



FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA
DEPARTMENT OF CHEMISTRY
SECOND SEMESTER EXAMINATION 2021/2022 ACADEMIC
SESSION
COURSE CODE: CHM 323

INSTRUCTION: ANSWER ANY THREE (3) QUESTIONS

Q1(a). Using benzene as a solvent, a student records the UV/Vis spectrum of *p* nitromethylbenzene. At a point, the student asks the lecturer for guidance after being confused by the spectrum. The lecturer sends the student away to record the spectrum using a different solvent. i. Give a likely reason why the spectrum from the analysis was confusing using benzene as a solvent. **[2.5 marks]**

ii. Suggest a suitable solvent that the student could use instead of benzene. Explain your answer **2.5 marks]**

1(b). When light passes through a compound some wavelengths are absorbed because their energy is used to promote an electron into a higher energy orbital.

i. Draw an energy diagram for this process and show the electron transition which is possible. **[5 marks]**

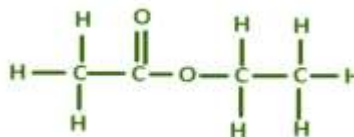
ii. Which transition needs the highest energy? **[1 mark]**

iii. Which transition absorbs light of the highest wavelength? **[1 mark]**

iv. Some of the transitions aren't useful in UV-visible spectrometry. Explain why. **[5 marks]**

Ethanal, CH₃CHO, produces two peaks involving the transition from the pi electrons in the C=O double bond and a lone pair on the oxygen. The peaks are at 180 and 290 nm. Which transition produces which peak? Explain your answer by reference to the first diagram to answer in 1b. **[3 mark]**.

Q2(a). State four (4) advantages of using tetramethyl silane (TMS) as a reference standard in an NMR spectroscopy **[4 marks]**.



2b. Given the organic compound below:

Draw a Proton NMR spectrum indicating the following [**3 marks each**]

- i. Chemical environment ii. Chemical Shift iii. Splitting

bii. From the compound in 2b indicate the most shielded protons. Give reasons for your answer [**2 marks**].

c. Given the following elements ^1H , ^{13}C , ^{12}C and ^{16}O .

i. Identify the element that is/are NMR active. [**1 mark**].

Identify the element that is/are not NMR active [**1 mark**]. Justify your answers in each case [**3 marks**]

Q3 (a). Enumerate two conditions for molecules to absorb in FTIR spectroscopy [**2 marks**]

i. Arrange the following molecules in order of intensity of absorption in an FTIR spectroscopy [**2marks**]

i. C-C-OH	ii. C-O	iii.
C-C-H	iv. C-Cl	

State four (4) Disadvantages of FTI-R spectroscopy [**4 marks**]

c. An unknown organic compound (hydrocarbon) with an m/z value molecular cation of 56 and base peak with an m/z value of 43, and other fragmentation with an m/z value of 15 and 29 was analyzed using mass spectrometry in FUT Minna Chemistry Lab. As a student of CHM 313:

i. Suggest the formula for the compound [**4 marks**]

ii. Account for all the possible fragmentation [**4 marks**]

iii. Draw the mass spectrum for the compound [**3 marks**]

iv. Give the IUPAC name of the compound [**1 mark**]

Q4 (a). Given below are two cyclic enones A and B. What happens to the wavelength in a UV-Visible spectrum when A is converted into B? [**3 marks**]



b. State the following rules i. Nitrogen rule **[2 marks]** ii. Hydrogen rule **[2 marks]** iii. Double bond equivalent **[2 marks]**

bi. A bottle containing an unknown organic compound was examined in a university laboratory. There was an incomplete label. A chemist analysed the sample using mass spectrometry, NMR XPS and FTIR. The result of the lab analysis indicates that the compound contained 3 carbon atoms with an m/z value of 58 molecular cation. From the information above

- i. Predict whether the organic compound contains a nitrogen atom. Give a reason for your answer **[3 marks]**
 - ii. Calculate the number of hydrogen in the compound **[3 marks]**
 - iii. Calculate the double bond equivalent **[3 marks]**
- b. List four factors, which impact the results in ultraviolet-visible spectroscopy. **[2 marks]**