



MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

SECOND YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF EDUCATION

SCH 202: ORGANIC CHEMISTRY II

DATE: 3/5/2019

TIME: 11.00-1.00 PM

INSTRUCTIONS TO CANDIDATES

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

SECTION A (COMPULSORY)

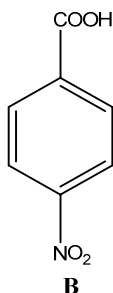
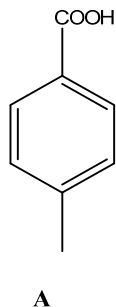
QUESTION ONE (30 MARKS)

a) Briefly explain the following terms (2 marks)

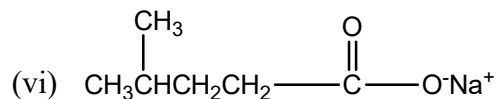
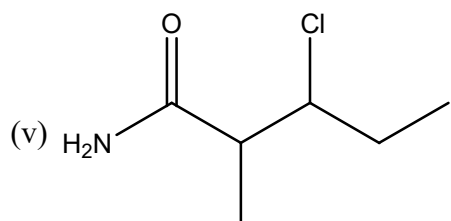
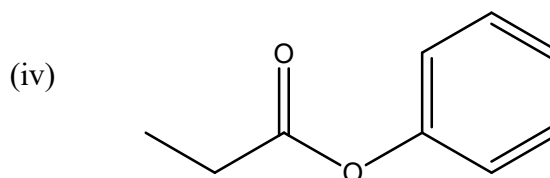
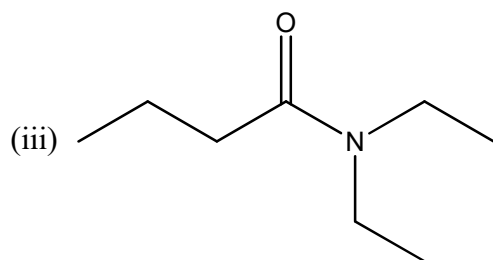
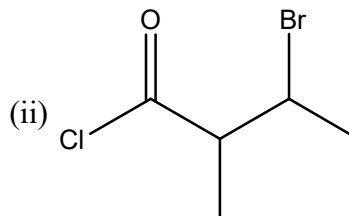
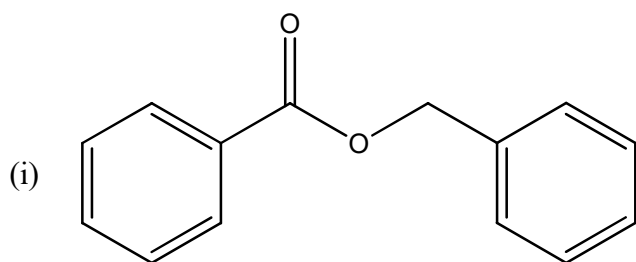
- (i) Carboxylic acid derivatives
- (ii) Saponification

b) With reasons, explain which carboxylic acid you would expect to be stronger, A or B?

(2 marks)



c) Provide the IUPAC names for each of the following compounds. (6 marks)

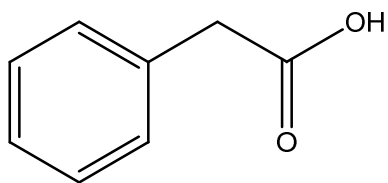


d) Draw the following molecules, based on their IUPAC name: (7 marks)

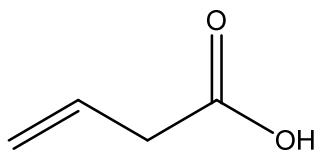
- i. 2-hydroxy-5,5-dimethylheptanedioic acid
- ii. N-Phenyl-N-propylacetamide
- iii. Benzoic propanoic anhydride
- iv. Benzoyl chloride
- v. 3-Ethyl-6-methyloctanedioic acid
- vi. 4-Hydroxycyclohexanecarboxylic acid
- vii. 2-Pentenitrile
- viii. Methyl-p-chlorobenzoate

e) Most carboxylic acids exist as cyclic dimers held together by two hydrogen bonds. With illustration, demonstrate how hydrogen bonding takes place. (3 marks)

f) Show how you would prepare each of the following carboxylic acids through a Grignard synthesis (6 marks)



(i)



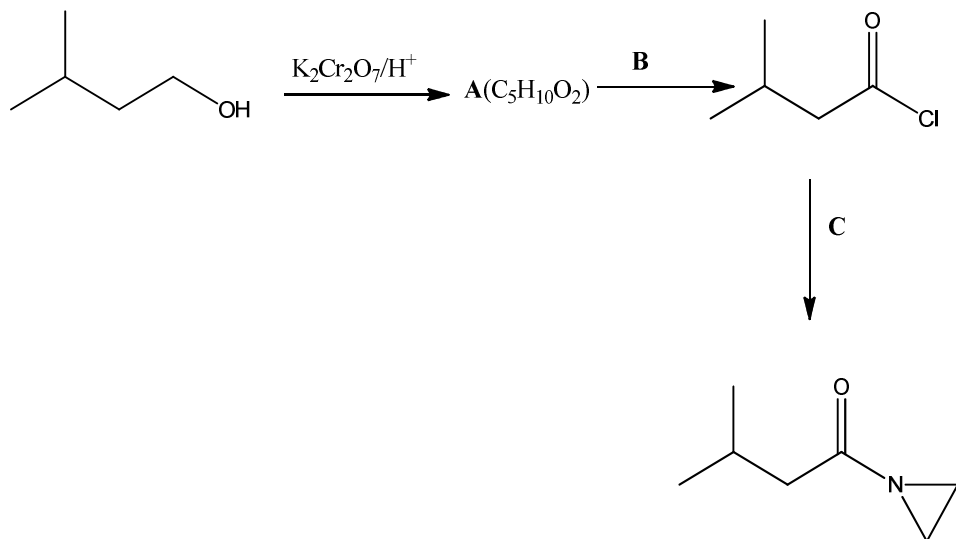
(ii)

g) Describe two ways in which acid anhydrides can be synthesized. (4 marks)

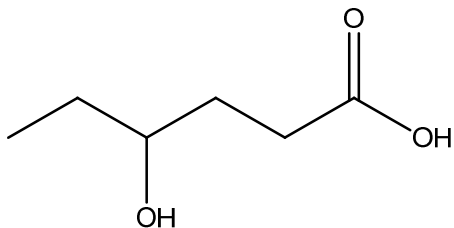
SECTION B (ATTEMPT ANY TWO QUESTIONS)

QUESTION TWO (20 MARKS)

a) Provide the missing compounds/reagents (A-C) in the following synthesis. (3 marks)



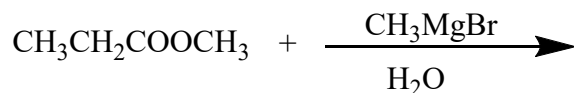
b) Using the appropriate mechanism, show the product that is formed when carboxylic acid shown below undergoes intramolecular esterification. (5 marks)



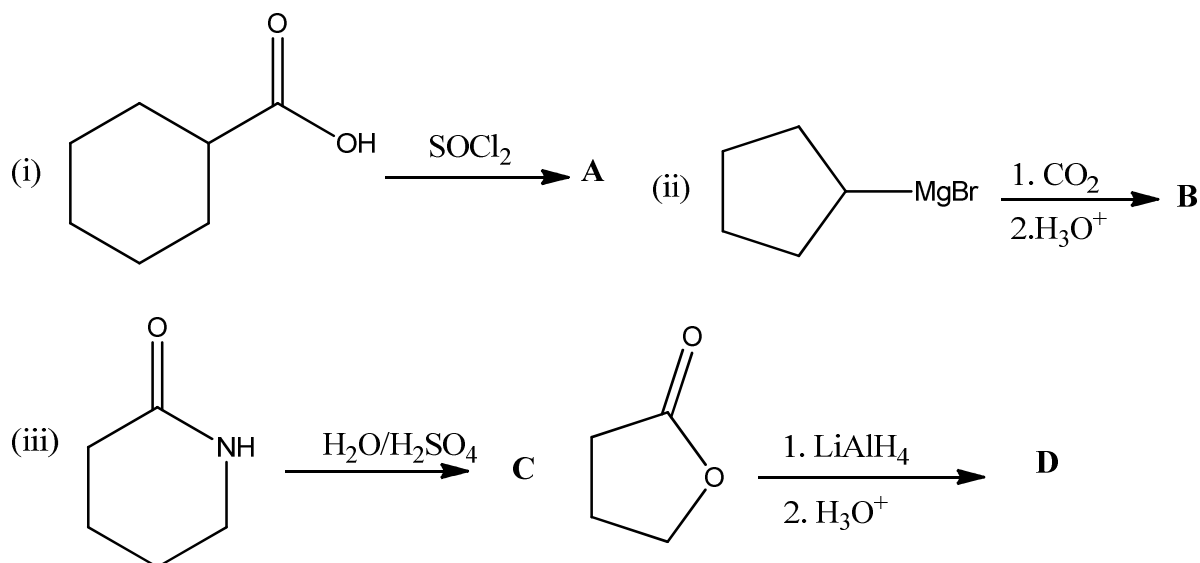
- c) Giving examples, discuss three methods of synthesizing ketones. (3 marks)
- d) Provide the major organic product that is formed when acetic anhydride reacts with each of the following (5 marks)
- (i) NH_3 (excess) (ii) $\text{CH}_3\text{CH}_2\text{OH}$ (iii) $\text{C}_6\text{H}_5 + \text{AlCl}_3$ (iv) $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$ (excess) (v) $(\text{CH}_3\text{CH}_2)_2\text{NH}$ (excess)
- g) Provide the functional groups that show the following Infra-red (IR) absorptions.
- Absorption at 1735 cm^{-1}
 - Absorption at 1810 cm^{-1}
 - Absorptions at $2500\text{--}3300\text{ cm}^{-1}$ and 1710 cm^{-1}
 - Absorption at 1715 cm^{-1} (4 marks)

QUESTION THREE (20 MARKS)

- a) Compound **E**, $\text{C}_4\text{H}_8\text{O}_2$ turns moist blue litmus paper red and on reaction with SOCl_2 , it yields compound **F**, $\text{C}_4\text{H}_7\text{OCl}$. Compound **F** reacts with $(\text{CH}_3)_2\text{CuLi}$ to give compound **G**, $\text{C}_5\text{H}_{10}\text{O}$, which when refluxed with Zn/Hg forms a straight chain compound **H**, C_5H_{12} . Deduce the possible structures for compounds **E**, **F**, **G**, and **H**. (4 marks)
- b) The reaction between an ester and a Grignard reagent is one of the routes applied to synthesize alcohols. In the reaction below, use curly arrows to show how the resulting alcohol is formed. (4 marks)



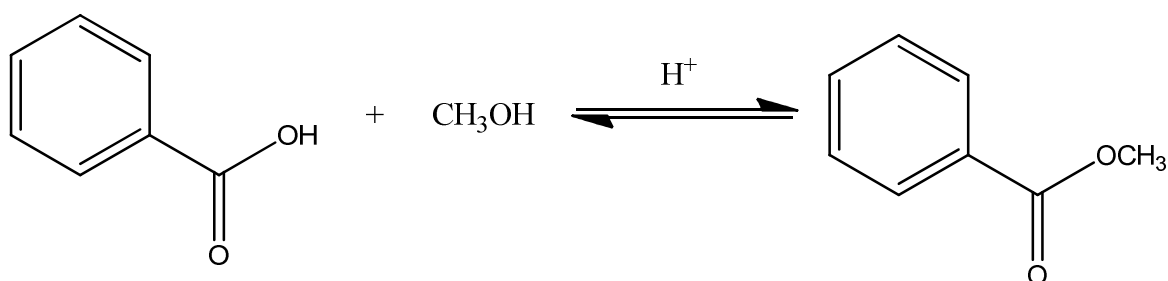
- d) Provide the major organic products from each of the following reactions (4 marks)



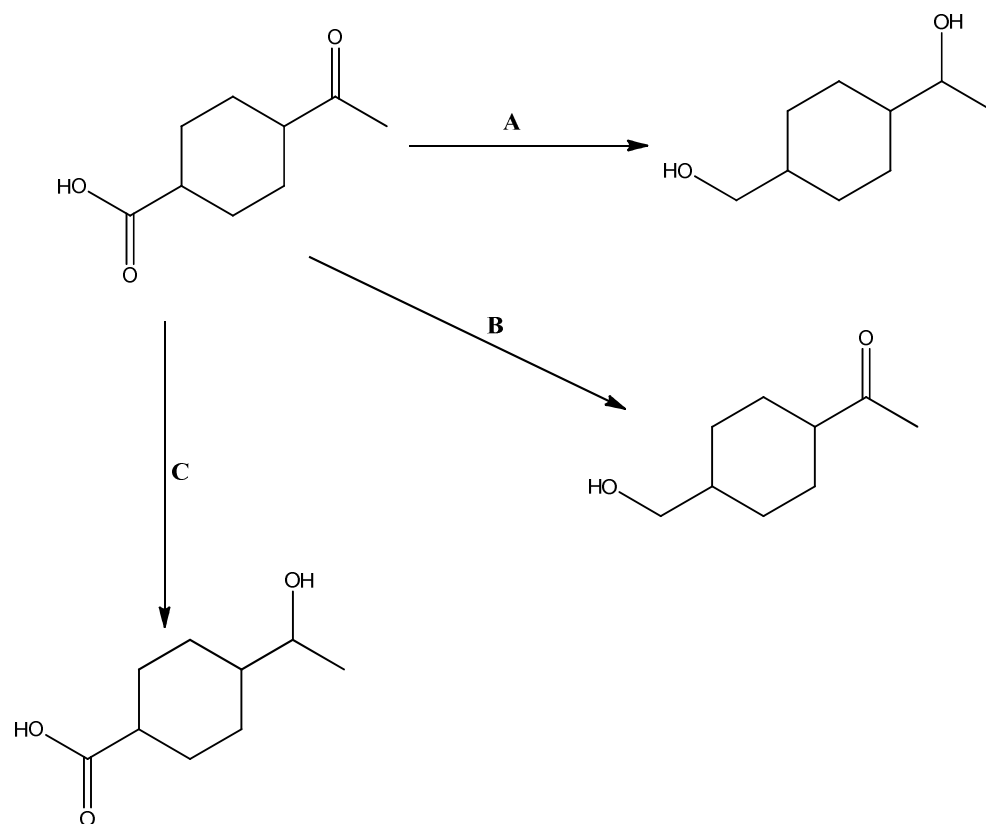
- c) Two alcohols **K** and **L** have a molecular formula $C_4H_{10}O$. Treating **K** with $KMnO_4$ leads to the formation of the corresponding acid. **L** doesn't react with either $KMnO_4$ or Chromium trioxide. Provide the possible structures of **K** and **L** and explain why **L** doesn't react with the mentioned reagents. (3 marks)
- d) Kevlar, a nylon polymer prepared by reaction of 1,4-benzenedicarboxylic acid (terephthalic acid) with 1,4-benzenediamine (p-phenylenediamine), is so strong that it's used to make bulletproof vests. Draw the structure of the resulting polymer and indicate the repetitive unit. (5 marks)

QUESTION FOUR (20 MARKS)

- a) Discuss two ways of synthesizing acetyl salicylic acid (aspirin) and explain the preferred way (4 marks)
- b) Using curly arrows, show the mechanism for the reaction shown below (4 marks)



- c) Identify the reagents required to complete each step in the reactions below. (3 marks)

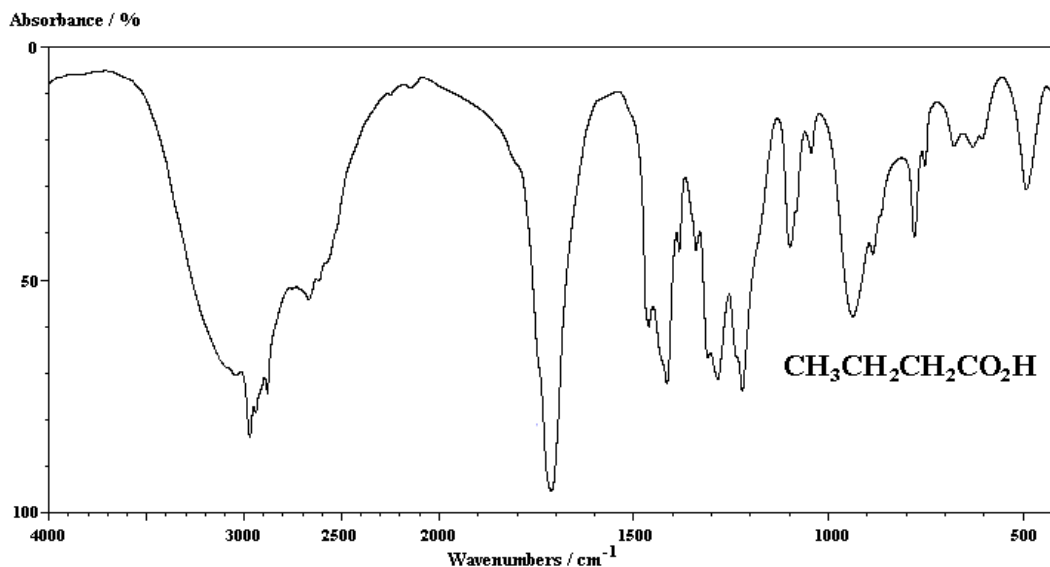


- d) When 1,6-hexanedioic acid (adipic acid) reacts with 1,6-hexanediamine with heat in an industrial process a polyamide called called Nylon is produced. Show how this polyamide is produced. (4 marks)
- e) Calculate pK_a 's for the following acids: (a) Lactic acid, $K_a = 8.4 \times 10^{-4}$ (b) Acrylic acid, $K_a = 5.6 \times 10^{-6}$ (2 marks)
- f) Explain why short chain amines are soluble in water while long chain amines are only sparingly soluble in water. (3 marks)

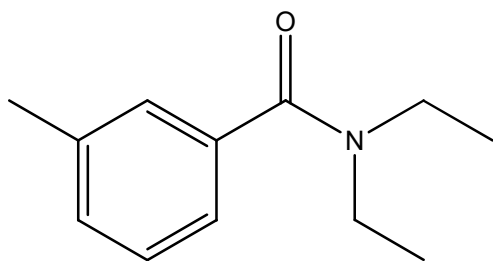
QUESTION FIVE (20 MARKS)

- a) One of the methods for synthesis of carboxylic acids is hydrolysis of nitriles. Using any nitrile as your starting component, provide a stepwise mechanism for acid hydrolysis of the nitrile to a carboxylic acid. (6 marks)
- b) Aldehydes and ketones have two sites where reactions can take place. Demonstrate the two sites using appropriate examples. (4 marks)

- c) The figure shown below is an infrared (IR) spectrum for butanoic acid. Identify three characteristic peaks with their stretching frequencies. (3 marks)



- d) N, N-Dimethyl-m-toluamide (DEET) shown below is an active ingredient in most widely used insect repellents against mosquitoes, fleas, and ticks. (4 marks)



- (i) Starting with the appropriate acid chloride, illustrate how one would go about to synthesis DEET.
- (ii) Discuss measures that one needs to put in consideration during the synthesis.
- e) Quiana, whose structure is shown below is a polyamide fiber with a silky texture. Identify the monomer units used in the synthesis of Quiana. (3 marks)

