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

INDUSTRIAL ORGANIC CHEMISTRY- SCH4115

FOR PART IV

Second Semester Examination Paper 2024

This examination paper consists of 7 printed pages

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

INSTRUCTIONS & INFORMATION

1. Answer **all** questions in Section A and Section B. Section A carries 40 marks and each question in Section B carries 20 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
TOTAL POSSIBLE MARKS	**100**

Section A

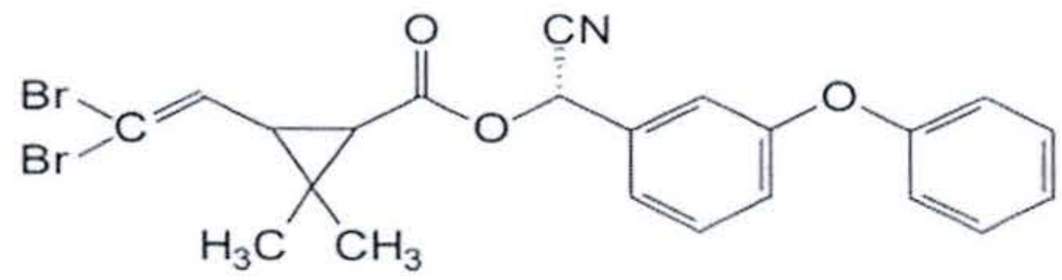
QUESTION 1

a. Define the following terms as they relate to pesticides:

i. Systemic [2 marks]
ii. Contact [2 marks]
iii. Efficacy [2 marks]
iv. LD_{50} [2 marks]
v. Synergist [2 marks]

b. Name six closely related compounds that possess insecticidal properties and are found in the naturally occurring plant, *Chrysanthemum Cineriafolium*. [6 marks]

c. The structure shown below belongs to a widely used pyrethroid compound.



i. *Identify* and *classify* the compound represented above. [3 marks]

ii. Describe briefly why such derivatives are important. [3 marks]

iii. Using the structure given above indicate the important segments that need to be maintained in order to retain the efficacy of the compounds similar the one given above. [4 marks]

iv. Explain how the compound shown above exerts its insecticidal properties on target pests. [3 marks]

d. DDT is one the oldest historically used organochlorine pesticide in public health and agriculture.

i. Identify the two main historical uses of DDT in Zimbabwe. [2 marks]

ii. DDT can be metabolized into various compounds in living systems. Draw an annotated scheme showing any three DDT metabolites including identifying the enzymes responsible for the metabolism. [6 marks]

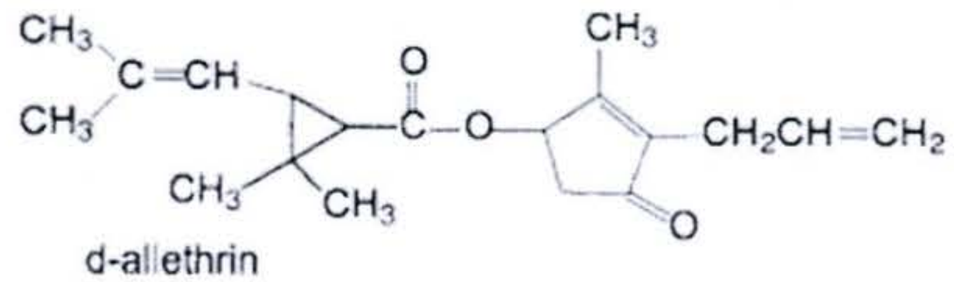
iii. Give a concise account on the mode of action of DDT on target pest. [3 marks]

iv. Give three reasons why the usage of DDT was discontinued in Zimbabwe. [3 marks]

Section B

QUESTION 2

Allethrin (shown below) represents a group of novel synthetic pyrethroids that were obtained by researchers *via* the structural modification of natural pyrethroids.



d-allethrin

i. Give 5 reasons that could have motivated the search for novel synthetic pyrethroids. [5 marks]

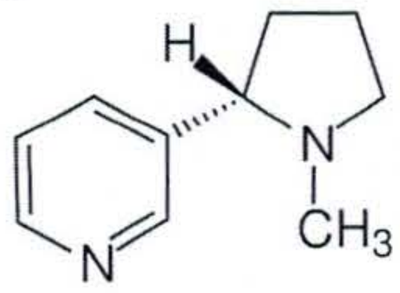
ii. Identify, with reasoning, the key pharmacophoric features that were retained on accessing synthetic pesticides from natural pyrethroids. [5 marks]

iii. Briefly explain the pharmacological significance of each pharmacophoric feature and its contribution towards overall efficacy. [5 marks]

iv. Give a detailed retrosynthetic scheme that identifies suitable starting materials from which allethrin can be synthesized. [5 marks]

QUESTION 3

Nicotine (below) is an alkaloid produced in the leaves and roots of the tobacco plant, genus *Nicotiana Tabacum*.



i. What is an alkaloid? [2 marks]

ii. State and justify the significance of nicotine to the tobacco plant. [2 marks]

iii. Using the structure given above for nicotine, identify and draw three potential metabolites that could be obtained in insects or vertebrates. [6 marks]

iv. Explain why nicotine acts as a stimulant at low doses but exhibits high toxicity to mammals when administered at high doses. [4 marks]

v. *Contrast* the insecticidal mode of action of nicotine with that of organophosphorus pesticides. [6 marks]

QUESTION 4

a) Organophosphorus pesticides constitute a group of potent synthetic pesticides that are used for pest control. A good example is malathion, which acts by irreversibly binding onto the cholinesterase enzyme catalytic site. Neverthess, malathion displays low mammalian toxicity. Explain why this happens.
[5 marks]

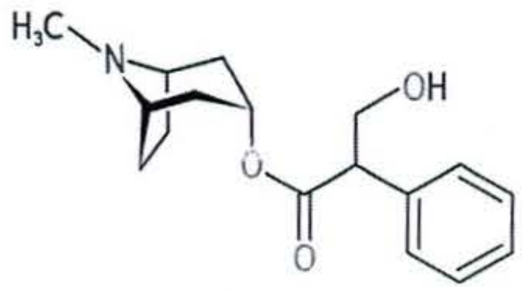
b. Malathion readily converts to malaoxon which is 60 times more potent than malathion. Using your chemistry knowledge suggest possible reasons why malaoxon has higher potency than its precursor, malathion. [5 marks]

c. Why should malathion not be contained in raw water that acts a source of drinking water? [5 marks]

d. Organophosphorus pesticides are generally toxic to bees, fish, birds and other forms of wildlife. Name and substantiate *any* two suitable alternative pesticides that can be used as substitutes for organophosphorus pesticides. [5 marks]

QUESTION 5

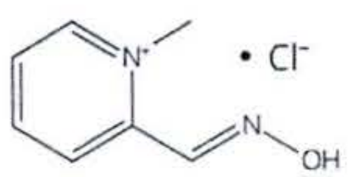
a. Atropine (shown below) is mostly used as an antidote for organophosphorus pesticide poisoning in humans.



i. Identify the salient structural features which make atropine an effective antidote. [5 marks]

ii. Elaborate on the possible mode of action of atropine and its contribution towards the reversal of organophosphate poisoning [5 marks]

b. Pralidoxime chloride is also readily used an effective antidode to insectide poisoning in mammals.



i. Identify two characteristics that justify the suitability of pralidoxime as an antidote. [5 marks]

ii. Preliminary storage of phosphorylated acetylcholinesterase before addition of pralidoxime has been observed to delay the reversal of poisoning due to a process called ''ageing''. What is ágeing'? [2 marks]

iii. How does ''ageing'' slow down the reversal of insecticide poisoning? [3 marks]

End of Question Paper.