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

INDUSTRIAL ORGANIC CHEMISTRY- SCH4115

FOR PART IV

Special Examination Paper April 2025

This examination paper consists of 5 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 **any three** questions from 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 agrochemicals:

i. Natural insecticide [2 marks]
ii. Molluscicide [2 marks]
iii. Organic insecticide [2 marks]
iv. Synergist [2 marks]
v. Environmental persistence [2 marks]

b. Give 4 major applications of pyrethrum products derived from *Chrysanthemum Cineriafolium*. [4 marks]

c. Identify with justification, four reasons that led to the exploration and subsequent usage of synthetic pyrethroids as insecticides. [6 marks]

d. Pyrethroid aerosol-based formulations are generally prepared containing an additive called a **synergist**. What role does the **synergist** play? [4 marks]

e. What do you understand by ***teratogenic*** agents? Draw the structure of one of the compounds that you may know. [4 marks]

f. Describe the insecticidal activity of organophosphorus insecticides. Give two advantages associated with using organophosphorus insecticides over organochlorine insecticides. [7 marks]

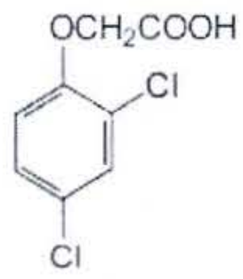
g. Give any two different ways of synthesising carbaryl and distinguish between the two. [5 marks]

SECTION B

Question 2

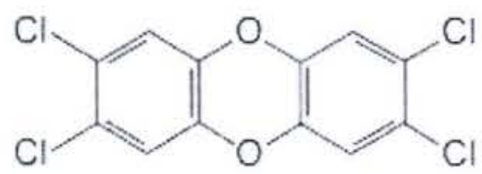
i. 2.4-dichlorophenoxy acetic acid (2,4-D), shown below, is commonly used as a weed killer. Give a brief account of its uses including mode of action and elaborate on the *pros* and *cons* of its uses.

[10 marks]



structure of 2,4-D

ii. Dioxins, with general structure shown below, belong to a family of halogenated organic compounds that are persistent and very toxic to living organisms.



dioxin

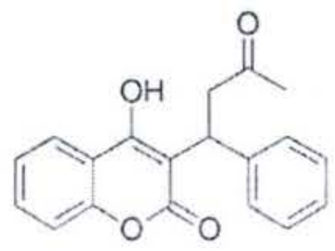
a) Identify the properties which make dioxins highly toxic. [6 marks]

b) What is the mode of toxicity of dioxin? [4 marks]

Question 3

a) Explain with the aid of chemical reactions and schematic diagram how organophosphate insecticide mimics acetylcholine. [10 marks]

b) Warfarin (shown below) belongs to a group of compounds called rodenticides.



i. Give a synthetic scheme for warfarin. [3 marks]

ii. What is the mode of action of warfarin [3 marks]

iii. What causes resistance to warfarin and how is it managed? [4 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. Nevertheless, malathion displays low mammalian toxicity. Explain why this happens. [5 marks]

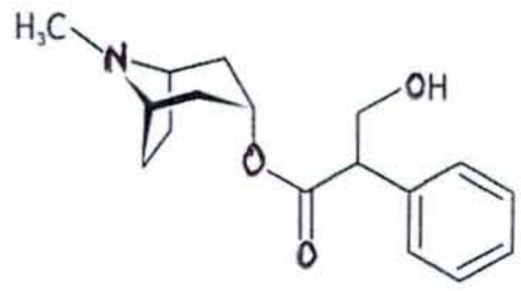
b. Malathion readily converts to malaoxon which is *60 times* more potent than malathion. Using your chemistry knowledge suggest possible reasons why malaoxon has higher potency than its precursor, malathion. [5 marks]

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, giving reasons, *any* two suitable alternative pesticides that can be used as substitutes for organophosphorus pesticides. [5 marks]

Question 5

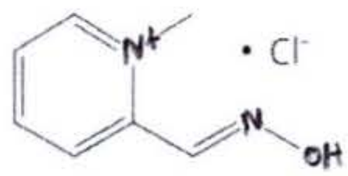
a. Atropine (shown below) is mostly used as an antidote for organophosphorus pesticide poisoning in humans.



i. What are the 3 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 antidote to insecticide 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 ageing'? [2 marks]

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

Question 6

Organophosphates and pyrethroids are potent insecticide classes that interfere with the transmission of nerve signals around the synaptic junction in mammals but at the ganglia in insects.

i) Using a clearly labelled diagram of the nerve junction, compare and contrast the mode of action of these two classes of insecticides. [14 marks]

ii) In your view, is it possible to reverse pesticide poisoning in insects and/or mammals? Clearly justify your answer. [6 marks]

End of Question Paper.