



MURANG'A UNIVERSITY OF TECHNOLOGY

SCHOOL OF PURE APPLIED AND HEALTH SCIENCES

DEPARTMENT OF PHYSICAL AND BIOLOGICAL SCIENCES

UNIVERSITY ORDINARY EXAMINATION

2021/2022 ACADEMIC YEAR

THIRD YEAR FIRST SEMESTER EXAMINATION FOR BACHELOR OF
SCIENCE IN ANALYTICAL CHEMISTRY AND INDUSTRIAL CHEMISTRY

ACH312– ORGANIC SPECTROSCOPY

DURATION: 2 HOURS

INSTRUCTIONS TO CANDIDATES:

1. Answer question one and any other two questions
2. Mobile phones are not allowed in the examination room.
3. You are not allowed to write on this examination question paper.
4. The table of IR absorption frequencies of organic functional groups is attached
5. The tables showing the Woodward-Fieser rules for the prediction of position absorption maxima is attached

QUESTION ONE (30 MARKS)

a) Define the following terminologies as used in spectroscopy.

- i. Phosphorescence. (2 marks)
- ii. Fluorescence. (2 marks)
- iii. Triple state. (2 marks)
- iv. Intersystem crossing. (2 marks)
- v. Quantum yield. (2 marks)
- vi. Chromosphere. (2 marks)
- vii. Auxochrome. (2 marks)

b) Which of these molecules corresponds to the IR spectrum below?

c) Explain what causes shielding and de-shielding effect in NMR. (4 marks)

d) Name two types of horization used in mass spectrometry. (2 marks)

QUESTION TWO (20 MARKS)

Use the Woodward- Fieser rules to predict the position of $\pi \rightarrow \pi^*$ absorption maxima of the following compound.

(20 marks)

QUESTION THREE (20 MARKS)

- a) The basic ^{13}C -NMR spectrum and three DEPT spectra were recorded on a sample of the compound $\text{C}_{18}\text{H}_{21}\text{NO}_3$ in CDCl_3 solution (figure 1).
- How many quaternary carbon atoms are present in the molecule? (2 marks)
 - In the DEPT 135° spectrum, three resonances are phased downward what does this imply. (2 marks)
 - From the DEPT 90° experiment and with comparison with DEPT 135° determine the type and number of protonated carbon atoms present in the molecule. (4 marks)
 - Explain why solvent CDCl_3 signals disappear in all the DEPT spectra (2 marks)
- b) Define the following terminologies.
- Auxochrome. (2 marks)
 - Bathochromic shift. (2 marks)
 - Magnetically equivalent nuclei. (2 marks)
 - Off-resonance coupling. (2 marks)

- v. Compiling constant. (2 marks)
- vi. Induced magnetic field
- c) 0-Nitrophenol has an O-H band at 3200 cm^{-1} in KBr pellets as well as in CHCl_3 solution the P-nitrophenol gives the OH bands at 3330 cm^{-1} for KBr and at 3520 cm^{-1} for CHCl_3 solution. Explain. (3 marks)

QUESTION FOUR (20 MARKS)

- a) . Define the following terms
- Shielding
 - Spin-spin splitting
 - Magnetic equivalence
 - Chemical shift
 - Finger print region (5 marks)
- b) i) Briefly explain why a C=O bond stretch occurs at 1750 cm^{-1} and C-O stretch occurs at 1100 cm^{-1}
- ii) Explain the variation in the vibration frequency of the C=C band in the compounds shown below

(3 mks)

- c) Which structural features may produce a bathochromic or a hypsochromic effect in an organic compound. (5 marks)
- d) Which out of benzene colourless or quinone (yellow) has more easily promoted electrons. (3 marks)
- e) Which radiation infra-red or ultraviolet has.
- i. shorter wavelength.
 - ii. Lower energy. (2 marks)