Strathmore UNIVERSITY

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: 17th March 2025 **Time 16:00-18:30 Hours**

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

Important constants: R = 8.314 J/mole-K; F =96,500 C/mole

QUESTION 1 (20 MARKS)

(a) Define the following terms **[4 marks]**

(i) Half life

(ii) Hybridization

(iii) Redox reaction

(iv) Isomers

(b) List four properties of a homologous series **[2 marks]**

(c) Using the first order equation $\ln [A] = \ln [A_0] - kt$ show that $t_{1/2} = \frac{0.693}{k}$ **[3 marks]**

(d) Express the rate of reactions in terms of the rate of change of each of the reactant and each of the products **[3 marks]**

(i) $3ClO^-(g) \longrightarrow ClO_3^-(aq) + 2Cl^-(aq)$

(ii) $2SO_2(g) + O_2(g) \longrightarrow 2SO_3(g)$

(iii) $C_2H_4(g) + Br_2(g) \longrightarrow C_2H_4Br_2(g)$

(e) Explain the following observations

(i) CH_3CH_2OH is much more soluble in water than is $CH_3CH_2CH_2CH_2CH_2OH$ **[3 marks]**

(ii) Chloroethanal is more reactive than ethanal **[2 marks]**

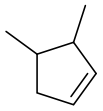
(iii) Ethanoic acid has high boiling point than ethanol **[3 marks]**

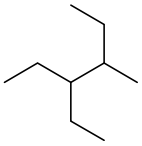
(f) Determine the oxidizing and reducing agents in the following reaction **[3 marks]**

$KMnO_4(aq) + H_2SO_4(aq) + NaCl(aq) \longrightarrow$

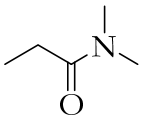
$Cl_2(aq) + NaHSO_4(aq) + K_2SO_4(aq) + MnSO_4(aq)$ acidic solution

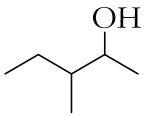
(g) Give the IUPAC names for the following compounds **[5 marks]**

(i) 

(ii) 

(iii) $(CH_3)_3CCOOH$

(iv) 

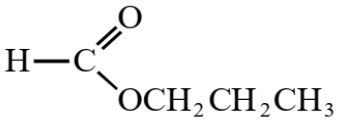
(v) 

(h) Given that E°red Cu^{+2} = 0.34 V, write out the balanced half reactions and solve for the E°red for Zn^{+2} ,

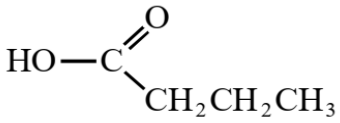
$Zn|Zn(NO_3)_2||Cu(NO_3)_2|Cu$ E°cell= 1.10 V **[2 marks]**

QUESTION 2 [15 MARKS]

(a) Consider the following pair of isomers.



C



D

I. Give the systematic name for compound C and D **[2 marks]**

II. Identify a reagent which could be used in a test-tube reaction to distinguish between

i. C and D. In each case, state what you would observe.

i. Reagent **[1 mark]**

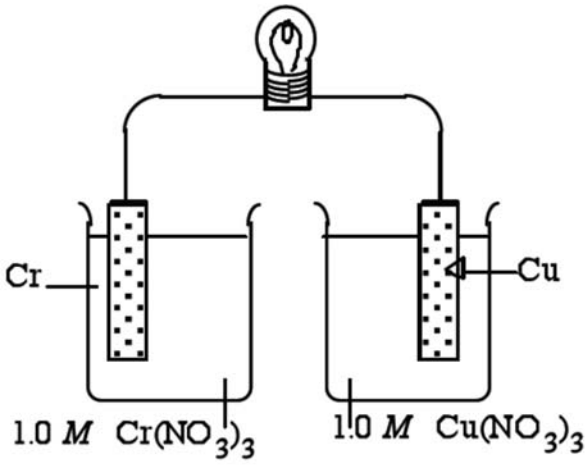
ii. Observation with C **[1 mark]**

iii. Observation with D **[1 mark]**

(b) A galvanic cell is constructed using a chromium electrode in a 1.00-molar solution of $Cr(NO_3)_3$ and a copper electrode in a 1.00-molar solution of $Cu(NO_3)_2$. Both solutions are at 25°C.

(i) Write a balanced net ionic equation for the spontaneous reaction that occurs as the cell operates. Identify the oxidizing agent and the reducing agent **[3 marks]**

(ii) A partial diagram of a cell in (b) is shown below



I. Identify the metal which is the cathode [1 mark]

II. Determine the additional component needed for the cell to function well.
Explain its purpose [2 marks]

III. Calculate K and ΔG° for the reaction [4 marks]

QUESTION 3 (20 MARKS)

(a) Compounds 'A' and 'B' react according to the chemical equation

$$A(g) + 2B(g) \longrightarrow 2C(g)$$

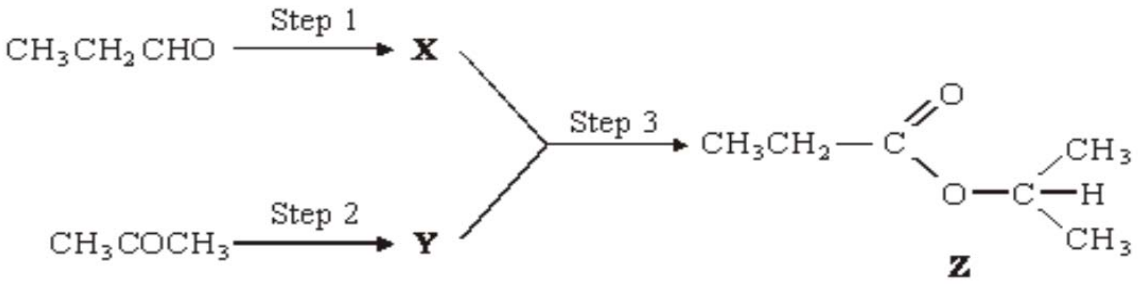
Concentration of either 'A' and 'B' were changed keeping the concentrations of one of the reactants constant and rates were measured as a function of initial concentration. Following results were obtained. Choose the correct option for the rate equations for this reaction:

Experiment	Initial concentration of [A] [M]	Initial concentration of [B] [M]	Initial rate of formation [C] [M]
1	0.3	0.3	0.1
2	0.3	0.6	0.4
3	0.6	0.3	0.2

(i) Calculate the overall reaction order **[5 marks]**

(ii) Calculate the average value of k **[2 marks]**

(b) Compound Z can be produced by the reaction of compound X with compound Y as shown in the synthesis outlined below.



a) Identify compounds X and Y. **[2 marks]**

b) Name the type of reaction involved, the reagents and conditions for each of the following steps in the synthesis; **[6 marks]**

Step 1: Reaction
Reagents
Conditions

Step 3: Reaction
Reagents
Conditions

QUESTION 4 (20 MARKS)

(a) Use the structure below to answer questions below

X **Y**

(i) Differentiate between saturated and unsaturated compounds **[2 marks]**

(ii) Using line bond formula, draw and name isomer of compound X **[2 marks]**

(iii) Using observations, give two experiments you can use to distinguish compound **X** and Compound **Y** [**4 marks]**

(b) Balance the following redox reaction using half reaction method [4 marks]

$$Br^-(aq) + SO_4^{2-}(aq) \longrightarrow Br_2(aq) + SO_2(g)$$

(c) Draw and classify the alcohols with the molecular formula C_4H_9OH [3 marks]

QUESTION 5 (20 marks)

(a) A 1.00 g sample of **M** is completely burned in excess oxygen, producing 1.91 g of CO_2 and 1.17 g of H_2O. Determine the molecular formula of compound M if its molar mass is approximately 46 g/mol **[5 marks]**

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

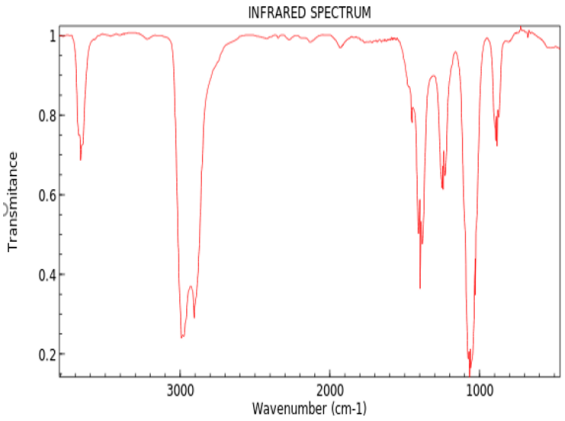


Figure 1: IR spectra for compound **M**

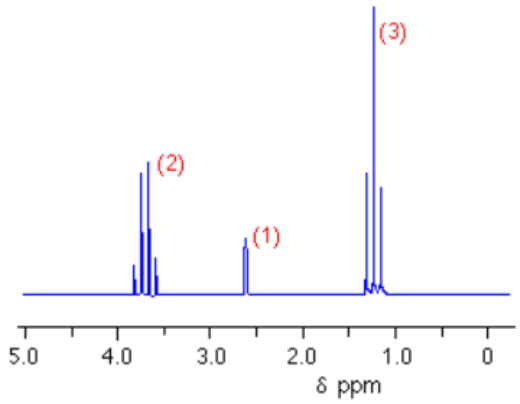


Figure 2: ^{1}H spectra for compound **M**

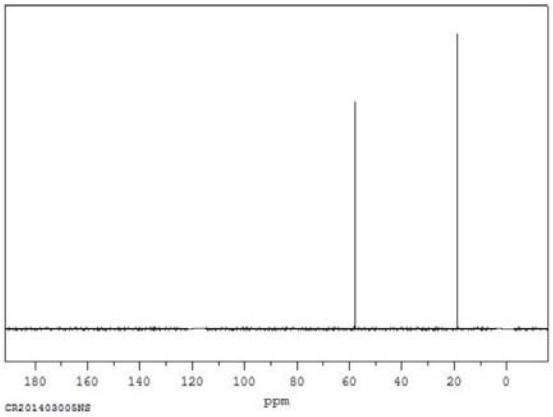


Figure 3: ^{1}H spectra for compound **M**

(c) Draw structures for the following compounds

(i) 2,2-dimethyl-3-heptyne [1 mark]

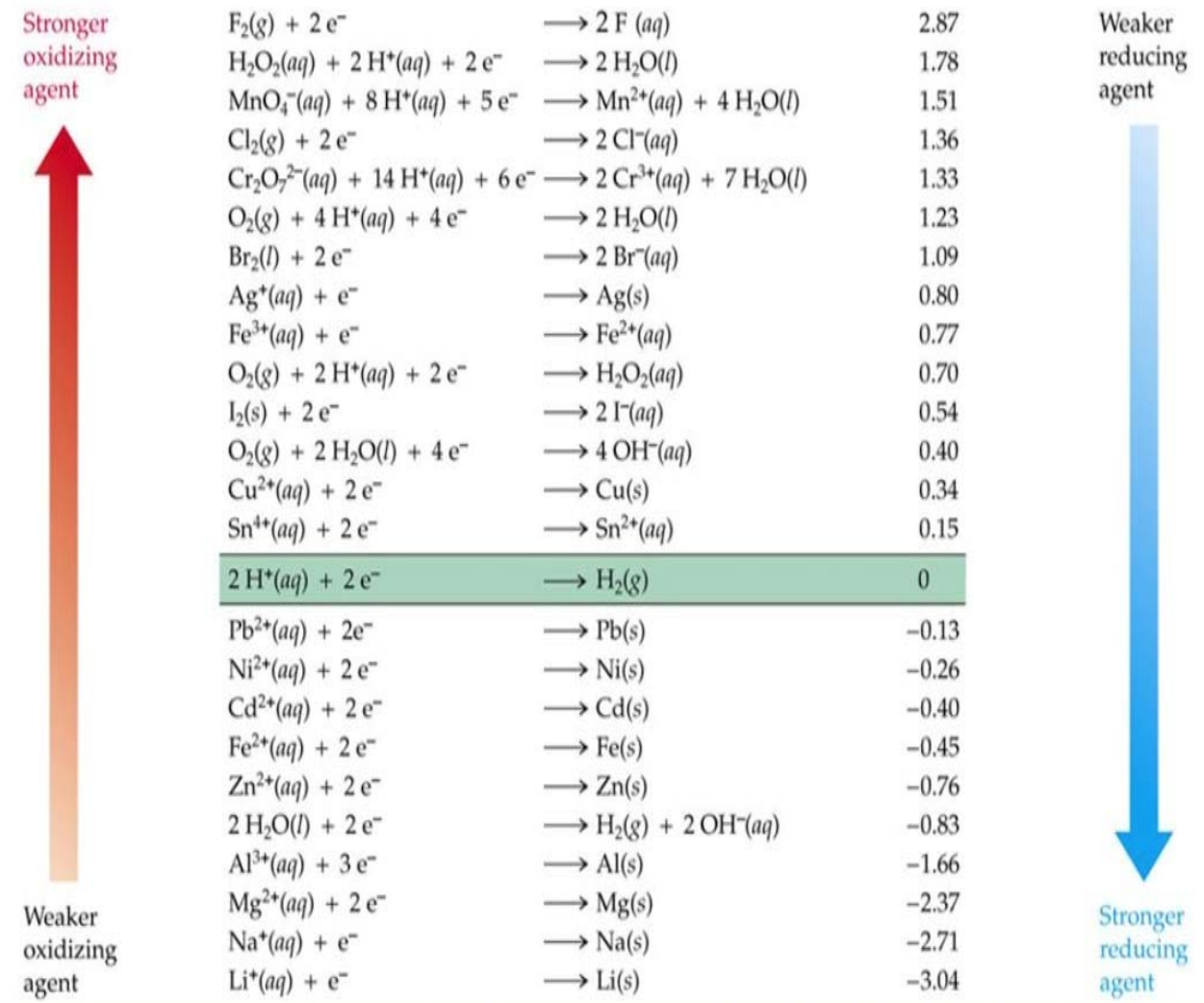
(ii) Cis-but-2-ene [1 mark]

(iii) 2-propylhexanoic acid [1 mark]

(iv) 3-pentenal [1 mark]

(v) 2-methylbutanoic anhydride [1 mark]

Table 1: Periodic Table



$F_2(g) + 2\,e^-$	$\longrightarrow 2\,F\,(aq)$	2.87
$H_2O_2(aq) + 2\,H^+(aq) + 2\,e^-$	$\longrightarrow 2\,H_2O(l)$	1.78
$MnO_4^-(aq) + 8\,H^+(aq) + 5\,e^-$	$\longrightarrow Mn^{2+}(aq) + 4\,H_2O(l)$	1.51
$Cl_2(g) + 2\,e^-$	$\longrightarrow 2\,Cl^-(aq)$	1.36
$Cr_2O_7^{2-}(aq) + 14\,H^+(aq) + 6\,e^-$	$\longrightarrow 2\,Cr^{3+}(aq) + 7\,H_2O(l)$	1.33
$O_2(g) + 4\,H^+(aq) + 4\,e^-$	$\longrightarrow 2\,H_2O(l)$	1.23
$Br_2(l) + 2\,e^-$	$\longrightarrow 2\,Br^-(aq)$	1.09
$Ag^+(aq) + e^-$	$\longrightarrow Ag(s)$	0.80
$Fe^{3+}(aq) + e^-$	$\longrightarrow Fe^{2+}(aq)$	0.77
$O_2(g) + 2\,H^+(aq) + 2\,e^-$	$\longrightarrow H_2O_2(aq)$	0.70
$I_2(s) + 2\,e^-$	$\longrightarrow 2\,I^-(aq)$	0.54
$O_2(g) + 2\,H_2O(l) + 4\,e^-$	$\longrightarrow 4\,OH^-(aq)$	0.40
$Cu^{2+}(aq) + 2\,e^-$	$\longrightarrow Cu(s)$	0.34
$Sn^{4+}(aq) + 2\,e^-$	$\longrightarrow Sn^{2+}(aq)$	0.15
$2\,H^+(aq) + 2\,e^-$	$\longrightarrow H_2(g)$	0
$Pb^{2+}(aq) + 2e^-$	$\longrightarrow Pb(s)$	−0.13
$Ni^{2+}(aq) + 2\,e^-$	$\longrightarrow Ni(s)$	−0.26
$Cd^{2+}(aq) + 2\,e^-$	$\longrightarrow Cd(s)$	−0.40
$Fe^{2+}(aq) + 2\,e^-$	$\longrightarrow Fe(s)$	−0.45
$Zn^{2+}(aq) + 2\,e^-$	$\longrightarrow Zn(s)$	−0.76
$2\,H_2O(l) + 2\,e^-$	$\longrightarrow H_2(g) + 2\,OH^-(aq)$	−0.83
$Al^{3+}(aq) + 3\,e^-$	$\longrightarrow Al(s)$	−1.66
$Mg^{2+}(aq) + 2\,e^-$	$\longrightarrow Mg(s)$	−2.37
$Na^+(aq) + e^-$	$\longrightarrow Na(s)$	−2.71
$Li^+(aq) + e^-$	$\longrightarrow Li(s)$	−3.04

Table 2: Standard Electrode potentials at 25 °C