



School of Computing and Engineering Sciences

Bachelor of Science in Electrical and Electronic Engineering

End of Semester Examination

Course Code: CHE 1201

Unit Name: Chemistry II

Date: Monday 9th March 2026.

Time 16.00 - 18.00 Hours

Instructions: Answer Question **ONE** and any other **TWO** Questions

Important constants: $R = 8.314 \text{ J/mole-K}$; $F = 96,500 \text{ C/mole}$

Students to be provided with graph papers

QUESTION 1 (30 MARKS)

- (a) A voltaic cell is based on $\text{Co}^{2+}(\text{aq})/\text{Co}(\text{s})$ half-cell and $\text{AgCl}(\text{s})/\text{Ag}(\text{s})$ half-cell.
- (i) Write the balanced overall reaction of the cell [3 marks]
 - (ii) Calculate the standard potential of the cell [1 mark]
- (b) Draw and name all the isomers of a molecule with a molecular formula $\text{C}_3\text{H}_8\text{O}$ [3 marks]
- (c) Halogenation of alkanes is a substitution reaction while for alkenes is addition reaction
- (i) Give two differences between substitution and addition reaction [2 marks]
 - (ii) State the conditions for halogenation of alkanes [1 mark]
 - (iii) Describe the application of the two reactions stated [2 marks]
- (d) Draw the structures of the following compounds
- (i) 1-methylcyclobutanol [1 mark]
 - (ii) 2-cyclopropyl-3,5-dimethyloctane [1 mark]
 - (iii) Cis-2-butenoic acid [2 marks]
 - (iv) 4,4-dimethyl-1-pentyne [1 mark]
 - (v) 3,3-dimethyl-2-pentanone [1 mark]
- (e) The boiling point of amines below was found to be 56.3° , 37.5° and 77.8° .
- $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_2\text{NH}_2$ $(\text{CH}_3\text{CH}_2)_2\text{NH}$ $\text{CH}_3\text{CH}_2\text{N}(\text{CH}_3)_2$
- i) Assign each, its correct boiling point [1½ marks]

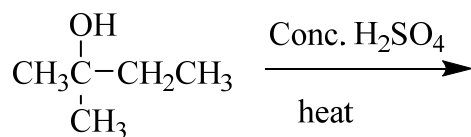
- ii) Explain the assignments in (i). Use illustration for your answer **[4½ marks]**
- (f) A first order reaction is one in which the rate of reaction depends on a single reactant. For a reaction $A \longrightarrow \text{products}$. Show that for a first order reaction, the general rate equation at any time is given by $\ln[A]_t = -kt + \ln[A]_0$ **[3 marks]**
- (g) Explain the use of Nuclear Magnetic Resonance (NMR) in determining structures of organic compounds **[3 marks]**

QUESTION 2 [15 MARKS]

- (a) Using s, p orbitals and hybridization, show the bonding in methane by properly labeling the hybrid orbitals formed as they overlap with hydrogen orbitals to form bonds **[5 marks]**
- (b) The following data were obtained for the gas decomposition of gas phase decomposition of nitrogen dioxide at 300° C, $\text{NO}_2(\text{g}) \longrightarrow \text{NO}(\text{g}) + 1/2\text{O}_2(\text{g})$;

Time (s)	$[\text{NO}_2]$ [M]
0.0	0.01000
50.0	0.00787
100.0	0.00649
200.0	0.00481
300.0	0.00380

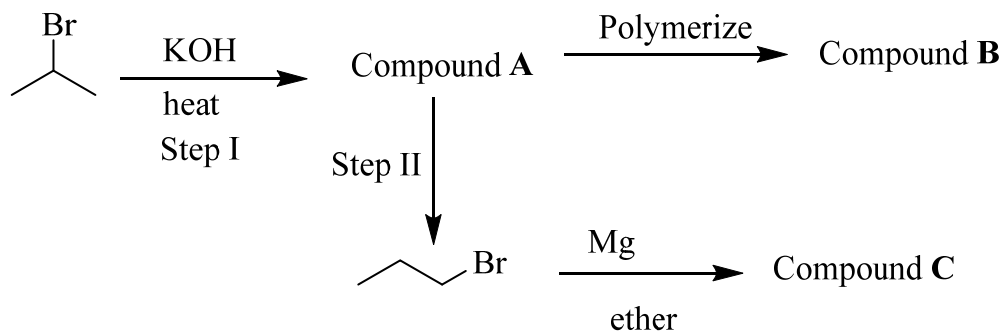
- Plot two curves using the equations of the 1st and 2nd order. Determine which type of reaction took place **[6 marks]**
- (c) One of the methods of preparation of alkenes is dehydration of alcohols. The number of products formed depends on the type of alcohol used as a reagent. Use this reaction to answer the questions that follow



- (i) Name another dehydrating agent apart from conc. Sulphuric acid **[1 mark]**
- (ii) Draw and name the products formed **[3 marks]**

QUESTION 3 (15 MARKS)

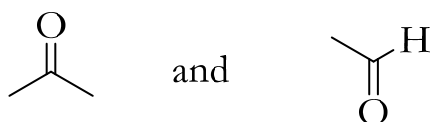
(a) Study the reaction scheme below and answer the questions that follow:-



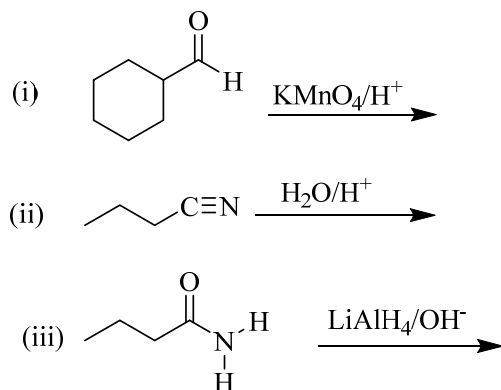
- Name the structure of compound **A**, **B** and **C** [3 marks]
 - Determine the reagents for step II [2 marks]
 - State one use of compound **B** [1 mark]
- (b) Define fuel cell and explain how it generates electricity [3 marks]
- (c) A voltaic cell is constructed that uses the following reaction and operates at 298 K.
- $$\text{Zn(s)} + \text{Cd}^{2+}(\text{aq}) \longrightarrow \text{Zn}^{2+}(\text{aq}) + \text{Cd(s)}$$
- Determine the emf of the cell under standard conditions [2 marks]
 - Calculate the emf of the cell when $[\text{Cd}^{2+}] = 1.50 \text{ M}$ and $[\text{Zn}^{2+}] = 0.15 \text{ M}$ [4 marks]

QUESTION 4 (15 MARKS)

(a) Use the structure below to answer questions below



- Explain two reasons why aldehydes are more reactive than ketones [4 marks]
 - Using observations, give a visual experiment you can use to distinguish the two compounds [3 marks]
- (b) Give the names and structures of major products for the following reactions [3 marks]



(c) Balance the following redox equation using the half reaction

[5 marks]



QUESTION 5 (15 marks)

(a) A 1.50 g sample of compound **X** was completely burned in excess oxygen. The combustion products were collected, giving 2.20 g of carbon dioxide (CO_2) and 0.90 g of water (H_2O). Mass spectrum analysis shows that the molar mass of compound **X** is 60 g mol^{-1} . Determine the molecular formula of **X**

[5 marks]

(b) The figures below shows IR, ^1H and ^{13}C NMR spectra data for compound **X** in (a). Use the data in combination with data in (a) to determine the structural formula of compound **X**. Give an explanation in each case [5 marks]

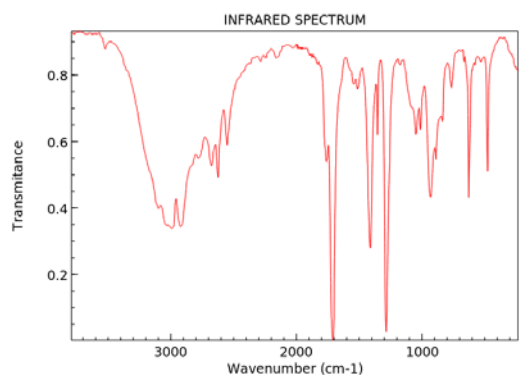


Figure 1: IR spectra for compound **M**

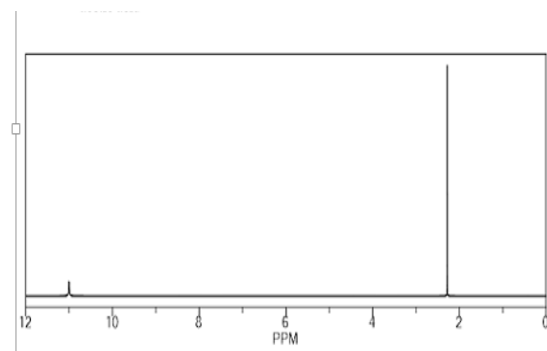


Figure 2: ^1H spectra for compound **M**

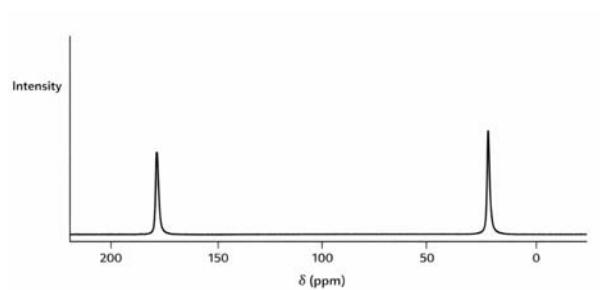


Figure 3: ^{13}C spectra for compound **M**

(c) Give the IUPAC names for the following compounds

[5 marks]

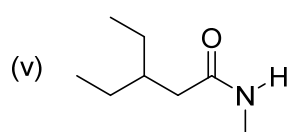
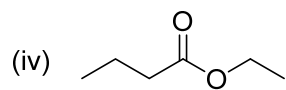
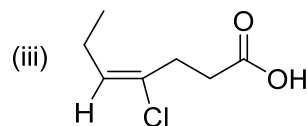
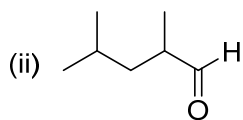
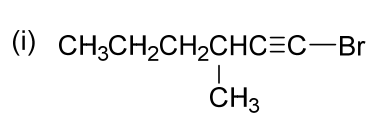




Table 1: Periodic Table

Half Cell	Electrode Reduction Reaction	E° , in Volt
Au Au ⁺	Au ⁺ + e ⁻ → Au	+1.69
Au Au ³⁺	Au ³⁺ + 3e ⁻ → Au	+1.4
Pt Pt ²⁺	Pt ²⁺ + 2e ⁻ → Pt	+1.19
Pd Pd ²⁺	Pd ²⁺ + 2e ⁻ → Pd	+0.92
Ag Ag ⁺	Ag ⁺ + e ⁻ → Ag	+0.80
Cu Cu ⁺	Cu ⁺ + e ⁻ → Cu	+0.52
Cu Cu ²⁺	Cu ²⁺ + 2e ⁻ → Cu	+0.34
Ag AgCl Cl ⁻	AgCl + e ⁻ → Ag + Cl ⁻	+0.22
Cu Cu ²⁺	Cu ²⁺ + e ⁻ → Cu ⁺	+0.16
Pb Pb ²⁺	Pb ²⁺ + 2e ⁻ → Pb	-0.13
Sn Sn ²⁺	Sn ²⁺ + 2e ⁻ → Sn	-0.14
Ni Ni ²⁺	Ni ²⁺ + 2e ⁻ → Ni	-0.26
Co Co ²⁺	Co ²⁺ + 2e ⁻ → Co	-0.28
Fe Fe ²⁺	Fe ²⁺ + 2e ⁻ → Fe	-0.44
Zn Zn ²⁺	Zn ²⁺ + 2e ⁻ → Zn	-0.76
Mn Mn ²⁺	Mn ²⁺ + 2e ⁻ → Mn	-1.18
Al Al ³⁺	Al ³⁺ + 3e ⁻ → Al	-1.68
Mg Mg ²⁺	Mg ²⁺ + 2e ⁻ → Mg	-2.36
Na Na ⁺	Na ⁺ + e ⁻ → Na	-2.71
K K ⁺	K ⁺ + e ⁻ → K	-2.93
Li Li ⁺	Li ⁺ + e ⁻ → Li	-3.05

Table 2: Standard Electrode potentials at 25 °C