MAASAI MARA UNIVERSITY
REGULAR UNIVERSITY EXAMINATIONS
2023/2024 ACADEMIC YEAR
MASTERS FIRST SEMESTER

SCHOOL OF PURE, APPLIED AND HEALTH SCIENCES
MASTER OF SCIENCE CHEMISTRY (MSc.)

COURSE CODE: CHE 8107
COURSE TITLE: MODERN SYNTHETIC METHODS IN ORGANIC CHEMISTRY

DATE: 2ND FEBRUARY 2024 **TIME: 0830 - 1030HRS**

INSTRUCTIONS TO CANDIDATES

1. Answer the compulsory question ONE in section A and any other TWO in section B.
2. All University Examinations rules and regulations apply.

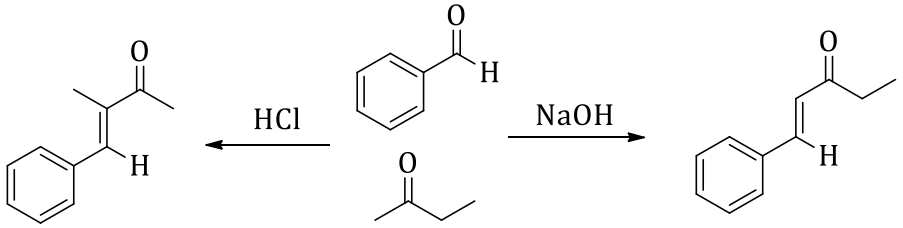
This paper consists of 5 printed pages. Please turn over:

SECTION A

QUESTION ONE (30 MARKS)

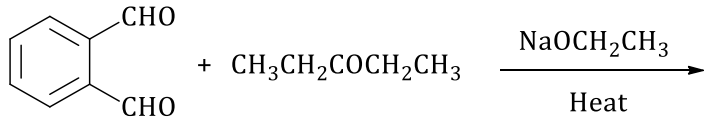
a) Discuss three important factors that one must consider before designing a chemical synthesis. (3 marks)

b) Acid- or base-catalyzed reaction gives different product in mixed aldol condensation. Base catalysis favors reaction at a methyl position whereas acid catalysis favors the opposite. Why? (5 marks)



c) Provide the final product. Show stereochemistry where applicable. (4 marks)

i.



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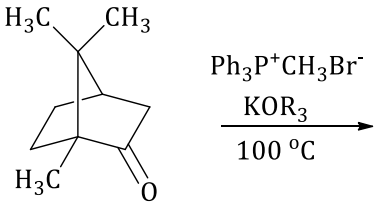
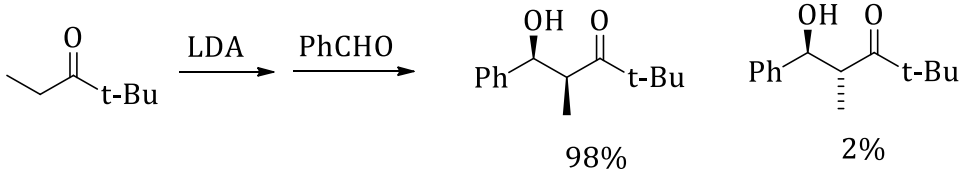
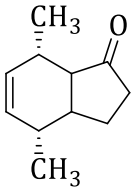


d) Diastereoselectivity in aldol reaction favours one product over the other. Why? Explain. Hint: use Zimmerman-Traxler transition state. (8 marks)



e) Briefly define kinetic and thermodynamic control terminologies using clear examples, and explain the conditions that ideally favour each control in the formation of enolates. (6 marks)

f) The following compound was synthesized via intramolecular aldol condensation (*to form dienophile*) then followed by Diel's Alder reaction. Perform retrosynthesis and show the structures of the starting diene, and the oxo-aldehyde used. (4 marks)



SECTION B

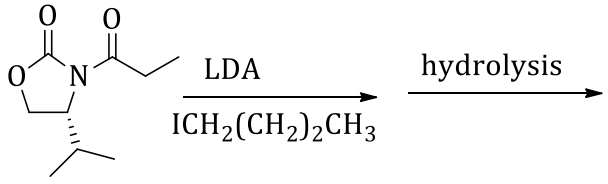
QUESTION TWO (20 MARKS)

a) What is a chiral auxiliary? What is its significance in synthesis? (2 marks)

b) Draw intermediate for the following reactions showing how chiral auxiliaries direct reactions and provide the final product paying attention to stereochemistry.

(6 marks)

i.



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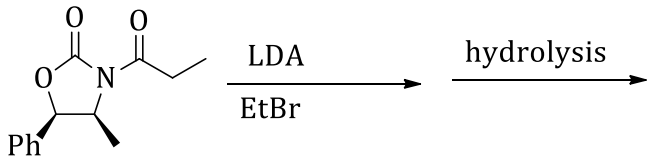
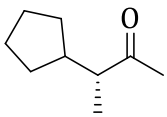
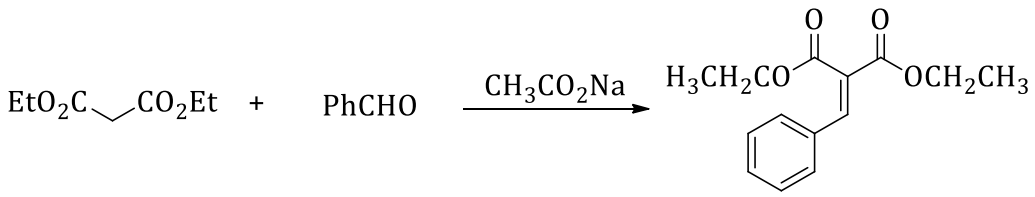


c) You have synthesized enantiomerically pure ketone **X**. You tested the optical activity again a week later and found that the sample is no longer 100% *ee*. What is the most likely explanation for the racemization process? (2 marks)

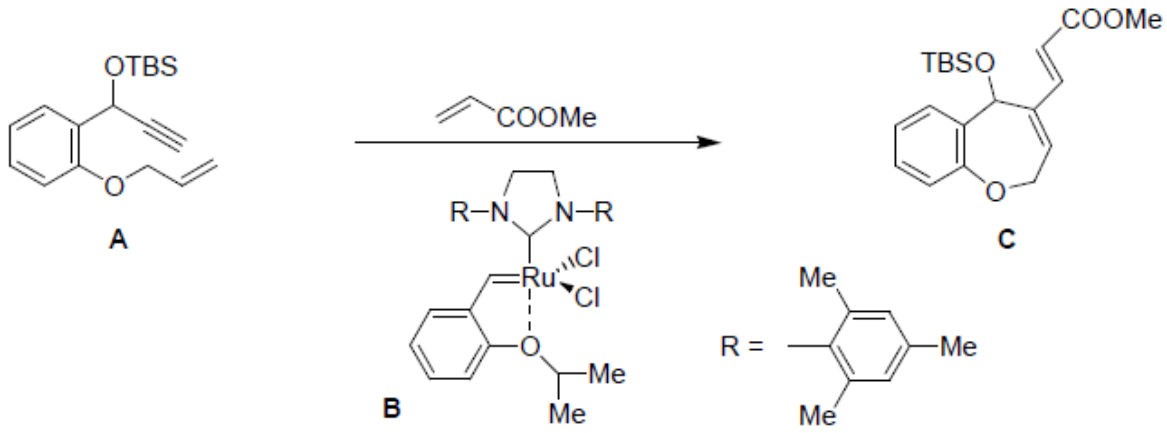


Ketone **X**

d) Knoevenagel condensation is a reaction involving an active methylene compound and an aldehyde or ketone. Propose detailed arrow-pushing mechanism for the following reaction. (4 marks)



e) Treatment of **A** with 3 equivalents of methylacrylate in the presence of 10 mol % of Ru catalyst **B** produces the bicyclic product **C**. Provide detailed mechanistic explanations for all steps involved. (6 marks)



QUESTION THREE (20 MARKS)

a) Differentiate between the following terminologies using examples. (2 marks)

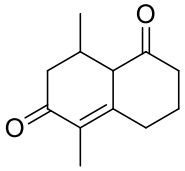
i. Claisen condensation and Michael addition

ii. Syn and Anti addition

b) What two carbonyl compounds are needed to synthesize each of the following compounds, using Robinson annulation? Perform retrosynthetic analysis.

(6 marks)

i.



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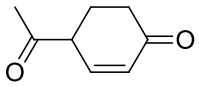
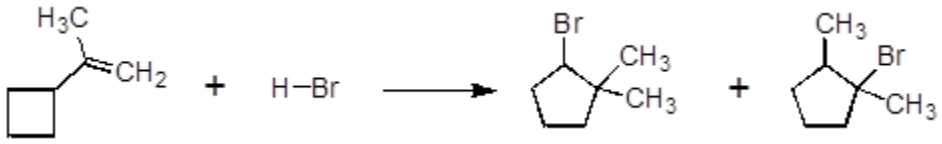
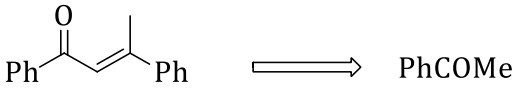


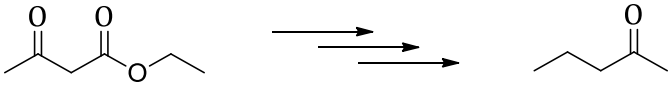
c) Propose a detailed arrow-pushing mechanism for the following reaction: (4 marks)



d) Propose multi-step synthetic pathway that lead from the starting material in the right to the product given. You need to show an accurate reaction scheme using the proper reagents/conditions and show the major products made along the way. All carbons in the product originate from the starting material. (Arrow pushing mechanism is not necessary). (4 marks)



a) Given the following reagents and conditions, clearly show the reaction scheme for the formation of 2-pentanone from ethyl acetoacetate via acetoacetic ester synthesis: NaOEt/EtOH, EtBr, NaOH/H_2O, H_3O^+ and heat. (4 marks)

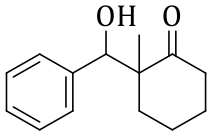


QUESTION FOUR (20 MARKS)

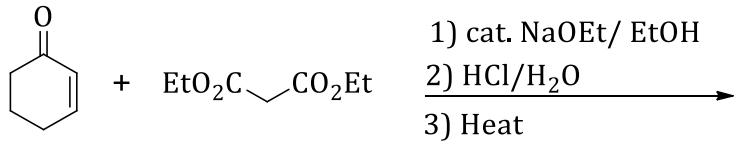
a) Mixed aldol reactions of aliphatic ketones and aldehydes leads to mixed products.

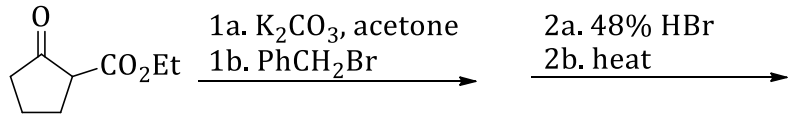
i. State the different possible ways of controlling regioselectivity in mixed aldol reactions. (3 marks)

ii. What is Mukaiyama reaction? Explain why the following product is preferentially formed from cyclohexanone and benzaldehyde via Mukaiyama reaction. (3 marks)

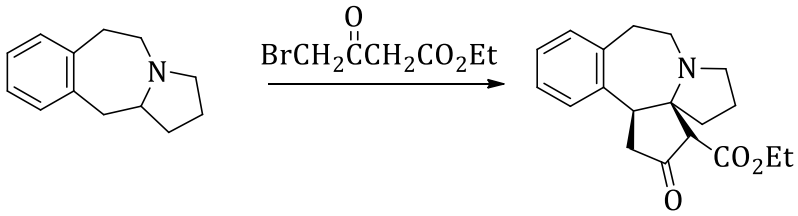


b) Provide the final product. Show stereochemistry where applicable. (6 marks)

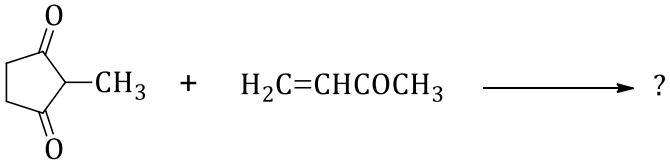
i. 

ii. 

c) Propose a detailed arrow-pushing mechanism for the following reaction. (5 marks)



d) What product would you expect from Robinson annulation of the following reactants? Show detailed multistep reaction scheme. (3 marks)



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