respiratory, digestive, and nervous systems.
- Describe how these systems work together to maintain homeostasis in the human body.
- Understand the effects of lifestyle choices on human health.

##### Evolution:

- Explain the theory of evolution by natural selection and provide evidence for it.
- Understand the concept of common ancestry and the tree of life.
- Discuss the role of mutations and adaptation in the evolutionary process.

### **Biotechnology and Genetic Engineering:**

- Describe the applications of biotechnology in fields like medicine, agriculture, and forensics.
- Understand the ethical and societal implications of genetic engineering and biotechnology.
- Explain the basics of DNA technology and genetic modification.

### **Plant Biology:**

- Describe the structure and function of plant cells and tissues.
- Explain photosynthesis and cellular respiration in plants.
- Understand the life cycle of plants and their role in ecosystems.

### **Microbiology:**

- Explain the role of microorganisms in various ecosystems and their impact on human health.
- Understand the principles of disease transmission and prevention.
- Describe the importance of beneficial microorganisms in processes like fermentation.

### **Biological Diversity:**

- Explore the classification of living organisms into domains, kingdoms, and phyla.
- Understand the importance of conservation and biodiversity preservation.
- Identify and describe different groups of organisms, from prokaryotes to eukaryotes.

### **Scientific Method and Experimentation:**

- Apply the scientific method to investigate biological questions and problems.
- Design and conduct experiments, collect data, and analyze results.
- Communicate findings through scientific reports and presentations.

## **2. ELECTROSTATICS**

- **Coulomb's Law:** Students should be able to explain and apply Coulomb's Law, understanding how the magnitude of the electrostatic force between two point charges depends on their charges and the distance between them.
- **Electric Charge:** Students should be able to define and differentiate between positive and negative charges. They should understand that like charges repel, while opposite charges attract.

- **Quantization of Charge:** Students should comprehend the concept of quantization of charge and recognize that charge is quantized in units of the elementary charge ( $e$ ).
- **Electric Field:** Students should understand the concept of an electric field, be able to calculate the electric field around point charges, and recognize its direction.
- **Electric Potential Energy:** Students should be able to calculate the electric potential energy between two charges and understand how it relates to the work done in bringing charges together or moving them apart.
- **Electric Potential (Voltage):** Students should grasp the concept of electric potential (voltage) and be able to calculate the voltage difference between two points in an electric field.
- **Electric Potential Difference:** Students should understand that electric potential difference causes the flow of charge, commonly known as electric current.
- **Insulators and Conductors:** Students should be able to distinguish between insulators and conductors, understanding the movement of charges in both types of materials.
- **Electric Fields and Conductors:** Students should know that the electric field inside a conductor is zero at electrostatic equilibrium.
- **Gauss's Law:** Students should be introduced to Gauss's Law and understand its application in calculating the electric field for symmetric charge distributions.
- **Practical Applications:** Students should be able to discuss and provide examples of practical applications of electrostatics in daily life, such as static electricity, Van de Graaff generators, and inkjet printers.
- **Safety Precautions:** Students should be aware of safety precautions related to electrostatic discharge and understand the risks associated with handling charged objects.
- **Historical Perspective:** Students should have an appreciation of the historical development of the understanding of electrostatics, including the contributions of scientists like Benjamin Franklin and Michael Faraday.
- **Experiments and Demonstrations:** Students should be able to conduct simple experiments and demonstrations related to electrostatics to reinforce their understanding of the concepts.

### 3. GEOLOGY

#### Identify Major Geologic Concepts:

- Define and differentiate key geologic terms, such as minerals, rocks, fossils, erosion, weathering, and plate tectonics.

- Explain the significance of geological time scales and understand the concept of Earth's geological history.

### **Rock Types and Formation:**

- Classify common rock types (igneous, sedimentary, and metamorphic) based on their properties, origins, and processes.
- Explain how each type of rock is formed and the associated geological processes involved.

### **Plate Tectonics and Earth's Structure:**

- Describe the structure of the Earth's interior (crust, mantle, core) and explain how it relates to plate tectonics.
- Understand the theory of plate tectonics and its role in shaping the Earth's surface, including the formation of mountains, earthquakes, and volcanic activity.

### **Landforms and Surface Processes:**

- Identify and explain the formation of various landforms, such as mountains, valleys, canyons, and coastlines, through processes like erosion, deposition, and weathering.
- Describe how glaciers, rivers, wind, and waves shape the Earth's surface.

### **Fossils and Earth's History:**

- Understand the concept of fossils and their role in reconstructing Earth's history.
- Explain how the principles of relative dating and radiometric dating are used to determine the age of rocks and fossils.

### **Natural Hazards and Resources:**

- Recognize the potential natural hazards associated with geological processes, including earthquakes, volcanic eruptions, landslides, and tsunamis.
- Discuss the importance of Earth's resources, such as minerals, groundwater, and fossil fuels, and the environmental impact of their extraction.

### **Environmental Awareness:**

- Analyze how human activities impact the environment and geology, including topics like soil erosion, land use planning, and resource conservation.

### **Scientific Inquiry and Methods:**

- Apply scientific methods, including observation, hypothesis testing, and data analysis, to investigate geological phenomena and answer questions about the Earth's past and present.

### **Geological Maps and Tools:**

- Interpret geological maps and use basic geological tools (compass, rock hammer, magnifying glass) to collect and analyze geological data.

### **Earth's Place in the Universe:**

- Understand the position of Earth within the solar system and the universe and how geological processes on other planets and celestial bodies compare to those on Earth.

## **4. ENERGY**

### **Define Energy:**

- Define energy as the ability to do work or the capacity to cause change, and recognize that it comes in various forms, including kinetic, potential, thermal, chemical, and more.

### **Identify and Describe Energy Transformations:**

- Recognize and describe energy transformations in various systems and processes, such as the conversion of potential energy to kinetic energy, electrical energy to light energy, and chemical energy to thermal energy.

### **Laws of Thermodynamics:**

- Explain the first and second laws of thermodynamics, including concepts like the conservation of energy and the tendency for energy to disperse or increase in entropy in isolated systems.

### **Renewable and Non-renewable Energy Sources:**

- Differentiate between renewable and non-renewable energy sources, and understand their environmental and economic implications.

### **Energy Conservation:**

- Understand the importance of energy conservation and its role in reducing energy consumption and environmental impact.

### **Energy Efficiency:**

- Explain the concept of energy efficiency and its significance in technology and engineering, as well as how to calculate and improve the efficiency of energy conversion systems.

### **Energy Units and Conversions:**

- Utilize appropriate units for measuring energy (e.g., joules, kilowatt-hours) and perform conversions between them.

### **Work and Power:**

- Define work and power, and apply these concepts to calculate the amount of work done and the power expended in various situations.

### **Energy Sources and Sustainability:**

- Analyze the sustainability and environmental impact of different energy sources, including fossil fuels, nuclear energy, and renewable energy options.

### **Energy Transfer:**

- Explain how energy is transferred through waves (e.g., electromagnetic waves) and mechanical waves (e.g., sound waves), and understand the relationship between frequency, wavelength, and energy.

### **Energy in Biological Systems:**

- Describe how energy is transferred and transformed within living organisms, including cellular processes like photosynthesis and respiration.

### **Energy Policy and Global Issues:**

- Explore the role of energy in global and local political, economic, and environmental issues, including climate change, energy security, and resource management.

### **Practical Applications:**

- Apply knowledge of energy principles to practical situations, such as designing energy-efficient devices, analyzing energy bills, and making informed decisions about energy consumption.

### **Safety and Ethics:**

- Understand the safety measures and ethical considerations associated with energy production and use, including issues related to the nuclear industry, environmental conservation, and occupational safety.

## **5. FORMS OF ENERGY**

### **Identify and Define Forms of Energy:**

- Define and identify different forms of energy, including mechanical, thermal, chemical, electrical, nuclear, and electromagnetic energy.

### **Energy Transformation:**

- Describe and illustrate how energy can change from one form to another, such as potential energy to kinetic energy or electrical energy to thermal energy.

### **Law of Conservation of Energy:**

- Understand the principle of the conservation of energy and explain that energy cannot be created or destroyed, only transformed from one form to another.

### **Thermal Energy and Temperature:**

- Understand the relationship between thermal energy and temperature, including the concept of thermal equilibrium.

### **Electromagnetic Energy:**

- Explain the properties and characteristics of electromagnetic energy, including the electromagnetic spectrum, and how it relates to visible light and other forms of radiation.

### **Electrical Energy:**

- Describe the generation, transmission, and utilization of electrical energy, including the principles of electrical circuits and safety precautions.

### **Mechanical Energy:**

- Understand the concepts of potential and kinetic energy, as well as the principles of work, power, and mechanical advantage.

### **Chemical Energy:**

- Explain how chemical reactions involve the release or absorption of energy and identify examples of chemical energy storage and conversion.

### **Nuclear Energy:**

- Describe the basics of nuclear energy, including nuclear fission and fusion, and their implications for energy production.

### **Renewable and Non-Renewable Energy Sources:**

- Differentiate between renewable and non-renewable energy sources, and discuss the environmental and economic implications of each.

### **Energy Efficiency and Conservation:**

- Explore the concepts of energy efficiency and conservation, and identify strategies for reducing energy consumption in daily life.

### **Energy in Everyday Life:**

- Recognize and analyze the various ways in which different forms of energy are used in everyday life, such as in transportation, heating, and electricity generation.

### **Energy in Environmental Issues:**

- Investigate and discuss how the choices and uses of energy sources impact environmental issues such as climate change, air quality, and resource depletion.

### **Energy Technologies:**

- Explore emerging energy technologies, including solar panels, wind turbines, and electric vehicles, and their potential to address energy challenges.

### **Energy Policy and Global Considerations:**

- Understand the role of energy policy at local, national, and global levels and its implications for energy security, sustainability, and international relations.

### **Heat:**

- Explain the nature of heat as a form of energy transfer.
- Describe the difference between temperature and heat.
- Understand the concept of thermal expansion and contraction.



- Apply the principles of heat transfer (conduction, convection, radiation) to real-world situations.
- Investigate how substances change state (e.g., melting, boiling) due to heat transfer.

### **Light:**

- Define light as a form of electromagnetic radiation.
- Explain the properties of light, including reflection, refraction, dispersion, and polarization.
- Understand the behavior of light in different mediums.
- Describe the formation and characteristics of images produced by mirrors and lenses.
- Explain the interaction of light with objects and the resulting perception of color.

### **Sound:**

- Define sound as a form of mechanical wave.
- Explain the relationship between sound, vibration, and pitch.
- Describe the properties of sound waves, including amplitude, frequency, and wavelength.
- Understand how the human ear detects and processes sound.
- Investigate the behavior of sound waves in different mediums and how they can be influenced by various factors.

### **Potential Energy:**

- Define potential energy as the energy an object possesses due to its position or state.
- Differentiate between gravitational potential energy and elastic potential energy.
- Calculate potential energy using the appropriate formula.
- Understand the concept of conservative and non-conservative forces in relation to potential energy.
- Apply the principles of potential energy to solve real-world problems and analyze physical systems.

### **Kinetic Energy:**

- Define kinetic energy as the energy of an object in motion.
- Calculate kinetic energy using the appropriate formula.
- Describe the relationship between potential and kinetic energy.
- Understand how the mass and velocity of an object affect its kinetic energy.
- Apply the principles of kinetic energy to analyze the motion of objects and solve practical problems.

### **Gravitational Potential Energy:**

- Understand the concept of gravitational potential energy as energy related to an object's position in a gravitational field.
- Calculate gravitational potential energy using the appropriate formula.
- Explain how changes in height or mass affect gravitational potential energy.
- Recognize the conservation of mechanical energy in the absence of non-conservative forces.
- Apply the principles of gravitational potential energy to analyze scenarios involving objects near the Earth's surface.

## **6. ATOM**

### **Atomic Structure:**

- Understand that atoms are the fundamental building blocks of matter.
- Describe the basic structure of an atom, including the nucleus (containing protons and neutrons) and electron cloud.
- Differentiate between protons, neutrons, and electrons in terms of their charge and location within the atom.
- Recognize the significance of the atomic number and mass number for identifying elements.

### **Elementary Particles:**

- Explain that protons and neutrons are composed of smaller particles called quarks.
- Describe the role of electrons in determining the chemical properties of an element.

### **Atomic Models:**

- Compare and contrast different atomic models, including the Bohr model and the electron cloud model.
- Explain the limitations and advances of each atomic model in representing the atom's structure.

### **Isotopes:**

- Define isotopes as atoms of the same element with different numbers of neutrons.
- Identify isotopes of common elements and their applications in various fields.

**Atomic Mass:**

- Define atomic mass and explain how it is calculated based on the weighted average of the masses of isotopes.
- Calculate the atomic mass of an element based on its isotopic composition.

**Electron Configuration:**

- Understand the concept of electron shells and subshells.
- Write electron configurations for elements using the periodic table.
- Explain the relationship between electron configuration and an element's position in the periodic table.

**Chemical Bonding:**

- Describe how atoms form chemical bonds through the sharing or transfer of electrons.
- Differentiate between ionic and covalent bonds and provide examples of each.
- Explain the role of valence electrons in chemical bonding.

**Molecules and Compounds:**

- Define molecules and compounds and distinguish between them.
- Identify common molecular compounds and their chemical formulas.
- Describe the properties of molecular and ionic compounds.

**The Periodic Table:**

- Use the periodic table to predict the properties of elements.
- Understand the organization of elements into periods and groups based on atomic structure and properties.

**Nuclear Reactions:**

- Explain the processes of nuclear decay, fusion, and fission.
- Understand the implications and applications of nuclear reactions in energy production and radioactive decay.

**Historical Context:**

- Explore the historical development of atomic theory, including contributions from scientists like Democritus, Dalton, Thomson, Rutherford, and Bohr.

### **Modern Advances:**

- Discuss modern advancements in atomic and subatomic particle research, such as particle accelerators and the discovery of new particles.

## **7. CHEMICAL REACTIONS**

### **Describe the Law of Conservation of Mass:**

- Explain that in a chemical reaction, the total mass of the reactants is equal to the total mass of the products.

### **Identify the Reactants and Products:**

- Recognize the reactants and products in a chemical reaction equation.
- Write balanced chemical equations for simple chemical reactions.

### **Classify Types of Chemical Reactions:**

- Differentiate between various types of chemical reactions, including synthesis, decomposition, combustion, single displacement, and double displacement reactions.
- Identify common characteristics and examples of each type of reaction.

### **Explain Factors Affecting Reaction Rates:**

- Understand how temperature, concentration, surface area, and the presence of a catalyst can affect the rate of a chemical reaction.

### **Define Activation Energy:**

- Define activation energy and its role in chemical reactions.
- Explain how activation energy can be affected by factors like temperature and catalysts.

### **Balance Chemical Equations:**

- Demonstrate the ability to balance chemical equations by ensuring the conservation of mass.
- Use coefficients to represent the relative quantities of reactants and products.

### **Interpret Chemical Reactions:**

- Interpret chemical equations to understand the stoichiometry of a reaction, including the mole ratios of reactants and products.

- Calculate the amount of reactants or products in a chemical reaction using stoichiometry.

#### **Apply Reaction Stoichiometry:**

- Solve problems involving limiting reactants and excess reactants in chemical reactions.
- Calculate the theoretical and actual yields in chemical reactions.

#### **Identify Chemical Reaction Mechanisms:**

- Describe the step-by-step process of complex reactions and explain reaction mechanisms.
- Recognize the intermediates and catalysts involved in reaction mechanisms.

#### **Relate Chemical Reactions to Everyday Life:**

- Explain the importance of chemical reactions in everyday life, such as in combustion, food digestion, and environmental processes.
- Recognize the role of chemical reactions in industrial and technological applications.

#### **Safety and Handling of Chemicals:**

- Understand and follow safety precautions and procedures when working with chemicals in a laboratory setting.
- Identify potential hazards and safe practices for chemical handling and disposal.

#### **Communicate Scientific Findings:**

- Present and communicate the results of chemical reactions and experiments effectively, using appropriate scientific language and symbols.
- Document and organize experimental data and observations.

### **8. CHANGES IN MATTER**

- Describe and differentiate between physical changes and chemical changes in matter, providing examples of each.
- Explain the fundamental differences between reversible and irreversible changes in the context of physical and chemical changes.
  
- Investigate and identify the factors that can influence the rate of chemical reactions, such as temperature, concentration, and surface area.

- Recognize the importance of energy changes in chemical reactions and the role of activation energy in determining reaction rates.
- Understand the concept of conservation of mass and how it applies to chemical reactions, emphasizing the law of conservation of mass.
- Explore how the periodic table and chemical formulas provide information about the composition of substances involved in chemical changes.
- Analyze and balance chemical equations to represent the reactants and products of chemical reactions.
- Investigate the concept of stoichiometry and its application in calculating reactant and product quantities in chemical reactions.
- Examine the factors influencing physical changes, such as changes in state (solid, liquid, gas), and understand phase transitions.
- Explore the role of pressure and temperature in phase changes, such as vaporization, condensation, and sublimation.
- Investigate the properties of acids and bases, including their characteristic chemical reactions and the concept of pH.
- Explore the effects of acids and bases on various substances, including indicators, metals, and household materials.
- Understand the basics of redox reactions and the transfer of electrons in chemical reactions.
- Investigate and understand how changes in the environment, such as temperature and pH, can affect enzyme activity and biological processes.
- Examine changes in living organisms, including growth, development, and reproduction, as well as the role of DNA and genetics in these processes.
- Explore ecological changes, including the concept of ecological succession and the impact of human activities on ecosystems.
- Investigate the impact of technological advancements on society and the environment, including both positive and negative consequences.
- Apply the scientific method to design and conduct experiments related to changes in matter and living organisms.
- Communicate scientific findings through written reports, oral presentations, and data analysis.

## 9. ORGANIC AND INORGANIC CHEMISTRY

### Chemical Elements and the Periodic Table

- Identify and describe the organization of elements on the periodic table.

- Understand the concept of atomic number, atomic mass, and the arrangement of electrons.

### **Chemical Bonding**

- Differentiate between ionic and covalent bonds.
- Explain the formation of chemical bonds using Lewis dot structures.
- Describe the role of valence electrons in chemical bonding.

### **Chemical Reactions**

- Identify and balance chemical equations for various types of reactions, such as synthesis, decomposition, combustion, and displacement reactions.
- Understand the law of conservation of mass in chemical reactions.
- Predict the products of common chemical reactions.

### **Acids and Bases**

- Define acids and bases and understand their properties.
- Explain the concept of pH and how it relates to the strength of acids and bases.
- Identify common acids and bases in everyday life.

### **Organic Chemistry**

- Define organic compounds and understand the significance of carbon in organic chemistry.
- Identify and classify hydrocarbons (alkanes, alkenes, alkynes) and their properties.
- Understand the basics of functional groups and nomenclature in organic compounds.

### **Chemical Nomenclature**

- Name and write chemical formulas for inorganic compounds, including ionic and covalent compounds.
- Understand the rules for naming organic compounds, including hydrocarbons, alcohols, and carboxylic acids.

### **Chemical Kinetics and Equilibrium**

- Describe the factors affecting the rate of chemical reactions.
- Understand the concept of chemical equilibrium and Le Chatelier's principle.

### **Chemical Thermodynamics**

- Define key concepts such as enthalpy, entropy, and Gibbs free energy.

- Explain the first and second laws of thermodynamics.

### **Chemical Stoichiometry**

- Perform stoichiometric calculations to determine the quantity of reactants and products in chemical reactions.
- Use the mole concept and Avogadro's number in stoichiometric calculations.

### **Environmental Chemistry**

- Discuss the impact of human activities on the environment, including pollution and climate change.
- Identify and understand chemical processes related to environmental issues.

### **Applications of Chemistry**

- Explore real-world applications of chemistry in industries, medicine, and technology.
- Discuss the role of chemistry in solving global challenges.

## **10. NEWTON'S LAW OF MOTIONS**

### **Newton's First Law (Law of Inertia):**

- Describe and explain the concept of inertia, as defined by Newton's first law of motion.
- Recognize and provide examples of objects at rest and in motion, illustrating the application of the law of inertia.
- Analyze scenarios to identify balanced and unbalanced forces and how they relate to the state of motion of an object.

### **Newton's Second Law ( $F = ma$ ):**

- Understand and apply the formula  $F = ma$ , where  $F$  represents force,  $m$  represents mass, and  $a$  represents acceleration.
- Calculate the net force acting on an object when given the mass and acceleration, and vice versa.
- Differentiate between mass and weight and understand that weight is a force.
- Apply Newton's second law to real-world situations and solve problems related to force, mass, and acceleration.



### **Newton's Third Law (Action-Reaction):**

- Describe Newton's third law of motion and explain that for every action, there is an equal and opposite reaction.
- Provide examples to illustrate the concept of action and reaction pairs.
- Apply the third law to analyze situations involving forces, such as collisions and interactions between objects.
- Recognize how action-reaction pairs can result in motion, even when the net force on an object is zero.

### **Applications and Real-World Context:**

- Understand and appreciate how Newton's laws of motion are fundamental in explaining the behavior of objects in various contexts, including transportation, sports, and engineering.
- Analyze and solve problems related to motion, forces, and equilibrium in everyday situations.
- Identify the role of technology and engineering in applying Newton's laws to design and improve devices and systems.

### **Critical Thinking and Scientific Inquiry:**

- Engage in critical thinking by analyzing and predicting the consequences of forces acting on objects.
- Design and conduct experiments to test and verify the principles of Newton's laws.
- Evaluate the limitations and exceptions to Newton's laws, such as when objects approach the speed of light or are very small.
- Communicate findings and explanations effectively, using scientific language and graphical representations.

## **11. MACHINES**

### **Understand the Concept of Machines:**

- Define what a machine is and identify common examples.
- Differentiate between simple and complex machines.
- Explain the role of machines in making work easier.

### **Types of Machines:**

- Identify and describe the six basic types of simple machines: lever, pulley, wheel and axle, inclined plane, wedge, and screw.
- Provide real-world examples of each type of simple machine.

### **Mechanical Advantage and Efficiency:**

- Define mechanical advantage (MA) and understand how it relates to machines.
- Calculate the mechanical advantage of simple machines.
- Explain the concept of efficiency in machines and its importance in real-world applications.

### **Lever Systems:**

- Identify the three classes of levers and their characteristics.
- Analyze real-life scenarios to determine the type of lever system in use.
- Calculate the mechanical advantage of a lever system.

### **Pulley Systems:**

- Understand the concept of fixed and movable pulleys.
- Calculate the mechanical advantage of pulley systems.
- Explain how pulley systems can be used to change the direction and magnitude of forces.

### **Inclined Planes and Wedges:**

- Explain how inclined planes and wedges function as simple machines.
- Calculate the mechanical advantage of an inclined plane.
- Discuss the practical applications of inclined planes and wedges in everyday life.

### **Wheel and Axle Systems:**

- Describe the components and function of a wheel and axle.
- Calculate the mechanical advantage of wheel and axle systems.
- Recognize common examples of wheel and axle systems.

### **Screws and Screw Threads:**

- Understand the concept of a screw as a simple machine.
- Analyze the relationship between the pitch of screw threads and the mechanical advantage.

- Identify various applications of screws in technology and engineering.

#### **Efficiency and Mechanical Advantage in Complex Machines:**

- Explore how complex machines are made up of combinations of simple machines.
- Calculate the overall mechanical advantage and efficiency of complex machines.
- Discuss the trade-offs between mechanical advantage and efficiency in machine design.

#### **Applications and Real-World Examples:**

- Explore and discuss real-world applications of machines in various industries and technologies.
- Analyze how machines have transformed human work and productivity.
- Investigate historical and contemporary developments in machine technology.

#### **Safety and Maintenance:**

- Understand the importance of safety precautions when working with machines.
- Describe proper maintenance practices for machines to ensure their longevity and reliability.

#### **Problem-Solving and Engineering:**

- Apply knowledge of machines to solve engineering problems.
- Design, build, and test simple machines or mechanisms to achieve specific goals.

## **12. FACTS AND FUNCTIONS**

#### **Understanding Scientific Facts:**

- Students will demonstrate the ability to recall and explain key scientific facts and concepts relevant to their grade level.
- Students will differentiate between scientific facts and non-scientific claims, and evaluate the credibility of information sources.

#### **Scientific Terminology:**

- Students will be able to define and use scientific terminology accurately in written and oral communication.

**Observation and Data Collection:**

- Students will demonstrate the ability to make accurate and detailed observations, record data, and differentiate between qualitative and quantitative data.

**Classification and Categorization:**

- Students will categorize and classify living and non-living things based on observable characteristics and functions.
- Students will be able to explain the principles of taxonomy and its importance in organizing living organisms.

**Scientific Method:**

- Students will understand and apply the scientific method, including the steps of making observations, asking questions, formulating hypotheses, conducting experiments, and drawing conclusions.

**Functions of Biological Systems:**

- Students will describe the major functions of the human body systems, including the circulatory, respiratory, digestive, and nervous systems.
- Students will analyze how these systems work together to maintain homeostasis.

**Chemical Reactions:**

- Students will understand and identify chemical reactions, including synthesis, decomposition, combustion, and redox reactions.
- Students will balance chemical equations and explain the conservation of mass in chemical reactions.

**Physical Laws and Principles:**

- Students will demonstrate an understanding of fundamental physical laws, such as Newton's laws of motion and the laws of thermodynamics.
- Students will apply these laws to analyze real-world phenomena.

**Environmental Science:**

- Students will describe the impact of human activities on the environment and understand the concepts of ecosystems, biodiversity, and conservation.
- Students will recognize the role of environmental science in addressing global challenges.

### **Astronomy and Earth Science:**

- Students will explain the Earth's position in the solar system, its rotation and revolution, and the causes of day and night.
- Students will describe geological processes, such as plate tectonics, and their impact on the Earth's surface.

### **Scientific Communication:**

- Students will effectively communicate scientific information through written reports, presentations, and discussions.

### **Critical Thinking and Problem-Solving:**

- Students will analyze scientific problems, generate hypotheses, design experiments, and draw evidence-based conclusions.

## **13. TEMPERATURE**

- Understand the concept of temperature as a measure of the average kinetic energy of particles in a substance.
- Differentiate between the Celsius and Kelvin temperature scales and convert between them.
- Explain the significance of the absolute zero temperature on the Kelvin scale.
- Describe how temperature is measured using common thermometric devices like mercury thermometers, alcohol thermometers, and digital thermometers.
- Understand the concept of thermal expansion and how it relates to temperature changes in materials.
- Explain the effect of temperature on the physical properties of matter, such as volume, density, and state changes (melting, freezing, boiling, condensation).
- Describe the role of temperature in various natural phenomena, including weather patterns, climate change, and the water cycle.
- Analyze and interpret temperature data from various sources, such as weather stations, climate records, and laboratory experiments.
- Apply mathematical concepts to calculate temperature changes in real-world situations, such as heating and cooling processes.
- Investigate the concept of heat transfer and understand the difference between conduction, convection, and radiation.
- Demonstrate safe and proper techniques for using laboratory equipment to measure and record temperature accurately.

- Discuss the impact of temperature on living organisms, including how temperature affects metabolic processes, ecosystems, and adaptations in different environments.
- Explore the relationship between temperature and energy transfer, including concepts like specific heat capacity.
- Engage in scientific inquiry by designing and conducting experiments to investigate temperature-related phenomena.
- Evaluate the ethical and environmental implications of human activities that impact temperature and contribute to global warming and climate change.
- Recognize the importance of temperature control in various industries, including manufacturing, food processing, and healthcare.

## **14. WATER**

### **Understanding the Chemical Structure of Water:**

- Describe the molecular structure of water (H<sub>2</sub>O) and the arrangement of atoms in a water molecule.
- Explain the polarity of water and how this polarity affects its properties.

### **Properties of Water:**

- Identify and explain the unique physical properties of water, including surface tension, capillary action, and high heat capacity.
- Describe the role of hydrogen bonding in determining the properties of water.

### **Water Cycle:**

- Explain the various stages of the water cycle, including evaporation, condensation, precipitation, and runoff.
- Describe the role of the sun's energy in driving the water cycle.

### **Water as a Solvent:**

- Understand the role of water as a universal solvent and its importance in various natural processes.
- Explain the concept of solubility and factors affecting it.

### **Water Quality and Pollution:**

- Investigate the concept of water quality and the parameters used to assess it, including pH, turbidity, and chemical contaminants.

- Understand the sources and consequences of water pollution, as well as methods for water purification and treatment.

#### **Aquatic Ecosystems:**

- Describe the characteristics of aquatic ecosystems, such as freshwater lakes, rivers, and marine environments.
- Understand the interdependence of organisms within aquatic ecosystems and the role of water in sustaining life.

#### **Human Water Usage and Conservation:**

- Analyze human water consumption patterns and their impact on local and global water resources.
- Propose strategies for water conservation and sustainable water management.

#### **Climate Change and Water Resources:**

- Explain the relationship between climate change and water resources, including the effects of melting ice caps and changing precipitation patterns.
- Discuss the potential consequences of water scarcity and increased extreme weather events.

#### **Water and Society:**

- Investigate the social, economic, and political aspects of water access, distribution, and conflicts on a global scale.
- Understand the significance of access to clean and safe drinking water as a human right.

#### **Water-related Scientific Investigations:**

- Design and conduct experiments or investigations related to water properties, water quality, or the water cycle.
- Analyze data, draw conclusions, and communicate findings effectively.

### **15. ELECTROCHEMISTRY**

#### **Knowledge and Understanding:**

- Define electrochemistry and its relevance in everyday life and various industries.
- Explain the difference between a chemical reaction and an electrochemical reaction.
- Describe the structure of an electrochemical cell, including the anode, cathode, and electrolyte.

- Identify and explain the key components of a galvanic (voltaic) cell and an electrolytic cell.
- Understand the concept of oxidation and reduction and how they relate to electrochemical reactions.
- Recognize the difference between anode and cathode in the context of electrochemical cells.
- Explain the role of electrons and ions in electrochemical reactions.
- Understand the importance of the standard hydrogen electrode (SHE) and its use as a reference in electrochemical measurements.
- Describe the significance of the electromotive force (EMF) or cell potential in electrochemical cells.
- Explain the factors that affect cell potential, including concentration, temperature, and pressure.

#### **Skills and Abilities:**

- Perform simple experiments to demonstrate the principles of electrochemistry.
- Assemble and label a simple galvanic cell and an electrolytic cell.
- Calculate the cell potential and understand how it is related to the spontaneity of a reaction.
- Predict the products of electrochemical reactions and balance redox equations.
- Use the Nernst equation to calculate cell potential under non-standard conditions.
- Interpret and analyze data from electrochemical experiments and draw conclusions based on the results.
- Understand and apply Faraday's laws of electrolysis to calculate the amount of substance deposited or evolved during electrolysis.
- Describe the industrial applications of electrochemistry, such as electroplating, corrosion prevention, and the production of chemicals like chlorine and sodium hydroxide.
- Identify and describe real-life examples of electrochemical processes, including batteries and fuel cells.
- Discuss the environmental and economic implications of electrochemical processes and their sustainability.

#### **Critical Thinking and Problem Solving:**

- Analyze and evaluate the advantages and disadvantages of various types of batteries and fuel cells.



- Propose solutions to common problems related to electrochemical processes, such as battery degradation and corrosion.
- Predict the behavior of electrochemical cells under different conditions and propose ways to optimize their performance.
- Compare and contrast the principles of galvanic and electrolytic cells and their applications.
- Explain the role of electrochemistry in addressing environmental challenges, such as clean energy production and pollution control.

**Communication:**

- Clearly and concisely explain electrochemical concepts, principles, and experimental results in both written and oral forms.
- Present findings from experiments and investigations related to electrochemistry in an organized and coherent manner.
- Collaborate with peers in group projects or discussions related to electrochemistry, exchanging ideas and viewpoints effectively.

**16. NATURAL RESOURCES**

**Define and classify natural resources:**

- Differentiate between renewable and non-renewable resources.
- Categorize natural resources into various types, including mineral resources, energy resources, and biological resources.

**Understand the importance of natural resources:**

- Explain how natural resources are essential for human survival and economic development.
- Analyze the role of natural resources in maintaining ecological balance and biodiversity.

**Explore the impact of human activities on natural resources:**

- Investigate how extraction, consumption, and pollution affect natural resource availability and quality.
- Evaluate the consequences of overexploitation and unsustainable resource management practices.

### **Study the conservation and sustainable management of natural resources:**

- Describe strategies for conserving and protecting natural resources.
- Analyze the concept of sustainability and its application to resource management.

### **Investigate renewable energy sources:**

- Explain the functioning of various renewable energy technologies, including solar, wind, and hydropower.
- Evaluate the advantages and limitations of renewable energy sources.

### **Explore non-renewable resources and their extraction:**

- Describe the formation of fossil fuels and mineral resources.
- Discuss the environmental, economic, and social implications of extracting and using non-renewable resources.

### **Study the role of natural resources in global issues:**

- Analyze the connection between natural resources and issues like climate change, deforestation, and water scarcity.
- Investigate international agreements and initiatives related to resource management and conservation.

### **Investigate the impact of technology on resource utilization:**

- Explain how technological advancements influence the exploration, extraction, and utilization of natural resources.
- Discuss the potential benefits and risks associated with new technologies in resource management.

### **Examine case studies and real-world examples:**

- Analyze specific examples of resource management or mismanagement, both locally and globally.
- Identify successful conservation and sustainable resource management practices.

### **Develop critical thinking and problem-solving skills:**

- Engage in debates and discussions on resource-related ethical and policy issues.
- Propose solutions for addressing resource-related challenges in society.

## **17. ENVIRONMENT**

### **Ecosystem Dynamics:**

- Understand the concept of ecosystems and their components, including biotic and abiotic factors.
- Analyze the interrelationships within ecosystems, such as food chains and food webs.
- Explain the flow of energy and cycling of matter within ecosystems.

### **Biodiversity and Conservation:**

- Describe the importance of biodiversity and the different levels of biodiversity (genetic, species, ecosystem).
- Recognize threats to biodiversity, including habitat destruction, invasive species, and pollution.
- Investigate and propose strategies for the conservation of biodiversity.

### **Climate Change:**

- Comprehend the principles of climate change and the role of greenhouse gases.
- Analyze the impacts of climate change on the environment, ecosystems, and human society.
- Discuss mitigation and adaptation strategies to address climate change.

### **Natural Resource Management:**

- Identify various natural resources, such as water, forests, and minerals, and their significance.
- Evaluate the sustainable management of natural resources to ensure their availability for future generations.
- Discuss the consequences of resource over-exploitation and the importance of conservation.

### **Pollution and Environmental Health:**

- Explore different types of pollution, including air, water, and soil pollution.
- Understand the causes and effects of pollution on human health and the environment.
- Examine methods to mitigate and prevent pollution.

### **Waste Management and Recycling:**

- Investigate the generation and disposal of solid waste and the environmental impact.
- Discuss the importance of waste reduction, recycling, and sustainable waste management practices.

### **Environmental Ethics and Stewardship:**

- Discuss the ethical considerations related to environmental issues.
- Recognize the concept of environmental stewardship and personal responsibility.
- Evaluate the role of individuals and communities in sustainable environmental practices.

**Environmental Legislation and Policies:**

- Understand the role of local, national, and international laws and policies in addressing environmental concerns.
- Analyze the effectiveness of environmental regulations and their impact on society and the environment.

**Environmental Science Research and Data Analysis:**

- Develop research skills to collect, analyze, and interpret environmental data.
- Design and conduct investigations to address specific environmental questions or issues.

**Case Studies and Real-World Applications:**

- Investigate specific environmental case studies and real-world examples of environmental challenges and solutions.
- Apply scientific knowledge to propose solutions to current environmental issues.