



NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY
FACULTY OF APPLIED SCIENCES
DEPARTMENT OF APPLIED CHEMISTRY

INDUSTRIAL ORGANIC CHEMISTRY- SCH4215

FOR PART IV

Examination Paper March 2025

This examination paper consists of 6 printed pages

Time Allowed: 3 hours
Total Marks: 100
Special Requirements: Scientific Calculator
Internal Examiner: Dr C. Changunda
External Examiner:

INSTRUCTIONS & INFORMATION

1. Answer **all** questions in Section A and any **3** questions in Section B. Section A carries 40 marks and each question in Section B carries 60 marks.
2. Start new question on a new page. (Not each part of a question).
3. Show mechanisms or synthesis by means of push and pull arrows.

MARK ALLOCATION

QUESTION	MARKS
1.	40
2.	20
3.	20
4.	20
5.	20
6	20
7	20
8 - 10	20
TOTAL POSSIBLE MARKS	100

Section A

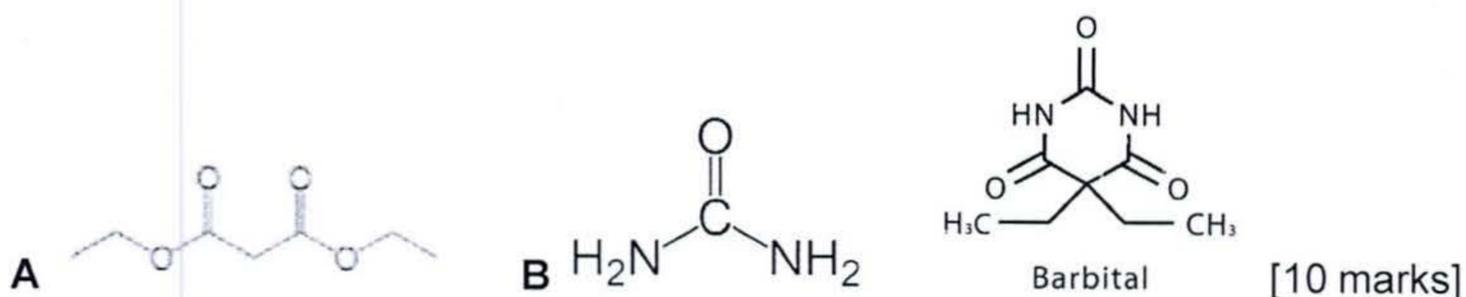
Question 1

- a. Giving examples of your choice, define the following terms as they relate to plastic manufacturing:
- i. resin [2 marks]
 - ii. initiator [2 marks]
 - iii. promoter [2 marks]
 - iv. retarder [2 marks]
 - v. addition polymerization [2 marks]
- b. Using a named polymer of choice, state 5 key characteristics of a good polymer. [5 marks]
- c. Enumerate on three challenges associated with reliance on synthetic polymers. [3 marks]
- d. Pharmaceutical industries play a key role in enhancing and maintaining public health. Identify three main reasons as to how this is achieved. [6 marks]
- e. Give the therapeutic class of each of the following drugs: (do not repeat the class)
- (i) metformin (ii) amoxil (iii) ranitidine
 - (iv) phenobarbital (v) aspirin (vi) nevirapine [6 marks]
- f. Propose a reaction scheme and mechanism for the synthesis of aspirin from phenol. Use reagents of your choice. Use curved arrows to illustrate the mechanism. [5 marks]
- g. State 5 challenges associated with the manufacturing process of antiretroviral medications like nevirapine. [5 marks]

Section B

Question 2

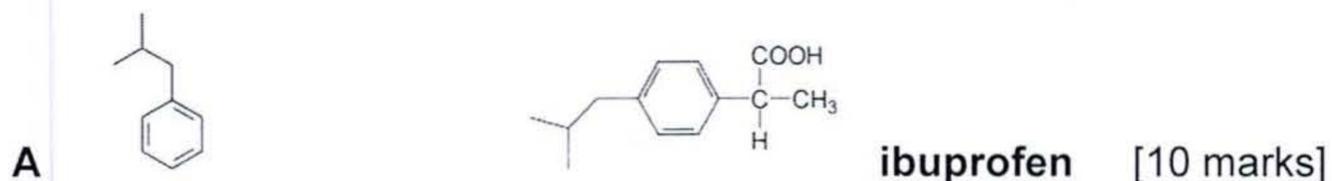
- (a) Outline the synthesis of barbital (shown below) or any barbiturate of your choice, from diethylmalonate (**A**) and urea (**B**). Use reagents such as sodium ethoxide, chloroethane, urea etc.



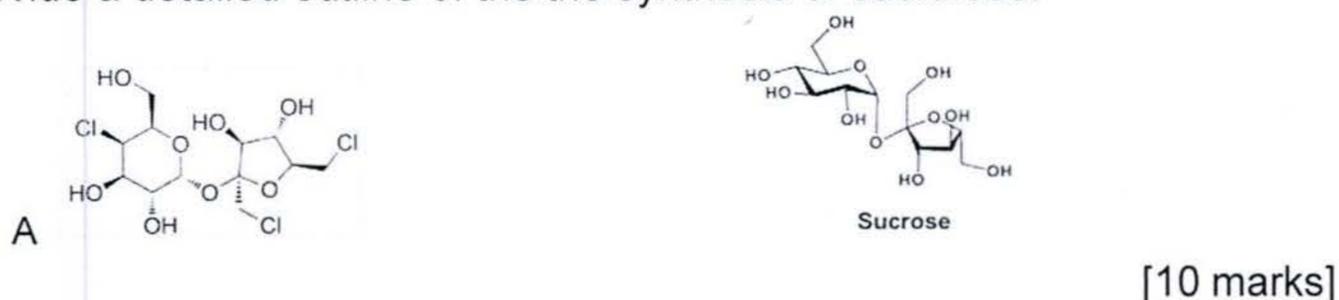
- (b) i) Barbiturates are psychoactive medicinal agents. Briefly describe the mode of action of these drugs. [5 marks]
- ii) Give three reasons why barbitals are the most widely used type of psychoactive drugs. [5 marks]

Question 3

- a) Ibuprofen is used as an anti-inflammatory drug. Outline the synthesis of ibuprofen from isobutyl benzene (**A**). Use reagents such as ethanoyl chloride, phosphorus bromide, sodium cyanide, acid, base and any other reagents needed.



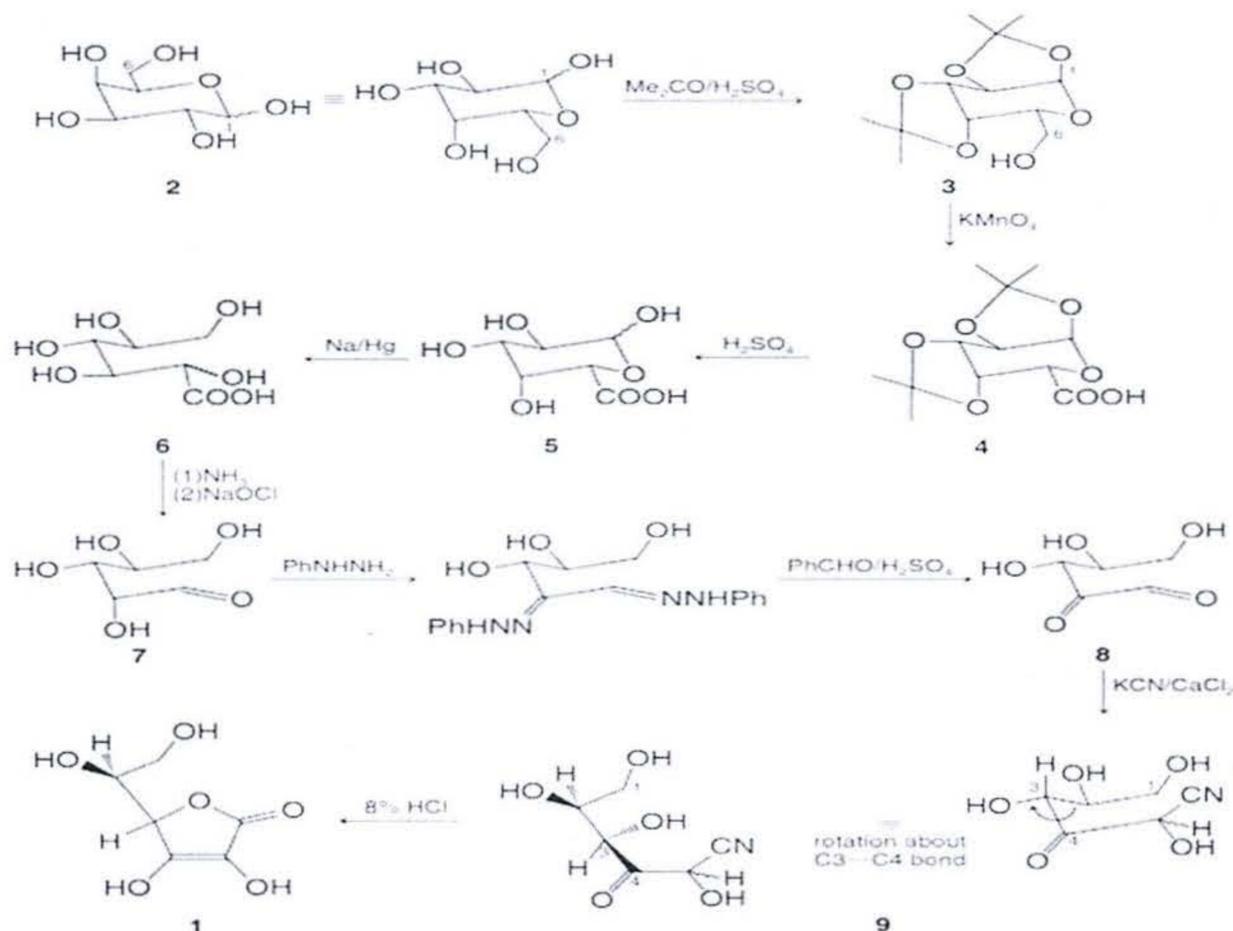
- b) Sucralose (**A**) is an artificial sweetener which is synthesized from sucrose via chlorination and selective hydrolysis. Using sucrose as starting material, provide a detailed outline of the the synthesis of sucralose.



Question 4

In 1933, Haworth and co-workers synthesized vitamin C (**1**) from *D*-(+)-galactose (**2**) using the reaction scheme shown below.

- a. Why did Haworth and co-workers introduce the acetal functional groups in **3**? [3 marks]
- b. Write a mechanism for the formation of one of the acetals. [3 marks]
- c. Write a mechanism for the hydrolysis of one of the acetals (**4** to **5**). Assume that water was present in the reaction mixture. [3 marks]
- d. In the reaction from **5** to **6** you can assume that there was acid (e.g., HCl) present with the sodium amalgam. What reaction occurred here and from what functional group did that reaction actually proceed. [4 marks]
- e. Write a mechanism for the formation of a phenylhydrazone from the aldehyde carbonyl of **7**. [Do not be concerned about the phenylhydrazone group at C2. [4 marks]
- f. What reaction was used to add the carbon atom that ultimately became the lactone carbonyl carbon in ascorbic acid (**1**)? [3 marks]



Synthesis of ascorbic acid (vitamin C, 1) starting from *D*-(+)-galactose (2)

Question 5

Describe the manufacture of industrial alcohol by:

- i. Synthesis from ethylene [8 marks]
- ii. Sugar or corn fermentation [8 marks]
- iii. Contrast the two manufacturing processes [4 marks]

Question 6

- a. With the aid of a flow diagram, provide a detailed description of the bulk polymerization or production of polystyrene on a commercial scale [12 marks]
- b. List some of the main properties and applications of the polymer [8 marks]

Question 7

- a. Nylon is made by the condensation of adipic acid and hexamethylene diamine. Provide a detailed description of the of the synthesis and polymerization Nylon 6 or Nylon 6,6. [12 marks]
- b. Give **two** main properties and **two** key applications of the Nylon polymer. [4 marks]
- c. What are four challenges associated with the use of nylon. [4 marks]

Question 8

Using a flow diagram, give a detailed outline of the manufacturing process of **either**,

- i. Wine from grapes [20 marks]

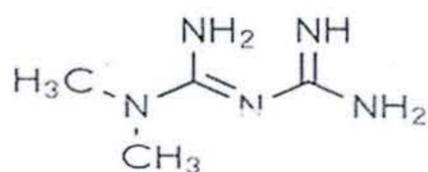
or

- ii. Beer production from hops, cereals etc [20 marks]

In each case, identify and highlight respective microorganisms and their various roles during the fermentation process.

Question 9

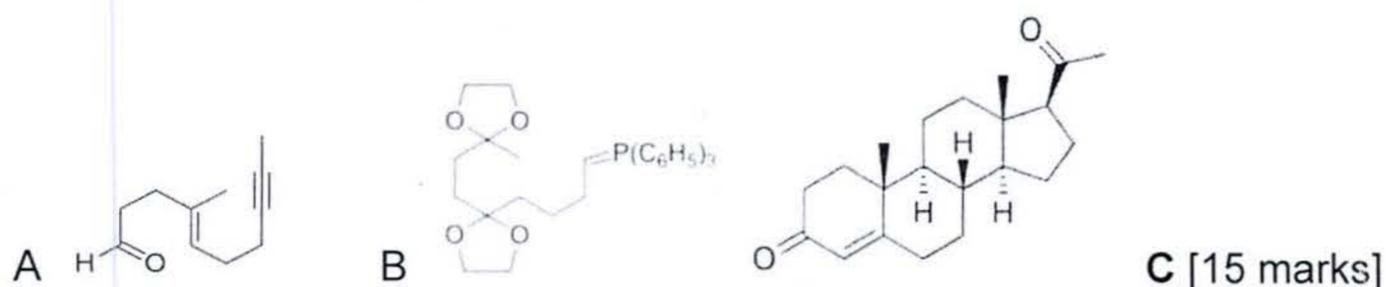
- a. Diabetes is a chronic medical condition which is caused by the body's failure to control blood glucose levels. Metformin (shown below) is one of the drugs that is conventionally used to manage diabetes.



- i. Using a schematic diagram, give a detailed outline of the synthetic scheme of Metformin. [12 marks]
- ii. Briefly describe the mode of action of Metformin. [6 marks]
- iii. In addition to medication, name two other approaches that can be used for managing diabetes. [2 marks]

or

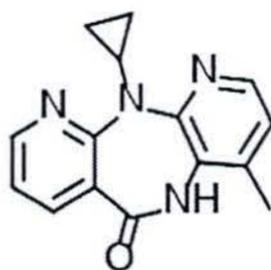
- b. Progesterone is the most important pregnancy regulating hormone which controls ovulation cycles in women.
 - i. Outline the synthesis of progesterone **C** using the following structures (**A** and **B**) as starting materials.



- ii. State 5 major effects associated with use of steroids [5 marks]

Question 10

Nevirapine (below) is an antiretroviral drug which is used in the first line treatment of HIV and AIDS. It belongs to the drug class known as non-nucleoside reverse transcriptase inhibitors which act by binding onto allosteric site of the reverse transcriptase to suppress viral replication.



- i. Using a schematic diagram, propose a detailed outline for the synthesis of nevirapine. [12 marks]
- ii. Briefly describe the mode of action of nevirapine [5 marks]
- iii. Propose any 3 challenges associated with use of this drug class in the treatment and management of HIV and AIDS. [3 marks]

End of Question Paper.