



**UNIVERSITI KUALA LUMPUR
MALAYSIAN INSTITUTE OF INDUSTRIAL TECHNOLOGY**

**FINAL EXAMINATION
JANUARY 2016 SEMESTER**

COURSE CODE : JGB 10502
COURSE TITLE : INDUSTRIAL CHEMISTRY
PROGRAMME LEVEL : BACHELOR
DATE : 26 MAY 2016
TIME : 9.00 AM – 12.00 PM
DURATION : 3 HOURS

INSTRUCTIONS TO CANDIDATES

1. Please read the instructions given in the question paper **CAREFULLY**.
 2. This question paper is printed on both sides of the paper.
 3. This question paper consists of **TWO (2)** sections.
 4. Answer **ALL** questions in Section A. Choose **THREE (3)** questions in section B.
 5. Please write your answers on the answer booklet provided.
 6. Please answer all questions in English only.
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THERE ARE 8 PAGES OF QUESTIONS EXCLUDING THIS PAGE.

SECTION A (Total: 40 marks)**INSTRUCTION: Answer ALL questions.****Please use the answer booklet provided.****Question 1**

- (a) Ammonia is a weak base that is widely used as household cleanser. Ammonia has the formula NH_3 . Ammonia dissolved in water according to the reaction below.



Calculate the pH of 0.1 Molar Ammonia given the K_b is $1.8 \times 10^{-5} \text{ mol/dm}^3$ at 298 K.
(3 marks)

- (b) Buffer is widely use in the chemical industry. A typical weak acid buffer contains acetic acid and sodium acetate.

i. Give the definition of a buffer. (2 marks)

ii. Discuss how the buffer reacts when a small amount of OH^- is added to it.
(2 marks)

- (c) A manufacturer of fruit juice wants to test whether the juice produce is according to the approve standard. The **acidity** of the fruit juice must not exceed pH= 3.5 to be safe for consumption. From the titration the concentration of $[\text{H}^+]$ of the fruit juice is 0.00010 Molar. Discuss whether the fruit juice is safe for consumption assuming that the acid in the fruit juice is totally dissociated in water.

(3 marks)

Question 2

Infrared spectroscopy is a powerful tool for identifying organic compounds. Below is the infrared spectrum of an unknown compound.

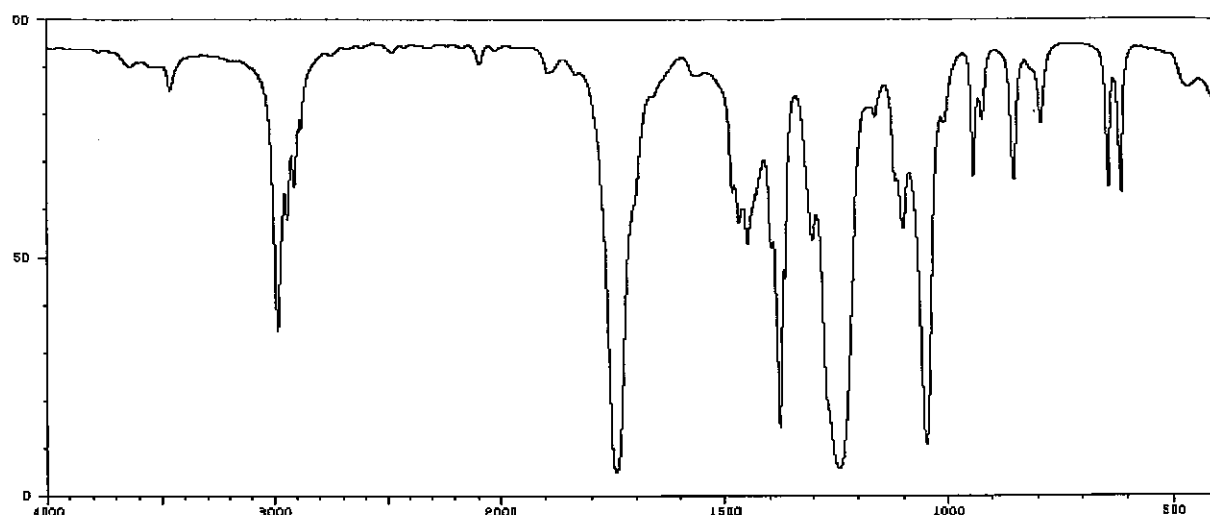


Figure 1: Infrared Spectrum of Unknown Compound

- (a) Explain what occurs at molecular level during absorption of infrared radiation. (3 marks)
- (b) The compound has a molecular formula of $\text{CH}_3\text{-CO-O-C}_2\text{H}_5$. From the spectrum in Figure 1 above, determine the absorption peaks responsible for the C=O and C-H functional groups. (4 marks)
- (c) Most molecules have quite complex spectra and can be identified from the 'fingerprint' region. Sketch the 'fingerprint' region on the spectrum above. (3 marks)

Question 3

The reaction of hydrochloric acid with calcium carbonate is as shown below.



- (a) Give the **FOUR (4)** factors that will affect the rate of reaction. (4 marks)
- (b) Explain the change to the time required to complete the reaction when the temperature is increased from 273° K to 373° K. (3 marks)
- (c) Figure 3 below shows the change in the volume of carbon dioxide production at 1 Molar HCl. On the same diagram show the change in the volume of carbon dioxide production at 0.5 Molar and 2 Molar HCl.

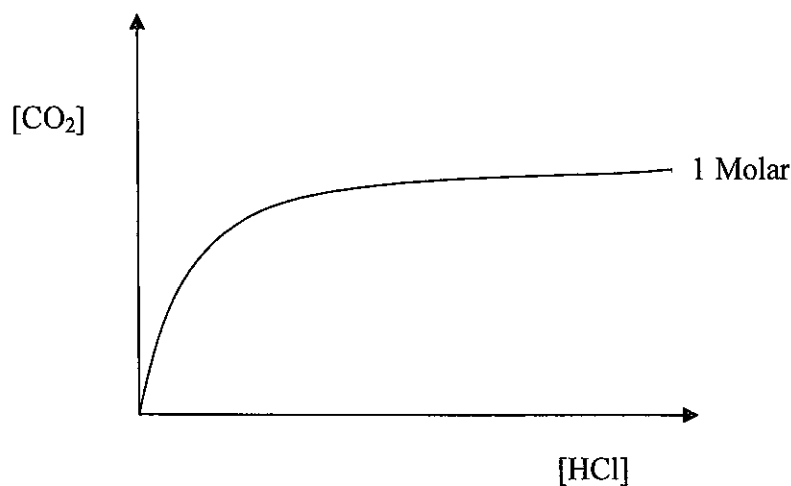


Figure 2: Volume of CO_2 versus acid concentration.

(3 marks)

Question 4

^1H NMR spectrum is a particularly powerful tool in structural determination as it enables information to be gained on the precise chemical environment of all protons in a molecule.

Figure 3 shows the NMR spectrum of ethyl acetate.

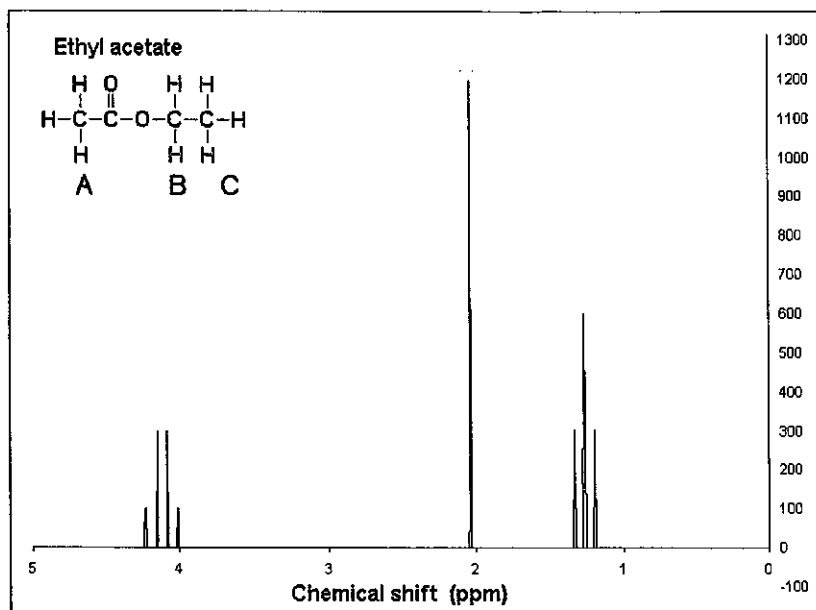


Figure 3: ^1H NMR spectrum of ethyl acetate

- (a) In NMR spectroscopy tetramethylsilane (TMS) is used. Explain the function of TMS. (2marks)
- (b) Explain the multiplicity of the peaks at 4.2 ppm. (2 marks)
- (c) The three different peaks show that the hydrogen atoms within the molecule are in three different chemical environments. Describe the peaks associated with proton A, B and C in ethyl acetate molecule. (6 marks)

SECTION B: (Total: 60 marks)**INSTRUCTION: Answer any THREE (3) questions.****Please use the answer booklet provided.****Question 1**

- (a) Hydrocarbons are organic compounds that consist of carbon and hydrogen.
Hydrocarbon consists of saturated and unsaturated hydrocarbons.
- State the definition of saturated hydrocarbon. (2 marks)
 - Alkanes undergo combustion reaction. Show the balance equation for the combustion of pentane. (3 marks)
- (b) The Malaysian economy depends to a large extent to the oil industry. Describe the process of separating the mixture of hydrocarbons in crude oil. (5 marks)
- (c) Sulfuric acid (H_2SO_4) is a clear, colorless, odorless, viscous liquid that is very corrosive. As the largest-volume industrial chemical produced in the world, consumption of sulfuric acid is often used to monitor a country's degree of industrialization.
- Give **TWO (2)** industrial usages for sulfuric acid. (2 marks)
 - Identify the manufacturing process that will produce sulfuric acid. (2 marks)
 - The production of sulfuric acid involves **THREE (3)** steps. Describe these steps. (6 marks)

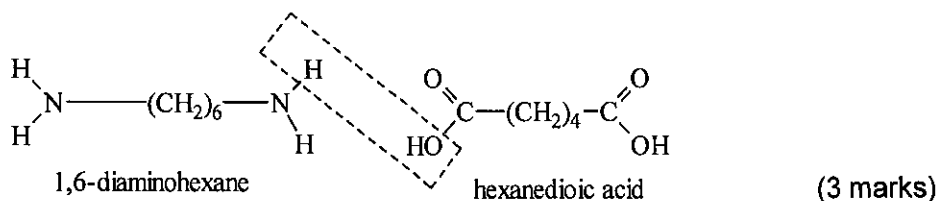
Question 2

- (a) A polymer is large molecule that consists of small repeating unit call monomers. In the past hundred years, the plastics industry has made synthetic polymers that are in many of the materials we use every day, such as carpeting, plastic cups and nonstick pan.
- i. Describe additional polymerization by using Polyethene as an example. (2 marks)
 - ii. A manufacturer wanted to produce LDPE. Describe the free radical mechanism that will produce LDPE. (3 marks)
- (b) The **octane rating** is a measure of how likely a gasoline or liquid petroleum fuel is to self-ignite. The higher the number, the less likely an engine is to pre-ignite and suffer damage. Branched hydrocarbons such as isooctane are added to gasoline to increase the octane rating. For this reason, straight-chain hydrocarbons are converted to more useful branched alkanes.
- i. Identify the chemical process that change straight-chain hydrocarbons to useful branched alkanes. (2 marks)
 - ii. Discuss in term of collision theory the benefit of adding branched hydrocarbons to gasoline. (3 marks)
- (c) The most important metallurgical process involving carbon is the reduction of hematite ore in a blast furnace.
- i. Identify the three main feed that is put into the blast furnace. (3 marks)
 - ii. State the **TWO (2)** reactions involved in the reduction of iron ore to iron. (4 marks)
 - iii. Iron and steel is frequently recycled. Discuss **ONE (1)** reason which favours recycling. (3 marks)

Question 3

- (a) Polyesters and polyamides are condensation polymers and are widely use as fibers in clothing. These polymers give fabric more desirable characteristics such as stretchiness and better wash ability.

- Explain the term condensation polymerization. (2 marks)
- Draw the polymer of Terylene from the following monomers.



- (b) Natural gas is Malaysia's gas reserves is approximately three times the size of crude oil reserves of 5.46 billion barrels.

- Explain the typical composition of raw natural gas. (2 marks)
- Discuss one reason why natural gas is preferred as fuel compared to gasoline and diesel.

(3 marks)

- (c) Aluminium is the 3rd most abundance element and the most abundance metal in the Earth's crust. Aluminium is a relatively soft, durable, lightweight, ductile and malleable metal with appearance ranging from silvery to dull gray, depending on the surface roughness. The main ore for Aluminium is Bauxite.

- Explain the function of Cryolite in the manufacturing of Aluminium. (2 marks)
- Describe the electrolysis of bauxite to produce Aluminium. (5 marks)
- Discuss **THREE (3)** properties of Aluminium and relate to its industrial usage. (3 marks)

Question 4

(a) Alkenes are unsaturated hydrocarbon and are more reactive than alkanes.

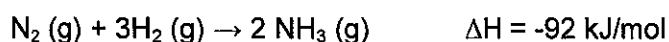
- i. Explain why alkenes are more reactive than alkanes. (2 marks)
- ii. Alkenes undergo addition reaction. Show the structural formula and name the product of the addition reaction below.



(b) One of the chemical processes used in refining of crude oil is cracking.

- i. Write the balanced equation for the thermal cracking of $\text{C}_{10}\text{H}_{22}$ and discuss why the process is important. (3 marks)
- ii. State the conditions for steam cracking. (2 marks)

(c) Ammonia, NH_3 , is the most important commercial compound of nitrogen. It can be produced by reacting nitrogen with hydrogen gas. The process used to produce ammonia commercially is known as the Haber process.



- i. Indicate whether the reaction is endothermic or exothermic (2 marks)
- ii. Write the equilibrium expression for the above reaction. (2 marks)
- iii. The manufacturer wanted to increase the yield of NH_3 without increasing the cost. Suggest a way that the manufacturer can achieve this. (3 marks)
- iv. Industrially, this process is carries out at 450°C . Discuss why it is not manufactured at a much higher or much lower temperature. (3 marks)

END OF EXAMINATION PAPER

