

[Question of Term Final Examination]

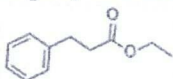
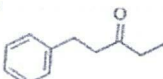
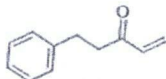
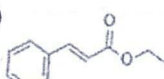
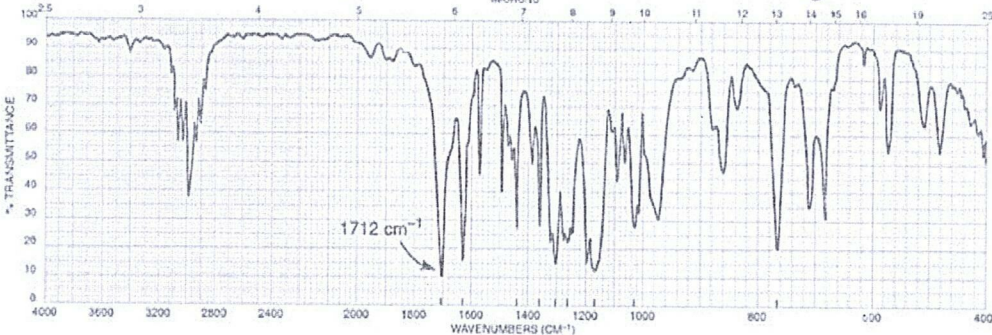
KHULNA UNIVERSITY

School: Science, Engineering & Technology	Discipline: Chemistry	Program: MS
Year: First	Term: First	Examination Year: 2026
Course Code: 0531 18 Chem 5101	Course Title: Spectroscopic Techniques and Applications	
Total Marks: 60	Time: 3 hours	Credit: 4.0

- Use separate answer script for each section.
- Figures in the margin indicate full marks. Questions are of equal value.

Section A

There are **FOUR** questions in this section. Answer any **THREE** questions.

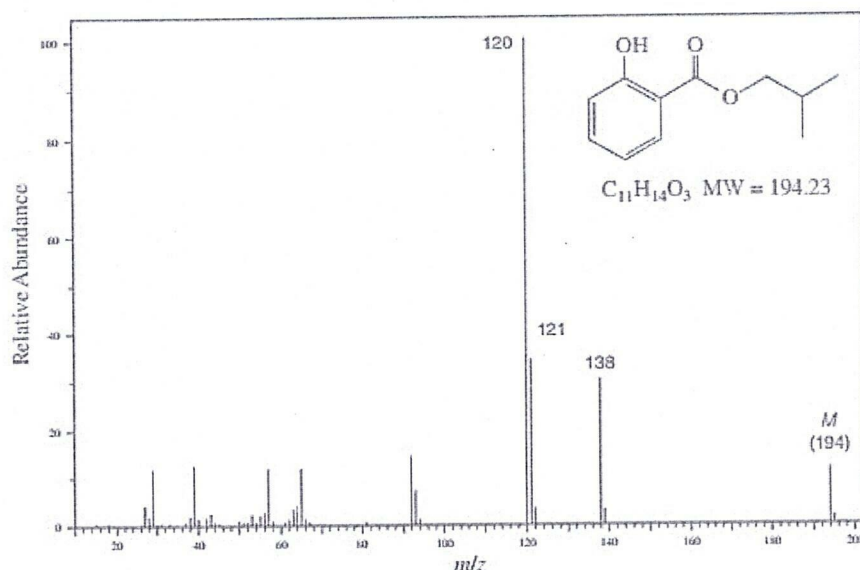
Question No.	Question Description	Marks
1.	<p>a) Explain why an increase in conjugation causes absorption at longer wavelengths in UV-Visible spectroscopy. [L5, CLO1]</p> <p>b) How does the Jahn-Teller distortion influence the UV-Visible spectra of transition metal complexes? [L2, CLO1]</p> <p>c) Explain the different types of charge transfer (LMCT & MLCT) transitions observed in UV-Visible spectroscopy. [L5, CLO1]</p>	2 3 5
2.	<p>a) Illustrate the electronic transitions possible in molecules containing σ, π, and non-bonding electrons, and discuss their spectroscopic significance. [L2; CLO8]</p> <p>b) Calculate the theoretical stretching frequency of the C-H bond using Hook's law. [L3, CLO10]</p> <p>c) Examine the given IR spectrum and identify the molecular structure that best matches the spectrum. Justify your answer by interpreting the key absorption bands. [L4, CLO10]</p> <div style="display: flex; justify-content: space-around; align-items: flex-end;"> <div style="text-align: center;"> <p>(i)</p>  </div> <div style="text-align: center;"> <p>(ii)</p>  </div> <div style="text-align: center;"> <p>(iii)</p>  </div> <div style="text-align: center;"> <p>(iv)</p>  </div> </div> <div style="text-align: center; margin-top: 10px;">  </div>	3 2 5
3.	<p>a) What are the essential criteria for a molecule to be IR active? Explain with suitable examples. [L5, CLO1]</p> <p>b) What are overtone bands in FTIR spectroscopy? Explain how they affect the appearance and interpretation of IR spectra. [L2, CLO2]</p>	3 4

- c) What is depolarization ratio? How does it help in molecular symmetry determination? [L3, CLO5] 3
4. a) Discuss Raman scattering and illustrate the process using an energy level diagram. [L6, CLO1] 3
- b) Why are Stokes lines more intense than anti-Stokes lines? [L1, CLO1] 3
- c) How is Raman spectrum used in drug analysis? [L3, CLO4] 4

Section B

There are **FOUR** questions in this section. Answer any **THREE** questions.

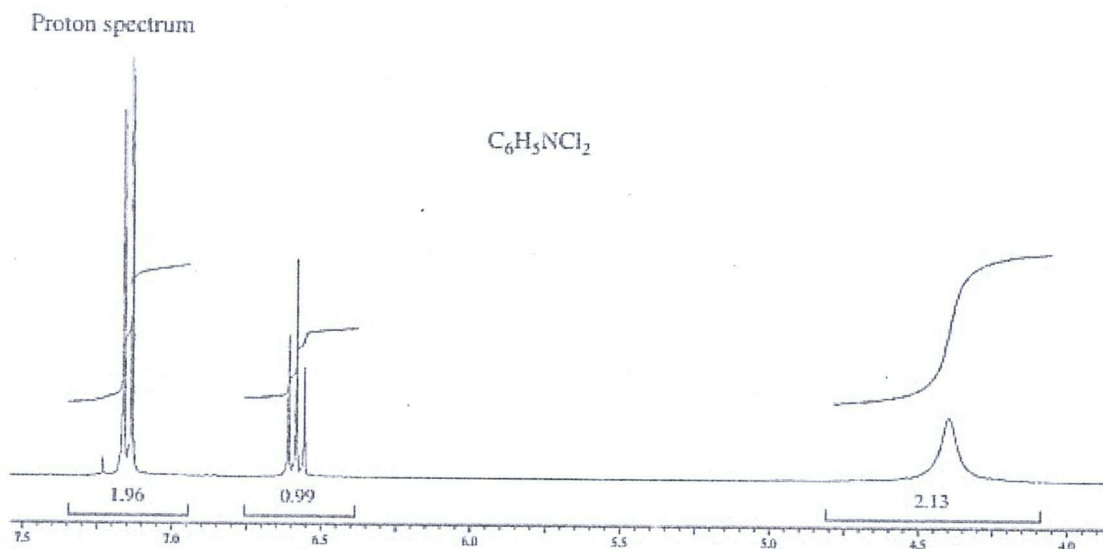
Question No.	Question Description	Marks
5.	a) Predict the origin of spin-spin splitting in NMR spectroscopy. [L3, CLO7]	5
	b) Draw and label the ^1H NMR spectra of the following compounds: [L6, CLO7]	5
	i) $\text{H}_3\text{C}-\text{C}_6\text{H}_4-\text{CH}_2\text{Cl}$ ii) $\text{CH}_2\text{C}(\text{CH}_3)\text{CH}_2\text{CH}_2\text{C}(\text{Cl})\text{CH}_2$	
6.	a) How can the presence of the $-\text{OH}$ proton be confirmed in the ^1H NMR spectrum of 2-methyl-1-propanol? [L4, CLO7]	5
	b) Define off-resonance decoupling. Sketch the off-resonance decoupled ^{13}C spectrum of 1-propanol. [L4, CLO7]	5
7.	a) Propose the possible fragmentation pathways of cyclohexanol in mass spectrometry. [L3, CLO8]	5
	b) The EI-MS spectrum of isobutyl salicylate is given below. Assume the fragmentation of the compound. [L4, CLO8]	5



8. The proton NMR spectrum of a compound with formula $C_6H_5NCl_2$ is shown. The normal carbon-13 and the DEPT experimental results are tabulated. The FTIR spectrum shows peaks at 3432 and 3313 cm^{-1} and a series of medium-sized peaks between 1618 and 1466 cm^{-1} . Predict the structure of the compound. [L6, CLO9]

10

Normal Carbon	DEPT-135	DEPT-90
118.0 ppm	Positive	Positive
119.5	No peak	No peak
128.0	Positive	Positive
140.0	No peak	No peak



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KHULNA UNIVERSITY

School: Science, Engineering & Technology Discipline: Chemistry

Program: MS

Year: First

Term: First

Examination Year: 2026

Session: 2025-2026

Course Code: 0531 18 Chem 5103

Course Title: Macromolecular Chemistry

Total Marks: 60

Time: 3 hours

Credit: 4.0

- Use separate answer script for each section.
- Figures in the margin indicate full marks. Questions are of equal value.

Section A

There are **FOUR** questions in this section. Answer any **THREE** questions.

Question No.	Question Description	Marks
1.	a) Define ' T_g ' and ' T_m ' of polymers. Describe the structural changes that occur in a crystalline polymer as it is heated from below T_g to T_m . [L4, CLO2]	4
	b) Distinguish the reaction of phthalic acid with glycerol and ethylene glycol. [L4, CLO2]	3
	c) How pendant groups in polyacrylonitrile have an effect on the solubility? [L2, CLO1]	3
2.	a) Evaluate the concept of initiator efficiency (f), its typical value range, and the main reactions responsible for initiator wastage. [L6, CLO1]	4
	b) Develop the rate expression " $R_p = k_p[M](R_i/2kt)^{1/2}$ " for free radical polymerization through the three mechanistic steps and applying steady-state assumption. [L6, CLO2]	4
	c) Distinguish between two term 'stereoselective polymerization' and 'stereospecific polymerization'. [L4, CLO1]	2
3.	a) Evaluate the curing mechanism of diglycidyl ether of bisphenol A (DGEBA) with a primary amine. Justify why the fully cured epoxy network is infusible, insoluble, and chemically resistant while the uncured polymer is a viscous liquid. [L5, CLO2]	4+2
	b) Discuss the effect of inhibition constant (z) in radical polymerization. [L6, CLO2]	4
4.	a) Discuss ATRP mechanism in living radical polymerization (LRP). [L6, CLO2]	4
	b) Why LRP model is more efficient than conventional radical polymerization? [L2, CLO2]	2
	c) Evaluate why simple phenol is a poor retarder ($z = 0.012$) while 2, 4, 6-trimethylphenol ($z = 5.0$) is significantly more effective, and explain the role of oxygen in activating phenols as retarders. [L5, CLO2]	4

Section B

There are **FOUR** questions in this section. Answer any **THREE** questions.

Question No.	Question Description	Marks
5.	a) Explain the micellar nucleation mechanism involved in emulsion polymerization. [L2, CLO3]	5
	b) Give a brief discussion on miniemulsion and dispersion polymerization. [L6, CLO3]	5
6.	a) Write a brief note on initiators and surfactants. [L6, CLO3]	4
	b) Illustrate the seeded emulsion polymerization. [L2, CLO3]	2
	c) Discuss a method used to determine the colloidal stability of the polymer particles. [L6, CLO3]	4
7.	a) Write down the basic principle of TGA. [L2, CLO3]	2
	b) Characterize the copolymer of methyl methacrylate and styrene P(MMA- <i>co</i> -St) using FT-IR spectrophotometry. [L3, CLO3]	4
	c) Explain the use of SEM and TEM techniques in the characterization of organic-inorganic hybrid particles. [L6, CLO3]	4
8.	a) Explain how the molecular weight of a polymer can be determined using end-group analysis. [L2, CLO3]	3
	b) Categorize the distillation fractions obtained from petrochemicals. [L4, CLO4]	3
	c) Describe the methods for the preparation of butadienes and acrylonitrile. [L6, CLO4]	4

[Question of Term Final Examination]

KHULNA UNIVERSITY

School: Science, Engineering & Technology Discipline: Chemistry

Program: MS

Year: First

Term: First

Examination Year: 2026

Session: 2025-2026

Course Code: 0531 18 Chem 5105

Course Title: Synthetic Organic Chemistry

Total Marks: 60

Time: 3 hours

Credit: 4.0

- Use separate answer script for each section.
- Figures in the margin indicate full marks. Questions are of equal value.

Section A

There are **FOUR** questions in this section. Answer any **THREE** questions.

Question No.	Question Description	Marks
1.	a) Illustrate the complete mechanism for the nitration of Pyrrole and justify the preferential formation of 2-nitropyrrole on the basis of resonance stabilization. [L4, CLO1]	6
	b) Outline a stepwise synthetic route for the conversion of 4-(<i>tert</i> -butyl) phenol into 5-(<i>tert</i> -butyl) benzofuran, mentioning the important reagents and reaction conditions involved. [L6, CLO1]	4
2.	a) What are Polycyclic Aromatic Compounds (PACs)? Discuss their classification with examples? [L2, CLO1]	5
	b) Explain why anthracene can be easily oxidized to 9, 10-anthraquinone or reduced to 9, 10 dihydroanthracene. Discuss this in terms of the "loss of resonance energy". [L4, CLO1]	5
3.	a) How does umpolung play a role in the activity of Grignard reagents? [L2, CLO2]	2
	b) Explain the synthetic importance of the Simmons–Smith cyclopropanation reaction. [L4, CLO2]	3
	c) Illustrate the detailed mechanism of allylic oxidation by Selenium dioxide. [L5, CLO2]	5
4.	a) Differentiate between chromophores and auxochromes with examples. [L2, CLO3]	2
	b) Write the reaction involved in the preparation of Orange I. [L3, CLO3]	5
	c) Explain how fibre structure influences dye absorption. [L3, CLO3]	3

P.T.O.

Section B

There are **FOUR** questions in this section. Answer any **THREE** questions.

Question No.	Question Description	Marks
5.	<p>a) Give the mechanism of a free radical chlorination reaction and discuss the stereochemical outcome of the reaction in each of the following cases:</p> <p>(i) When a bond to a chiral center is broken</p> <p>(ii) When no bond to a chiral center is broken.</p> <p>Explain your answers with appropriate reasoning. [L4, CLO4]</p> <p>b) Explain why the addition of bromine to 2-butene proceeds via anti-addition instead of <i>syn</i>-addition, with reference to the reaction mechanism. [L4, CLO4]</p>	5
6.	<p>a) Consider the following reaction:</p> $\text{CH}_2 = \text{CH} - \text{CH}_3 \xrightarrow{\text{HBr}} ?$ <p>Now give the reaction mechanism with product formation. According to his reaction, discuss the role of substrate regioselectivity and product regioselectivity. [L5, CLO4]</p> <p>b) Give your justification for the following reaction: [L5, CLO4]</p> <div style="text-align: center;"> <p>(Product -1)</p> <p>(Product -2)</p> </div>	4
7.	<p>a) Make a flowchart for the natural synthesis of penicillin V. [L3, CLO5]</p> <p>b) Why the industrial synthesis of Penicillin V is important even though it can be produced naturally by microorganisms? [L4, CLO5]</p> <p>c) Narrate the sources, necessity and deficiency of β- carotene. [L2, CLO5]</p>	4 3 3
8.	<p>a) How Zineb is synthesized from ethylenediamine? Discuss the process. [L2, CLO6]</p> <p>b) Explain the preparation process of carbyne. [L2, CLO6]</p> <p>c) Mention the toxicity of Avadex to humn. [L1, CLO6]</p>	4 3 3

[Question of Term Final Examination]

KHULNA UNIVERSITY

School: Science, Engineering & Technology Discipline: Chemistry

Program: MS

Year: First

Term: First

Examination Year: 2026

Session: 2025-2026

Course Code: 0531 18 Chem 5107

Course Title: Bioenergetics and Biomolecules

Total Marks: 60

Time: 3 hours

Credit: 4.0

- Use separate answer script for each section.
- Figures in the margin indicate full marks. Questions are of equal value.

Section A

There are **FOUR** questions in this section. Answer any **THREE** questions.

Question No.	Question Description	Marks
1.	a) Discuss the major molecular and cellular events that occur during each sub-phase of Interphase: G1, S, and G2. [L6, CLO1]	4
	b) Evaluate the technique of subcellular fractionation by comparing the principles and applications of differential centrifugation and density-gradient centrifugation. [L5, CLO1]	4
	c) Distinguish between autotrophs and heterotrophs with reference to their carbon and energy sources. Give one example of each. [L4, CLO1]	2
2.	a) Analyze the factors that establish the theoretical upper and lower size limits of a cell. [L4, CLO1]	2
	b) Draw the four-subunit composition of the cohesin complex and justify the 'embrace model' explaining how the cohesin complex is formed. [L5, CLO2]	4
	c) Compare the lock-and-key and induced-fit models of enzyme-substrate interaction. Which model more accurately represents the behavior of most real enzymes? Justify your answer. [L4, CLO4]	2+2
3.	a) Define "Lectins" and describe their role as "Readers" of the sugar code. [L2, CLO2]	4
	b) Analyze the coding capacity of monosaccharides sugar with structural features. [L4, CLO2]	3
	c) Sketch and explain the function of condensing complex in organisms using <i>C. elegans</i> as an example. [L5, CLO2]	3
4.	a) Discuss the digestion and absorption process of protein in presence of Zymogen. [L6, CLO4]	5
	b) Show the molecular mechanism underlying lactose intolerance. How undigested lactose can be measured in clinical diagnosis? [L2, CLO4]	3+2

Section B

There are **FOUR** questions in this section. Answer any **THREE** questions.

Question No.	Question Description	Marks
5.	a) Define hormone receptors. Write four important buffers in extracellular fluids of body water which minimize pH changes by binding or releasing H^+ ions. [L1, CLO2]	3
	b) Categorize of the following vitamins which are fat soluble and water soluble. Write the functions and deficiency of them. [L4, CLO2] Vitamin E ; Vitamin K ; Vitamin B ₂ ; Vitamin B ₁₂	4
	c) Explain Organ function test. Discuss the types and purpose of Organ function test. [L4, CLO2]	3
6.	a) 'ATP acts as universal currency of free energy in biological system'- justify this statement. [L4, CLO3]	3
	b) Show the hydrolysis product and ionization product of 1,3-bisphosphoglycerate. Give opinion why this happens. [L2, CLO2]	4
	c) Demonstrate hydrogen donor and hydrogen acceptor with example. When normally occurs intramolecular H-bonding in proteins or DNA like macromolecules? [L2, CLO2]	3
7.	a) What is insulin? Discuss the functions of insulin and relate with type-1 and type -2 diabetes. [L6, CLO4]	3
	b) Classify high energy compounds based on the type of high energy bond. Write the biological role of high energy compounds. [L2, CLO4]	4
	c) If your blood vessel is damaged by an accident, make up how it can recover using physiological process. [L6, CLO4]	3
8.	a) Discuss the causes and symptoms of Human immunodeficiency virus (HIV) infection. [L6, CLO4]	3
	b) Make a list of the challenges and applications of gene therapy. [L1, CLO4]	4
	c) 'Antioxidants help protect the body from damage caused by free radicals'- justify this statement. [L5, CLO4]	3

[Question of Term Final Examination]

KHULNA UNIVERSITY

School: Science, Engineering & Technology **Discipline:** Chemistry **Program:** MS
Year: First **Term:** First **Examination Year:** 2026 **Session:** 2025-2026
Course Code: 0531 18 Chem 5111 **Course Title:** Chemical Analysis & Instrumental Techniques
Total Marks: 60 **Time:** 3 hours **Credit:** 4.0

- Use separate answer script for each section.
- Figures in the margin indicate full marks. Questions are of equal value.

Section A

There are **FOUR** questions in this section. Answer any **THREE** questions.

Question No.	Question Description	Marks
1.	a) Classify the primary separation mechanisms involved in chromatography. For each mechanism, explain the underlying principle of how components are separated and identify the typical analytes. [L2, CLO1 & 2]	5
	b) Define the migration rate of a solute in a chromatographic system. [L1, CLO1]	2
	c) Describe the physical significance of the retention factor (k') in the following scenarios: [L2, CLO1 & 2]	3
	i) What does it imply about the solute's interaction with the stationary phase when $k' = 0$?	
	ii) What are the practical consequences for the elution time and peak broadening when k' is very high ($k' > 20$)?	
2.	a) In Reversed-Phase HPLC (RP-HPLC), a researcher observes that two analytes co-elute (overlap) when using a mobile phase of Methanol : Water (50:50). Propose and justify two distinct analytical strategies for manipulating the mobile phase solvent system to resolve these peaks. Critically evaluate how each strategy differs in its thermodynamic impact on the separation. [L6, CLO2]	5
	b) A student suggests using a U-HPLC column with 1.8 μm particle size and 60 Å pore size to analyze synthesized silver nanoparticles capped with large plant proteins. Critically evaluate this choice. Is it appropriate? [L6, CLO2]	5
3.	a) A researcher needs to quantify inorganic anions (e.g., Cl^- and SO_4^{2-} in a highly water-soluble sample. [L5, CLO2]	6
	i) Critically evaluate the limitations of Gas Chromatography (GC) for this specific application. In your assessment, identify the primary physico-chemical properties of these analytes that conflict with GC requirements.	
	ii) Select the most appropriate HPLC mode for this separation and justify your choice by explaining how the stationary phase chemistry interacts with these specific ionic species to achieve resolution.	
	b) Compare the driving forces (pressure mechanisms) used in GC versus HPLC. How does the physical state of the mobile phase in each technique determine whether it acts as a chemically active participant in separation or simply as a transport medium? [L4, CLO2]	4

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|----|----|---|---|
| 4. | a) | Define the purpose of using an inert atmosphere (e.g., Nitrogen) versus an oxidative atmosphere (e.g., Air or Oxygen) during a Thermogravimetric Analysis (TGA). What specific chemical process is being observed when the atmosphere is switched to Oxygen? [L1, CLO4] | 4 |
| | b) | The thermal decomposition of Calcium Oxalate Monohydrate ($\text{CaC}_2\text{O}_4 \cdot \text{H}_2\text{O}$) is a classic three-step process in Thermogravimetric Analysis (TGA). [L5, CLO4] | 6 |
| | | i) Draw the TGA curve. For each distinct mass-loss steps, identify the chemical species being evolved and write the corresponding balanced chemical equation. | |
| | | ii) Calculate the theoretical percentage weight loss for the first step (dehydration) and the second step (decarbonylation) based on the molar masses (Ca=40, C=12, O=16, H=1). | |
| | | iii) Justify why the final residue remains stable above 800 °C in an inert atmosphere, and predict how the curve would change if the experiment were performed in a high-pressure CO_2 environment. | |

Section B

There are **FOUR** questions in this section. Answer any **THREE** questions.

Question No.	Question Description	Marks
5.	a) What is the principle of Ultraviolet Photoelectron Spectroscopy (UPS)? [L1, CLO2]	5
	b) Discuss the role of LEED in analyzing surface crystal structure. [L2, CLO7]	5
6.	a) Explain why SEM requires a vacuum environment. [L2, CLO2]	3
	b) Which technique is more suitable for atomic-level resolution: STM or AFM? Justify. [L5, CLO2]	4
	c) How can AFM be used to measure surface roughness at nanoscale? [L4, CLO7]	3
7.	a) State the Beer–Lambert Law used in AAS. [L1, CLO3]	3
	b) Suggest an appropriate technique (AAS, ICP-AES, or FES) to determine trace metals in drinking water and justify your choice. [L3, CLO3]	3
	c) Recommend an oxidation method for TOC analysis in wastewater and justify your choice. [L6, CLO3]	4
8.	a) Define Stokes shift. [L1, CLO5]	2
	b) Suggest how PL spectroscopy can be used to analyze semiconductor materials [L3, CLO5]	4
	c) Explain concentration quenching and its impact on analytical results. [L6, CLO7]	4