



School of Computing and Engineering Sciences

Bachelor of Science in Electrical and Electronic Engineering

End of Semester Examination

CHE 1201: Chemistry II

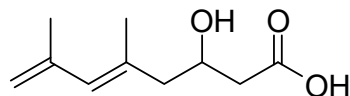
Date: 12th March 2024

Time 15:30-18:00 Hours

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

QUESTION 1 (20 MARKS)

- (a) An organic compound has a molecular formula $C_5H_{12}O$. One of its isomers is a straight chain alcohol. Draw its:
- (i) Condensed formula [1 mark]
 - (ii) Dash formula [1 mark]
 - (iii) Line bond formula [1 mark]
- (b) Explain the following trends in the periodic table
- (i) Atomic radius increases down the group [1 mark]
 - (ii) Fluorine is more reactive than iodine [1 mark]
- (c) Identify the oxidizing and reducing agents in the following reaction [2 marks]
- $$2H_2O(l) + Al(s) + MnO_4^-(aq) \longrightarrow Al(OH)_4^- + MnO_2(s)$$
- (d) The boiling point for butane is $-1^\circ C$ and that of 1-propanol is $97^\circ C$. The two compounds have almost the same relative molecular mass. Explain the difference in boiling points [2 marks]
- (e) Study the structure and use it to answer the question that follow



State two methods other than Mass spectroscopy, the spectroscopic techniques that you would use to identify the compound. Give explanations for your answer [2 marks]

(f) Using s and p notations, indicate the type of bonding in methane [2 marks]

(g) An acidic solution contains 0.1 M HCl

(i) Define the term pH and give its expression [1 mark]

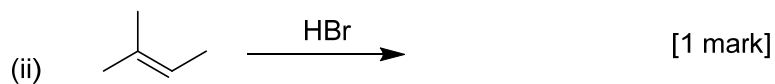
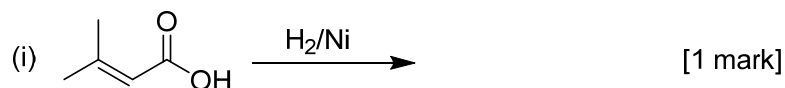
(ii) Calculate the pH of the solution [1 mark]

(h) The decomposition of hydrogen peroxide is represented by the following equation



If the initial concentration of H_2O_2 was 0.2546 M, and the initial rate is 9.35×10^{-4} M/s. determine the concentration of hydrogen peroxide at time, $t = 35$ s [3 marks]

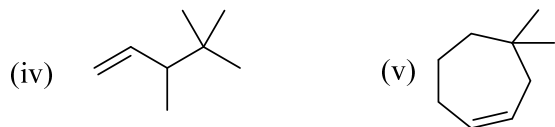
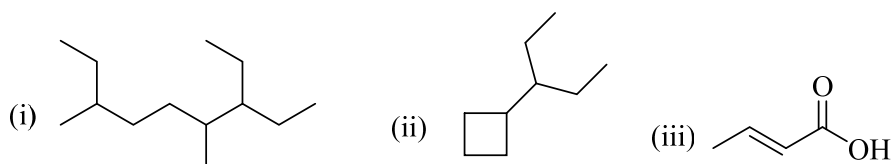
(i) Give the structure and name of the major products for the following reactions



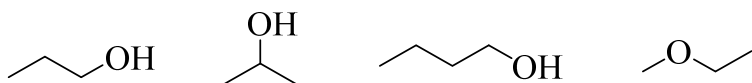
QUESTION 2 (20 MARKS)

(a) Determine the number of moles of HF that must be present in 0.2 L to form a solution with pH of 3.25 given that $K_a = 6.8 \times 10^{-6}$ [5 marks]

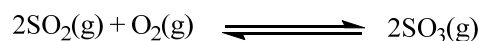
(b) Give IUPAC names for the following compounds [5 marks]



(c) Study the structures below and answer the questions that follow:



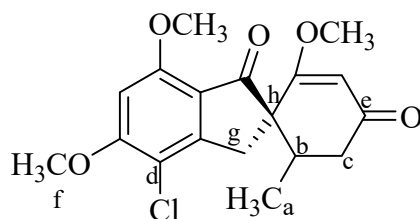
- (i) Arrange the compounds in increasing order of Boiling point [2 marks]
- (ii) Using illustrations, give explanation for your answer in c(i) above [5 marks]
- (d) The following reaction is a key step in the industrial production of sulfuric acid. Use it to answer the questions that follow.



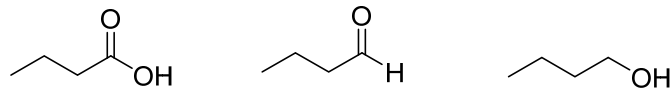
A mixture of SO_2 and O_2 was maintained at 800K until the system reached equilibrium. The equilibrium mixture contained $5.5 \times 10^{-2} \text{ M SO}_3$, $3.5 \times 10^{-3} \text{ M O}_2$, and $3.0 \times 10^{-3} \text{ M SO}_2$. Calculate at this temperature, the value of K_c [3 marks]

QUESTION 3 (20 MARKS)

- (a) The molecule shown below is Griseofulvin, an antifungal compound. Study it and answer the questions that follow:



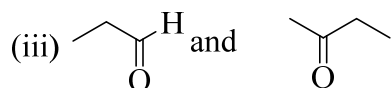
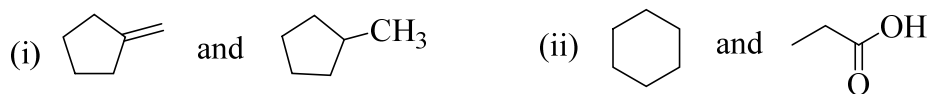
- (i) List any TWO sp^3 and sp^2 hybridized orbitals [2 marks]
- (ii) List any secondary and primary carbon atom [2 marks]
- (b) Explain the difference between an oxidation-reduction reaction and a half-reaction. [2 marks]
- (c) A solution A has a PH of 12.6. Calculate;
- (i) The hydronium ion concentration of solution A [2 marks]
- (ii) The hydroxide ion concentration of solution A [2 marks]
- (d) Complete and balance the following half-equations, and indicate whether oxidation or reduction is involved. [4 marks]
- i. $\text{ClO}_2(\text{g}) \longrightarrow \text{ClO}_3^-(\text{aq})$ (acidic solution)
- ii. $\text{MnO}_4^-(\text{aq}) \longrightarrow \text{MnO}_2(\text{s})$ (acidic solution)
- (e) Use the structures below to answer questions that follow



- (i) Arrange the compounds in the increasing order of boiling point [3 Marks]
 (ii) Using illustrations, explain your answer in (c)(i). [3 Marks]

QUESTION 4 (20 MARKS)

- (a) Give two factors that affect the rate of a reaction involving solid reactants [2 marks]
 (b) Give simple visual chemical tests, including observations that you would use to differentiate between the following pairs of compounds [9 marks]



- (c) Consider the gas-phase reaction between nitric oxide and bromine at 273 °C:



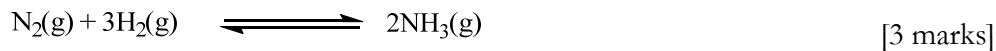
The following data for the initial rate of appearance of NOBr were obtained:

Experiment	[NO] (M)	[Br ₂] (M)	Initial Rate (M/s)
1	0.10	0.20	24
2	0.25	0.20	250
3	0.10	0.50	60
4	0.35	0.50	735

- (i) Determine the rate law [4 marks]
 (ii) Determine the value for rate constant [2 marks]
- (d) The spectra in the attachment are of ethanoic acid, CH₃COOH (Figure 1), and ethanoic anhydride, (CH₃CO)₂O (Figure 2). Draw the full structural formula for both compounds and then determine, giving reasons, which spectrum is due to which compound. [3marks]

QUESTION 5 (20 MARKS)

- (a) List three factors that would affect the equilibrium position in the following reaction.



(b) Draw structures for the following compounds

(i) *Trans*-1-isopropyl-3-methylcycloheptane [2 marks]

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

(iii) 1-cyclopropylbut-2-ene [1 marks]

(iv) 2-propylhexanoic acid [1 mark]

(v) 3-pentenal [1 marks]

(c) Adding 0.3 moles make a buffer CH_3COOH and 0.03 moles CH_3COONa to enough water to make 1.00 L of solution. The pH of the buffer is 4.74.

Calculate the pH of this solution:

(i) After 0.020 moles of NaOH is added [4 marks]

(ii) After 0.020 moles of HCl is added [4 marks]

(d) A sample of an organic compound with a mass of 1.224 g was completely burned in oxygen and found to produce 2.340 g of carbon dioxide and 1.433 g of water only. Determine the empirical formula of the organic compound [3 marks]

Figure 1

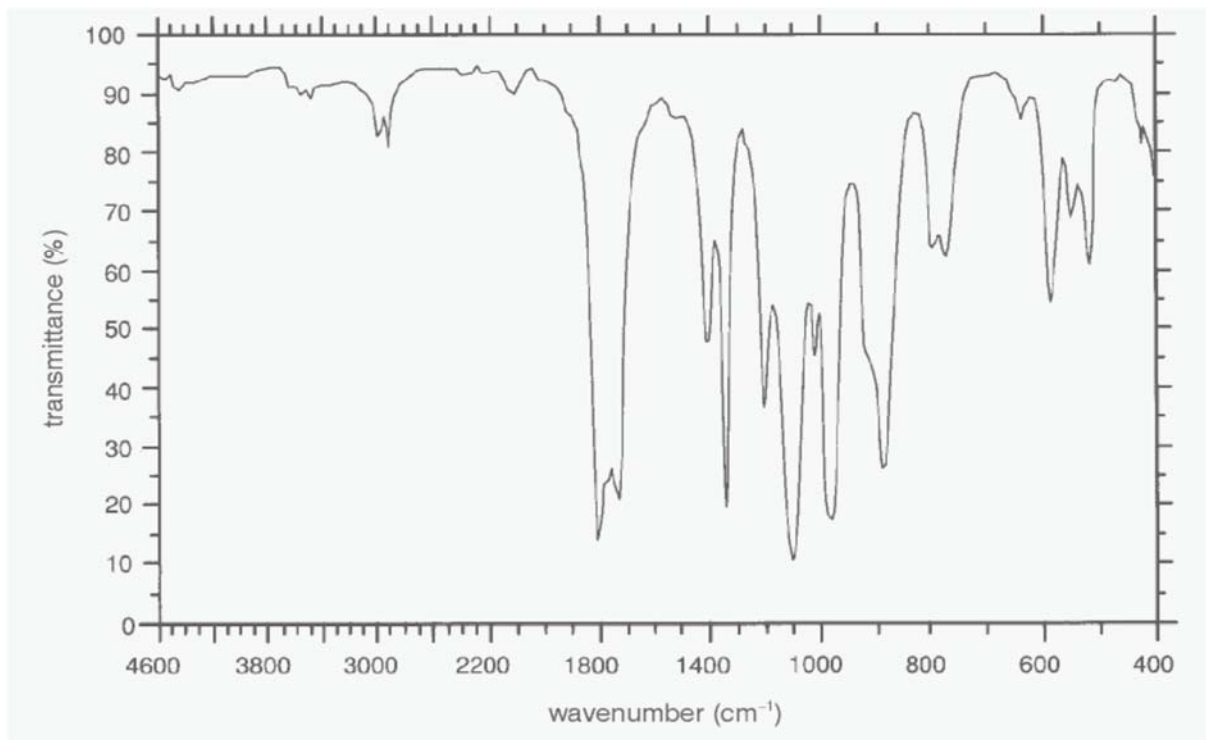


Figure 2

