



MACHAKOS UNIVERSITY

University Examinations 2018/2019

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

DECEMBER SESSION EXAMINATION FOR

BACHELOR OF EDUCATION

SCH 302: THE CHEMISTRY OF AROMATIC COMPOUNDS

DATE: SCHOOL BASED

TIME:

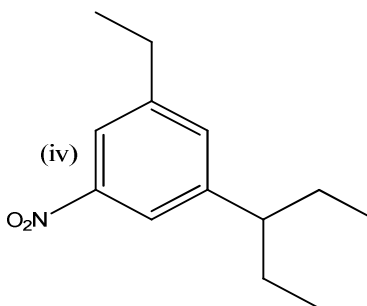
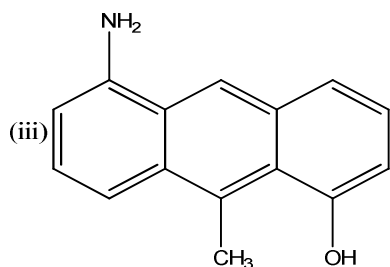
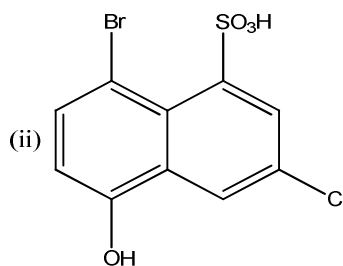
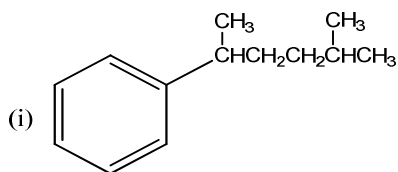
INSTRUCTIONS TO CANDIDATES

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

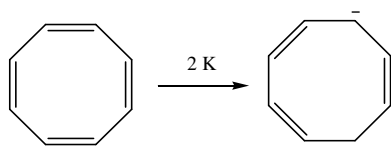
SECTION A (COMPULSORY)

QUESTION ONE (30 MARKS)

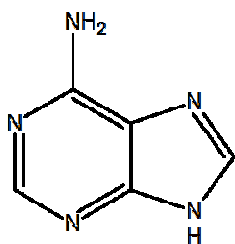
- a) Explain briefly the following terms (3 marks)
- Heterocyclic compounds
 - Annulenes
 - Spectroscopy
- b) Draw the structures corresponding to the following names (5 marks)
- p*-Bromochlorobenzene
 - p*-Bromotoluene
 - m*-Chloroaniline
 - 1-Chloro-3,5-dimethylbenzene
 - tert*-Butylbenzene
- c) Give IUPAC names for the following compounds (4 marks)



- d) Attempts to come up with the structure of benzene started in the early 19th century. One of the first people to attempt was August Kekulé. Describe the Kekulé proposal on the structure of benzene and give reasons why it was latter disapproved. (6 marks)
- e) The electron cloud of benzene is said to be below and above the ring. With illustration, justify this observation. (4 marks)
- f) Treatment of cyclooctatetraene with potassium yields a dianion. With reasons, classify the starting material and product as either aromatic, antiaromatic or nonaromatic. (2 marks)



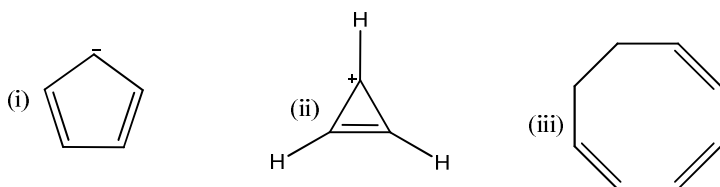
- g) Discuss two main sources of aromatic hydrocarbons. (4 marks)
- h) The molecule below is called adenine and it's aromatic. One of the nitrogens in the core donates two electrons to the pi system to make the molecule aromatic. Identify the nitrogen responsible for this. (2 marks)



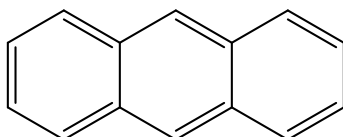
PART B (ANSWER ANY TWO QUESTIONS)

QUESTION TWO (20 MARKS)

- a) Molecules are said to be aromatic if they satisfy the Hückel's rule.
- Describe the Hückel's rule for aromaticity. (3 marks)
 - Using the Molecular orbital diagram for benzene, illustrate the basis of the Hückel's rule. (6 marks)
- b) Using the polygon rule (polygon and circle method), decide whether the following species are aromatic or anti-aromatic. (4 marks)



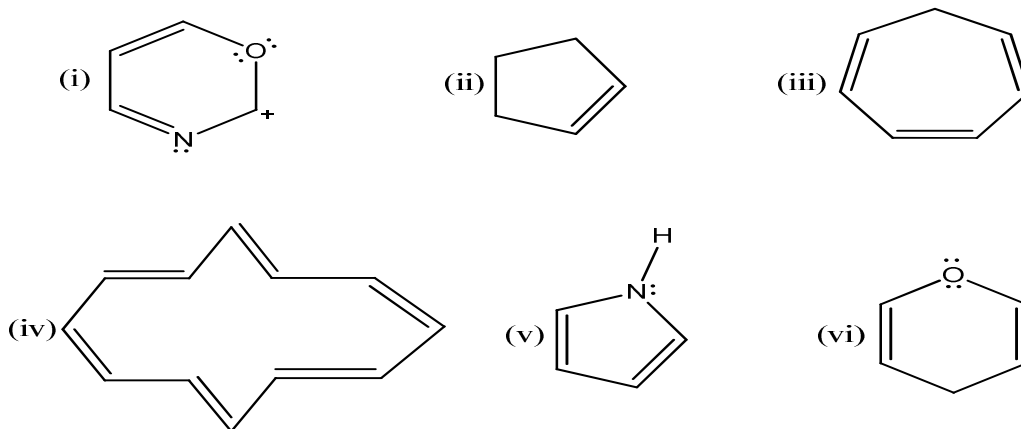
- c) Draw all the resonance structures for the molecule anthracene shown below. (3 marks)



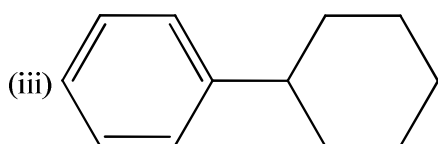
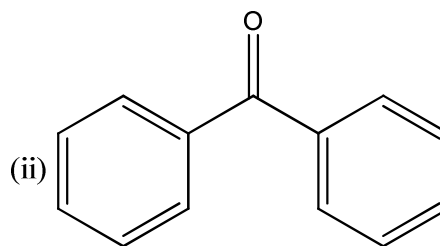
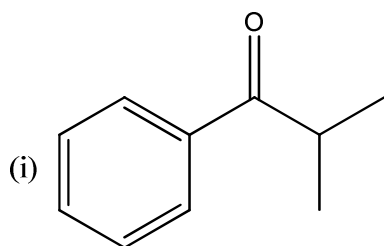
- d) In alkylation of benzene using 1-chlorobutane, it is expected that butylbenzene is formed as the major product. However, this is not the case and instead (1-methylpropyl) benzene is the major product. With illustration, explain this observation. (4 marks)

QUESTION THREE (20 MARKS)

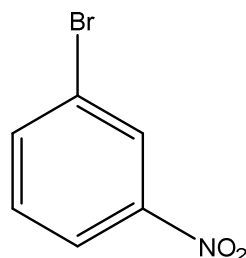
- a) Providing reasons, classify the following compounds as either aromatic, anti-aromatic or non-aromatic. (6 marks)



- b) Identify the acid chloride and alkyl halide that might be used in a Friedel–Crafts acylation and Friedel – crafts alkylation to prepare the following compounds. (6 marks)



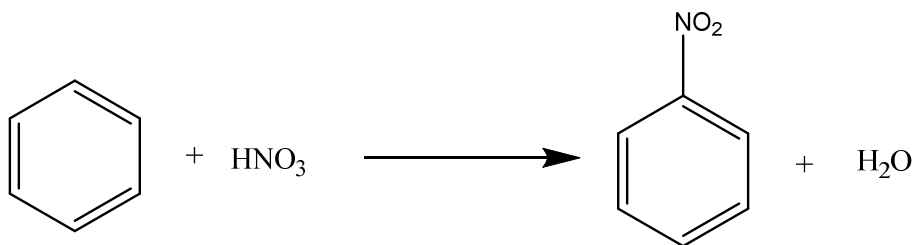
- c) Describe how you would go about to synthesized the compound shown below. (4 marks)



- d) Draw all the resonance structures of cyclopentadienyl anion. (2 marks)
- e) Cyclobutadiene undergoes diels-alder reaction to form a diels-alder product. Following the appropriate mechanism, show how the product is formed. (2 marks)

QUESTION FOUR (20 MARKS)

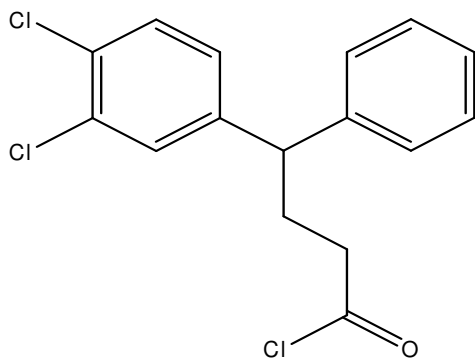
- a) Benzene is said to be highly stable compared to other unsaturated compounds. Confirm this statement using heats of hydrogenation. (6 marks)
- b) Alkenes undergoes addition reactions whereas benzene normally undergoes substitution reactions. Explain why benzene doesn't normally undergo addition reactions. (2 marks)
- c) Nitration of benzene involves the reaction between benzene and concentrated nitric acid: as shown below.



- i. State the conditions for the reaction.
 - ii. The electrophile in this case is the nitronium ion, NO_2^+ . Write an equation showing its formation.
 - iii. Give the mechanism for the reaction. (6 marks)
- d) Outline the steps involved in synthesis of propyl benzene. Show the mechanism for each step. (6 marks)

QUESTION FIVE (20 MARKS)

- a) Show a stepwise mechanism for the intramolecular Friedel-Crafts acylation of the molecule shown below using AlCl_3 catalyst. (6 marks)



- b) The methyl group in methylbenzene is 2,4-directing (ortho, para-directing). Draw the resonance structures of the carbocation intermediates formed by ortho, meta, para electrophilic attack. Use these resonance structures to account for the primary observation of formation of only two products substituted at ortho and para positions. (4 marks)
- c) Provide the major product formed in the following reactions: (10 marks)

