



MACHAKOS UNIVERSITY

University Examinations 2023/2024

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FOURTH YEAR FIRST SEMESTER EXAMINATION FOR
BACHELOR OF EDUCATION SCIENCE (SPECIAL NEEDS EDUCATION)
BACHELOR OF SCIENCE IN ANALYTICAL CHEMISTRY
BACHELOR OF EDUCATION (SCIENCE)
SCH 402: CONCEPTS OF ORGANIC SYNTHESIS

DATE: /12/2023

TIME:

INSTRUCTIONS:

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

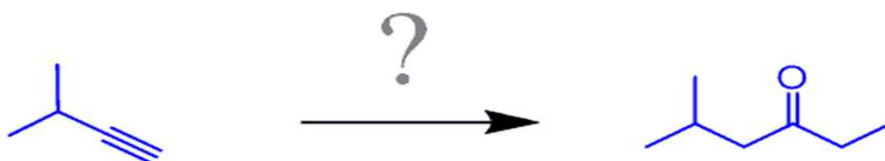
SECTION A

QUESTION ONE (30 MARKS)

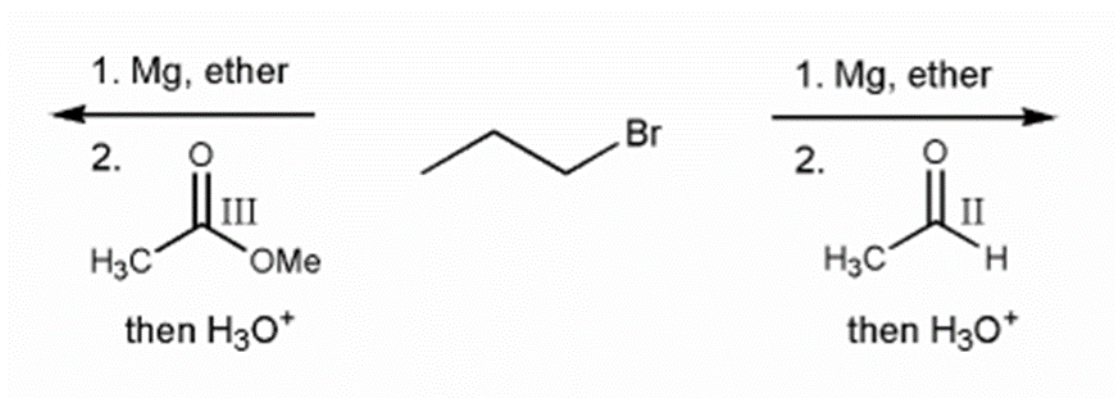
a) Differentiate between the following: (6 marks)

- (i) Aldol addition and aldol condensation
- (ii) Stabilized and unstabilized ylides
- (iii) Convergent and linear synthesis

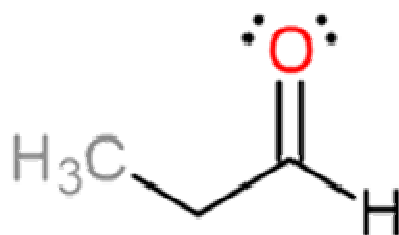
b) Propose an efficient synthetic route for the following ketone (4 marks)



c) Explain the major difference in the addition of a Grignard reagent to an oxidation state III carbonyl (ester/acid chloride) versus an oxidation state II carbonyl (aldehyde/ketone) (4 marks)



- d) Outline five guidelines in choosing a disconnection point during a retrosynthetic analysis. (5 marks)
- e) Wittig reaction is useful for synthesis of alkenes. Discuss the driving force for this reaction. (2 marks)
- f) Explain why carbocation rearrangement occur. (2 marks)
- g) Provide the product of the reaction between water and pent-3-en-2-one. (2 marks)
- h) Define an enolate and provide the most stable resonance structures of the base catalyzed enolate of the molecule shown below. (3 marks)



- i) Provide two key requirements of Claisen condensation reaction. (2 marks)

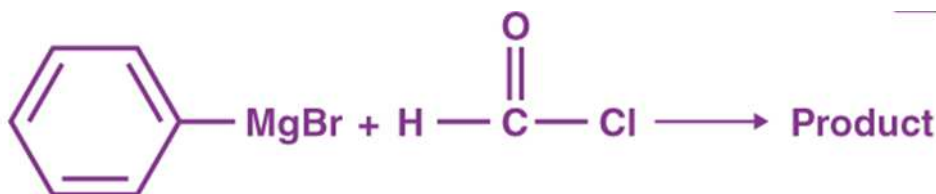
SECTION B

QUESTION TWO (20 MARKS)

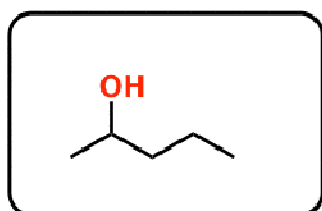
- a) The reaction of Grignard reagent, C_2H_5MgBr with C_8H_8O followed by hydrolysis gives compound "A" which reacts instantly with Lucas reagent (solution of anhydrous zinc chloride in concentrated hydrochloric acid) to give compound B, $C_{10}H_{13}Cl$. Provide the structure for compound B. HINT. The starting compound A is aromatic.

(2 marks)

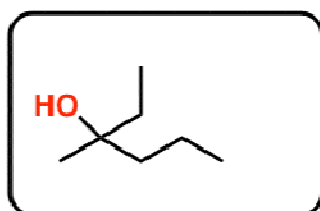
- b) Complete the reaction given below, showing the proper mechanism. (4 marks)



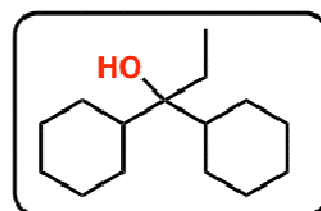
- c) How would you synthesize each of the following molecules through a Grignard Reaction? (6 marks)



A



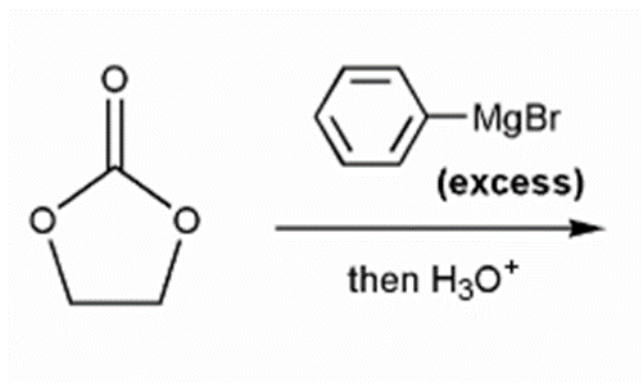
B



C

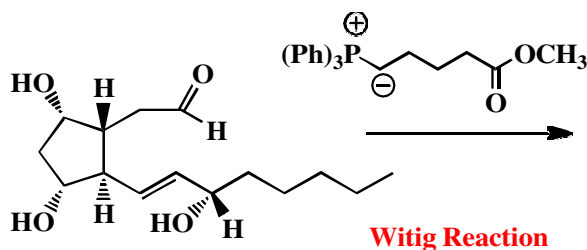
- d) Grignard reagents are made by adding a halogenoalkane to small bits of magnesium in a flask containing ether solvents. The flask is fitted with a reflux condenser, and the mixture is warmed over a water bath for 20 - 30 minutes.

- i. Write the structure for the Grignard reagent formed if this reaction is carried out starting from 1-bromopropane (2 marks)
 - ii. Everything has to be perfectly dry because Grignard reagents react with water. Write the equation of the reaction between water and the Grignard reagent formed from 1-bromopropane (2 marks)
- e) Draw out the mechanism for the addition of excess phenyl magnesium bromide to the carbonyl compound below. (4 marks)

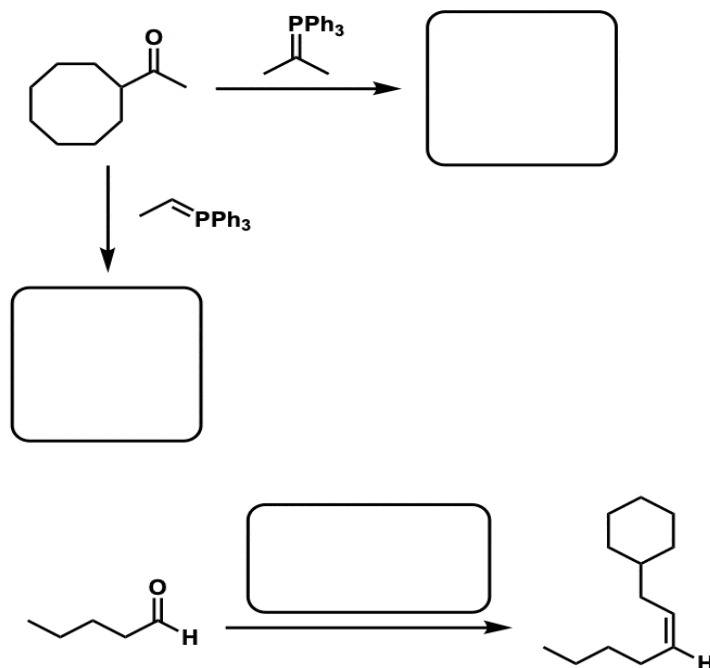


QUESTION THREE (20 MARKS)

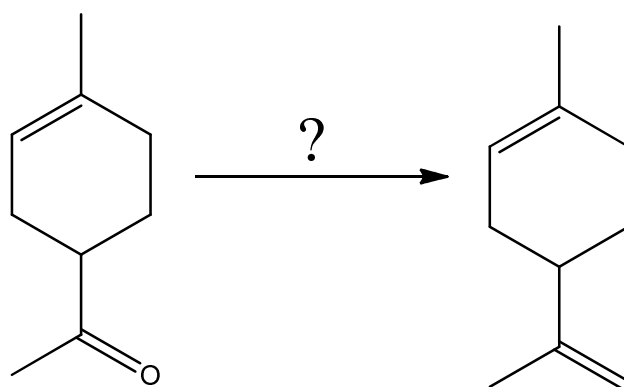
- a) Define a ylide. (1 mark)
- b) Draw the predominant product (including stereochemistry) of the following reaction that was used in the actual synthesis of prostaglandin; which is an important natural product molecule. (2 marks)



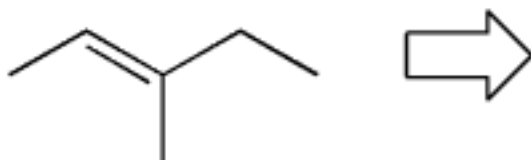
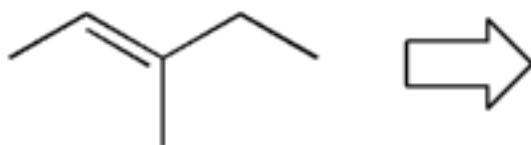
- c) Complete the reactions below by providing the correct structures. (6 marks)



- d) Describe the Limitation of the Wittig reaction. (2 marks)
- e) Limonene is a terpene found in citrus foods such as lemons and oranges. It can be easily prepared by the Wittig reaction of 1-(4-methylcyclohex-3-enyl) ethanone with a phosphorus ylide. Complete the reaction shown below by identifying the appropriate ylide and provide the mechanism for the reaction. (4 marks)

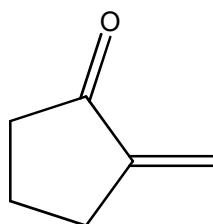


- f) Show two ways of preparing the alkene below via the Wittig reaction starting from triphenyl phosphine (PPh_3). From the two routes, identify the best route providing reasons. (5 marks)

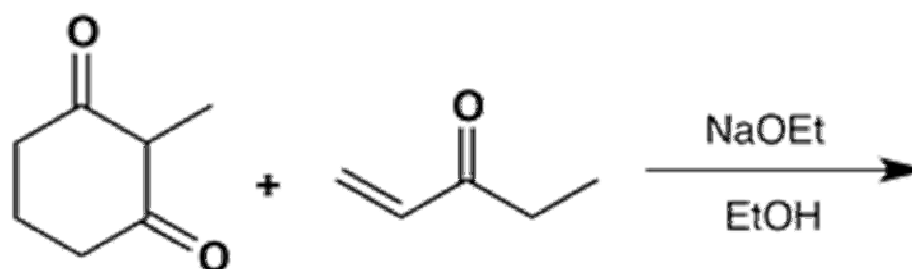


QUESTION FOUR (20 MARKS)

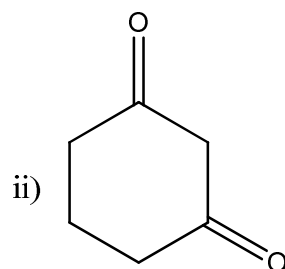
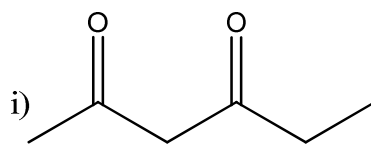
- a) Describe three different types of Claisen condensations reactions (3 marks)
- b) Perform a retrosynthetic analysis on the target molecule shown below and:
- Indicate the synthons and synthetic equivalents (SEs). (2 marks)
 - Use the identified SEs to perform a forward reaction for the target molecule. (4 marks)



- c) Following the proper mechanism, provide the main product of the following reaction. (7 marks)

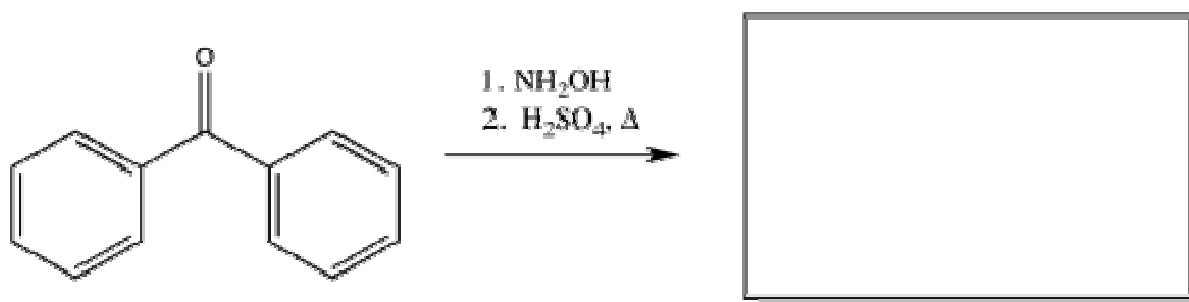


- d) The following molecules can be made from Claisen condensation reaction. Identify the starting materials that could potentially give rise to such a product. (4 marks)

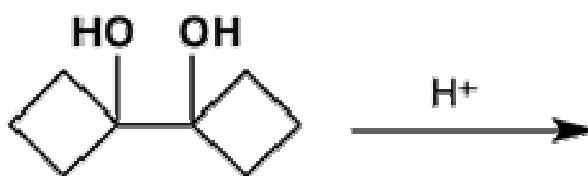


QUESTION FIVE (20 MARKS)

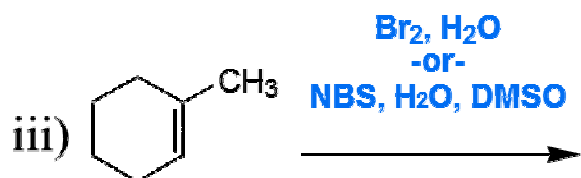
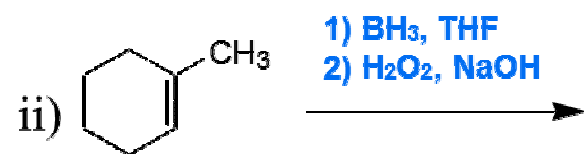
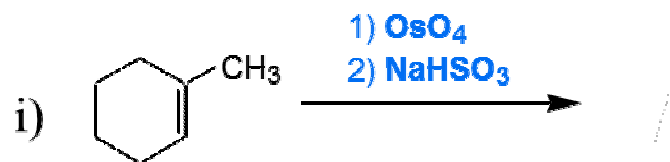
- a) Following the appropriate mechanism, predict the product of the following Beckmann rearrangement. (6 marks)



- b) Predict the main product and provide a mechanism for the following rearrangement of a bicyclic diol. (5 marks)



- c) Provide the products in the following reactions. (6 marks)



- d) Describe three ways in which crossed aldol reactions can be designed to be useful.
(3 marks)