CHEMISTRY

CURRICULUM FOR SECONDARY EDUCATION (SHS 1 - 3)

NaCCA

NATIONAL COUNCIL FOR CURRICULUM & ASSESSMENT OF MINISTRY OF EDUCATION

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CONTENTS

CHEMISTRY CURRICULUM DEVELOPMENT PANEL

WRITERS		
	Name	Institution
1.	Joshualynn Oddei	Wesley Grammar Senior High School
2.	Benjamin Kuffour Asiamah	Achimota School
3.	Bismark Kwame Tunu	Opoku Ware School
REVIEWERS		
	Name	Institution
1.	Prof. E.E. Kwaansa-Ansah	Kwame Nkrumah University of Science and Technology
CURRICULUM WRITING GUIDE TEAM		
	Name	Institution
1.	Prof. Winston Abroampa	Kwame Nkrumah University of Science and Technology
2.	Cosmos Eminah	University of Education, Winneba
3.	Aaron Akwaboah	Ministry of Education
4.	Evans Odei	Achimota School
5.	Paul Michael Cudjoe	Prempeh College
6.	Ahmed Amihere	University of Education, Winneba
TRIALLING TEAM		
	Name	Institution
1.	Nana Opoku Ware	Adventist Senior High School
2.	Boateng Emmanuel	Adventist Senior High School
3.	George Afriyie	Opoku Ware School
4.	Gyamfi Richard	Opoku Ware School
5.	Rashid Ahmed	Uthmaniya Senior High School
6.	Alhassan Mohammed	Uthmaniya Senior High School

NaCCA TEAM			
1.	Prof. K. O. Kwarteng	12.	Bridget Anku
2.	Prof. Edward Appiah	13.	Anthony Sarpong
3.	Mr. Matthew Owusu	14.	Seth Nii Nartey
4.	Reginald Quartey	15.	Kenneth Wontumi
5.	Joana Vanderpuije	16.	Sharon Antwi-Baah
6.	Anita Collison	17.	Dennis Adjasi
7.	Rebecca Abu Gariba	18.	Ogyampo S. Amankwah
8.	Genevieve Mensah	19.	Abigail Owusu Oduro
9.	Veronica Odom	20.	Priscilla B. Plange
10.	Joachim Seyram Honu	21.	Abigail Birago Owusu
11.	Dr. Mercy Nyamekye	22.	Uriah Otoo
EXTERNAL QUALITY ASSURANCE TEAM			
1.	Prof. Kwame Akyeampong	4.	Dr. Esinam Avornyo
2.	Dr. Jane Cullen	5.	Dr. Christopher Yaw Kwaah
3.	Dr. Sean Higgins		

SCOPE AND SEQUENCE

Chemistry Summary

S/N	STRAND	SUB-STRAND	YEAR 1			YEAR 2			YEAR 3		
			CS	LO	LI	CS	LO	LI	CS	LO	LI
1	Physical Chemistry	Matter and its Properties	3	4	22	1	2	8	-	-	-
		Equilibria	1	1	3	2	2	9	4	4	10
2	Systematic Chemistry of the Elements	Periodicity	1	1	2	2	2	4	1	1	2
		Bonding	2	2	5	1	1	2	-	-	-
3	Chemistry of Carbon Compounds	Characterization of Organic Compounds	1	1	2	1	1	1	-	-	-
		Organic Functional Groups	1	1	2	1	1	5	2	2	4
Total			**9**	**10**	**36**	**8**	**9**	**29**	**7**	**7**	**16**

Overall Totals (SHS 1 – 3)

Content Standards	24
Learning Outcomes	26
Learning Indicators	81

YEAR ONE

Subject CHEMISTRY
Strand 1. PHYSICAL CHEMISTRY
Sub-Strand 1. MATTER AND ITS PROPERTIES

Learning Outcomes	21st Century Skills and Competencies	GESI[1], SEL[2] and Shared National Values
1.1.1.LO.1		
Use the knowledge and understanding of the scientific practices in Chemistry to explain the structure of the atom as well as the stability of its nucleus.	**Digital Learning:** • Use ICT devices to watch YouTube videos of violent reactions • By using simulations and videos of Rutherford and J.J. Thompson's experiment using laptop or tablet or smart phone and projector. • The use of Chemsketch to fill the orbitals and also watch videos of the process of filling the orbitals. • Highly proficient learners use Chemsketch to fill the orbitals and whole class may watch a video of the process of filling the orbitals. **Collaboration and Communication:** • To discuss the impact of chemistry and chemistry-related careers. • Discussing laboratory rules and hazard symbols. • Use think-pair-share approach to explain why chemicals should not be stored alphabetically and discuss how to put out small fires. **Critical Thinking:** • Learners engage in analysis of evidence gathered. • Evaluating and critiquing the postulates. • Relating measurement of atoms to C-12 scale.	**GESI:** • Respect individuals of different abilities as they practice putting out fire. • Be aware of diversity and the need to practice inclusion as they use ICT and role-play. • Be aware of misconceptions/myths about gender and disabilities as they discuss chemistry-related careers. **SEL:** • Embrace diversity and practice inclusion (with respect to gender and unfamiliar household items). • Respect views of individual learners. Be sensitive to the inter-relatedness of the various spheres of life. • Practice communication (e.g. dialoguing and listening to others.) • Work together with other learners. • Develop the strategies for learners to complete a task or learn a new concept. • Work to build learners' confidence in ICT devices.

[1] Gender Equality and Social Inclusion
[2] Socio-Emotional Learning

	Creativity and Innovation: • Designing a model of Dalton's atom. • Learners construct models and draw them. • Using balloons, play dough or clay or modelling clay to model the shapes of s and p-orbitals. **Problem-Solving Skill:** Performing calculations using the problem-solving strategy.	**National Core Values:** • Patriotism • Tolerance
1.1.1.LO.2		
Use the mole concept to determine the amount and quantity of various substances involved in chemical reactions.	**Collaboration and Communication:** • Mixed-ability groups engage in discussions. • Working together to prepare standard solutions. **Critical Thinking and Problem Solving:** • Relating measurement of atoms to Carbon -12 scale. • Comparing the actual mass of particles to one-twelfth the mass of the carbon-12 isotope. • Calculating amount of substances. • Calculating the various parameters using mathematical equations and giving a valid answer. • Calculating the moles of a given substance using the mass. **Leadership and Personal Development:** By playing different roles in group activities during the preparation of solutions and discussions on the mole concept.	**GESI:** • Be aware be of individuals' abilities as they undertake problem-solving activities. • Begin to ask questions of some of their stereotypes and biases as they prepare standard solutions. **SEL**: • Provide opportunities for learners to feel successful in performing calculations. • Offer learners with a range of strategies to help manage the steps in calculations involving the mole concept • Work together with other learners in preparing a standard solution. • Work to build learners' confidence in the use of laboratory apparatus. **National Core Values:** • Tolerance • Respect for others • Discipline
1.1.1.LO.3		
Write mole ratios for chemical equations and apply it in quantitative analysis.	**Collaboration and Communication:** • Use think-pair-share approach to write chemical formulae of compounds and balance equation.	**GESI:** • Respect individuals of different backgrounds as they share ideas to write chemical

	• Sharing ideas to determine mole ratio and performing the calculations **Critical Thinking:** Performing calculations to determine percentage composition. **Problem Solving:** Solving questions involving limiting reagents. **Global Citizenship:** By learning about the importance of the mole in the preparation of solutions across the globe by Chemists.	formulae of compounds and balance equations. • Appreciate individuals of different backgrounds as differentiated tasks are given to learners to perform the experiments. • Be aware of some misconceptions/myths about gender and disabilities as they role-play activities **SEL:** • Practice communication (e.g. dialoguing and listening to others). • Develop strategies for learners to write and balance chemical equations. • Provide opportunities for learners to express the various forms of writing mole ratios. • Develop the strategies for learners to complete the tasks in using the mole ratio in performing calculations. **National Core Values:** Tolerance
1.1.1.LO.4		
Use the kinetic theory of matter to explain the behaviour of solids, liquids and gases under different conditions and describe the laboratory preparation of gases as well as their uses in everyday life.	**Digital Learning:** • Using video or simulation to observe the behaviour of particles in solids, liquids and gases. • Using ICT devices for virtual learning or watching videos. **Creativity and Innovation:** Using role-play to illustrate the behaviour of particles. **Communication and Collaboration:** • Planning and working together to prepare gases.	**GESI:** • Notice individuals of different backgrounds as they collaborate to plan and work together to prepare gases. • Be aware of some misconceptions/myths about gender and disabilities as they role-play to illustrate the behaviour of particles. • Comfortably work with other learners as they undertake problem-solving activities.

	• Learners share ideas on explanation of the effect of molecular mass on rate of diffusion. **Critical Thinking and Problem Solving:** • Analysing the observed relationships to sketch a graph and derive mathematical relationship and engage in problem solving. • Using think-pair-share approach to solve theoretical questions. **Personal Development:** Learners acquire and apply scientific manipulative skills in performing the experiment.	**SEL:** • To practice identifying how others may be feeling and using active listening skills such as body positioning as they role-play to illustrate the behaviour of particles. • To work together in groups to prepare gases and share ideas on the effect of molecular mass on rate of diffusion. **National Core Values:** • Tolerance • Discipline • Honesty

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century and GESI	Assessment
1.1.1.CS.1	1.1.1.LI.1	1.1.1.AS.1
Demonstrate understanding of the scientific practices in chemistry using relevant acquired skills to solve problems as well as explaining the structure of the atom and its stability.	**Describe chemical processes around us, and their applications in everyday life.** **Digital Learning:** • Watch a video or slides/pictures on a variety of natural and artificial phenomena that can be explained by Chemistry and make observations. • From the observations, deduce and discuss the meaning of Chemistry. • Through a group discussion, distinguish among the traditional branches of Chemistry: Pure Chemistry (physical, organic and inorganic) Applied Chemistry (Medicine, Pharmacy, Environmental Chemistry, Biochemistry, Chemical Engineering, Agriculture, Petrochemistry, etc.). • Discuss the centrality of Chemistry as a science discipline, which is related to other science subjects. • With the aid of charts and pictures, summarize ways in which Chemistry affects daily life under the following headings: (Food and Nutrition, Agriculture, Medicine, Transportation, Energy etc.) • In mixed-ability groups, discuss careers in Chemistry and Chemistry-related fields. • Discuss the education and training required for the careers.	Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning Level 4 Extended critical thinking and reasoning
	1.1.1.LI.2	1.1.1.AS.2
	Discuss and explain safety rules and hazard symbols in the laboratory. **Talk for Learning:** • In pairs or groups, watch videos or use charts to show wrong practices in the Chemistry laboratory and discuss the 'dos' and 'don'ts' in the Chemistry laboratory, and hence the rules and regulations that should be followed in the Chemistry laboratory. • Examine the assay of chemical containers or reagents, electrical gadgets and other materials and identify the hazard symbols on them. Discuss a. chemical hazards under the following headings: (corrosive, toxic, oxidising, flammable, explosive, radioactive, irritant/harmful, biohazard) b. Prohibition signs under the following headings: (No naked flame, danger, No smoking, High voltage, etc) c. First aid sign (First aid, safety shower, eye wash station).	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning

	• Sketch the hazard symbols and explain what they mean. • Through think-pair-share, exchange ideas on how to handle those materials safely using personal protective equipment (chemical goggles, hand gloves, apron/laboratory coat, respirator/gas mask etc) and safety equipment (eye shower station, fume chamber etc). **Collaboration and Communication:** Discussing laboratory rules and hazard symbols.	
	1.1.1.LI.3	1.1.1.AS.3
	Explain why chemicals should be stored by compatibility and not alphabetically in the laboratory. **Exploratory Learning:** • Visit the school chemical store or Chemistry laboratory to observe how chemicals are stored. • In mixed ability groups, explain why chemicals should be stored by compatibility and not alphabetically in the laboratory. • Watch a video showing an uncontrollable or violent reaction between chemicals right next to each other. E.g., hydrogen peroxide and hydrazine, or, oxidising materials and flammable materials, acetic acid and nitric acid or reaction between potassium permanganate and glycerol. • Using think-pair-share approach, discuss and practise how to put out small fire using fire blanket and fire extinguisher.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	1.1.1.LI.4	1.1.1.AS.4
	Investigate the scientific method of inquiry. **Inquiry-Based Learning:** In mixed-gender groups, • Discuss the steps involved in the scientific method of inquiry. • Apply the scientific method to solve a named problem in the school environment or nearby community. • Design a poster outlining the method used and share with the class for discussion.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	1.1.1.LI.5	1.1.1.AS.5
	Identify the main postulates of Dalton's atomic theory and explain the weaknesses of the theory.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning**

	Talk for Learning: Review the description of the atom and its sub–atomic particles from JHS syllabus. **Group Work:** In mixed-ability groups, • Discuss the Dalton's atomic theory. • Evaluate and critique each of the postulates of Dalton's atomic theory with the aid of relevant charts or other resources. **Project–Based Learning:** • Construct a model to represent the atom as a simple sphere with no internal structure. • Draw a diagram of the atom modelled. • Display the model and diagram for class discussion.	Level 4 Extended critical thinking and reasoning
	1.1.1.LI.6	1.1.1.AS.6
	Describe the cathode rays experiment and alpha particles scattering experiment and identify the weaknesses of J. J. Thompson and Rutherford's models of the atom. **Activity-Based Learning:** In mixed-ability groups, • Use simulation or videos or charts to investigate the properties of cathode rays under the following headings: a. Effect in a magnetic field, b. Effect in electric field c. Effect on photographic plate. • Use simulation to investigate or chart to illustrate or video to show and describe J. J. Thompson's cathode ray experiment and Rutherford's alpha scattering experiment. • Describe the structure of the atom based on analysis of the evidence gathered from both experiments. **Project-Based Learning:** Individually or in groups, • Construct a model to represent the atom. • Draw a diagram of the atom modelled • Display the model and diagram for class discussion.	Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning Level 4 Extended critical thinking and reasoning:
	1.1.1.LI.7	1.1.1.AS.7
	State the main postulates of Bohr's planetary theory and explain the importance of the quantum numbers to the electron structure of the atom.	Level 1 Recall Level 2 Skills of conceptual understanding

	Collaborative Learning: In small mixed ability or mixed-gender (where applicable) groups, • Discuss the main postulates of Bohr's planetary theory with the aid of books, charts or pictures on Bohr's planetary theory. • Distinguish between a continuous spectrum and line spectrum and explain how the lines in the emission spectrum of hydrogen are related to electron energy levels. • Discuss the contribution of Quantum theories towards the development of atomic structure. • Distinguish between an orbit and an orbital with examples. **Demonstrative Learning:** • Discuss and undertake calculations on the following Quantum numbers: a) Principal quantum number b) Angular momentum quantum number or Azimuthal quantum number c) Magnetic quantum number d) Spin quantum number • Discuss the importance of quantum numbers to the electron structure of the atom. **Project-Based Learning:** • Model the shapes of s and p-orbitals using materials in the environment or clay or modelling clay or inflated balloons. • Draw the orbitals modelled and describe the s and p orbitals. • Discuss the number of orbitals making up the s, p, and d subshells and the number of electrons that occupy each. • Watch videos to reinforce the concept learnt.	**Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	1.1.1.LI.8	1.1.1.AS.1.8
	Apply Aufbaus principle, Pauli's exclusion principle and Hund's rule of maximum multiplicity to write electron configuration of the first thirty elements of the periodic table. **Group Learning:** Research from the Internet, library, books and other sources about Aufbaus principle, Pauli's exclusion principle and Hund's rule of maximum multiplicity. In three large groups, do class presentations on the following: • Aufbaus Principle and the order in which orbitals are filled in a given element. • Pauli's exclusion principle and • Hund's rule of maximum multiplicity.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning

	• How to express electron configurations using (a). s, p, d notation. (b). Electrons-in-boxes method. **Activity-Based Learning:** • Apply the rules and principles to write electron configuration of the first thirty elements of the periodic table and their ions. • Identify all the irregularities in writing electron configurations. • Explain the differences in stability between fully filled, half-filled and partially filled orbitals in subshells. **Digital Learning:** Watch videos or observe demonstrations of the process of filling orbitals (the shape and names of the orbitals of d subshells are not required).	
	1.1.1.LI.9	1.1.1.AS.9
	Describe radioactivity, the properties of radiations and compare isotopes based on their stability as well as their applications in everyday life. **Through a Class Discussion:** • Explain relative atomic mass and relative molecular mass. • Describe the principal parts of a mass spectrometer and explain how it works, using charts or pictures or models. **Problem Solving Approach:** • Identify peaks on a simple mass spectrum and use them to calculate the relative abundance and masses of isotopes. • Calculate the relative atomic mass of different elements from: (a). Mass spectrum (b). Percentage abundance data **Collaborative Learning:** • Discuss radioactivity and distinguish between nuclear reactions and chemical reactions. • Use simulations or charts to investigate and describe the properties of alpha, beta and gamma radiations	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning

	• Complete and balance simple nuclear reaction equations. • Explain why certain nuclei are unstable in terms of neutron-to-proton ratio and binding energy per nucleon. **Problem Solving Approach:** • Define and determine the half-life of a nuclide from experimental data and by calculation. • Use half-life information to determine the amount of radioisotopes remaining at a given time. **Using Think-Pair-Share Approach:** Discuss the uses of radioisotopes and explain the principle behind each use as well as the risks associated with radioactivity.	
Teaching and Learning Resources	M**ATERIALS** • ICT devices • Household items with labels • Chemical containers with labels • Containers having chemical assay • Personal protective equipment (goggles, laboratory coat/apron, hand gloves etc) • Hydrogen peroxide • Hydrazine • Oxidising materials • Flammable materials • Acetic acid and nitric acid • Worksheets with incomplete nuclear reactions with prepared mark schemes • Worksheets of empty orbital diagram for learners to complete • Worksheets with blank column for numbers of proton, neutrons and electrons • Fire extinguisher • Fire blanket • Material for setting fire • Markers • Cardboard	• Graph sheet • Models: Use One balloon per s orbital, two balloons joined at their knots per p-orbital, three (different coloured) pairs of balloons to make one subshell of P orbital **WEBSITES** • Chemsketch or simulation for filling atomic orbitals • Http://www.kentchemistry.com/links/atomicstructure/PauliHundsRule.htm • Http://www.youtube.com.watch?v=2AFPfg0come • Http://www.khanacademy.com • Https://www.youtube.com/watch?v=ZIAyNFLRFuw • https://phet.colorado.edu/en/simulations/rutherford-scattering • https://www.khanacademy.org/science/chemistry/electronic-structure-of-atoms/history-of-atomic-structure/a/discovery-of-the-electron • http//www.youtube.com/watch?v=PpOAlj7sOEc • https://www.khanacademy.org/science/chemistry/electronic-structure-of-atoms/history-of-atomic-structure/v/rutherfords-gold-foil-experiment • Http//www.youtube.com/watch?v=m92QR7CBNoQ **CHARTS** • Charts of hazard, prohibition and mandatory symbols • Videos or charts of wrong practices in the chemical laboratory • Chart of the mass spectrometer

	• Potassium permanganate and glycerol • Counters with up and down orientation to represent electron spin-pairing and boxes to represent orbitals • Modelling clay (plasticine) • Clay • Styrofoam • Calculator	• Mass spectrogram for analyses • Charts of experimental set-up of J. J. Thompson's experiment and Rutherford's alpha particle scattering experiment • Charts of line and continuous spectra • Chart showing how the energy levels in the hydrogen give rise to spectral series

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century and GESI	Assessment
1.1.1.CS.2	1.1.1.LI.1	1.1.1.AS.1
Demonstrate an understanding of the mole concept and its significance to the quantitative analysis of chemical reaction.	**Explain relative atomic mass and relative molecular mass.** **Prior to the lesson:** Find-out why carbon-12 isotope is used as a reference scale for measurement. **Activity-Based learning:** Use a beam balance to demonstrate the determination of the mass of an element/compound by placing the standard (Carbon-12) in one pan and the mass to be determined in the other pan.	Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning Level 4 Extended critical thinking and reasoning
	1.1.1.LI.2	1.1.1.AS.2
	Describe the atomic mass unit as an average mass. **Talk -for -Learning:** Through a presentation by your teacher, explain how the atomic mass unit, (AMU) of an individual particle (atom or molecule) is obtained by comparing the actual mass of the particle to one-twelfth the mass of 1 atom of the carbon-12 isotope.	**Level 1 Recall** Level 2 Skills of conceptual understanding Level 3 Strategic reasoning Level 4 Extended critical thinking and reasoning
	1.1.1.LI.3	1.1.1.AS.3
	Describe the mole as a unit of amount of substance. **Talk for Learning:** Through a class activity: • Explain the mole in relation to various elementary entities (atoms, ions, molecules, electrons, protons, neutrons). • Discuss the relationship between the Mole and Avogadro's Constant.	**Level 1 Recall** Level 2 Skills of conceptual understanding Level 3 Strategic reasoning Level 4 Extended critical thinking and reasoning
	1.1.1.LI.4	1.1.1.AS.4
	Calculate different physical quantities (number of entities, mass and volume) based on the amount of substance.	Level 1 Recall

	Problem-Based Approach: • Describe how the amount of a substance (n) can be used to determine the number of entities (atoms, molecules or ions), mass (m) of a substance, volume (V) of a gas using mathematical equations that represent their interconversions. • Practice calculations involving the amount of substance, number of entities and molar quantities.	**Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning Level 4 Extended critical thinking and reasoning
	1.1.1.LI.5	1.1.1.AS.5
	Explain the mole concept and its relevance in preparation of standard solutions. **Initiating Talk for Learning:** Brainstorm on the need to know the concentration of solutions. **Think-Pair Share:** Use mass and relative molecular mass to determine number of moles of a given substance. **Experiential Learning:** • Identify the apparatus for preparing standard solutions from solid solutes or liquid solutes. • In small groups, apply the mole concept to prepare standard solutions in $moldm^{-3}$ and gdm^{-3}	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**
	1.1.1.LI.6	1.1.1.AS.6
	Use IUPAC nomenclature to name inorganic compounds, write the formulae of compounds based on the laws of chemical combination and write balanced chemical equations. **Group Presentations:** In small groups, • Research and give class presentations on the IUPAC rules for naming various groups of inorganic compounds. • Apply the IUPAC rules to name binary and ternary compounds, oxoacids, salts and hydrated salts • Design a chart on the IUPAC rules for naming inorganic compounds to be posted in the classroom	Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning Level 4 Extended critical thinking and reasoning

	Problem-Based Learning: In a class activity, • Discuss the laws that are applied in writing or determining chemical formulae of various compounds. • Calculate the empirical and molecular formulae of various inorganic compounds. • Write chemical formulae for named binary and ternary compounds, oxoacids, oxosalts and hydrated salts. • Determine the percentage composition of elements in various compounds based on their formulae. E.g., MgO, **Cu_2O** and CuO. **Collaborative Learning:** • With the aid of a chart, discuss the rules to be followed in balancing chemical equations. • In pairs or groups, write and balance chemical equations for the following: a. Combustion b. Synthesis c. Displacement or replacement d. Decomposition e. Ionic equation **Initiating Talk for Learning:** Using relevant examples, discuss the laws of chemical combination namely: • Law of conservation of matter • Law of constant proportion • Law of multiple proportion **Inquiry-Based Learning:** • In pairs or groups, perform a simple experiment to show that mass is conserved in a chemical reaction. • Use the reaction between molar solutions of Na_2CO_3 and $CaCl_2$.	
	1.1.1.LI.7	1.1.1.AS.7
	Perform calculations involving stoichiometric relationships. **Experiential Learning:** • Work in small mixed ability groups to perform experiments on some common reactions in the laboratory.	Level 1 Recall **Level 2 Skills of conceptual understanding**

<table>
<tr><td></td><td colspan="3">• Based on the reactants used, write down balanced equations on each of the reactions.
• In pairs or groups, determine the mole ratio of species in each of the chemical reactions.
• Use the mole ratio to calculate the following quantities in chemical reactions:
a. Number of entities
b. Amount of substance
c. Mass of substance
d. Concentrations in gdm^{-3}, $moldm^{-3}$ and ppm
e. Volume of substance
• Determine the limiting and excess reagents in chemical reactions by comparing the available moles of each reactant to the moles required for complete reaction using the mole ratio.
• Work individually to calculate the percentage yield of products.</td><td>Level 3 Strategic reasoning
Level 4 Extended critical thinking and reasoning</td></tr>
<tr><td>Teaching and Learning Resources</td><td>• Worksheets with sample questions
• Worksheets to record results.
• Na_2CO_3
• $CaCl_2$
• Bolt and nuts
• Resources for measuring volume and preparing solutions
• Weighing scale</td><td>• Calculator

MATERIALS
• Periodic table containing the elements with their relative atomic masses
• Calculator
• Beam balance or diagram of beam balance Substances of different weights</td><td>• Apparatus for preparing solutions (beaker, funnel, stirrer, volumetric flask, weighing scale),
• Worksheet with sample questions on the interconversion of amount of substance to number of entities and molar quantities.
• Solid solutes (e.g., NaOH, NaCl) Liquid solutes (e.g., HCl) Solvent (e.g., water)

CHARTS
• Charts showing interconversion between amount of substance and other quantities</td></tr>
</table>

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century and GESI	Assessment
1.1.1.CS.3	1.1.1.LI.1	1.1.1.AS.1
Demonstrate understanding of the use of the kinetic theory of matter to explain the behaviour of solids, liquids and gases under different conditions and describe the laboratory preparation of gases as well as their uses in everyday life.	**Explain the kinetic theory of matter and apply it to distinguish between the properties of solids, liquids and gases.** **Collaborative Learning:** • Review and recall chemical bonding and states of matter from JHS curriculum. • With the aid of simulation or videos or charts, investigate/illustrate the behaviour of the particles in solids, liquids and gases and record the observations. • In groups of three, draw sketches to represent the arrangement of particles in solid, liquid and gaseous substances. • Research about the kinetic theory of matter and use it to explain the properties which distinguish gases from liquids and solids under the following headings: a) Volume b) Shape c) Compressibility d) Density e) Spacing of particles f) Motion of particles g) Force of attraction between particles h) Arrangement of particles • In mixed-ability groups or in pairs use the kinetic theory to explain the various change of state processes. **Experiential Learning:** • Perform experiments to determine the melting point of a solid. • Perform experiment to determine the boiling point of a liquid.	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**
	1.1.1.LI.2	1.1.1.AS.2
	State and perform calculations involving various gas laws and analyse graphs based on the laws.	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning

	Exploratory Learning: • In small mixed-ability groups, research from the Internet, library, books and other resources about the various gas laws (Boyle's law, Charles' law, Avogadro's law, Gay-Lussac's law in terms of: a) The formulae b) Variables c) Conditions required • Use simulation or charts to illustrate the relationships among the various variables. • Sketch graphs of the relationship and deduce the mathematical relationship between the variables. • Based on the Boyle's, Charles' and Gay-Lussac's laws, determine the expression for the combined gas law. **Task-Based Learning:** Perform calculations involving the various gas laws.	**Level 4 Extended critical thinking and reasoning:**
	1.1.1.LI.3	1.1.1.AS.3
	State Graham's law of diffusion/effusion and Dalton's law of partial pressures and apply them to perform calculations. **Talk for Learning:** In small mixed-ability groups, • Discuss Graham's law of diffusion/effusion and use it to describe and explain the effect of relative molecular mass and/or density on the rate of diffusion/effusion of gases. • Explain Dalton's law of partial pressures and its application in determining the total pressure of a mixture of gases or the partial pressure exerted by each component in a mixture of gases. **Experiential Learning:** • Design and perform an experiment to investigate the rate of diffusion of gaseous ammonia and hydrogen chloride. • Make deductions from the results of the experiment. **Problem Solving Approach:** Perform calculations involving diffusion/effusion as well as Dalton's partial law of pressure.	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**

	1.1.1.LI.4	1.1.1.AS.4
	Write the ideal gas equation and apply it in simple calculations using the different numerical values of R and units of pressure and volume. **Collaborative Learning:** • Review previous knowledge on the Boyle's law, Charles' law and Avogadro's law. • Work in groups to show how the laws above can be combined to give the ideal gas law. • Discuss each of the variables in the ideal gas Law. **Problem Solving Approach:** Practice using the ideal gas equation (PV = nRT) in solving theoretical tasks including determination of molar mass. **In small mixed-ability groups:** Use ideal gas equation to determine the molar mass of different gases.	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**
	1.1.1.LI.5	1.1.1.AS.5
	Explain why gases show deviation from ideal behaviour and suggest how the ideal gas equation could be modified to describe gas behaviour more accurately. **Project-Based Learning:** • Through various sources such as the internet, videos or books, explain qualitatively in terms of intermolecular forces and molecular size: a. The conditions necessary for a real gas to approach ideal behaviour. b. The limitations of ideality at very high pressure and very low temperature. **Talk for Learning:** In a whole class discussion, State and explain Van der Waals equation and discuss its applications.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	1.1.1.LI.6	1.1.1.AS.6
	Design and perform experiments to prepare and test for gases (hydrogen, ammonia and carbon (IV) oxide gases).	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning

	Collaborative Learning: In small mixed-ability groups, • Discuss the properties of each of the following gases: hydrogen, carbon (IV) oxide and ammonia. • State their uses in everyday life. **Experiential Learning:** • Perform experiments to prepare hydrogen, ammonia and carbon (IV) oxide gas. • Create charts to illustrate the experimental setup for the preparation of each of the gases. • Make deductions on each practical activity. **NB:** Where apparatus is not available, virtual laboratory or video can be used.		**Level 4 Extended critical thinking and reasoning**
Teaching and Learning Resources	• Melting point determination apparatus • Chart to illustrate the behaviour of particles • [Simulations (PHET), video, virtual laboratory can be used here] • Graph board • Graph sheets • Long cylindrical transparent glass tube • Small wads cotton wool • Forceps or bungs (to fit into the ends of the glass tube) • Conc. HCl and Conc. NH_3	• Chemical goggles • Protective gloves • Retort stand with clamps • Strip of universal indicator paper • Calculator • Worksheets with steps for the calculation • Gas preparation kits • Wooden splint	• Lime water • Marble chips • Hydrochloric acid • Magnesium ribbon • Calcium hydroxide • Ammonium chloride etc. • Universal litmus paper

Subject **CHEMISTRY**
Strand **1. PHYSICAL CHEMISTRY**
Sub-Strand **2. EQUILIBRIA**

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
1.1.2.LO.1		
Apply the solubility rules to analyse and predict the behaviour of common ionic compounds in qualitative analysis.	**Critical Thinking and Problem Solving:** • Observing and constructing understanding on the behaviour of common ionic compounds based on the solubility rules. • Determine ions present in an unknown sample. **Communication and Collaboration:** • Sharing ideas on factors that affect solubility • Sharing ideas to explain solubility rules as well as testing and deducing the ions present **Personal Development:** • Learners acquire analytical skills through the activities on qualitative analysis of common ionic compounds. • Acquisition of skills in plotting of graphs and analysis of the curve. **Leadership:** Learners assume different roles in the group activities on qualitative analysis	**GESI:** • Appreciate individuals of different backgrounds as they collaborate to share ideas on factors that affect solubility. • Interrogate their stereotypes and biases as they construct understanding on the behaviour of common ionic compounds based on the solubility rule. • Be aware of misconceptions/myths about gender and disabilities as they play different roles in the activities on qualitative analysis. **SEL:** • To work together in groups to share ideas on the factors that affect solubility. • Offer learners multiple options for communicating and completing their work. • Provide learners the opportunity to evaluate their own work as they acquire the skills in plotting graphs **National Core Values:** • Honesty • Justice • Tolerance • Empathy

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century and GESI	Assessment
1.1.2.CS.1	1.1.2.LI.1	1.1.2.AS.1
Demonstrate knowledge and application of solubility and solubility rules.	**Explain the term solubility and describe the factors that affect solubility of substances.** **Talk for Learning:** • Using sample solutions, brainstorm to explain the terms solute, solvent and solution. • With the aid of sample solutions such as sugar solution, mixture of kerosene and water, a mixture of coke and carbon dioxide, describe the various types of solutions based on the state of solute and solvent and give specific examples (solid-liquid, solid-gas, gas-liquid, solid-solid, liquid-liquid, gas-gas solutions). **Demonstration:** Watch a video or prepare samples of the various types of solutions (unsaturated, saturated and supersaturated). **Inquiry-Based Learning:** In groups, • Perform experiment to investigate the factors that affect solubility: temperature, pressure, nature of solute and solvent (molecular size and polarity) NB: Stirring or shaking increases the rate of solubility. • Relate the factors to everyday life such as dissolution of salt in soup, sugar in hot and cold water, carbon (IV) oxide in fizzy drinks.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	1.1.2.LI.2	1.1.2.AS.2
	Determine the solubility of soluble and sparingly soluble substances. **Activity-Based Learning:** Perform an experiment to determine the solubility of a named salt at different temperatures. **Collaborative Learning:** In groups, analyse a given data on salts and determine their solubilities.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning

	Exploratory Learning: • Plot a graph of solubility curve using data from experiment. • Analyse and deduce information from the curve.		
	1.1.1.LI.3		1.1.1.AS.3
	Perform tests on water-soluble compounds to identify ions based on the solubility rules. **Talk for Learning:** Brainstorm to explain the solubility rules and predict the effect of precipitating agents on some ions. **Inquiry-Based Learning:** In mixed gender grouping where applicable, • Design and perform experiment to test for the presence of the following cations (Al^{3+}, Ca^{2+}, Cu^{2+}, Fe^{2+}, Fe^{3+}, Zn^{2+}, Pb^{2+}, NH_4^+) using $NaOH_{(aq)}$ and $NH_{3(aq)}$ as precipitating reagents, • Design and perform tests to identify and describe the behaviour of the following anions (CO_3^{2-}, Cl^-, Br^-, I^-, NO_3^-, SO_3^{2-}, SO_4^{2-}, S^{2-}) • Design and perform an experiment to determine the presence of salt using the grid method.		Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**
Teaching and Learning Resources	**MATERIALS** • Worksheets, • Simulations (PHET), video, virtual laboratory can be used here. • Warm and cold water • Sugar • Common salt • Thermometer • Beaker	• Tripod stand • Salts containing desired cations or anions, • Test tubes • Wash bottle • Gauze • Source of heat • Excel sheet • Graph	• Distilled water • Bench solutions, • Dropper **CHARTS** • Chart of the solubility rules • Chart on the solubility of different salts

Subject **CHEMISTRY**
Strand **2. SYSTEMATIC CHEMISTRY OF THE ELEMENTS**
Sub-Strand **1. PERIODICITY**

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
1.2.1.LO.1		
Describe and explain the trends of periodic properties on the periodic table.	**Critical Thinking and Problem Solving:** • Analysing the electron configuration to determine the position of each element on the periodic table and predict its properties. • Analyse and predict trends in each periodic property. **Communication and Collaboration:** • Working in groups to write the electron configuration of elements • Teaming up to classify and group different elements **Digital Literacy:** By watching videos and making online research on the periodic table	**GESI:** • Accept individuals of different backgrounds as they work together to analyse the electron configurations and determine the position of each element in the periodic table. • Contribute meaningfully as learners team up to classify and group different elements. **SEL:** • Provide opportunities for learners to evaluate their work as they analyse and predict trends in each periodic property. • To work together in groups as they team up to classify and group different elements. **National Core Values:** • Tolerance • Respect for other's views • Patience • Humility

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century and GESI	Assessment
1.2.1.CS.1	1.2.1.LI.1	1.2.1.AS.1
Demonstrate knowledge and understanding of how periodic properties change with atomic number and principal quantum number.	**Use the electron configuration of elements to determine their position on the periodic table.** **Activity-Based Learning**: Independently, write the electron configuration of the first thirty elements based on the orbital notation. **Collaborative Learning:** In pairs, classify the elements according to the following categories: • The blocks (s, p, d) • Groups (IUPAC system and the roman numeral system). • The period in which the element belongs. • Metals, semi-metals and non-metals. • Describe the physical properties (hardness, density, melting point, boiling point and physical state) and chemical properties of some representative elements (groups 1, 2 and the noble gases). • Make a design of the periodic table in pairs.	Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning Level 4 Extended critical thinking and reasoning
	1.2.1.LI.2	1.X21.1.AS.2
	Explain how periodic properties change with atomic number and principal quantum number. **Talk for Learning:** State and explain the periodic law. **Collaborative Learning:** • Research and do presentations on each of the periodic properties (atomic size, ionic size, ionization energy, electron affinity and electronegativity). • The presentations on the periodic properties should cover the following headings: a) The meaning of each periodic property. b) Factors that affect each periodic property. c) The variation of the periodic property in the periodic table. • Account for discrepancies in the periodic properties with respect to beryllium, boron, oxygen and nitrogen.	Level 1 Recall **Level 2 Skills of conceptual understanding:** Level 3 Strategic reasoning: Level 4 Extended critical thinking and reasoning:

Teaching and Learning Resources	**MATERIALS** • Videos on the periodic table • Worksheets to write the electronic configuration of the first thirty elements	**CHARTS** • Chart of the periodic table • Flipcharts for group presentations

Subject **CHEMISTRY**
Strand **2. SYSTEMATIC CHEMISTRY OF THE ELEMENTS**
Sub-Strand **2. BONDING**

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
1.2.2.LO.1		
Predict and explain ionic, covalent and metallic bonding as well as their characteristic properties.	**Communication and Collaboration:** • Discussing in groups and describing the formation of ionic bonds • Discussing among themselves how covalent bonds and metallic bonds are formed **Critical Thinking and Problem Solving:** Using the electron dot to illustrate simple, dative and polar covalent bonds. **Personal Development and Leadership:** • Ability to pursue self-directed learning with the desire to chart a path to become effective lifelong learners. • By playing various individual roles in group presentations and activities	**GESI:** • Respect individuals of different backgrounds as they discuss among themselves how covalent, ionic and metallic bonds are formed. • Accept others as they play various roles in group presentations and activities. • Interrogate their stereotypes and biases as they use the electron dot to illustrate simple, dative and polar covalent bonds. **SEL:** • Provide opportunities for learners to work together in groups to discuss the formation of ionic and covalent bonds. • Work together with other learners to discuss the properties of ionic and covalent compounds. • To help learners accurately assess their own capabilities and qualities as they pursue self-directed learning with the desire to chart a path to become effective lifelong learners. **National Core Values:** • Tolerance • Empathy

1.2.2.LO.2		
Predict and describe the type of intermolecular bonds that will be formed between a group of compounds	**Critical Thinking:** • Identifying and illustrating the various types of bonds under intermolecular bonding. • Critically examine the conditions that help in the formation of the Van der Waal's forces. **Digital Learning:** Using digital tools to watch the video animation of Hydrogen bonding **Collaboration:** Discussing in groups the factors that determine bond strength. **Personal Development:** Ability to pursue self-directed learning with the desire to chart a path to become effective lifelong learners.	**GESI:** • Respect individuals of different backgrounds by giving equal opportunities to both males and females as they discuss the factors that determine bond strength. • Create opportunity to support diverse group to complete tasks that require critical thinking. **SEL:** • Work to build learners confidence in associating the type of intermolecular bonding with a particular molecule. • To help learners accurately assess their own capabilities and qualities as they pursue self-directed learning with the desire to chart a path to become effective lifelong learners. **National Core Values:** • Tolerance • Empathy • Discipline

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century and GESI	Assessment
1.2.2.CS.1	1.2.2.LI.1	1.2.2.AS.1
Demonstrate knowledge and understand of the formation and properties of inter-atomic bonding.	**Explain ionic bonding, its formation and state the properties of ionic compounds.** **Talk for Learning:** • Review the meaning of chemical bonding and the types of interatomic bonding (ionic, covalent and metallic) from JHS curriculum. • Discuss the factors that affect ionic bond formation (ionization energy, electron affinity, electronegativity difference and lattice energy). • Using illustrations, explain the formation of cations and anions and relate the charge on simple ions to the group number of the element on the periodic table. **Activity-Based Learning:** In mixed ability groups, • Use atomic models or simulations or electron dots to describe and explain the formation of ionic bonds between metals and non-metals. • Use models to illustrate and describe the formation of Sodium chloride crystals. • Discuss the properties of ionic compounds.	Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning Level 4 Extended critical thinking and reasoning
	1.2.2.LI.2	1.2.2.AS.2
	Explain covalent bonding, its formation and state the properties of covalent compounds **Talk for Learning:** • Review the previous knowledge on covalent bonding from the JHS curriculum through a class discussion. • Identify and distinguish between the types of covalent bonds (simple covalent, dative or co-ordinate and polar covalent bonds). **Exploratory Learning:** • Using atomic models, explain the formation of covalent bonds between different non-metals. • Use electron dot structures or models to illustrate the formation of simple (H_2), dative (NH_4^+) and polar (HF) covalent bonds.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning

	Initiate Talk for Learning: • In groups, discuss and explain the following terms polarization, polarizability, polarizing power, ionic character and covalent character then state the factors that introduce ionic character in covalent bonds. • Predict bond type in terms of electronegativity difference between atoms. • Discuss the properties of covalent compounds.	
	1.2.2.LI.3	1.2.2.AS.3
	Explain metallic bonding, its formation, factors that affect its formation and properties of metals **Use of Digital Resources:** Watch a video or listen to a presentation (with the aid of relevant charts) on metallic bonding. **Activity-Based Learning:** • Based on the presentation, design a mind map on the explanation of metallic bonding, factors that affect its formation as well as its properties. • Work individually to design models to show metallic bonding (lattice of positive ions in a pool of electrons). **Talk for Learning:** • Explain each of the factors that affect metallic bond formation. • Discuss the properties of metallic solids and link the properties to metallic bonding.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
Teaching and Learning Resources	**WEBSITES** • https://study.com/academy/lesson/cation-definition-examples-quiz.html atomic models, diagrams https://www.khanacademy.org/science/in-in-class-10-chemistry-india/x87dd2847d57ee419:in-in-metals-and-non-metals/x87dd2847d57ee419:in-in-metals-reacting-with-nonmetals/v/ionic-bonds-reaction-of-metals-non-metals-metals-and-non-metals-chemistry-khan-academy • atomic models, diagrams https://www.khanacademy.org/science/in-in-class-10-chemistry-india/x87dd2847d57ee419:in-in-carbon-and-its-compounds-coming-soon/x87dd2847d57ee419:in-in-bonding-in-carbon-covalent-bond/v/covalent-bond-and-lewis-dot-structure-h2o-co2-chemistry-khan-academy **CHARTS** • Chart on ionic, covalent and metallic bonds	

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century and GESI	Assessment
1.2.2.CS.2	1.2.2.LI.1	1.2.2.AS.1
Demonstrate knowledge and understanding that, the type of chemical bond in a compound determines the physical and chemical properties of that compound.	**Describe the types of intermolecular forces and explain how they arise from the structural features of molecules.** **Talk for Learning:** • With the aid of charts, models or other resources, identify the different types of intermolecular forces found in compounds (ionic and covalent compounds). *Note: Ionic compounds are linked by inter-ionic or electrostatic forces* • Watch a video or use a chart to reinforce the types of intermolecular forces in molecules. **Collaborative Learning:** Using think-pair-share, • Deduce and describe: a. Dipole-dipole type of Van der Waal's forces. b. Induced-dipole-induced-dipole type of Van der Waal's forces. • Using charts of molecular mass (molecular size, number of electrons per molecule) of the halogens and their boiling points, deduce and explain the factors that affect the strength of Van der Waal's forces of attraction. • In pairs, and with the aid of charts or any other data, visualize and deduce the factors that affect the strength of hydrogen bond. a. Electronegativity and size of elements directly bonded to the hydrogen. b. Number of hydrogen bonds per molecule. c. Orientation of the hydrogen bond.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	1.2.2.LI.2	1.2.2.AS.2
	Explain how intermolecular forces affect physical properties of compounds. **Talk for Learning:** Discuss and explain how intermolecular forces affect physical properties such as solubility, density, viscosity, enthalpy of vaporisation, volatility, surface tension, melting point and boiling points of compounds.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning

	Experiential Learning: Perform activities to demonstrate some physical properties of covalent and ionic compounds such as their solubility in different solvents, density, melting point etc. **Inquiry-Based Learning:** • Predict the physical properties of various compounds based on the types of intermolecular forces that exist in them. • Relate the physical properties of polar and non-polar compounds to their everyday life application.		
Teaching and Learning Resources	**CHARTS** • Chart illustrating the types of intermolecular bonds • Chart containing the trend of covalent compounds according to their physical properties • Charts of boiling points of hydrides of Group 15, 16 and 17 elements • Charts of boiling points of halogens Molecular models,	• Table of NH_3, H_2O and HF and their boiling points **WEBSITES** • Https://www.youtube.com/watch?v=RSRiywp9v9w • https://www.youtube.com/watch?v=aH2IbYs_XjY	

Subject **CHEMISTRY**
Strand **3. CHEMISTRY OF CARBON COMPOUNDS**
Sub-Strand **1. CHARACTERISZATION OF ORGANIC COMPOUNDS**

Learning Outcomes	**21st Century Skills and Competencies**	**GESI, SEL and Shared National Values**
1.3.1.LO.1		
Apply the knowledge and understanding in science to describe qualitative and quantitative elemental analysis of organic compound.	**Digital Learning:** • Using virtual laboratory or videos to demonstrate distillation, fractional distillation and chromatography where apparatus is not available. • Using calculators to perform calculations involving mass and percentage mass. **Critical Thinking and Problem Solving:** Critically analyse a chromatogram to deduce the component in a natural sample. **Communication and Collaboration:** Interacting to plan and execute the activity. **Personal Development:** Encouraging the acquisition of analytical skills as they analyse and interpret paper chromatograms.	**GESI:** • Appreciate individuals of different background as they interact to plan and execute an activity. • Embrace diversity and practice inclusion as they critically analyse chromatograms to deduce the components in a natural sample. • Collectively use digital learning tools. **SEL:** • Provide opportunity for learners to make valid interpretations of chromatograms. • To work together in groups to share ideas to critically analyse chromatograms. **National Core Values:** • Patience • Tolerance

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century and GESI	Assessment
1.3.1.CS.1	1.3.1.LI.1	1.3.1.AS.1
Demonstrate knowledge and understanding of the general processes involved in qualitative and quantitative elemental analysis of organic compound.	**Describe qualitative and quantitative elemental analysis of organic compounds.** **Digital Learning:** • Watch video clips or observe teacher demonstration of: a. Distillation b. Fractional distillation c. Crystallization • Discuss the key steps in the use of recrystallization, drying and distillation to purify a given impure organic compound. **Inquiry-Based Learning:** Explore the use of melting and boiling points to determine the purity of a given organic compound. **Experiential Learning:** • Demonstrate the determination of melting points of some organic solids (benzoic acid, oxalic acid, ethanamide). • Describe paper chromatography as an analytical technique that separates components in a mixture of organic compounds and state its uses in everyday life, such as in forensics, natural product, environmental analysis etc. • Analyse and interpret simple paper chromatograms including the use of R_f-values.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning:
	1.3.1.LI.2	1.3.1.AS.2
	Design and perform experiment to test for the presence and mass composition of carbon, hydrogen, sulphur, nitrogen and halogens in organic compounds. **Experiential Learning:** In small mixed-ability groups, design and conduct experiments to test for the presence of carbon, hydrogen, sulphur, nitrogen and halogens in organic compounds. **Inquiry-Based Learning:** • Describe how the mass of elements (C, H, X) is obtained.	Level 1 Recall: Level 2 Skills of conceptual understanding: Level 3 Strategic reasoning: **Level 4 Extended critical thinking and reasoning:**

	• Perform calculations involving percentage composition using secondary data and review the calculation of empirical and molecular formulae.	
Teaching and Learning Resources	• Virtual laboratory can be used, laptop, smart phone, video • Materials: fractionating column, Liebig condenser, round bottom flask, adapter, conical flask; thermometer, ethanol-water mixture, powdered charcoal, stirrer/hotplate and liquid paraffin Chromatography: beaker, chromatography paper, capillary tube, cardboard, glass or other green plant, ethanol for pigment extract, petroleum ether: propanone mixture to use as eluant • Test tubes, Bunsen burner, metal tong, pestle, mortar, gauze, filter paper, funnel, protective cloth and eye google • Organic compounds containing N, S, and halogens, sodium metal, dil NaOH, dil H_2SO_4, HNO_3, dil $AgNO_3$, $FeSO_4$, $FeCl_3$, sodium pentacyanonitrosyl ferrate (II).	

Subject **CHEMISTRY**
Strand **3. CHEMISTRY OF CARBON COMPOUNDS**
Sub-Strand **2. Organic Functional groups**

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
1.3.2.LO.1		
Predict and classify organic compounds.	**Communication and Collaboration:** • Learning and sharing ideas together on what organic chemistry is and the unique nature of carbon and types of organic compounds. • Learning and sharing ideas together on what homologous series is. **Critical Thinking and Problem Solving:** Through sharing of ideas and brainstorming sessions on why carbon forms many compounds as well as the features of compounds in a homologous series	**GESI:** • Respect individuals of different backgrounds as learners share ideas on what organic chemistry and homologous series are. • Gain awareness of diversity and practice inclusion as learners brainstorm to come out with the reasons why carbon forms many compounds. **SEL:** • To work together in groups to share ideas on the unique nature of carbon. • To solve problems relating to homologous series. • Help learners to discuss why carbon forms many compounds. **National Core Values:** • Tolerance • Honesty

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century and GESI	Assessment
1.3.2.CS.1	1.3.2.LI.1	1.3.2.AS.1
Demonstrate knowledge and understanding organic chemistry to classify organic compounds.	**Distinguish between organic and inorganic compounds and classify organic compounds.** **Inquiry-Based Learning:** Prior to the lesson, investigate to find out answers to the following task: The meaning of organic chemistry and why carbon forms many compounds. **Collaborative Learning:** Through a class activity, differentiate between organic compounds and inorganic compounds, giving examples. **Activity-based Learning:** • With the aid of cut-outs on types and examples of organic compounds, classify different organic compounds into aliphatic hydrocarbons, alicyclic hydrocarbons, aromatic hydrocarbons and heterocyclics. • In small mixed-ability groups, model the various classes of organic compounds and draw their structures.	Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning Level 4 Extended critical thinking and reasoning
	1.3.2.LI.2	1.3.2.AS.2
	Explain homologous series and state their properties. **Talk for Learning:** Deduce the meaning of homologous series using the inductive approach. **Inquiry-Based Learning:** • Write down the homologous series for alkanes and alkenes. • Discuss the properties of homologous series based on the example. • Demonstrate ways of representing organic compounds (molecular formula, condensed formula and structural formula) with the aid of charts, models etc.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
Teaching and Learning Resources	• Work sheet for learners to tabulate the differences of organic compounds. • Molecular models to represent organic functional groups	

YEAR TWO

Subject **CHEMISTRY**
Strand **1. PHYSICAL CHEMISTRY**
Sub-Strand **1. MATTER AND ITS PROPERTIES**

Learning Outcomes	21st Century Skills and Competencies	GESI[3], SEL[4] and Shared National Values
2.1.1.LO.1		
Describe the different energy changes that occur as a result of reorganization of atoms.	**Communication and Collaboration:** • Discussion of the meaning of enthalpy changes and uses of their values. • Sharing of ideas, planning, designing and performing experiment together. • Sharing ideas, and applying Hess' Law. • Sharing ideas on differences between bond energy and bond dissociation energy. **Critical Thinking and Problem Solving:** • Use mathematical thinking skills to solve problems involving enthalpy changes. • Using mathematical thinking skills to calculate enthalpy changes and evaluate the experiment • Using mathematical thinking skills to calculate enthalpy of reaction • Using mathematical thinking skills to calculate enthalpy changes **Creativity and Innovation:** • Designing hot/cold packs. • Constructing energy cycles and Born-Haber cycles. **Digital Learning:** Watching video to reinforce concepts.	**GESI:** • Respect individuals of different backgrounds as learners share ideas, plan, design and perform experiment together. • Accept diversity and practice inclusion as learners collaborate and communicate scientific ideas. • Examine and dispel misconceptions/myths about gender and disabilities as they design and construct Born-Haber cycle. **SEL:** • Develop their own strategies to complete tasks such as construction of energy cycles and designing hot and cold packs. • To work together in groups to share ideas in the application of Hess' law. **National Core Values:** • Tolerance: • Honesty • Integrity • Discipline

[3] Gender Equality and Social Inclusion
[4] Socio-Emotional Learning

	Personal Development: Learners develop the skills necessary to conduct research and sustain this throughout their lives as they undertake various tasks.	
2.1.1.LO.2		
Use the concept of chemical kinetics to explain that chemical reactions proceed at different rates depending on their conditions and design experiment to investigate these conditions.	**Communication and Collaboration:** • Sharing ideas on rate of reaction • Sharing ideas, planning, and designing and perform experiment to investigate factors that affect the rate of reaction • Sharing ideas on rate constant, sketching and analyzing order of reactions **Critical Thinking and Problem Solving:** • Deducing the suitable method of monitoring reaction to determine the rate. • Analysing experimental results and evaluating experiment and give practical application of concepts. • Learners will apply the theory to explain effects of the factors • Deducing rate expressions, analyse graphs and calculate half-life **Digital Learning:** • Using virtual learning to perform suitable experimental procedure or may watch video to reinforce concept. • Learners watch video/use simulation to reinforce concepts. • Watching video on rate law and order of reaction • Watching video on rate law and order of reaction. **Creativity and Innovation:** Learners will role-play collision theory.	**GESI:** • Appreciate individuals of different backgrounds as learners collaborate and share ideas on rate of reaction. • Interrogate their stereotypes and biases as they plan, design and perform experiments to investigate factors that affect the rate of reaction. • Examine and dispel misconceptions/myths about gender and disabilities as they think critically and solve problems. **SEL:** • Learners will confidently explain the effects of factors that affect the rate of reaction. • Learners show empathy, compassion and respect towards the needs and feeling of others as they undertake the role-play. • Learners will understand and express ideas confidently and accommodate the views of others as they collaborate to undertake all the experiments. **National Core Values:** • Tolerance • Inquirer • Honesty and integrity • Discipline

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century and GESI	Assessment
2.1.1.CS.1	2.1.1.LI.1	2.1.1.AS.1
Demonstrate knowledge and understanding that energy changes occur in chemical reactions as a result of reorganization of atoms at different rates.	**Explain the various standard enthalpy changes that occur and carry out calculations to determine them.** **Demonstration:** Use hot water in a bottle to demonstrate and come out with the meaning of the terms chemical system, surrounding and distinguish between open, closed and isolated systems **Collaborative Learning:** • In small-mixed ability groups, (a). Discuss the meaning of chemical energy, enthalpy and enthalpy changes during chemical reaction. (b). Explain that chemical reactions are accompanied by enthalpy changes that can be exothermic or endothermic and give examples. • Watch video to reinforce the concept of endothermic and exothermic reactions. **Activity-Based Learning:** • Draw a simple enthalpy profile diagram to show endothermic and exothermic reactions. • Explain the following terms: standard enthalpy change of reaction, standard enthalpy change of formation, standard enthalpy change of combustion, standard enthalpy change of neutralization, standard enthalpy of solution and hydration. • Carry out calculations to determine their value and discuss their importance.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	2.1.1.LI.2	2.1.1.AS.2
	Determine the various enthalpy changes as well as the calorific value of common foods and fuels used in everyday life through calorimetry. **Inquiry-based learning:** • In small mixed-ability groups, design and carry out circus experiments to determine c. Enthalpy change of combustion of alcohols and food substances, such as maize or groundnut. d. Enthalpy of neutralization of acid and base (HCl and NaOH)-enthalpy of solution (NH_4Cl and $CaCl_2$ solutes). e. Enthalpy of solution (Zn and $CuSO_4$ solutes)	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**

	• Use the relationship, $\Delta H = mc\Delta T$ to calculate enthalpy changes from the experimental results. • Interpret the results and evaluate the experiment. **Digital Learning:** Watch video or use virtual laboratory to reinforce the measurement of energy content of food and fuels.	
	2.1.1.LI.3	2.1.1.AS.3
	Explain Hess's law of constant heat summation and apply it to construct energy cycle diagrams as well as calculate relevant enthalpy changes. **Activity-Based Learning:** State Hess' law and apply it to construct simple energy cycle diagrams. **Inquiry-Based Learning:** • Carry out calculations involving-determination of enthalpy changes that cannot be found by direct experiment using thermochemical equations, energy cycles and given data. Examples: Enthalpy change of reaction from enthalpy change of combustion and enthalpy change of formation. • Use Born-Haber cycle to determine ionization energy and electron affinity, lattice energy, dissociation energy, atomization energy, sublimation energy, etc. **Digital Learning:** Watch videos to reinforce concept.	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**
	2.1.1.LI.4	2.1.1.AS.4
	Explain bond energy and apply it to determine endothermic and exothermic reactions. **Talk for Learning Approach:** Using think-pair-share approach, distinguish between bond dissociation energy and bond energy **Activity-Based Learning:** • Calculate the enthalpy change of reaction from bond energy values. • Discuss bond energy as a measure of energy content hence, bond strength. • Discuss that the amount of energy released per unit mass is a factor in choosing fuel used at home, transport and industry.	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**

	2.1.1.LI.5	2.1.1.AS.5
	Explain the term rate of reaction and describe the suitable experimental procedures for measuring rates of reactions. **Collaborative Learning Approach:** Using think-pair-share approach, discuss and explain the term rate of reaction and determine ways of expressing the rate (initial rate, average rate and instantaneous rate). **Inquiry-Based Approach:** In small mixed-ability group, discuss suitable methods or use virtual laboratory to determine suitable procedures for measuring rates of reaction. Examples colour change, changes in volume of gas evolved, formation of precipitate, change in mass, appearance, and disappearance of product etc.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	2.1.1.LI.6	2.1.1.AS.6
	Perform experiments to investigate the factors that affect the rate of reaction and analyse the data from the rate experiments. **Experiential Learning**: • In small mixed-ability groups and using circus activities, design, and perform experiments to investigate the effect of the following on rate of reaction: a. Change in concentration (using gas syringe to measure the volume of CO_2 from HCl and $CaCO_3$ reaction with time). b. Changes in surface area (using balance to measure loss of mass or using gas syringe to measure volume of CO_2 produced from HCl and $CaCO_3$ reaction with time). c. Changes in temperature or concentration with respect to time (Sulphur-clock experiment). d. Catalyst (using gas syringe to measure the volume of oxygen gas produced from decomposition of H_2O_2 by MnO_2) **Talk for Learning:** • In small mixed-ability and mixed-gender groups where applicable, analyse the experimental data and graphs of reactions and deduce patterns and hence the effect of the parameters on the rate of reaction. • Discuss practical applications of each outcome on everyday life (Example, surface area and safety of grain mill factories, why a glowing splint rekindles when it is put in a bottle of oxygen	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**

	gas, why smoking is forbidden in areas where bottled oxygen is in use, burning of charcoal, the use of antioxidants as competitive inhibitors to preserve food etc.).	
	2.1.1.LI.7	2.1.1.AS.7
	Describe the collision theory and use it to explain qualitatively, the effects of the factors that affect the rate of reaction. **Collaborative Learning:** • In a class session, brainstorm on the interactions occurring in a chemical reacting system and describe the collision theory. • Highlight the main points of the collision theory. **Activity-Based Learning:** • Role-play to simulate the collision theory. • Predict and explain using the collision theory, the qualitative effect of each factor on the rate of reaction. • Sketch and use the Maxwell-Boltzmann energy distribution curve to explain the effect of temperature change and catalyst on the rate of reactions.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	2.1.1.LI.8	2.1.1.AS.8
	Construct rate equations from experimental data, analyze graphs to deduce the order of reactions and solve problems involving the rate expression. **Collaborative Learning:** • In mixed gender group where applicable, distinguish between the terms rate constant and order of reaction with respect to a particular reactant and overall order of reaction. • Brainstorm to come out with definition of rate determining step. **Problem Solving Approach:** • Deduce the rate expression for a reaction from experimental data. i.e., $r=k[A]^x[B]^y$ • Using think-pair-share approach, sketch graphical representation for zero, first and second order reactions. • Use mathematical skills to solve problems involving the rate of reaction, including half-life of a reaction from first order and its significance as well as using half-life to predict the order of reaction.	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**

	Note: *Calculations involving the Arrhenius equation and its interpretations are beyond the scope of this curriculum.*		
Teaching and Learning Resources	**MATERIALS** • Worksheets: for drawing and labelling enthalpy profile diagram. • Worksheets for supporting calculation of standard enthalpy changes. • Worksheets with task on applying Hess' law to calculate enthalpy of reaction. • Calculator • Hot water • Hydrochloric acid • Sodium hydroxide pellets • Thermometer • Copper sulphate • Zinc powder • Virtual lab on calorimetry • Use of gas syringe • Chemical balance • Calcium chloride	• Probe • Beakers (100ml and 400ml) • Ammonium chloride • Calorimetry setup • Conical flask • Beakers • Marble chips • Hydrochloric acids • Kits for sulphur-clock experiment • Kits for investigating effect of catalyst on decomposition of H_2O_2 • Graph sheets **WEBSITE** • Videos on the topic:khanacademy.org	

Subject **CHEMISTRY**
Strand **1. PHYSICAL CHEMISTRY**
Sub-Strand **2. EQUILIBRIA**

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
2.1.2.LO.1		
Explain that dynamic equilibrium is attained when the rates of the forward and backward reactions are equal and this principle has industrial applications.	**Communication and Collaboration:** Communicating ideas to establish the relationship between the equilibrium constant and the concentration of chemical entities in a chemical reaction. **Critical Thinking and Problem Solving:** • Thinking through to explain reversible processes. • Using the Le Chatelier's principle as the basis to predict the direction of a chemical reaction based on the type of stress that is imposed. • Using the Le Chatelier's principle as the basis to discuss how chemists increase their yields in the Haber and Contact processes. • Thinking through the idea of mass action to deduce an expression for equilibrium constant	**GESI:** • Respect individuals of different backgrounds as they share ideas to establish the relationship between the equilibrium constant and concentration of the chemical entities in a reaction. • Embrace diversity and practice inclusion as learners think critically and solve problems. • Interrogate their stereotypes and biases about gender as they discuss how Chemists increase their yields in the Haber and Contact process. **SEL:** • To work together in groups to establish the relationship between the equilibrium constant and the concentration of chemical entities. • To enable learners to confidently use the Le Chatelier's principle to predict the yields in reversible reactions. **National Core Values:** • Discipline • Patience • Prudence
2.1.2.LO.2		
Apply your knowledge in acids and bases to classify and describe	**Communication and Collaboration:**	**GESI:**

substances as acids and bases as well as determine the concentration of analyte through titration.	• Working in groups and sharing ideas while brainstorming. • Learners will communicate their observations of the physical properties of acids and bases. • Learners will work in groups to explore the properties of acids and bases. • Learners will communicate their findings in the circus activity verbally and in written form. • Learners will investigate the strength of acids and bases in groups around the various stations of the circus activity. • Working in mixed-ability groups to undertake experiments. • Learners discuss the various types of salts. **Critical Thinking and Problem-Solving Skills:** • Learners will predict the strength of the acid or base used as the electrolyte based on the brightness of the bulb lit. • Learners brainstorm to differentiate among the different types of salts. • Determining concentration of an analyte, percentage purity of an impure sample, percentage of water of crystallization in a hydrated salt and relative atomic mass. **Digital Literacy:** Making online investigations and watching videos on reversible and irreversible reactions. **Personal Development:** Working individually to identify and write down the conditions that will optimize a desired outcome of a reaction.	• Accept individuals of different backgrounds as they collaborate and share their observations on the physical properties of acids and bases. • Embrace diversity and practice inclusion as learners investigate their findings in the circus activity. • Examine and dispel misconception/myths about gender and disabilities as they determine concentration of analyte and percentage purity. **SEL:** • To work together to share ideas on physical and chemical properties of acids and bases. • To foster learners' awareness of different types of salts and how to identify them. **National Core Values:** • Respect: • Honesty • Patience • Tolerance

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century and GESI	Assessment
2.1.2.CS.1	2.1.2.LI.1	2.1.2.AS.1
Demonstrate understanding that a balance of opposing reactions occur in chemical equilibrium systems to attain equilibrium and this principle is applied in chemical industrial processes.	**Explain the terms reversible and irreversible reactions and dynamic equilibrium.** **Participatory Learning:** • Explain what reversible reactions are after watching a short video of reversible and irreversible reactions and apply them to physical, chemical, biological and environmental processes. • Use graphical method to explain the concept of dynamic equilibrium. **Exploratory Learning:** Conduct an experiment on the reversible reaction between anhydrous copper (II) tetraoxosulphate (VI) and water or any other workable reagent.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	2.1.2.LI.2	2.1.2.AS.2
	State Le Chatelier's Principle and apply it to deduce qualitatively, the effects of various factors on the positions of equilibrium and on the value of the equilibrium constant. **Talk for Learning Approach:** • Identify the factors that affect chemical equilibrium and use Le Chatelier's principle to predict the direction of the shifting from various possible stress (these should include changes in concentration, temperature, pressure, volume and catalyst) on a system at equilibrium • In groups discuss and predict the effect of each of the factors on the position of equilibrium as well as the equilibrium constant. **Activity-Based Learning:** Individually, identify and write down a set of conditions that will optimize a desired outcome of a reaction, such as a product.	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**
	2.1.2.LI.3	2.1.2.AS.3
	Apply the concepts of equilibrium and rates to industrial processes (Haber and Contact Process). **Exploratory Approach:** Investigate from the Internet and other sources about how Le Chatelier's principle is applied in industrial processes.	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning

	Collaborative Learning: Give group presentations on how Chemists carry out reactions economically to get the highest yields in the shortest possible time using the Haber and Contact processes in the production of ammonia and sulphuric acid.	**Level 4 Extended critical thinking and reasoning**
	2.1.2.LI.4	2.1.2.AS.4
	Deduce expressions for equilibrium constants in terms of concentrations and partial pressures and perform relevant calculations from appropriate data. **Activity-Based Learning:** • In mixed-ability groups, deduce expression for equilibrium constant using the law of mass action. • Using the think-pair-share approach, explain the significance of the equilibrium constant. • Perform calculations to determine equilibrium concentrations or partial pressures and equilibrium constant using experimental data and the initial quantities of reactants. • Establish the relationship between Kp and Kc using the ideal gas equation. • Perform calculations involving Ksp of sparingly soluble salts.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
Teaching and Learning Resources	**MATERIALS** • Video on the topic. • Worksheet containing tables to be completed on the equilibrium factors. • Worksheet with scaffolding strategies in Kc, Kp and Ksp	**CHARTS** • Chart of the production line of the Haber and Contact processes. • Chart of processes that are reversible

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century and GESI	Assessment
2.1.2.CS.2	2.1.2.LI.1	2.1.2.AS.1
Demonstrate knowledge and understanding of the concepts and properties of acids and bases to classify substances as well as determine concentration of analysis through titration.	**Explain Arrhenius, Bronsted-Lowry and Lewis concepts of acids and bases.** **Collaborative Learning:** With the aid of charts or videos, brainstorm to find answers to the following tasks: • Arrhenius theory of acids and bases and give their strengths and limitations • Bronsted-Lowry theory of acids and bases and give their strengths and limitations. • Types of Bronsted-Lowry acids (simple acids, oxoacids and hydrated cations) and bases. • Lewis theory of Acids and Bases and give their strengths and limitations. **Activity-Based Learning:** • Deduce the conjugate acid-base pairs in a given acid-base reaction. • Classify household chemical, fruits, vegetables etc as acids or bases • Watch video to reinforce the concepts.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	2.1.2.LI.2	2.1.2.AS.2
	Describe the physical and chemical properties of acids and bases. **Exploratory Learning:** In small mixed ability groups, • Explore using virtual laboratory or simulation or simple activities, the physical properties of acids and bases under the following headings: pH, feel, behaviour in indicators (including litmus paper) *Note:* No chemicals should be tasted in the laboratory. **Experiential Learning:** • Undertake experiments on acids such as: a) Reaction with metals like Zn, Fe and Mg. b) Reaction with bases (Neutralization). c) Reaction with trioxocarbonate(IV), (CO_3^{2-}) or hydrogentrioxocarbonate(IV), (HCO_3^-) d) Reaction with basic oxides. • Undertake experiments on bases such as: a. Reaction with acidic oxides. b. Reaction with ammonium salts to liberate ammonia gas	Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning Level 4 Extended critical thinking and reasoning

	c. Reaction with acids. **Talk for Learning:** Discuss application of neutralization in treating insect bites, stomach indigestion, treating soil and lake acidity.	
	2.1.2.LI.3	2.1.2.AS.3
	Distinguish between strong and weak acids, strong and weak bases in terms of the extent of dissociation, rate of reaction, electrical conductivity, pH value in aqueous solution and enthalpy change of neutralization value. **Inquiry-Based Learning**: • Explain qualitatively, the differences between weak and strong acids and weak and strong bases in terms of dissociation. • Using a circus activity, investigate acid or base strengths based on the following methods: a. Conductivity measurement or using the acids or bases as electrolyte with electric bulb in a circuit. b. pH measurement using a pH meter or universal indicator method. c. Use of heat of neutralisation value. • Discuss basicity of acids and relate it to the strength of acids.	Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning Level 4 Extended critical thinking and reasoning
	2.1.2.LI.4	2.1.2.AS.4
	Explain the meaning of salt and classify salts. **Talk for Learning:** • Brainstorm to come out with the meaning of salt. • Differentiate among normal, acidic, basic, double, complex, hydrated, deliquescent, hygroscopic and efflorescent salts with examples. **Experiential Learning:** • In small mixed-ability groups, undertake experiments to prepare soluble and insoluble salts. • Discuss various uses of salts in everyday life. **Field trip or Excursion**: Take an industrial trip to a salt mining site to identify the processes involved in their operations.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning

<table>
<tr><td></td><td colspan="2">2.1.2.LI.5</td><td>2.1.2.AS.5</td></tr>
<tr><td></td><td colspan="2">Determine the quantity of analyte in a solution using acid-base titration.

Exploratory Learning: Perform titrations and use the data obtained to determine the concentration of an analyte in a solution. The titrations include:
a. Simple acid-base titrations for determining percentage purity, percentage of water of crystallization in a hydrated salt, relative atomic mass.
b. Back or Indirect titration.
c. Double-indicator titration.</td><td>Level 1 Recall
Level 2 Skills of conceptual understanding
Level 3 Strategic reasoning
Level 4 Extended critical thinking and reasoning</td></tr>
<tr><td>Teaching and Learning Resources</td><td>• Worksheets with illustrative examples of Arrhenius, Bronsted-Lowry and Lewis acids and bases for Learners to identify
• Fruits
• Vegetables
• Common acids (HCl, HNO_3, H_2SO_4, CH_3COOH, H_2CO_3,
• Bases
• Universal indicator with pH colour chart
• Litmus papers
• Ammonium compound (e.g., ammonium chloride)
• Bases: NaOH(aq), KOH(aq), $Ca(OH)_2$, NH_3
• Zinc chips, iron filings, magnesium ribbon
• pH meter
• A simple electric circuit with electric bulb/ lamp, beakers, wire, key/switch</td><td>• Mixture of Na_2CO_3 and $NaHCO_3$)
• Methyl orange and phenolphthalein indicators
• Burette
• Pipette
• Conical flask
• Droppers
• Retort stand and clamp
• Pipette filler
• White tile
• Wash bottle with distilled water
• Calculator</td><td></td></tr>
</table>

Subject **CHEMISTRY**
Strand **2. SYSTEMATIC CHEMISTRY OF THE ELEMENTS**
Sub-Strand **1. PERIODICITY**

Learning Outcomes	**21st Century Skills and Competencies**	**GESI, SEL and Shared National Values**
2.2.1.LO.1		
Predict and describe the trends of chemical and physical properties of elements and their compounds in the periodic table.	**Collaboration and Communication and Critical Thinking:** • Brainstorming to come out with the physical and chemical properties of the period 3 elements. • Watching a video on the reactivity of the elements to re-enforce the concept by searching on YouTube. • Using their mathematical thinking skills to plot graphs from data. From the graphs, deduce periodic trends in properties of the period 3 elements. • Brainstorming to come out with the physical and chemical properties of the period 3 compounds. **Problem-Solving Skills:** • Writing chemical equations on worksheets to show chemical reactions of the compounds. • Investigating the thermal stabilities of the specified carbonates by conducting heat tests on them.	**GESI:** • Embrace diversity and practice inclusion as learners collaborate and think critically. • Examine and dispel misconceptions/myths about gender and disabilities as diverse groups are supported with scaffold worksheets to write chemical equations. • Interrogate their stereotypes and biases as they investigate the thermal stabilities of carbonates and nitrates **SEL:** Provide opportunities for learners to evaluate their own work on writing chemical equations **National Core Values:** • Respect • Tolerance • Selflessness

2.2.1.LO.2		
Predict and describe the physical and chemical properties of the halogens as well as their uses in everyday life.	**Critical Thinking and Problem Solving:** • Learners think critically and communicate as they discuss variations and anomalies in physical properties of the halogens. • Learners think critically as they discuss electron configurations and variable oxidation states of the halogens and link them to their chemical properties. • Learners brainstorm to deduce the differences in the reactivity of the halogens based on their electrode potential. **Communication and Collaboration:** • Learners communicate as they dialogue in pairs to explain the chemical basis for the uses of the reactions of halogens in everyday life. • Learners collaborate as they work in mixed-ability groups. • Learners communicate and think critically as they engage in discourse and write balanced chemical equations. • Demonstrations and carrying out investigations make learners creative. **Digital Learning:** Learners practice digital learning by watching a video on the reaction of the halogens with water.	**GESI:** • Embrace diversity and practice inclusion as they communicate to explore the uses of the reactions of halogens in everyday life. • Interrogate their stereotypes and biases about gender as they deduce the differences in the reactivity of the halogens. • Refute misconceptions/myths about gender and disabilities as they demonstrate and carryout investigation. **SEL:** Provide opportunities for learners to evaluate their own work on writing chemical equations involving halogens. **National Core Values:** • Respect • Open-mindedness

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century and GESI	Assessment
2.2.1.CS.1	2.2.1.LI.1	2.2.1.AS.1
Demonstrate understanding of the regular patterns of chemical and physical properties of elements and their compounds in the periodic table.	**Describe the patterns in physical and chemical properties of the period 3 elements.** **Talk for Learning:** With the aid of charts, videos or books, discuss trends in the properties of period 3 elements including: a. Metallic property, b. Physical properties (density, melting point and boiling point, hardness). c. Chemical properties (reaction with some common reagents, example, water, acids, alkalis air or oxygen, chlorine) **Digital Learning:** Research on the internet or watch videos on the reactions of period 3 elements. **Problem-Based Learning:** Plot a graph of physical properties from given data and use it to deduce trends in physical properties of the elements in period 3.	Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning Level 4 Extended critical thinking and reasoning
	2.2.1.LI.2	2.2.1.AS.2
	Describe the patterns in physical and chemical properties of compound (hydrides, oxides, hydroxides and chlorides) of period 3 elements. **Talk for Learning Approach:** Using think-pair-share approach, predict and describe the physical properties of the compounds of the period three elements. a. Hydrides: structure and bonding, acid-base characteristics, their reaction with water and air. b. Oxides: structure and bonding, acid-base characteristics, hydrolytic behaviour and solubility in water. c. Hydroxides: types, structure and bonding, acid-base characteristics. d. Chlorides: types, structure and bonding, acid base characteristics, reaction in water and air. **Collaborative Learning:** • In small groups, discuss the thermal stability of carbonates (CO_3^{2-}) and nitrates (NO_3^-) of period two and three elements to include Li, K and Ca and account for their differences. • Write chemical equations to show how the compounds decompose on heating.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning

	Experiential Learning: • Perform simple experiments to compare the thermal stabilities of Na_2CO_3, K_2CO_3 and $CaCO_3$. • Test for any gas that evolves. • Write balanced chemical equations of the reactions that take place.		
Teaching and Learning Resources	• ICT tools • Textbooks • Graph sheets to plot given data • Worksheets	• Samples of the carbonates and nitrates of Li, Na, K, Mg and Ca • Source of heat • Lime water	• Delivery tube • Test tubes • Test tube holder

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century and GESI	Assessment
2.2.1.CS.2	2.2.1.LI.1	2.2.1.AS.1
Demonstrate knowledge and understanding of the pattern of the physical and chemical properties of the halogens as well as their uses.	**Explain the physical and chemical properties of the halogens (Group 17 elements).** **Talk for Learning Approach:** • In mixed-ability groups, discuss the variations in the physical properties of the halogens under the following headings: a. Physical State b. Melting and Boiling points c. Bond energies • Discuss any anomalies in the bond energies. **Collaborative Learning:** • In mixed-ability groups, discuss the electron configurations and the exhibition of variable oxidation states of the halogens. • Discuss the similarities in chemical nature of the halogens. • Deduce the differences in the reactivity of the halogens based on their standard electrode potential values. • Use the following reactions for your discussions: a. Halogens with halide ions (displacement reactions). b. Halide ions with silver ions (precipitation reactions). **Digital Learning:** • In mixed-ability groups, watch videos and discuss the reagents, conditions and products formed when the halogens react with water and alkalis. • Write balanced chemical equations to show how the reactions occur.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	2.2.1.LI.2	2.2.1.AS.2
	Describe the reaction of halide salts and explain the differences in acid strength of the hydrogen halides as well as the uses of the halogens. **Talk for Learning Approach:** Using think-pair-share approach, • Explain the differences in reducing power of the halides. • Write chemical equations to illustrate the various reactions of halides salts with concentrated tetraoxosulphate (VI) acid.	Level 1 Recall: **Level 2 Skills of conceptual understanding:** Level 3 Strategic reasoning:

	Collaborative Learning: In mixed-ability groups: • Discuss the acid strengths of hydrogen halides under the following headings: a. Relative bond strengths of HX, where X is F, Cl, Br and I. b. Ka values of HX • Discuss the thermal stability of the halogen halides in terms of their bond energies. • Explain the chemical basis for the uses of the reactions of halogens in everyday life under the following headings: a. Purification of water for drinking b. The use bleach to oxidise dyes and other coloured molecules c. Disinfecting toilets d. Use of halogenated hydrocarbons as solvents, refrigerants and in aerosols	Level 4 Extended critical thinking and reasoning:
Teaching and Learning Resources	• Periodic table showing atomic numbers, electron configuration of the elements as well as their fixed or variable oxidation states • ICT tools • KOH • NaOH	• Worksheets • Bleach solution • Water • A piece of stained cloth

Subject **CHEMISTRY**
Strand **2. SYSTEMATIC CHEMISTRY OF THE ELEMENTS**
Sub-Strand **2. BONDING**

Learning Outcomes	**21st Century Skills and Competencies**	**GESI, SEL and Shared National Values**
2.2.2.LO.1		
Describe the structure, chemical bonding and properties of molecular compounds.	**Critical Thinking and Problem Solving:** • Using the molecular models to predict the shape of molecules. • Use diagrams to explain the formation of hybrid orbitals **Communication and Collaboration:** • Learners will work together in using the molecular models. • Learners will brainstorm to come out with the uses of diamond and graphite. • Work in small mixed-ability groups to discuss formation of orbitals.	**GESI:** • Respect individuals of different backgrounds as they critically think and solve problems. • Practice inclusion and accept diverse opinions as they work together and use the molecular models. • Examine and dispel misconceptions/myths about gender and disabilities as they use diagrams to explain the formation of hybrid orbitals. **SEL:** To work together in groups to use molecular models in predicting the shape of molecules. **National Core Values:** Tolerance

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century and GESI	Assessment
2.2.2.CS.1	2.2.2.LI.1	2.2.2.AS.1
Demonstrate knowledge and understanding of the role of modelling, evidence and theory in explaining the structure, bonding as well as properties of molecular compounds	**Predict the shape and bond angles for species and distinguish between sigma and pi bonds.** **Collaborative Learning Approach:** • Use electronegativity values to predict the relative polarity of bonds. • Predict the shape and bond angles for species with 4, 3, and 2 negative charge centres on the central atom using the Valence shell electron pair repulsion (VSEPR) theory. • Predict whether or not a molecule is polar from its molecular shape and bond polarities **Talk for Learning:** • Discuss in a small mixed-ability group, how orbital overlap of two atoms results in the formation of molecular orbital. • Describe and distinguish between sigma and pi bonds.	Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning Level 4 Extended critical thinking and reasoning:
	2.2.2.LI.2	2.2.2.AS.2
	Explain hybridization and relate it to various structures. **Collaborative Learning Approach:** • Engage in a teacher led discussion on hybridization as the mixing of atomic orbitals of different energy and shape to obtain a set of new orbitals of equivalent energy and shape. • Explain the characteristics of hybrid orbitals. **Activity-Based Learning:** Working in pairs, use molecular models to identify and explain the various types of hybridization (sp, sp^2, sp^3, sp^3d, sp^3d^2 and dsp^2) **Collaborative Learning:** In small mixed ability groups, • Identify and explain the relationship between the Lewis dot structures and hybrid orbitals • Use the orbital diagram configuration to explain the formation of (sp, sp^2, sp^3, sp^3d, sp^3d^2 and dsp^2) hybrid orbitals and model it with the molecular orbitals models. • Predict shape and bond angles of molecules (CH_4, $BeCl_2$, BCl_3, NH_3, H_2O, PCl_5, SF_6, $[Ni(CN)_4]^{2-}$) based on the hybrid orbitals of the central atom.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning

	Home Task: Research through the Internet, books or other sources to: • Describe and compare the structure and bonding in diamond and graphite using molecular models. • Come out with the uses of diamond and graphite based on their structures. • Describe structure and bonding of silicon (IV) oxide.		
Teaching and Learning Resources	**MATERIALS** • Molecular models • Toothpick • Modelling clay • Ball and stick models	• Coloured balloon • Worksheets with orbital diagram • Balloons of different colours • Coloured balloons • Thread	• Periodic table • Ball and stick models **CHARTS** • Chart containing diagrams of molecular orbitals • Chart of the Lewis dot structures

Subject **CHEMISTRY**
Strand **3. CHEMISTRY OF CARBON COMPOUNDS**
Sub-Strand **1. CHARACTERISATION OF ORGANIC COMPOUNDS**

Learning Outcomes	**21st Century Skills and Competencies**	**GESI, SEL and Shared National Values**
2.3.1.LO.1		
Describe sigma and pi bonds of carbon compounds and explain their structure and bonding.	**Communication and Collaboration:** Sharing ideas on the use of molecular model to construct multiple bonds. **Creativity and Innovation:** Manipulating models to represent multiple bonds.	**GESI:** • Embrace diversity and practice inclusion as they share ideas on the use of molecular models to construct multiple bonds. • Examine and dispel misconceptions/myths about gender and disabilities as they manipulate models to represent multiple bonds. **SEL:** To work together in groups to share ideas in using molecular models to construct multiple bonds. **National Core Values:** Tolerance

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century and GESI		Assessment
2.3.1.CS.1	2.3.1.LI.1		2.3.1.AS.1
Demonstrate knowledge and understanding of multiple bonds and use it to account for the structure of compounds.	**Apply the concept of hybridization to explain sigma and pi bond of organic compounds and explain their structure and bonding.** **Exploratory Learning:** • In small mixed-ability groups, use molecular models to construct carbon-carbon double bond and carbon-carbon triple bond. • Use the models constructed to describe how carbon-carbon double bond and carbon-carbon triple bond are formed. **Inquiry-Based Learning:** With the aid of relevant videos, charts or pictures brainstorm to come out with the formation of pi and sigma bonds in unsaturated hydrocarbons either through the liner/co-axial or lateral/sideway overlap of orbitals.		Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**
Teaching and Learning Resources	• Molecular models • Worksheet on task on pi bond formation	• Toothpicks and modelling clay • Videos on the topic: khanacademy.org	

Subject **CHEMISTRY**
Strand **3. CHEMISTRY OF CARBON COMPOUNDS**
Sub-Strand **2. ORGANIC FUNCTIONAL GROUPS**

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
2.3.2.LO.1		
Explain the source, structure, nomenclature, properties, uses of the various classes of organic compounds and the test for their functional groups.	**Communication and Collaboration:** Sharing ideas on generating members of alkane series, applying IUPAC rules and discussing properties and uses of alkanes. **Critical Thinking and Problem Solving:** • Applying ideas on toxicity and environmental effects of products of reactions of alkanes. • Applying ideas on alkanols as biofuel on energy sustainability **Digital Learning:** Watch video to reinforce concept **Creativity and Innovation:** Designing alcohol breathalyser	**GESI:** • Respect individuals of different backgrounds as they share ideas and apply IUPAC rules to name compounds, discuss properties and uses of alkanes. • Interrogate their stereotypes and biases about gender as they apply their ideas on toxicity and environmental effects of product of reactions of alkanes. • Examine and dispel misconceptions about gender and disabilities as they design alcohol breathalyser. **SEL:** To work together in groups to apply IUPAC rules in naming alkanes. **National Core Values:** • Tolerance • Discipline • Honesty • Integrity

Content Standards	Learning Indicators and Pedagogical Exemplars with 21St Century and GESI	Assessment
2.3.2.CS.1	2.3.2.LI.1	2.3.2.AS.1
Demonstrate knowledge and understanding of source, structure, nomenclature, properties and uses of organic compounds as well as the characteristic test for their functional groups.	**Explain the nomenclature, structure, properties and everyday uses of alkanes.** **Activity-Based Learning:** Prior to the lesson, find out about the general formula, properties and nomenclature of alkanes and other hydrocarbons. **Talk for Learning:** • In a whole class discussion, talk about organic reactants (saturated, unsaturated compounds, electrophiles, nucleophiles, free radicals), types of organic reactions, factors that affect organic reactions, homolytic and heterolytic fission, functional groups and isomerism (chain, position, functional group, geometrical isomerism) • Generate the formulae and structure of the first 10 members of the alkanes series using their general molecular formula. **Activity-Based Learning:** • Model each isomer of alkane (C4 and C5). • Apply IUPAC rules to name straight chain (C1 – C10) and branched chain alkanes up to C6. **Inquiry-Based Learning:** • Investigate the physical properties of alkanes such as melting points, boiling points, density, volatility and solubility. • Explain the low reactivity of alkanes in terms of bond enthalpies and bond polarity. • Describe using equations, complete and incomplete combustion reactions of alkanes and discuss the effect of their products to the environment (greenhouse effect and global warming), release of CO and the use of catalytic converter to minimize the pollution. **Collaborative Learning:** • Discuss the effect of other products of burning fuel (formation of acid rain). • Describe using equations, the reactions of methane with chlorine. Discuss the effect of the product (CFCs) on ozone layer. • Discuss free radical mechanism of the reaction of methane and chlorine. • Discuss cracking and reformation of alkanes.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning

	• Discuss the uses of alkanes. (i.e., Uses of the various petroleum fractions obtained from fractional distillation of crude oil).	
	2.3.2.LI.2	2.3.2.AS.2
	Explain the nomenclature, structure, properties of alkenes and alkynes. **Collaborative Learning Approach:** Using think-pair-share, • Generate the formulae and structure of the first six alkenes series using their general molecular formula. **Activity-Based Learning** • Model each isomer of alkene (C4 and C5). • Apply IUPAC rules to name alkenes up to C6 (straight chain and branched chain). • Design a mind map to show the sources, the laboratory preparation and physical properties of alkenes • Write chemical equations to illustrate the reactions of symmetrical and unsymmetrical alkenes with: a. Hydrogen b. Halogens c. Steam d. Hydrogen halides e. $KMnO_4$ **Note:** Use Markornikov's rule for the unsymmetrical alkenes. **Experiential Learning:** Distinguish between alkanes and alkenes using bromine water or bromine in tetrachloromethane. **Initiating Talk for Learning:** • Outline the economic importance of the reactions of alkenes (production of margarine and alcohol). • Watch video to reinforce the concepts taught.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning

	Collaborative Learning Approach: • Generate the formulae and structure of the first six alkynes in their homologous series using their general molecular formula. • Determine structure of the isomers of C4 and C5 • Discuss the acidity of terminal alkynes and distinguish them chemically from non-terminal alkynes. • Describe the preparation of ethyne, • Write chemical equations to illustrate reactions of terminal and non-terminal reaction with a) Hydrogen, b) Halogen c) Hydrogen halide • Discuss the use of ethyne in welding (combustion reactions of alkynes) • Watching video to reinforce the concepts taught.	
	2.3.2.LI.3	2.3.2.AS.3
	Describe the structure, bonding, properties of benzene and its uses in everyday life. **Collaborative Learning Approach:** In small groups, describe the structure, stability and bonding of Benzene (Kekule, resonance and molecular orbital theories). **Digital Learning:** Watch videos or use virtual laboratory to investigate and identify patterns of substitution reactions of benzene with halogens, conc. HNO_3, conc. H_2SO_4, alkyl halide and acyl halide. **Inquiry-Based Learning:** • Discuss addition reactions of benzene with hydrogen and Halogens. • Use concept map to summarise the reactions of benzene. • Discuss the importance of benzene in everyday life.	Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning Level 4 Extended critical thinking and reasoning
	2.3.2.LI.4	2.3.2.AS.4
	Explain the structure, nomenclature, preparation, properties and uses of alkanols as well as their characteristics test. **Collaborative Learning Approach:** • Through think-pair-share approach, generate the formulae of alkanols up to C6. • Describe the classes and isomers of alkanols. • Apply IUPAC rules to name Alkanols up to C6 and their isomers.	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**

	Experiential Learning: • Prepare alkanols in the laboratory. • Compare and contract the preparation of ethanol by fermentation and hydration and discuss the physical properties of alkanols. **Activity-Based Learning:** • Watch video or use virtual laboratory to investigate or write the following reactions of alkanols; dehydration, esterification, substitution (reaction with phosphorus trihalides), metals, oxidation of primary and secondary alkanols, iodoform reaction and Lucas reaction. • Describe some synthetic pathways involving alkanols • Discuss the use of ethanol at home, hospital, pharmaceutical industries and research work in Chemistry and related science laboratories. **Project-Based Learning:** • In a small mixed-ability group, plan and design alcohol breath analyser using potassium dichromate. (STEM application) • Discuss energy efficiency by evaluating the advantages and disadvantages of biofuels.	
	2.3.2.LI.5	2.3.2.AS.5
	Explain the structure, nomenclature, preparation, properties and uses of alkanoic acids as well as their characteristic test. **Collaborative Learning Approach:** • Generate members of alkanoic acids (carboxylic acids) up to C6. • Apply IUPAC rules to name alkanoic acids up to C6 and their isomers. • Write chemical equations for the production of alkanoic acids (i.e., from primary alkanols, alkanals, alkyl benzene). • Discuss the biological way of producing ethanoic acid from acid fermentation. • Discuss the physical properties of alkanoic acids (solubility in water, boiling point, melting point, density, volatility). • Account for the acidity of alkanoic acids and state the factors that affect their acidity. **Exploratory Learning:** Plan and carry out simple test tube experiments or watch videos or use virtual laboratory to investigate the reactions of alkanoic acids with the following substances: Na, NaOH, $NaHCO_3$, Na_2CO_3, NH_3, ROH, $LiAlH_4$	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**

	Experiential Learning: • Conduct an experiment to test for alkanoic acids through the reaction with alkanols to produce esters. • Talk about other ways of testing for the presence of alkanoic acids. **Initiating Talk for Learning:** • Describe some synthetic pathways of alkanoic acids. • Describe some uses of alkanoic acids (manufacture of synthetic flavouring, nylon, food preservatives, vinegar, terylene, brighteners).		
Teaching and Learning Resources	**MATERIALS** • Molecular models • Video of greenhouse effect, toxicity of CO, acid rain • Worksheets with task on naming, isomer, and properties • Worksheets with tasks on naming, isomers, properties, uses of alkenes • Video of preparation of ethyne • Worksheets with tasks on naming, isomers, properties, uses of alkynes • Materials to design alcohol breath analyser Kit for esterification reactions • Na, $NaHCO_3$, PCl_5, C_2H_5OH, $LiAlH_4$ • Worksheets on reactions of benzene **WEBSITE** • Virtual lab/video on laboratory and reactions of alkanoic acids • Virtual lab/video on laboratory and industrial preparation of alcohol	• Virtual labs on preparation of alkene, test for alkenes • Virtual lab on preparation of alkynes • Videos on the topic: khanacademy.org **CHARTS** • Charts on homologous series of alkanes, fractionating column • Charts on uses of alkynes • Charts on uses of alkenes • Chart on uses of benzene • Chart on classes of alcohols, uses of alkanols • Chart on uses of alkanoic acids • Chart on molecular orbital theory of benzene	

YEAR THREE

Subject **CHEMISTRY**
Strand **1. PHYSICAL CHEMISTRY**
Sub-Strand **2. EQUILIBRIA**

Learning Outcomes	21st Century Skills and Competencies	GESI[5], SEL[6] and Shared National Values
3.1.2.LO.1		
Use the knowledge in pH to distinguish between solutions that are acidic, neutral or basic.	**Collaboration and Communication:** Learners discuss the pH Scale in groups. **Critical Thinking and Problem Solving:** • Learners need to think through the best possible way to calculate the pH of specific solutions. • Learner will need to use pH as a case study to come up with a relationship between Ka and pKa. • By manipulating the Henderson-Hasselbalch equation to determine certain aspects of buffer solutions. • Glocal Citizenship • Learners will acquire knowledge on the relevance of pH an pOH on everyday life	**GESI:** • Respect individuals of different backgrounds as they collaborate and communicate. • Examine and dispel misconceptions/myths about gender and disabilities as they manipulate the Henderson-Hasselbalch equation to determine some aspects of buffer solution. • Embrace diversity and practice inclusion as they determine the relationship between Ka and pKa. **SEL:** • To provide Learners with a range of options to calculate the pH of a specific solution. • To provide opportunity for learners to manipulate the Henderson-Hasselbalch equation to determine certain aspects of buffer solutions. **National Core Values:** • Discipline • Tolerance • Respect

[5] Gender Equality and Social Inclusion
[6] Socio-Emotional Learning

3.1.2.LO.2		
Use your knowledge and understanding of concepts in hydration and hydrolysis to determine the types of salts.	**Critical Thinking and Problem Solving:** Learners will have to brainstorm to come out with the meaning of hydration and hydrolysis**.**	**GESI:** Put up with individuals of different backgrounds as they brainstorm to come out with the meaning of hydration and hydrolysis. **SEL:** Provide opportunities for learners to practice communication skills to come out with the meaning of hydration and hydrolysis. **National Core Values:** • Tolerance • Discipline
3.1.2.LO.3		
Use the understanding of hydrolysis of salts to decide on suitable indicator as well as plot and interpret titration curves.	**Collaboration and Communication:** Learners will discuss in groups acid-base indicators and draw titration curves. **Personal Development:** By learning to draw and interpret titration curves	**GESI:** • Embrace diversity and practice inclusion as communicate and collaborate. • Interrogate their stereotypes and biases about gender as they draw and interpret titration curves. **SEL:** • To provide opportunities for learners to practice communication skills to decide a suitable indicator for titration experiment. • To provide opportunities for learners to draw and interpret titration curves. **National Core Value:** Prudence
3.1.2.LO.4		
Describe oxidation and reduction reactions and apply their principles to electrochemical cells as well as their importance in everyday life.	**Communication and Collaboration:** • Learners brainstorm and share ideas in discussing concepts of oxidation and reduction and also in planning and investigating reactivity of metals.	**GESI:** • Embrace diversity and practice inclusion as all groups are involved in brainstorming and sharing ideas about oxidation and reduction.

	• Learners brainstorm and share ideas in discussing the meaning of oxidizing and reducing agents. • Brainstorm and share ideas on electrochemistry and how voltaic cells are constructed. • Design and construct simple voltaic cell. • Learners brainstorm and share ideas of factors that affect selective. • Learners brainstorm and discuss economic impact of corrosion and also share ideas in performing their investigations. **Critical Thinking and Problem Solving:** • Learners analyse the results of the experimental investigation to deduce patterns of reactivity. • Learners analyse titre value and apply Mathematical skill to determine concentration of analytes. • Learners analyse and predict the various product of electrolysis • Learners analyse their results and discuss ways of preventing rusting • Learners will perform calculations to determine cell potential and predict feasibility of reaction. **Innovation and Creativity**: • Learners design and perform redox titration. • Learners roll components of electrolytic cells and also design electrolytic cell. **Digital Learning:** Learners watch video on the lesson. **Personal Development and Leadership:** Learners develop the skills necessary to conduct research and sustain this throughout their lives as they undertake the experiments.	• Do away with misconceptions / myths about gender and disabilities as they design and construct simple voltaic cells. • Interrogate their stereotypes and biases as they analyse and predict the various product of electrolysis. **SEL:** • To provide opportunity for learners to share ideas in planning and investigating reactivity of metals • To provide opportunity for learners to feel successful in designing and performing redox titration **National Core Value:** • Tolerance • Discipline • Honesty • Integrity

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century and GESI	Assessment
3.1.2.CS.1	3.1.2.LI.1	3.1.2.AS.1
Demonstrate knowledge and understanding of the pH scale in determining the acidity and alkalinity of strong and weak acids, bases and aqueous solutions.	**Explain and undertake calculations on the concepts of pH, and pOH and describe their significance in everyday life.** **Digital Learning:** Watch a video or listen to a presentation on pH and pOH, how they are calculated and their applications. **Talk for Learning:** In a teacher-led discussion, explain pH (as the negative logarithm to the base ten of the hydrogen ion concentration of a solution) and deduce the mathematical expression for it (pH =-log [H+]) **Collaborative Learning:** • With the aid of relevant pictures or charts, describe the pH scale making emphasis on the various sections: a. Values below 7, is acidic. b. Values above 7, is basic. c. Exactly 7 is neutral. • Discuss the ionic product of water and deduce the relationship between pH, pOH and pKw • Calculate the pH and pOH of strong acids and strong bases. **Inquiry-Based Learning:** Research and discuss the significance of the values of pH in everyday life e.g. acid rain and its effect, pH of soil, blood, urine and saliva; shampoo and pharmaceutical products.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	3.1.2.LI.2	3.1.2.AS.2
	Explain the incomplete or partial ionization of weak acids and weak bases and calculate pKa and pKb. **Talk for Learning:** • Compare and contrast between a. Strong and weak acids b. Strong and weak bases	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning

	• Explain the ionization constant Ka for weak acids and Kb for weak bases, relate Ka to pKa and Kb to pKb. **Activity-Based Learning:** Calculate pKa, pKb, pH and pOH for weak acids and weak bases.	
	3.1.2.LI.3	3.1.2.AS.3
	Explain buffer solution, buffer action and their applications in everyday life. **Collaborative Learning:** In mixed-gender groups, research and give class presentations on: a. Buffer solution, its composition and how it behaves. b. How to calculate the pH of a buffer solution and the concentration of the various component of the buffer. **Experiential Learning:** In mixed ability group, prepare a buffer solution of a specific pH, given a weak acid and its salt and weak base and its salt. **Inquiry-Based Learning:** Give specific examples of the application of buffer in everyday life in: a. Living systems b. Industries	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning: **Level 4 Extended critical thinking and reasoning**
Teaching and Learning Resources	• pH scale • pH meter • Universal indicator • Calculator	

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century and GESI	Assessment
3.1.2.CS.2	3.1.2.LI.1	3.1.2.AS.1
Demonstrate knowledge and understanding of concepts of hydration and hydrolysis of salt.	**Explain hydration and hydrolysis of salts and predict the acidity or alkalinity of aqueous salt solutions.** **Talk for Learning:** In mixed-ability groups, brainstorm to come out with the meaning of hydration **Collaborative Learning:** • Use chemical equations to illustrate hydration of salts. • Explain some key features of hydration (exothermic in nature, a physical process). • Discuss the factors that affect hydrated energy a. Size of ion b. Charge on the ion **Talk for Learning:** Brainstorm to come out with the meaning of hydrolysis and discuss the types of hydrolysis (cation and anion hydrolysis). **Collaborative Learning:** • Use chemical equations to illustrate the mechanisms hydrolysis of salts (cation and anion). • Explain why some salts do not undergo hydrolysis.	Level 1 Recall **Level 2 Skills of conceptual understanding** Level 3 Strategic reasoning Level 4 Extended critical thinking and reasoning
Teaching and Learning Resources	• Worksheets	

<table>
<tr><th>Content Standards</th><th colspan="3">Learning Indicators and Pedagogical Exemplars with 21st Century and GESI</th><th>Assessment</th></tr>
<tr><td>3.1.2.CS.3</td><td colspan="3">3.1.2.LI.1</td><td>3.1.2.AS.1</td></tr>
<tr><td>Demonstrate understanding of concepts of hydrolysis of salt in the choice of indicators based on titration curves.</td><td colspan="3">Explain acid-base indicator, determine a suitable indicator for a titration and draw graphs to represent titration.

Collaborative Learning:
• In mixed gender-based groups, discuss acid-base indicators, their nature and their respective working ranges.
• Discuss the suitable indicator for an acid-base titration reaction taking into consideration the nature of the acid and base involved, the type of salt formed and the working range of acid-base indicators.

Exploratory Learning:
Work in groups to explore the use of different indicators for undertaking titrations in the laboratory.

Activity-Based Learning:
Draw or sketch an acid-base titration curve and indicate the appropriate indicator for:
a. Strong acid against a strong base
b. Strong acid against a weak base
c. Weak acid against a strong base
d. Weak acid against a weak base</td><td>Level 1 Recall:
Level 2 Skills of conceptual understanding:
Level 3 Strategic reasoning:
Level 4 Extended critical thinking and reasoning:</td></tr>
<tr><td>Teaching and Learning Resources</td><td>• Acid-base indicators
• Acidic substance</td><td>• Basic substance
• Beaker</td><td>• Graph board</td><td></td></tr>
</table>

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century and GESI	Assessment
3.1.2.CS.4	3.1.2.LI.1	3.1.2.AS.1
Demonstrate knowledge and understanding of redox and apply its principles to electrochemical cells as well as their importance in everyday life.	**Explain oxidation and reduction reactions and illustrate reactivity of metals experimentally.** **Talk for Learning:** Through a class session, explain oxidation and reduction reactions in terms of: a. Addition and removal of Oxygen and Hydrogen b. Electron transfer c. Changes in oxidation number **Collaborative Learning:** Working in groups of three, apply changes in oxidation state to deduce whether each of the following reactions are oxidation or reduction reactions: a. Combination reaction b. Decomposition reaction c. Combustion reaction d. Displacement reaction e. Disproportionation reaction f. Photosynthesis g. Respiration **Exploratory Learning:** • In small mixed ability or mixed gender groups, design and perform an experiment to illustrate the reactivity of metals. • Analyse results from the experiment and deduce patterns of reactivity of metals.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	3.1.2.LI.2	3.1.2.AS.2
	Explain the terms oxidizing agent, reducing agent, redox half equations and apply the principles in redox titrations. **Initiating Talk for Learning:** • Using think-pair-share approach, discuss the meaning of oxidizing and reducing agents in terms of the three definitions of oxidation and reduction reactions.	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**

	• Identify oxidizing and reducing agents from oxidation and reduction reactions based on changes in oxidation number of species involved. • Deduce simple oxidation and reduction half-equations given species involved in oxidation and reduction reactions and vice versa. • Explain the steps involved in balancing oxidation and reduction equations using medium method (in acidic and basic media). **Inquiry-Based Learning:** In small mixed-ability groups, design and perform oxidation and reduction titrations involving: • $KMnO_4$ versus Fe^{2+} • $KMnO_4$ versus $C_2O_4^{2-}$ • I_2/KI versus $S_2O_3^{2-}$ **Problem Solving Approach:** Calculate the concentration of an analyte, analyse and interpret the results. **Exploratory Learning:** Perform experiment to qualitatively test for the presence of oxidizing agents and reducing agents. **Talk for Learning**: Use charts, pictures, videos, to discuss the application of oxidizing and reducing agents in: • Beautician industry • Motor traffic control • Catalytic converter • Extraction of iron using carbon (II) oxide as reducing agent. • Household and swimming pool disinfection.	
	3.1.2.LI.3	3.1.2.AS.3
	Explain how redox is used to produce electricity in storage and fuel cells. **Collaborative learning**	Level 1 Recall: Level 2 Skills of conceptual understanding Level 3 Strategic reasoning

	• In gender-based groups where applicable, describe how a potential is developed between an electrode placed in aqueous solution of its ions and discuss the factors that affect its value: a. Nature of electrode b. Temperature of electrolyte c. Concentration of electrolyte d. Pressure of gas species • Explain why it is impossible to obtain an absolute electrode potential for a single half – cell. • Describe the standard hydrogen electrode. • Describe how to measure standard electrode potentials relative to the standard hydrogen electrode. • Describe how standard electrode potentials are used to construct and represent voltaic cells by writing and drawing of: a. Metals or non-metals in contact with their ions in aqueous solution b. Ions of the same element in different oxidation states • Use video or simulation to illustrate and explain the operation of a voltaic cell **Problem Solving Approach:** • Calculate a standard cell potential by combining two half-cells. • Predict the feasibility of a reaction using: a. Standard cell potentials b. Gibbs free energy ($\Delta G = -nFE_{cell}$) **Note:** Limitations of predictions made using standard cell potentials in terms of kinetic energy and concentrations are not required. **Exploratory Learning:** • Design and perform experiment to determine emf of voltaic cell. • Apply the principles of electrode potentials to modern storage cells: a. Lead-acid battery (wet cell) b. Alkaline cell (dry) c. Lithium-ion battery. d. Nickel-cadmium battery. e. Fuel cells	**Level 4 Extended critical thinking and reasoning**

	• Write their simple half and overall equations **Digital Learning:** Watch videos on storage and fuel cells and how scientists in car industry are developing fuel cell vehicles fuelled by: a. Hydrogen gas b. Hydrogen-rich fuels and their advantages over conventional diesel powdered vehicles (STEM)	
	3.1.2.LI.4	3.1.2.AS.4
	Explain qualitatively and quantitatively the operations of electrolytic cell as well as their applications in everyday life. **Collaborative Learning:** In small mixed-ability groups, describe using a diagram or simulations the essential components of an electrolytic cell. **Activity-Based Learning:** Use role-play to illustrate the two main transactions that occur at the bank (depositing and crediting), link them to the parts and functions of the components of electrolytic cells and describe how currents flow in an electrolytic cell. **Talk for Learning:** • Discuss the factors that influence the selective discharge of species at the electrodes during electrolysis. • Describe and predict the product of electrolysis of molten salts, dilute salt solution and concentrated salt solution (using inert and active electrode). **Inquiry-Based Learning:** Using circus activity, • Design and perform experiment to investigate electrolysis of various aqueous solutions in the laboratory. • Design and perform experiment to demonstrate electroplating as application of electrolysis.	Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**

	Talk for Learning: • Discuss extraction of aluminium and gold as application of electrolysis and the effect of illegal mining on the environment. • Discuss Faraday's laws of electrolysis and perform calculations based on the laws.			
	3.1.2.LI.5			3.1.2.AS.5
	Explain the concept of corrosion of metals and its application in everyday life. **Initiating Talk for Learning:** • Using think-pair-share approach, explain the following terms: a. Corrosion b. Rusting • Use equations to explain electrochemical processes involved in rusting. **Experiential Learning:** • In mixed ability or mixed gender groups where applicable, conduct an experiment to investigate the conditions needed for rusting and conditions that also affect the rate of rusting. • Design experiments to investigate ways of preventing rusting. **Talk for Learning:** • Reflect on the results of the investigation and explain redox and non-redox methods of preventing rusting • Discuss the impact of rusting and corrosion in everyday life. • Watch a video of the lesson to reinforce the concept.			Level 1 Recall Level 2 Skills of conceptual understanding Level 3 Strategic reasoning **Level 4 Extended critical thinking and reasoning**
Teaching and Learning Resources	**MATERIALS** • Test tubes in a rack • Strips of copper foil • Strips of zinc foil • Strip of silver wire • Emery paper • 0.5 M copper sulphate solution • 0.5 M zinc sulphate solution	• Retort stands • $KMnO_4$ • Iron (II) solution • Iodine solution • Potassium iodide • $Na_2S_2O_3$ • Starch • Test tubes • Test tube rack	• 0.1 M Iron (III) chloride solution • 0.02M potassium manganate (VII) • 0.1M potassium bromide • ICT tools • Calculator • Electrolysis cell • Power pack	• 1 M copper(II) chloride • Identical fresh nails • Test tube in test tube racks • Stoppers • Spatula • PH sensor • Temperature sensor • Stands and clamps

	• 0.1 M silver nitrate solution • 50 ml Burettes • 25 ml pipettes • 250 ml conical flasks • 100 ml beakers • White tiles	• Copper powder • Zinc powder • Bromine water • 0.1 M potassium iodide solution • 0.1 M potassium chloride solution	• Connecting wires and clips • Clamps and stands • Cover slides • Wooden splint • Droppers • 1 M tetraoxosulphate (VI) acid • 1 M sodium chloride solution	• Calcium chloride • Oil • Iron coated with zinc • Iron coated with tin • Iron filings • Salt

Subject **CHEMISTRY**
Strand **2. SYSTEMATIC CHEMISTRY OF THE ELEMENTS**
Sub-Strand **1. PERIODICITY**

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
3.2.1.LO.1		
Predict and describe the physical and chemical properties of the transition elements as well as their uses in everyday life.	**Communication and Collaboration:** • Learners communicate as they discuss and write the detailed electron configuration of the transition elements. • Learners collaborate as they work together in mixed-ability groups to list and explain the characteristic properties of the transition elements. • Learners communicate as they deliberate on the differences and similarities between transition metals and representative metals based on their reactions **Digital Learning:** • By watching videos via the internet or on a computer. • Learners brainstorm, collaborate and communicate as they draw and create shapes of complex compounds. • Learners communicate and collaborate as they deliberate in consolidating their work in groups and with other groups.	**GESI:** • Encourage learners of different backgrounds or abilities as they use digital tools for learning. • Discourage misconceptions/myths about gender and disabilities as they work together to explain the characteristic properties of transition elements. **SEL:** To enable learners to practice communication to predict and describe the physical and chemical properties of the transition elements **National Core Values:** • Tolerance • Respect • Appreciation

Content Standards	Learning Indicators and Pedagogical Exemplars with 21St Century and GESI	Assessment
3.2.1.CS.1	3.2.1.LI.1	3.2.1.AS.1
Demonstrate knowledge and understanding of the pattern of physical and chemical properties of the transition elements as well as their uses. Recognize the colour production, catalytic properties and many applications of transition elements.	**State and describe properties of transition elements and perform an experiment to investigate some properties of transition elements.** **Talk for Learning Approach:** • In mixed-ability groups, discuss and list the names of the first-row transition elements and explain what transition elements are. • Discuss the characteristic properties of transition elements under the following headings: a. Variable oxidation states b. Paramagnetism c. Complex ion formation d. Coloured compounds formation e. Catalytic abilities **Inquiry-Based Activity**: Perform simple experiment(s) to show the catalytic behaviour of transition elements using: a. Decomposition of hydrogen peroxide using manganese (IV) oxide as Catalyst b. Any other suitable reagents **Exploratory Learning:** Conduct an experiment to explain the applications of complex formation by causing water-insoluble species to dissolve by converting them into soluble complexes. E.g., insoluble Cu^{2+} salt in excess dilute ammonia. **Collaborative Learning** • Discuss and use molecular models or materials from the environment to create shapes of some common complex compounds (tetrahedral, square planar and octahedral) from given formulae. • Draw and name the complex compounds modelled. **Note:** Systematic naming of complexes should be treated.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning:** Level 4 Extended critical thinking and reasoning:

	3.2.1.LI.2		3.2.1.AS.2
	Outline the similarities and differences between transition metals and main group metals and everyday uses of transition metals. **Collaborative Learning:** • In mixed ability groups, brainstorm to come out with the similarities and differences between transition metals and main group metals in terms of: a. Hardness b. Reaction with water and acids c. Variable oxidation states d. Complex ion formation e. Coloured compounds formation f. Catalytic properties • In mixed-ability groups, discuss the uses of transition metals in everyday life.		Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
Teaching and Learning Resources	• Periodic table • Worksheets • Samples of transition elements; iron, copper, gold, etc. • Iron (III) trioxonitrate (V) • Sodium thiosulphate solution • Nickel (II) tetraoxosulphate (VI) catalyst • Copper (II) tetraoxosulphate (VI) Catalyst	• Iron (II) tetraoxosulphate (VI) catalyst • Cobalt (II) tetraoxosulphate (VI) catalyst Timer/clock • Dropper • Beakers • Reagent bottles containing the solutions of the catalysts • Iodine	• Potassium iodide solution • KOH • NaOH • Silver chloride and ammonia solution • Water • Materials from the environment such as styrofoam, wire, paper, beads

Subject **CHEMISTRY**
Strand **3 CHEMISTRY OF CARBON COMPOUNDS**
Sub-Strand **2 ORGANIC FUNCTIONAL GROUPS**

Learning Outcomes	21st Century Skills and Competencies	GESI, SEL and Shared National Values
3.3.2.LO.1		
Explain structure, preparation, properties of alkanoic acid derivatives and lipids as well as their uses in everyday life.	**Communication and Collaboration:** Learners share ideas in planning and performing the experiment. **Innovation and Creativity:** • The ability to model and name the various structures of alkanoic acid derivatives. • Learners share ideas in planning and producing soap as well as discussing ways of improving the quality of soap. **Critical Thinking and Problem Solving:** The ability of learners to think and represent reaction mechanism of alkanoic acid derivatives, suggest reaction pathways as well as use concept map as a reflection tool. **Critical Thinking and Problem Solving:** Learners investigate ways of producing soap using various materials and modelling the structures of fats and oils.	**GESI:** • Embrace diversity and practice inclusion as they share ideas to plan and perform experiments. • Interrogate their stereotypes and biases about gender as they model and name alkanoic acid derivatives. • Examine and dispel misconceptions/myths about gender and disabilities as they think critically to represent reaction mechanisms of alkanoic acid derivatives. **SEL:** To enable learners to practice communication to model and name the various structures of alkanoic acid derivatives **National Core Values:** • Tolerance • Discipline • Honesty • Integrity
3.3.2.LO.2		
Explain the structure, preparation, properties of polymers and their uses in everyday life.	**Communication and Collaboration:** • Learners will share ideas to discuss and describe properties of amino acids and carbohydrates. • Learners will have to give the uses of plastics in everyday life as well as explain the differences between condensation and addition polymerisation.	**GESI:** • Embrace diversity and practice inclusion as they share ideas to discuss and describe properties of amino acids and carbohydrates.

	Innovation and Creativity: • Learners will use molecular models to model different amino acids • Learners will use chemicals to produce a nylon rope.	• Examine and dispel misconceptions / myths about gender and disabilities as they use molecular models to represent different amino acids. • Interrogate their stereotypes and biases about gender as they explain differences between condensation and addition polymerisation. **SEL:** To enable learners to confidently use molecular models to model different amino acids **National Core Values:** • Tolerance • Discipline • Honesty • Integrity

Content Standards	Learning Indicators and Pedagogical Exemplars with 21St Century and GESI	Assessment
3.3.2.CS.1	3.3.2.LI.1	3.3.2.AS.1
Demonstrate knowledge and understanding of the concepts of organic chemistry to describe the structure and properties of alkanoic acid derivatives and lipids.	**Explain the structure, preparation and properties of alkanoic acid derivatives and their uses in everyday life.** **Digital Learning:** Watch videos, PowerPoint presentations or research on the internet and come out with the alkanoic acid derivatives (alkyl alkanoates, amides, acryl halide) and model structures of each alkanoic acid derivative. **Collaborative Learning:** • Write the structural formulae and give the IUPAC names of alkanoic acid derivatives modelled. • Discuss the formation of alkanoic acid derivative from alkanoic acids, given specific reagents conditions. **Exploratory Learning:** Design and perform experiment to prepare an alkyl alkanoate (ethyl ethanoate). **Talk for Learning:** In pairs, discuss the chemical properties of alkanoic acid derivatives given the appropriate reagents and conditions. **Collaborative Learning:** • In small mixed gender or mixed ability groups, give PowerPoint presentations that focus on: a. The mechanism for the reaction between alkanoic acid derivatives with nucleophilic reagents. b. Chemical equations for reduction of alkanoic acid derivatives c. Ways of testing for the presence of amide and alkyl alkanoate • Discuss and suggest synthetic pathways suitable for the conversions of alkanol or carboxylic acids to alkanoic acid derivatives. • Discuss the major use of alkyl alkanoates as solvents, perfumes and flavours.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning

	3.3.2.LI.2	3.3.2.AS.2
	Explain structure, properties and uses of fats and oils in everyday life. **Collaborative Learning:** • In gender-based groups where applicable, write general molecular formula for a fat molecule. • Model the structures of saturated and unsaturated fat and state the differences in structure and physical properties between them. • State some sources of fats and oils • Explain why fats and oils are triglycerides and write an equation for the formation of a generalized glyceride molecule from long chain fatty acid and glycerol. • Apply the concept of iodine number to determine the unsaturation of a fat. • Discuss the reactions of fats and oils under the following headings: a. Hydrolysis using alkaline solution (saponification) or acidic b. Conditions or using enzymes c. Catalytic hydrogenation (margarine production) d. Rancidity **Experiential Learning:** • In small mixed-ability groups, carry out experiments to prepare soap using local materials and discuss ways of improving upon the quality of the soap prepared. • Write a generalized structure for soap and outline the processes used in soap production. **Talk for Learning:** • Distinguish between soapy detergent and soapless detergents and describe how they act as grease-removing agents. • State the advantages of a soapless detergent over soapy detergent.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
Teaching and Learning Resources	**MATERIALS** • Molecular models • 250 ml beakers • Concentrated tetraoxosulphate (VI) acid • Ethanoic acid	• Brine • Heat source • 500 ml beakers • Test tube racks • Test tubes • Heat source

	• Ethanol Worksheets on synthetic pathways suitable for the conversions of alkanol or carboxylic acids to alkanoic acid derivatives • Worksheets with a variety of carboxylic acid derivatives and scaffolding strategies for their reaction with nucleophilic reagents • Oil • Caustic soda • Wood ash or plantain peel ashes	**CHARTS** • Charts showing major commercial use of esters

Content Standards	Learning Indicators and Pedagogical Exemplars with 21st Century and GESI	Assessment
3.3.2.CS.2	3.3.2.LI.1	3.3.2.AS.1
Demonstrate knowledge and understanding of the concepts of organic chemistry to describe the structure and properties of polymers.	**Explain polymers and describe proteins and carbohydrates as natural polymers of amino acid and glucose respectively.** **Collaborative Learning:** • In small groups, discuss, model and draw the molecular structures of amino acids such as alanine, glycine, serine, cysteine and. lysine. • Apply IUPAC rule to name each amino acid modelled. • Describe how amino acids could be combined to form protein • Describe and explain the primary structure of proteins as natural polymer • Discuss hydrolysis of proteins. • Test for proteins • Discuss the composition and structural features of carbohydrates • Describe the properties of carbohydrates **Experiential Learning:** • Investigate sugar and other carbohydrates for reducing properties • Test for reducing sugars using Fehling's solution, Benedict's solution and Tollen's reagent. • Explain the chemistry behind the observations made. **Talk for Learning:** • Classify carbohydrates into monosaccharide, disaccharide and polysaccharide giving examples of each. • Discuss starch as polymer of glucose and the test for starch. • Discuss the hydrolysis of disaccharide and polysaccharide to form monosaccharide.	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning
	3.2.2.LI.2	3.2.2.AS.2
	Explain the formation, properties and uses of synthetic polymers as well as their environmental impact. **Digital Learning:** Through internet-based research, prepare and make PowerPoint presentations (in groups) on a. Polymerisation and types of polymerisation b. Discuss synthetic and natural polymers	Level 1 Recall Level 2 Skills of conceptual understanding **Level 3 Strategic reasoning** Level 4 Extended critical thinking and reasoning

	c. The structure of the polymer product from a given alkene (using polyethylene, polyvinyl chloride, polytrafluoroethene as an example) d. The formation of nylon (a polyamide) and Terylene (a polyester) by condensation polymerisation **Collaborative Learning:** • Brainstorm to come out with the meaning of plastics and discuss types of plastics • Describe the pollution problems caused by nonbiodegradable plastics in the environment.		
Teaching and Learning Resources	• Worksheets with scaffolding strategies of various amino acid structures • Benedict's solution • Test tube in test tube racks • Droppers • Tollen's reagent • Starch	• Iodine • Reducing sugar • Nylon made materials • Animation/simulation • Beaker • Measuring cylinder	• Glass rod • 1,6-diaminohexane • Decanedioyl chloride • Cyclohexane • Fehling's solution