UNIVERSITI TEKNOLOGI PETRONAS

FINAL EXAMINATION
JANUARY 2025 SEMESTER

COURSE	:	**YBB1063 - ORGANIC CHEMISTRY I**
DATE	:	**8 APRIL 2025 (TUESDAY)**
TIME	:	**2:30 PM - 5:30 PM (3 HOURS)**

INSTRUCTIONS TO CANDIDATES

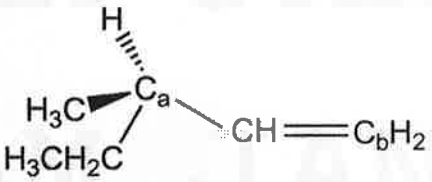
1. Answer **ALL** questions in the Answer Booklet.
2. Begin **EACH** answer on a new page in the Answer Booklet.
3. Indicate clearly answers that are cancelled, if any.
4. Where applicable, show clearly steps taken in arriving at the solutions and indicate **ALL** assumptions, if any.
5. **DO NOT** open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

Note :

i. There are **TEN (10)** pages in this Question Booklet including the cover page .

ii. **DOUBLE-SIDED** Question Booklet.

1. a. Consider the following compound X.



Compound X

i. Draw the hybridized orbitals for carbon atoms labelled as C_a and C_b in compound X.

[3 marks]

ii. Determine the stereochemical configuration of compound X and show all the steps involved in your work.

[5 marks]

b. Compound Y (in **FIGURE Q1(i)**) reacts with $N\equiv C^-$ to form product Z (in **FIGURE Q1(ii)**).

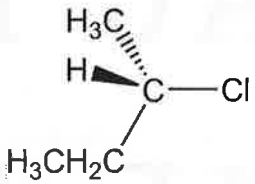


FIGURE Q1(i): Compound Y

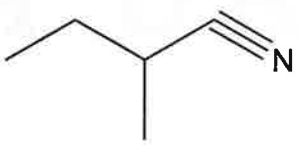


FIGURE Q1(ii): Product Z

i. Draw the three-dimensional structure of product Z to illustrate the inversion of its stereochemical configuration.

[3 marks]

ii. Based on your answer in **part (b)(i)**, explain the reason for the inversion of stereochemical configuration.

[3 marks]

iii. Based on your answers in **parts (b)(i)** and **(b)(ii)**, write the reaction mechanism illustrating the formation of product Z. Include the transition state species in your reaction mechanism.

[6 marks]

2. **FIGURE Q2** shows the reaction that produces a mixture of alkenes as the products.

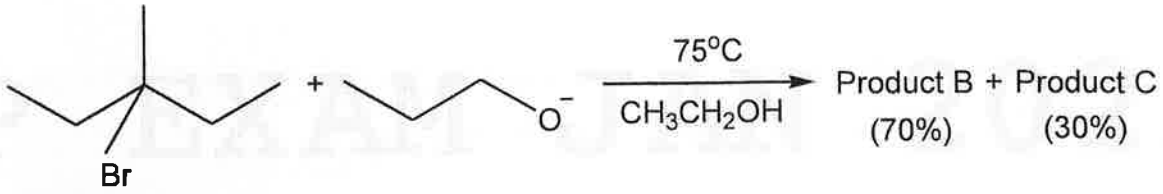


FIGURE Q2: Reaction leading to the formation of alkenes.

a. Suggest the bond-line formula(s) for products B and C.

[2 marks]

b. Explain why product B is the major product.

[3 marks]

c. The reaction mechanism proceeds in two steps to form products B and C. Explain the factors that favour this two-step mechanism, considering the nature of the alkyl halide, the temperature and the solvent used.

[6 marks]

d. Propose the reaction mechanism to illustrate the formation of product B.

[4 marks]

e. Since the reaction is exothermic, draw the complete energy diagram based on your answers in **part (d)**.

[5 marks]

3. a. Consider the reaction in **FIGURE Q3(a)**.

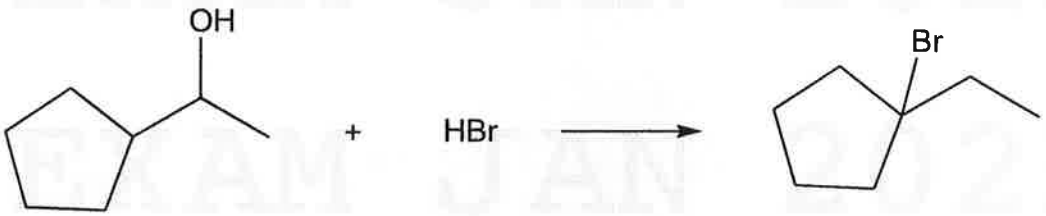


FIGURE Q3(a): Reaction leading to the formation of alkyl halide.

i. Suggest the reaction mechanism to show the formation of alkyl halide.

[6 marks]

ii. Based on answers in **part (a)(i)**, identify the type of shift to form the desired carbocation and rationalize the occurrence of carbocation rearrangement.

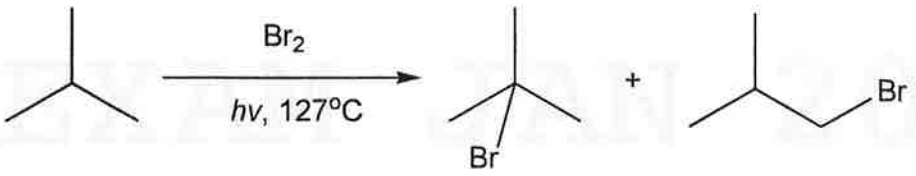
[4 marks]

iii. Substrate in **FIGURE Q3(a)** can be used to produce alkene as the major product through E1 reaction. Suggest the reagent(s) and temperature to promote the E1 reaction.

[2 marks]

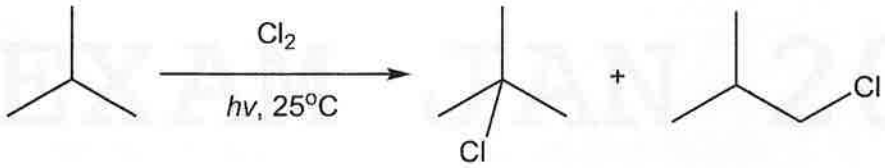
b. Consider the reactions 1 and 2 in **FIGURE 3(b)**.

Reaction 1:



Product D (>99%) Product E (trace)

Reaction 2:



Product F (40%) Product G (60%)

FIGURE Q3(b): Halogenation of 2–methylpropane.

i. Reaction 1 gives almost exclusive of product D and only trace of product E. Rationalize this statement.

[5 marks]

ii. As compared to Reaction 1, Reaction 2 gives very different results in terms of percentage yield of the products. Rationalize this statement.

[3 marks]

4. a. An unknown alkene with the formula C_8H_{16} is used as the substrate with a hot oxidizing agent to produce two carboxylic acids. The synthesis pathway is illustrated in **FIGURE Q4(a)**.

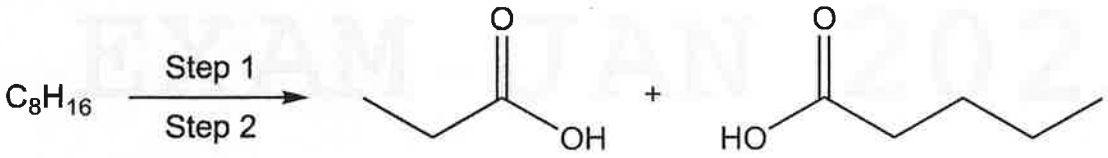


FIGURE Q4(a): Synthesis route to yield propanoic and pentanoic acids.

i. Suggest suitable reagent(s) for Step 1 and Step 2.

[4 marks]

ii. Draw the structure of the unknown alkene using a bond-line formula.

[3 marks]

b. Alkenes can be used as the substrate to form the racemic mixture of alky halides. Consider the reaction in **FIGURE Q4(b)** whereby the substrate (compound H) is an alkene.

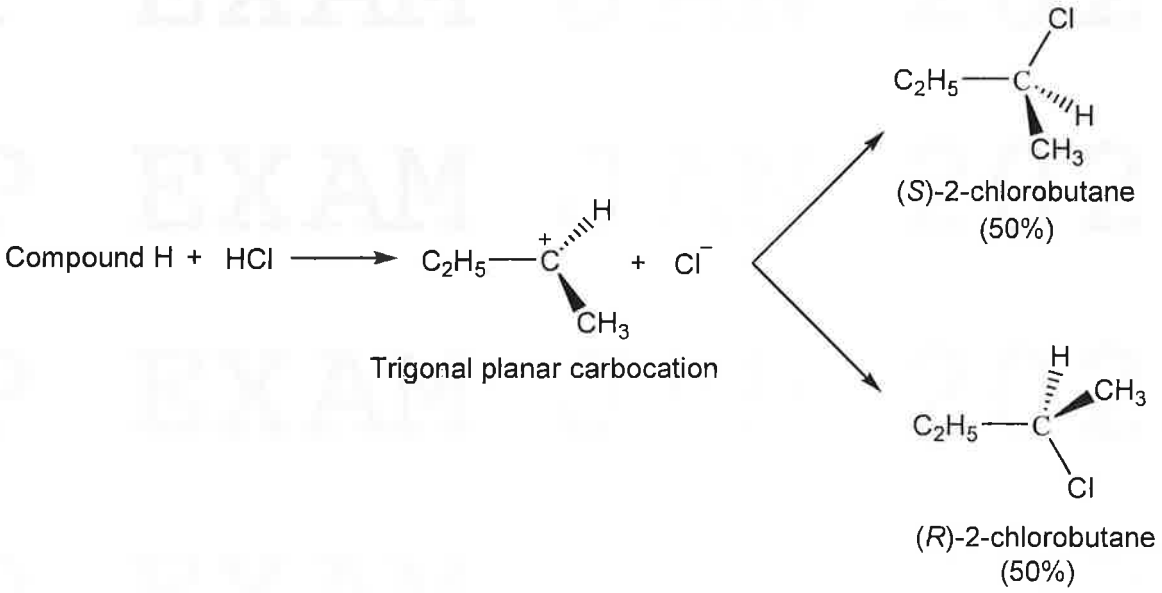


FIGURE Q4(b): Reaction to produce the racemic mixture.

i. Construct the structure of compound H using a bond-line formula.

[3 marks]

ii. Explain the reasons for the reaction producing the racemic mixture.

[4 marks]

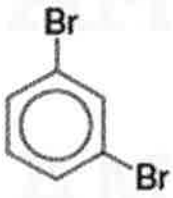
iii. Suggest the reaction mechanism to produce (*S*)-2-chlorobutane.

[6 marks]

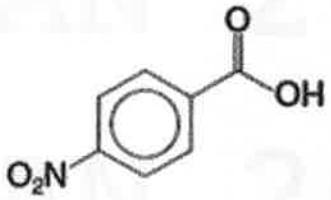
5. a. Using the polygon-and-circle method to outline the molecular orbitals of cyclobutadiene, explain why it is not aromatic based on Hückel's rule.

[3 marks]

b. Provide the names of compounds M and N, indicating the appropriate prefixes (*ortho-*, *meta-*, or *para-*).



Compound M



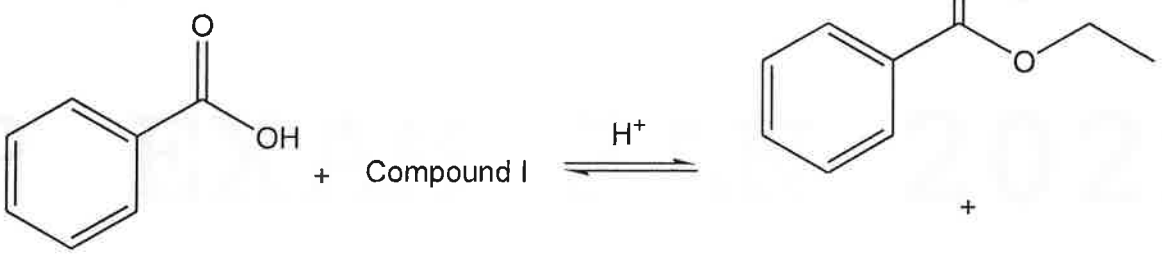
Compound N

FIGURE Q5(b): Molecular structures of compounds M and N.

[3 marks]

c. Draw the bond-line formula of compounds I, II, III, IV, V, VI for the following reactions.

i.



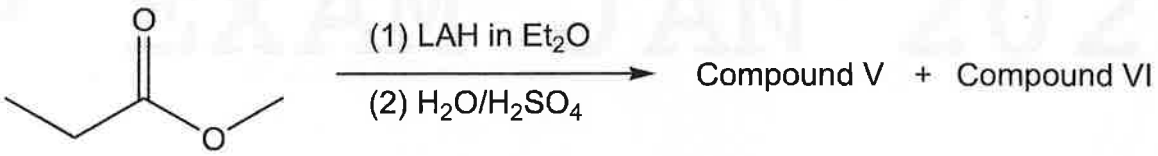
Compound II

[2 marks]

ii.

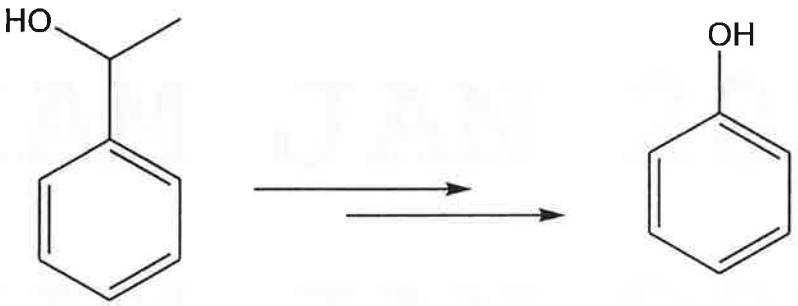
[3 marks]

iii.



[3 marks]

d. Outline the synthesis routes using the appropriate reagent(s) for the following reaction.



Final product

[6 marks]

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