



TECHNICAL UNIVERSITY OF MOMBASA

FACULTY OF APPLIED AND HEALTH SCIENCES

DEPARTMENT OF PURE & APPLIED SCIENCES

UNIVERSITY EXAMINATION FOR:

MASTERS OF SCIENCE IN CHEMISTRY

ACH 5108: ADVANCED SPECTROSCOPIC TECHNIQUES

SPECIAL/ SUPPLEMENTARY EXAMINATIONS

SERIES: SEPTEMBER 2018

TIME: 3 HOURS

DATE: Pick Date Sep 2018

Instructions to Candidates

You should have the following for this examination

-Answer Booklet, examination pass and student ID

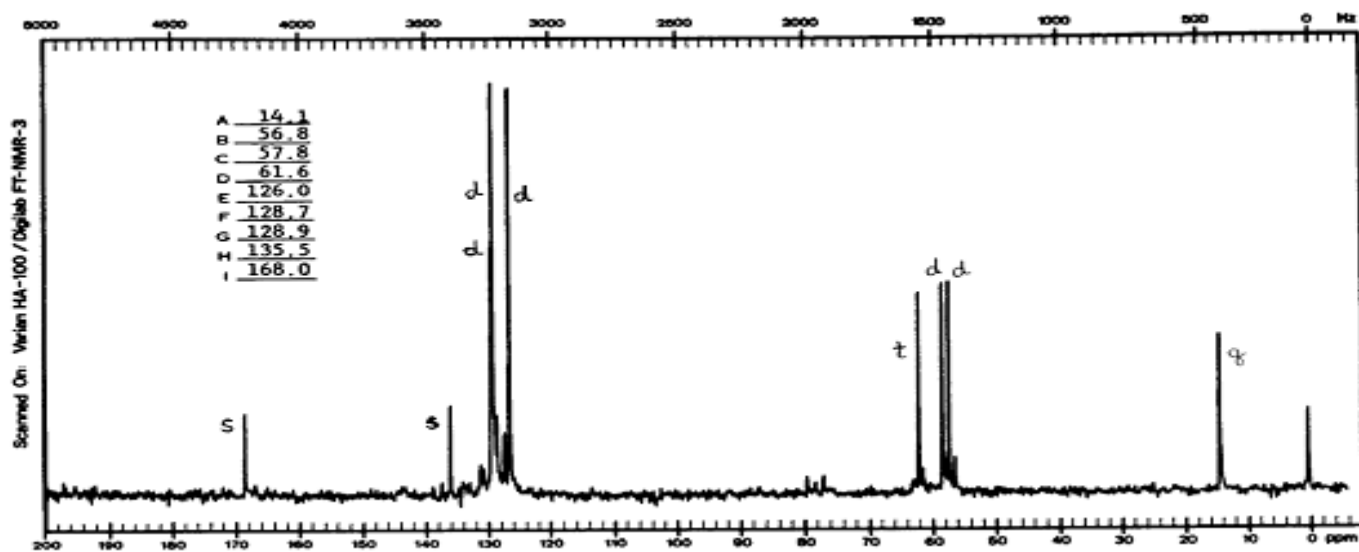
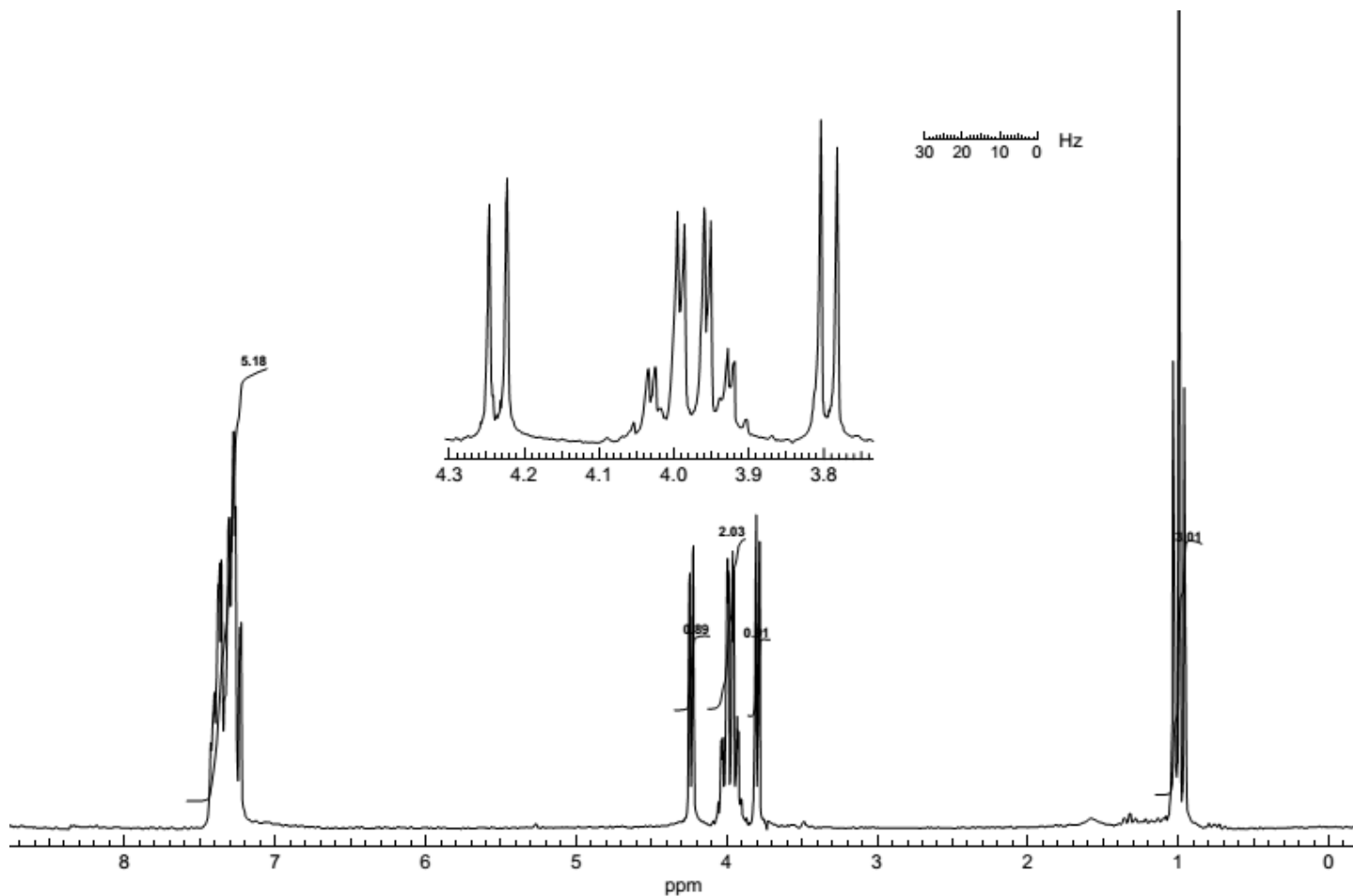
This paper consists of **SIX** Question(s). Attempt any **FOUR** questions.

Do not write on the question paper.

Question ONE

(a) What is peak resolution as applied in ^1H -NMR Spectroscopy? State four main factors which affect peak resolution in NMR spectroscopy. **[5 marks]**

(b) An organic molecule which has the molecular formula $\text{C}_{11}\text{H}_{12}\text{O}_3$ registered IR absorption signals associated with a carbonyl group and Aromatic ring. The ^1H -NMR and ^{13}C -NMR spectra of the molecule are given below:



- i. Compute the double bond equivalence (DBE) of the molecule. [2 marks]
- ii. State chemical shifts of the carbon atoms from ^{13}C -NMR spectrum of the compound and describe the structural information which can be deduced from the listed chemical shift values (Make use of the provided charts). [6 marks]

- iii. Draw the structure of the molecule and, label the structure with ^1H chemical shifts and multiplicity of the protons in the same magnetic environment. [10 marks]
- iv. What feature(s) of the spectra helped in the determination of the stereochemistry of the molecule? [2 marks]

Question TWO

- (a) Outline the theory of Electron spin resonance spectrometry. [6 marks]
- (b) Give detailed account on instrumentation of electron spin resonanace spectrometry. [6 marks]
- (c) Discuss the two relaxation methods in Electron spin resonance spectrometry. [8 marks]
- (d) Outline the applications of Electron spin resonance spectrometry in in nutraceutical and food research. [5 marks]

Question THREE

- (a) Outline the role of various components of an NMR spectrometer. [7 marks]
- (b) Describe proton decoupled and off resonance decoupled techniques used in ^{13}C NMR. [6 marks]
- (d) Explain why
- In ^{13}C NMR protonless carbon exhibits low intensity. [3 marks]
 - CDCl_3 exhibits a triplet at δ 76, 77 and 78 in its ^{13}C NMR spectrum. [2 marks]
- (e) Give an account of deuterium isotope substitution effects applied in ^{13}C NMR. [7 marks]

Question FOUR

- (a) Which kind of information is obtained from 2D NMR to aid in structural elucidation of organic molecules? [2 marks]
- (b) State six 2D NMR techniques. [3 marks]
- (c) Describe DEPT technique in detail clearly indicating piece of information that can be obtained from the experiment to aid in structure elucidation. [7 marks]
- (d) Name and describe two decoupled techniques applied in ^{13}C – NMR spectroscopy [8 marks]
- (e) Outline Nuclear overhauser effect (NOE) in NMR spectroscopy. [5 marks]

Question FIVE

- (a) Describe hyphenated techniques in advance spectroscopic techniques by making use of relevant example and outline their advantages. [8 marks]
- (b) Make use of a schematic presentation to outline the principle of excitation, signal generation and detection in a photoacoustic experiment. [7 marks]
- (c) State any ten areas of application of photoacoustic spectroscopy. [10 marks]

Question SIX

- (a) Outline the principle of Atomic fluorescence spectrometry (AFS) and account for its application to a great variety of environmental, biological and food samples. [8 marks]
- (b) State the three main types of atomic fluorescence and outline when each stated type occurs in Atomic fluorescence spectrometry (AFS) [6 marks]
- (c) State four factors which determine the intensity of the fluorescence radiation in Atomic fluorescence spectrometry (AFS). [4 marks]
- (d) Use a schematic diagram to outline the instrumentation in HG-AFS. [7 marks]