



UNIVERSITI  
TEKNOLOGI  
PETRONAS

## FINAL EXAMINATION MAY 2024 SEMESTER

**COURSE : CEB1013/CFB2043 - ORGANIC CHEMISTRY**  
**DATE : 13 AUGUST 2024 (TUESDAY)**  
**TIME : 2.30 PM - 5.30 PM (3 HOURS)**

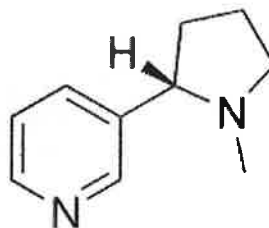
### INSTRUCTIONS TO CANDIDATES

1. Answer **ALL** questions in the Answer Booklet.
2. Begin **EACH** answer on a new page in the Answer Booklet.
3. Indicate clearly answers that are cancelled, if any.
4. Where applicable, show clearly steps taken in arriving at the solutions and indicate **ALL** assumptions, if any.
5. **DO NOT** open this Question Booklet until instructed.

**Note :**

- i. There are **SIX (6)** pages in this Question Booklet including the cover page .
- ii. **DOUBLE-SIDED** Question Booklet.

1. a. **FIGURE Q1** shows the chemical structure of nicotine, a toxic substance present in tobacco.



**FIGURE Q1. Chemical structure of nicotine.**

- i. Draw the Lewis' structure of nicotine. Clearly indicate the unshared electron pair, if any.

[4 marks]

- ii. Determine the hybridization and shape around **BOTH** nitrogen atoms.

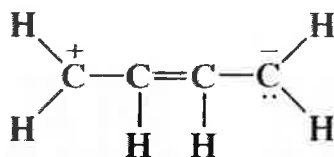
[4 marks]

- iii. Explain whether nicotine would be more soluble in water or benzene.

[4 marks]

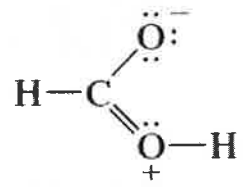
- b. Keeping the same atomic connections and moving only electrons, write a more stable Lewis's structure for each of the following. Specify formal charges, if any, in the new structure.

i.



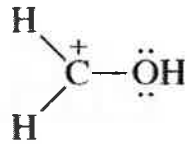
[4 marks]

ii.



[4 marks]

iii.



[4 marks]

2. Consider the following S<sub>N</sub>2 reaction:



a. By using curve arrow, draw the mechanism of the reaction and its intermediate/transition state.

[6 marks]

b. Explain what will happen to the reaction based on the following conditions:

i. The leaving group is changed from bromide to iodide.

[4 marks]

ii. The solvent is changed from acetone to CH<sub>3</sub>CH<sub>2</sub>OH

[4 marks]

iii. The alkyl halide is changed from CH<sub>3</sub>(CH<sub>2</sub>)<sub>4</sub>Br to CH<sub>3</sub>CH<sub>2</sub>CH<sub>2</sub>CH(Br)CH<sub>3</sub>.

[4 marks]

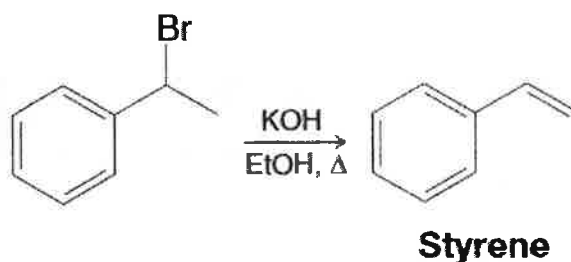
iv. The concentration of CN<sup>-</sup> is doubled.

[4 marks]

v. The concentration of CN<sup>-</sup> and CH<sub>3</sub>(CH<sub>2</sub>)<sub>4</sub>Br are doubled.

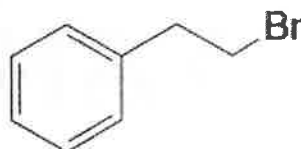
[4 marks]

3. a. **FIGURE Q3** shows the reaction of 1-bromo-1-phenylethane to produce styrene.



**FIGURE Q3. Synthesis of Styrene**

- i. Draw the reaction mechanism of the benzene production. [6 marks]
- ii. Explain the characteristics of the reaction. [6 marks]
- iii. Predict the product of the reaction if 1-bromo-1-phenylethane is replaced with 1-bromo-2-phenylethane, as shown below. Explain your findings.



[6 marks]

- b. Although ethyl bromide (bromoethane) and isobutyl bromide (1-bromo-2-methylpropane) are both primary halides, ethyl bromide undergoes  $S_N2$  reactions more than 10 times faster than isobutyl bromide does. When each compound is treated with a strong base/nucleophile, isobutyl bromide gives a greater yield of elimination products than substitution products, whereas with ethyl bromide this behavior is reversed. Explain the statement by drawing the structure of ethyl bromide and isobutyl bromide.

[8 marks]

4. a. Aromatic compound is a hydrocarbon with  $\sigma$  bonds and delocalized  $\pi$  electrons between carbon atoms forming rings. The presence of functional group attached to the ring determines its reactivity toward electrophilic aromatic substitution (EAS) reaction.

- i. Rank the reactivity of benzene, aniline and nitrobenzene shown in **FIGURE Q4a** toward  $\text{Cl}_2/\text{FeCl}_3$ .



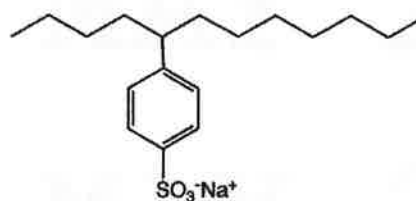
**FIGURE Q4a. Benzene, Aniline and Nitrobenzene**

[3 marks]

- iii. Draw the **MAJOR** products formed when benzene, aniline, and nitrobenzene undergo electrophilic aromatic substitution (EAS) reaction with  $\text{Cl}_2/\text{FeCl}_3$ .

[9 marks]

- b. Alkylbenzene sulfonates (**FIGURE Q4b**) are a class of anionic surfactants, widely used synthetic detergents in numerous household items such as shampoos, laundry detergents, dishwashing liquids, etc. Devise a synthesis route to produce alkylbenzene sulfonates from benzene. Write a process step by step, including catalyst, if any.



**FIGURE Q4b. Alkylbenzene sulfonates**

[12 marks]

-END OF PAPER-