

RESEARCH PROJECTObjectives of the Research Project

The research project will allow students to:

1. appreciate the use of the scientific method for discovery of new knowledge and to the solution of problems.
2. communicate accurately and effectively the purpose and results of research.
3. analyse relevant literature.
4. apply experimental skills and theory to the solution of problems.
5. synthesise information based on data collected.
 - (a) The research project should focus on at least one specific objective in the Unit. It can be from one or more modules within the Unit.
 - (b) The project must not exceed 1500 words. The word count does not include: Tables, References, Table of contents, Appendices and Figures. Two marks will be deducted for exceeding the word limit by 200 words.
 - (c) Collaborative work is encouraged. Where collaborative work is done, group sizes must not exceed six (6) persons per group. The teacher is expected to use the group mark for the project and add it to the marks for the other skills for each individual candidate within the group.
 - (d) The report should be typewritten and double-spaced using 12pt font and should contain the following:
 - (i) Statement of Problem.
 - (ii) Rationale.
 - (iii) Research questions/Hypotheses.
 - (iv) Review of Literature.
 - (v) Methodology (paragraph format).
 - (vi) Presentation of Data collected from Research.
 - (vii) Discussion of findings.
 - (viii) Recommendations.
 - (ix) Conclusion.
 - (x) Bibliography (Referencing style from Communication Studies).

CRITERIA FOR MARKING THE RESEARCH PROJECT

1.	<i>Statement of Problem</i>		(2)
	<ul style="list-style-type: none"> • <i>Problem identified and clearly stated (Problem identified but not clearly stated)</i> 	2 (1)	
2.	<i>Rationale/Statements of Purpose of Investigation</i>		(1)
	<ul style="list-style-type: none"> • <i>Clearly states reason for project, for example, the benefits (Justifies solutions for the problem)</i> 	1	
3.	<i>Research Questions/ Hypotheses</i>		(3)
	<ul style="list-style-type: none"> • <i>Clearly stated research questions/hypotheses (no more than two)</i> • <i>Testable</i> • <i>Variables clearly stated</i> 	1 1 1	
4.	<i>Critical review of Literature (Analysis and evaluation of appropriate literature)</i>		(7)
	<ul style="list-style-type: none"> • <i>In text citation using consistent format</i> • <i>At least four sources cited</i> • <i>Credible and relevant sources (scholarly articles) cited</i> • <i>Analysis of information from sources eg. Who, what...</i> <ul style="list-style-type: none"> - <i>Comparison of information from sources cited</i> - <i>Accurate analysis of information from sources</i> - <i>Final synopsis of the literature</i> - <i>Personal reflection in relation to the area researched</i> 	1 1 1 1 1 1 1	
5.	<i>Methodology</i>		(3)
	<p><u><i>For Non-Experimental Research only</i></u></p> <ul style="list-style-type: none"> • <i>Clearly outlines method(s) of collecting data (Method only stated)</i> • <i>Methods chosen supported by literature review OR alternative method justified</i> <p><u><i>For Experimental Research only</i></u></p> <ul style="list-style-type: none"> • <i>Clearly describes method used</i> • <i>Repetition</i> • <i>Appropriate use of apparatus and materials</i> 	2 (1) 1 1 1 1	
6.	<i>Presentation of data collected from research</i>		(3)
	<ul style="list-style-type: none"> • <i>Appropriate format for presentation of data</i> • <i>Use of tables, graphs/figures</i> • <i>Properly annotated (Titles of tables at top; titles of figures at bottom of figure; Drawings labelled...)</i> 	1 1 1	

MODULE 1**THE CHEMISTRY OF CARBON COMPOUNDS**

WEEK	ACTIVITY	TOPIC	Learning OBJECTIVES
1	<p><i>Past CAPE EXAM Questions will be given on every topic covered</i></p> <p><i>Handout On the properties of carbon and the sp, sp² and sp³ orbital hybrids</i></p> <p><i>Class work naming and drawing organic compounds based on the IUPAC system</i></p> <p><i>Test chapter 19</i></p>	<p>The Chemistry of Carbon Compounds</p> <p>Chapter 19 alkanes</p>	<ol style="list-style-type: none"> 1. Explain why carbon forms compounds comprised of carbon chains and rings. 2. Describe in detail the bonding in saturated alkanes and cycloalkanes. 3. Describe and account for the three-dimensional shape of methane. 4. Define the terms homologous series, structural isomerism, sp³ hybrid orbital and substituent. 5. Systematically name alkanes and cycloalkanes. 6. Write or draw. From molecular formulae or systematic names, the structures of alkanes and cycloalkanes. 7. Describe the physical properties, sources and uses of C-1 to C10 n-alkanes 8. Describe in outline the processes which occur when alkanes are subjected to combustion, thermal and catalytic cracking and bromination.
2	<p><i>Power point presentation on the hybrid orbitals and isomerism</i></p> <p><i>Activity drawing and naming alkenes and alkynes</i></p> <p><i>Test chapter 20</i></p> <p><i>IA test for alkenes alkanes and aromatic compounds</i></p>	<p>Chapter 20 Alkenes and Alkynes</p>	<ol style="list-style-type: none"> 1. Describe in detail the bonding in alkenes and alkynes. 2. Define the terms sp² hybrid, sp hybrid orbital, stereoisomer, geometric isomer. 3. Describe and account for the trigonal and linear shapes of alkenes and alkynes. 4. Account for the rigidity and reactivity of carbon – carbon multiple bonds 5. Systematically name alkenes, cycloalkenes and alkynes. 6. Write or draw, from molecular formulae or systematic names, the structures of alkenes, cycloalkenes and alkynes using the following formats, displayed structures, condensed formulae, and line drawings. 7. Describe the physical properties, source and uses of C3 to C4 alkenes and alkynes. 8. Describe the outcome of addition of X₂ and H₂ to alkenes and alkynes.

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3,4	<p><i>Class presentation on alcohols and amines each student will be assigned a section to research and present</i></p> <p><i>Complete chapter review questions</i></p> <p><i>Test Chap. 21</i></p> <p><i>I.A. preparation of an ester</i></p>	Chapter 21 Alcohols and Amines	<ol style="list-style-type: none"> 1. Define the term functional group and provide examples of functional groups. 2. Classify and systematically name simple alcohols and amines. 3. Describe the bonding to oxygen atoms and nitrogen atoms in alcohols and amines and account for the presence of lone pairs of electrons on these atoms. 4. Provide explanations for the relatively high boiling points and solubility in water of the lower alcohols 5. Describe the oxidation reactions of alcohols and apply these reactions and the colour changes observed in the oxidizing agents to qualitative analysis. 6. Describe the reactions which convert alcohols to esters, ethers and haloalkanes. 7. Explain why amines are basic, derive K_b and pK_b and relate their values to basicity.
5,6	<p><i>Hand out on structural isomerism and stereo chemistry do chapter review questions in class and discuss answers</i></p> <p><i>Test on stereo chemistry</i></p>	Chapter 22 Stereo-chemistry	<ol style="list-style-type: none"> 1. Explain the meaning of structural isomerism. 2. Describe and give examples of chain, functional group and positional isomers. 3. Explain the term geometrical isomerism. 4. Describe and give examples of cis/trans isomers. 5. Explain the origins of chirality and optical isomerism. 6. Give examples of chiral compounds.
7	<p><i>Class presentation in groups of two on aldehydes and ketones (include canonical from resonance hybrids and reactions of aldehydes and ketones)</i></p> <p><i>Complete revision questions</i></p>	Chapter 23 Aldehydes and Ketones	<ol style="list-style-type: none"> 1. Systematically name simple aldehydes and ketones 2. Define the terms canonical form and resonance hybrid 3. Describe the fundamental features of the carbonyl group: bonding, polarization, canonical forms, and resonance hybrids. 4. Apply known oxidation reactions of alkenes and alcohols to the preparation of aldehydes and ketones. 5. Describe the reduction of aldehydes and ketones to alcohols with NaBH_4 and LiAlH_4 6. Demonstrate the use of the following oxidation reactions of aldehydes in qualitative analysis:

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	<i>Test chapter 23</i>		<p>reaction with $\text{Cr}_2\text{O}_7^{2-}$, MnO_4^-, Fehling's or Benedict's solution, Tollens' reagent.</p> <ol style="list-style-type: none"> Describe the iodoform reaction of methyl ketones and of secondary alcohols with an adjacent methyl group. Draw and explain the mechanism for the reactions of aldehydes or ketones with HCN. Outline the condensation reaction between aldehydes or ketones and compounds with $-\text{NH}_2$ groups and apply the formation of derivatives of 2, 4-dinitrophenylhydrazine to qualitative analysis.
8	<p><i>home work: assignment: Writing equations for the reactions of carboxylic acids.</i></p> <p><i>IA: reactions of ethanoic acid.</i></p> <p><i>Preparation of ethyl ethanoate</i></p> <p><i>Test Ch. 24</i></p>	Chapter 24 Carboxylic acids and derivatives	<ol style="list-style-type: none"> Systematically name simple carboxylic acids, esters, acyl chlorides and amides. Explain the consequences of polarization of the $-\text{COOH}$ group. Describe 3 methods of preparing carboxylic acids Explain the relationship between K_a, pK_a and acidity of carboxylic acids, and the effect of electronegative substituents on the acidity of carboxylic acids. Describe the general features of amino acids. Write equations for the reactions of carboxylic acids with various bases and for carboxylate salts with mineral acid. Demonstrate the relationships between carboxylic acids & <ol style="list-style-type: none"> esters, acyl chlorides and amides Suggest methods for the preparation and hydrolysis of esters, acyl chlorides and amides
9,10	<p><i>video presentation on bonding in benzene</i></p> <p><i>class work naming derivatives of benzene</i></p> <p><i>test on</i></p>	Chapter 25 Aromatic Compounds	<ol style="list-style-type: none"> Identify and differentiate between aliphatic, alicyclic, conjugated, non-conjugated and aromatic compounds. Describe the bonding in benzene. Show the general mechanism of electrophilic aromatic substitution and the mechanisms for bromination and nitration of benzene. Define the term canonical form, resonance hybrid, resonance stabilization, and draw the canonical forms and resonance hybrids of

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	<i>aromatic compounds</i>		benzene and of the cationic intermediate in electrophilic aromatic substitution. 5. Name derivatives of benzene. 6. Describe the properties and main reactions of nitrobenzene and aniline 7. Explain why phenol is acidic and describe its main reactions – formation of trihalo-derivatives, esters and ethers. 8. Explain what is meant by an azo compound.
11	<i>PPT macromolecules</i> <i>Activity drawing of monomer and polymer units List the properties and uses</i> <i>Preparation of a nylon</i> <i>Individual assignment on the impact of plastic on the environment and what can be done to manage it for class presentation</i>	Chapter 26 Macro-molecules	1. Define the terms macromolecule, polymer and monomer and provide naturally occurring and synthetic examples of each. 2. Describe the key features of addition polymerization and condensation polymerization 3. Predict whether a given monomer or pair of monomers will polymerize by addition or condensation. 4. Draw the structure off the repeating units of a polymer formed from a given monomer or pair of monomers. 5. Recognize the repeating units in polymer chains and determine the structures of the monomers 6. Discuss, using specific examples, the uses and advantages of synthetic polymers. 7. Describe aspects of the impact of plastic on the environment. 8. Outline measures for minimizing and managing plastic waste.
12	<i>Video on drawing reaction mechanisms</i> <i>Test ch 27</i>	Chapter 27 Reaction Mechanisms	1. Define the following terms,: reaction mechanism, homolytic cleavage, heterolytic cleavage, nucleophile, electrophile, leaving group, chain reaction chain initiation, chain propagation, chain termination, substrate, solvolysis, S _N 1 reaction, S _N 2 reaction. 2. Illustrate electron movement in bond cleavage and bond formation using singly barbed/fish hook arrows for single electrons and doubly barbed /curly arrows for pairs of electrons. 3. Show and explain the reaction mechanism for the free radical chlorination of methane. 4. Show and explain the reaction mechanism for

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			<p>the addition of Br₂ to an alkene.</p> <p>5. Predict and explain the outcome of addition of H-X to an unsymmetrical alkene.</p> <p>6. Describe the main features of nucleophilic substitution (S_N1 and, S_N2) reactions.</p>
MODULE 2			
Analytical Methods and Separation Techniques			
1	<p><i>Assignment calculating mean value and standard deviation, significant figures Accuracy in different types of glass ware</i></p> <p><i>IA calibration of burette and pipette</i></p> <p><i>Test chap 28</i></p>	Chapter 28 Measurement in Chemical Analysis	<ol style="list-style-type: none"> 1. Define the terms mean and standard deviation and calculate the mean and standard deviation of data values provided. 2. Explain the meanings of the terms accuracy, precision, systematic error and random error. 3. Define uncertainty in measurement and include values for the uncertainty in reported data for temperature, volume, mass and length. 4. Report data and the results of calculations using the correct numbers of significant figures and digits after the decimal place. 5. For a given experiment, choose the correct glassware for measurement of volume and the correct balance for measurement of mass.
2	<p><i>IA gravimetric analysis of a hydrated magnesium sulphate</i></p> <p><i>Test on gravimetric analysis</i></p>	Chapter 29 Gravimetric analysis	<ol style="list-style-type: none"> 1. Define the terms gravimetric analysis, precipitation gravimetry and volatilization gravimetry. 2. Given the necessary data, calculate the percentage composition of a salt and the experimental percentage and number of moles of water of crystallization in a hydrated salt. 3. Give examples of precipitates which are useful in precipitation gravimetry and describe their properties. 4. Describe a simple experiment to determine the composition of a salt by precipitation gravimetry. 5. Determine the moisture content of foodstuffs and of soils and the amount of water of crystallization of hydrated salts.
3	<p><i>Video showing a redox titration</i></p> <p><i>Class work on calculating concentrations</i></p>	Chapter 30 Titrimetric Analysis	<ol style="list-style-type: none"> 1. Explain the meanings of the following terms as used in titrimetric analysis, analyte, end-point. Equivalence point, indicator primary standard, standard titrant, titration error. 2. Provide a general description of the process

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	<p><i>IA thermometric titration</i></p> <p><i>Virtual lab redox titration</i></p> <p><i>Test on titrimetric analysis</i></p>		<p>which occurs in a titration and explain how titrations are used in chemical analysis.</p> <ol style="list-style-type: none"> Calculate the concentration of acids and bases using data obtained from direct acid/base titrations and back titrations involving acid/base reactions Describe the principles of end-point detection by use of indicators, potentiometry, conductimetry and thermometry Calculate the concentrations of oxidizing and reducing agents using data obtained from direct redox titrations and back titrations involving redox reactions.
4	<p><i>Use spectroscopes to view different sources of light</i></p> <p><i>Test spectroscopy</i></p> <p><i>Students will make spectroscopes and download apps on their android or I-phone to calculate the wavelength of the different light sources</i></p>	Chapter 31 Introduction to Spectroscopy	<ol style="list-style-type: none"> Define the key features of wave motion: wavelength (λ), frequency (ν) and amplitude (A) Describe electromagnetic radiation as waves with velocity $3.0 \times 10^{10} \text{ cm s}^{-1} = \lambda \times \nu$ and as particles with energy $E = h\nu$ List the types of radiation comprising the electromagnetic spectrum in order of increasing or decreasing energy. Explain the meaning of the term quantized energy levels and provide a relevant illustration. Describe the changes which occur in atoms and molecules as a result of the absorption of ultraviolet and visible light radiation and of infrared radiation.
5	<p><i>Practice problems using Beer-Lambert's Law</i></p> <p><i>Past paper question on spectroscopy</i></p>	Chapter 32 Ultraviolet-Visible Spectroscopy	<ol style="list-style-type: none"> Describe what can occur when a molecule with covalent bonds is irradiated with UV-visible light. Define the terms lambda max (λ_{max}), chromophore, UV-visible spectrum, absorbance (A), molar extinction coefficient (ϵ), standard curve and chromophoric reagent. In general terms, relate the value of (λ_{max}) reagent Describe the features of a UV-visible spectrophotometer and outline the procedure for obtaining UV-visible spectra. Use the Beer-Lambert law ($\lambda = \epsilon cl$) to calculate the concentration of a given analyte in solution.

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			6. Explain how a standard curve is generated and how the concentration of a given analyte can be determined from a standard curve.
6	<p><i>Complete chapter revision questions</i></p> <p><i>Test Chp. 33</i></p>	Chapter 33 Infrared Spectroscopy	<ol style="list-style-type: none"> Describe what can occur when a molecule with covalent bonds is irradiated with infrared light. Define the term wavenumber $\tilde{\nu}$ (nu bar), and convert frequencies and wavelengths to wavenumbers In general terms, relate the value of $\tilde{\nu}$ (nu bar) for the stretching frequency of a bond between two atoms to the strength of the bond and the combined mass of the atoms. Recognize the absorption peaks of important functional groups in infrared spectra. Describe how gas, liquid, solution and solid samples are prepared for infrared analysis. Describe how infrared absorption affects the Earth's climate.
7	<p><i>Practice problems calculating the RAM of an element in a mass spectrum</i></p> <p><i>Identify simple compounds using their mass spectral patterns</i></p> <p><i>Exam question on Mass Spectra</i></p>	Chapter 34 Mass Spectrometry	<ol style="list-style-type: none"> Explain how atoms and molecules are made to form ions and ion radicals which can be detected by mass spectrometry. Define the terms base peak, fragment ion, ion radical, mass: charge ratio, molecular ion and relative abundance. Calculate the relative atomic mass of an element from its mass spectrum. Describe in outline how a mass spectrum is obtained. Deduce the number of carbon atoms in a compound from the relative abundance of the M^{+1} and the M^{+2} peaks. Recognize the presence of bromine and chlorine atoms in a compound from the relative abundance of the M^{+} and the $M+2$ peaks Identify simple compounds from their mass spectral fragmentation patterns.
8	<p><i>IA fractional distillation</i></p> <p><i>Video presentation Solvent extraction</i></p>	Chapter 35 Phase Separations	<ol style="list-style-type: none"> Discuss the chemical principles upon which simple distillation and fractional distillation are based. Discuss the advantages of carrying out distillation processes under reduced pressures. Discuss the chemical principles and use of steam distillation.

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	<i>Test on Phase separations</i>		<ol style="list-style-type: none"> Discuss the principles upon which solvent extraction is based Select appropriate methods of separation, given the physical and chemical properties of the components of a mixture. Perform distillation experiments. Carry out simple separation experiments based on solute partitioning between two immiscible solvents. Cite examples of the applications of the distillation methods used in various Industries.
9	<i>IA chromatography</i> <i>Quiz on chromatography</i>	Chapter 36 Chromatography	<ol style="list-style-type: none"> Explain the principles behind chromatographic methods. Explain the terms retention factor, retention time, visualizing agent and solvent front. Describe the basic steps in separating and quantifying the components of a mixture. Give examples of where chromatography is used.
Module 3			
Industry and the Environment			
	<i>Plan & Design Lab on Environmental effects</i>	Chapter 37 Environmental effects	<ol style="list-style-type: none"> Realize that the environment is sensitive to changes in chemical input. Know that we have the ability to influence environmental change Understand specific aspects of important natural cycles
10	<i>Class presentations by students on the different industries and their effects on the environment. Each group will also discuss what can be done to minimize negative effects</i>	Chapter 38 Chemical Industry	<ol style="list-style-type: none"> Name some important chemical industries and their products. Describe the processes used in these industries. Have a knowledge of the impact of these industries on the environment. Appreciate the social importance of these industries.

Chemistry (Unit 1)	1+ 2+ 03/2***	19 May 07 May 08 May	AM (1 hr 30 min) PM (2 hr 30 min) AM (2 hr)
Chemistry (Unit 2)	1+ 2+ 03/2***+	08 June 11 May 29 May	PM (1 hr 30 min) PM (2 hr 30 min) AM (2 hr)