



NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCE

DEPARTMENT OF APPLIED CHEMISTRY

ORGANIC CHEMISTRY

FOR CHEMICAL ENGINEERING STUDENTS (ECE)

SCH 1221

SECOND SEMESTER EXAMINATION PAPER

NOVEMBER 2024

This examination paper consists of 5 pages

**Time Allowed:** 3 hours

**Total Marks:** 100

**Special Requirements:** Graph Paper (on request)

**Internal Examiner:** MR I T KANDIRAI

**External Examiner:** PROF G MEHLANA

**INSTRUCTIONS**

1. Answer **all** questions from Section A and **any three** from Section B. Section A carries 40 marks and each question in Section B carries 20 marks. Marks are allocated are indicated in brackets [ ].
2. Start new question on a new page. (Not each part of a question.)
3. Show mechanism, chemical steps or synthesis by means of curved/curly arrows.

**MARK ALLOCATION**

QUESTION	MARKS
1.	40
2.	20
3.	20
4.	20
<b>TOTAL</b>	<b>100</b>

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SCH1221

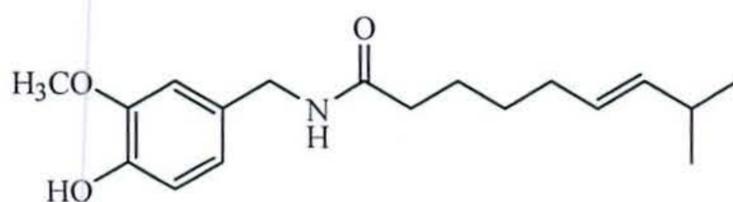
## SECTION A

1. (a) Give IUPAC names for the following compounds:

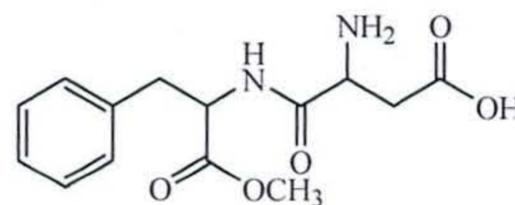
- i.  $\text{CH}_3\text{CH}_2\text{COCH}_2\text{CH}_3$     ii.  $\text{CH}_3\text{CONH}_2$     iii.  $\text{CH}_3\text{CH}=\text{CHCH}_2\text{CH}=\text{CH}_2$   
[3 marks]

(b) Alkanes are said to be **saturated** hydrocarbons yet alkenes and alkynes are **unsaturated** hydrocarbons. Fully explain why this is so?  
[4 marks]

(c) For each of the following compounds below, draw a circle around each functional group and give the name of the functional group.



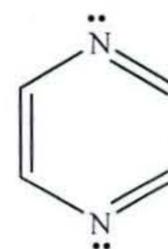
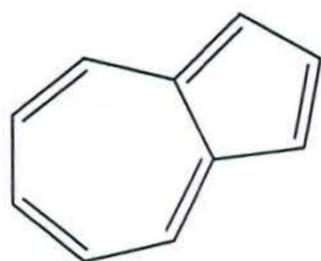
Capsaicin, the pungent substance in chilli pepper



Aspartame, a synthetic sweetener

[10 marks]

(d) State whether the following compounds are aromatic or non-aromatic and also indicate the number of pi electrons which support your answer.



[6 marks]

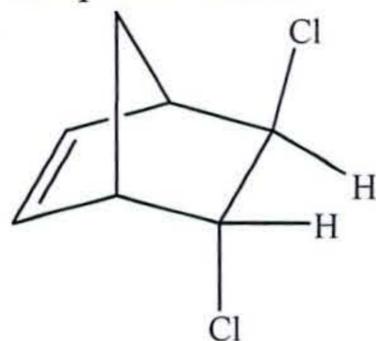
(e) From the list given below, select the substituents, which are (i) ortho/para directing and (ii) meta-directing. (Marks will be deducted for the wrong answer.)

- (i) ortho/para-directing                      (ii) meta-directing  
-CN, -CH<sub>3</sub>, -CHO, -OCH<sub>3</sub>, -F, -NO<sub>2</sub>, -COOH, -NH<sub>2</sub>,

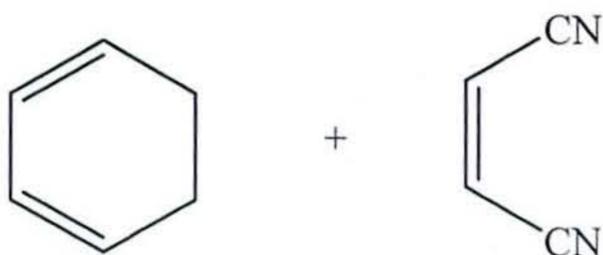
[4 Marks]

f) The Diels-Alder reaction is an example of a pericyclic reaction between a diene and a dienophile.

- i. Draw and label the diene and dienophile for the synthesis of the compound below.

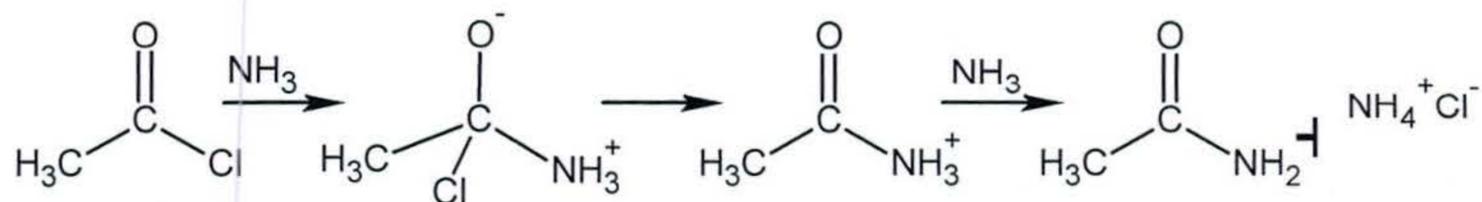


- ii. Draw the structure of the organic product formed from the reaction of the following starting materials.



[3 marks]

- (g) Ammonia reacts with acetyl chloride ( $\text{CH}_3\text{COCl}$ ) to give acetamide ( $\text{CH}_3\text{CONH}_2$ ).



Copy and complete the above scheme by including all nonbonding valence electrons and drawing curved arrows to represent the flow of electrons in each step.

[10 marks]

### SECTION B:

2. (a) With the aid of an appropriate example in each case, describe the following reaction mechanisms:
- Nucleophilic addition [5 marks]
  - Electrophilic addition [5 marks]
- (b) Starting with benzene as your only source of aromatic compound, how would you synthesise the following compounds? Assume that you can separate isomers if necessary.

(i) *o*-chloronitrobenzene [6 Marks]

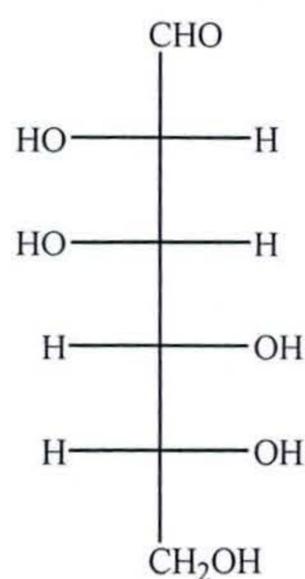
(c) What information does the term below give?

$$[\alpha] = +1.7^\circ$$

[4 Marks]

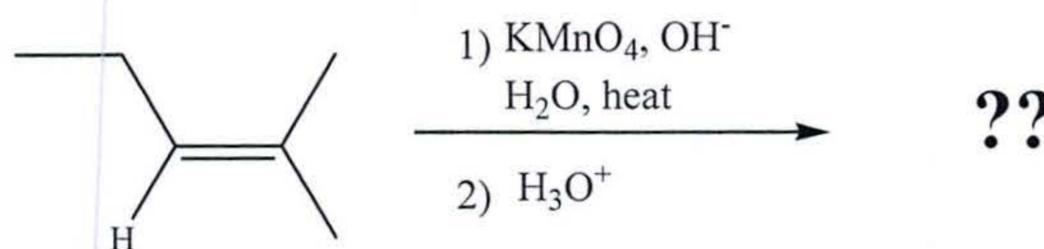
3 (a) Discuss  $sp^2$  hybridisation using an appropriate organic compound of your choice. Draw orbital as well as bonded structures and indicate the geometry of the molecule. [8 marks]

(b) Draw  $\alpha$  and  $\beta$  anomers of D-mannose, showing how the Fischer projection is converted to a Haworth projection.



[6 marks]

(c) Give and name the products of the following reaction, and indicate what type of reaction this is.



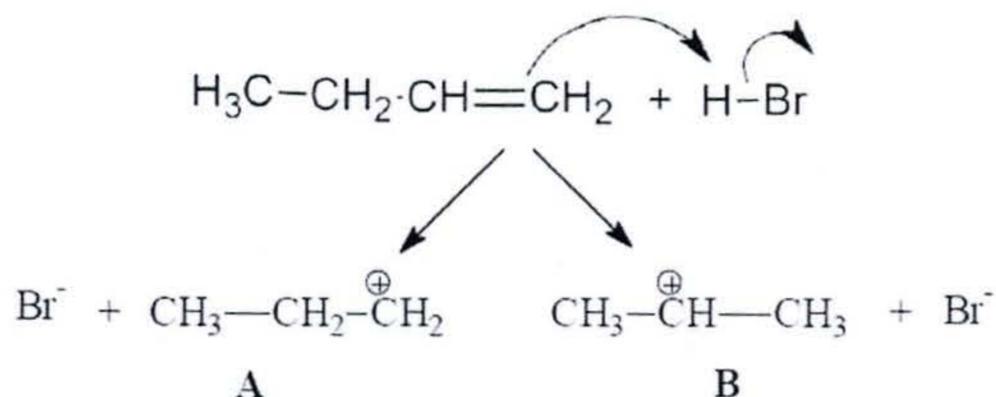
[6 marks]

4 (a) One of the typical reactions of haloalkanes is nucleophilic substitution. Describe with appropriate examples the  $S_N1$  and  $S_N2$  reaction mechanisms. [10 marks]

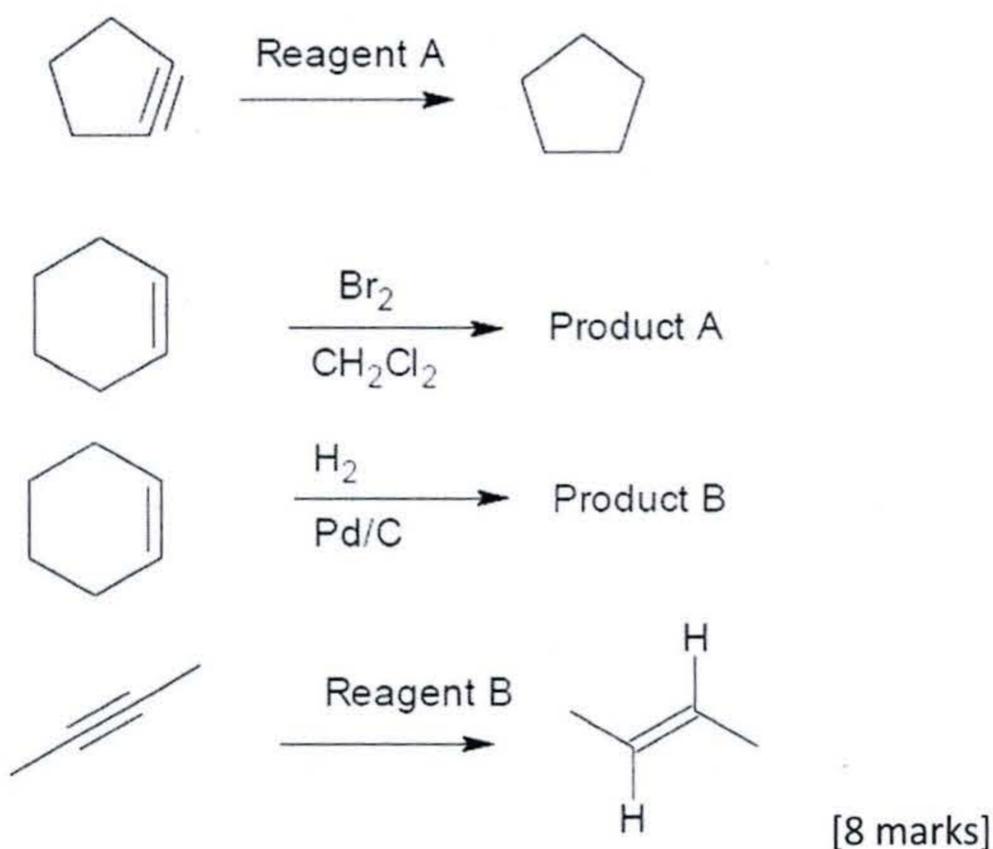
(b) When HBr reacts with an unsymmetrical alkene, e.g.  $(CH_3)_2C=CH_2$ , two products are possible. Give their structures, and indicate with reasons which product you would expect to be the major product. [6 marks]

- (c) Ethanol ( $\text{CH}_3\text{CH}_2\text{OH}$ ) and dimethyl ether ( $\text{CH}_3\text{OCH}_3$ ) are constitutional isomers, yet ethanol dissolves in water and dimethyl ether does not. Explain. [4 marks]

5 Consider the following addition reaction:



- (a) Which is the more stable carbocation in the following example, A or B?
- (b) Draw a detailed mechanism for the above reaction and clearly indicate which will be the major product. Explain your reasoning.
- (c) Indicate which is the nucleophile and which is the electrophile
- (d) 1-bromopropane and 2-bromopropane are isomers. Which type of isomers are they? [12 marks]
- (e) Give the missing reagent or product in each of the following reaction:



\*\*\*\*\* END OF QUESTION PAPER \*\*\*\*\*