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UNIVERSITY OF RUHUNA – FACULTY OF ALLIED HEALTH SCIENCES

DEPARTMENT OF PHARMACY

FOURTH BPHARM PART I EXAMINATION – APRIL 2023

PH 4123 PHARMACEUTICAL ANALYSIS – SEQ PAPER

TIME: TWO HOURS

INSTRUCTIONS

- There are four questions in this paper as **PART A, B, C,** and **D**.
- Answer all questions
- No paper should be removed from the examination hall.
- Do not use any correction fluid.
- Use illustrations where necessary.

PART A

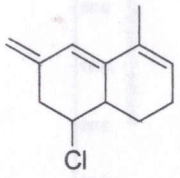
01

1.1 3-Buten-2-one gives two absorption peaks in its ultraviolet spectrum at 213 nm (ε = 7,100 L mol^{-1} cm^{-1}) and 320 nm (ε = 27 L mol^{-1} cm^{-1}). ***(20 marks)***

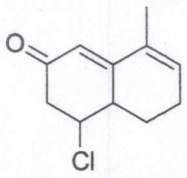
1.1.1 What type of transition is responsible for each absorption?

1.1.2 What is account for the difference in molar absorptivity for the two absorptions?

1.2 Predict λ_{max} values for the following two compounds **A** and **B** using Woodward-Fieser rules and explain whether UV-vis spectroscopy could be used to distinguish them. ***(25 marks)***



A

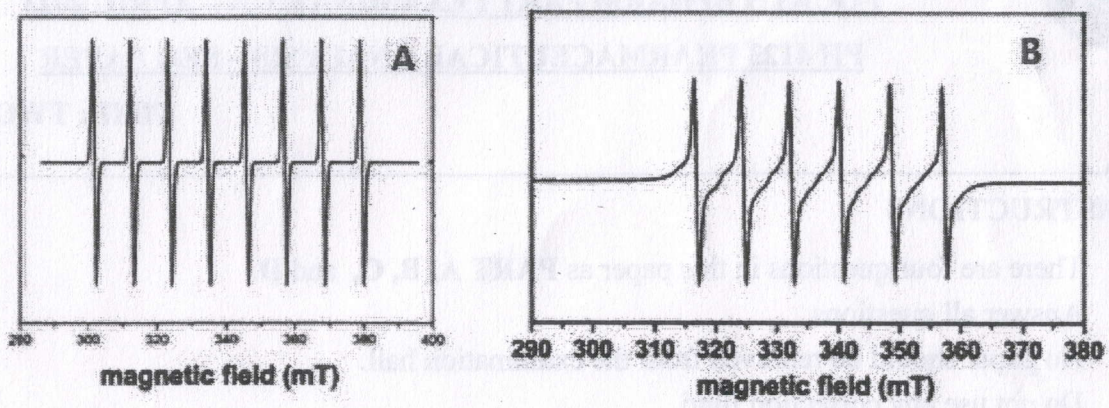


B

1.3 With the aid of a suitable energy level diagram, illustrate the following major photophysical processes that occur in a molecule in solution and categorize them into the radiative and nonradiative processes. ***(40 marks)***

1.3.1 Absorption (Excitation)
1.3.2 Fluorescence
1.3.3 Phosphorescence
1.3.4 Internal Conversion
1.3.5 Intersystem Crossing

1.4 Match the ESR spectra below to either $Cu(acac)_2$ or $VO(acac)_2$ (acac = acetylacetonate). Explain your answer. (I values of ^{63}Cu and ^{51}V are 5/2 and 7/2, respectively). ***(15 marks)***



02.

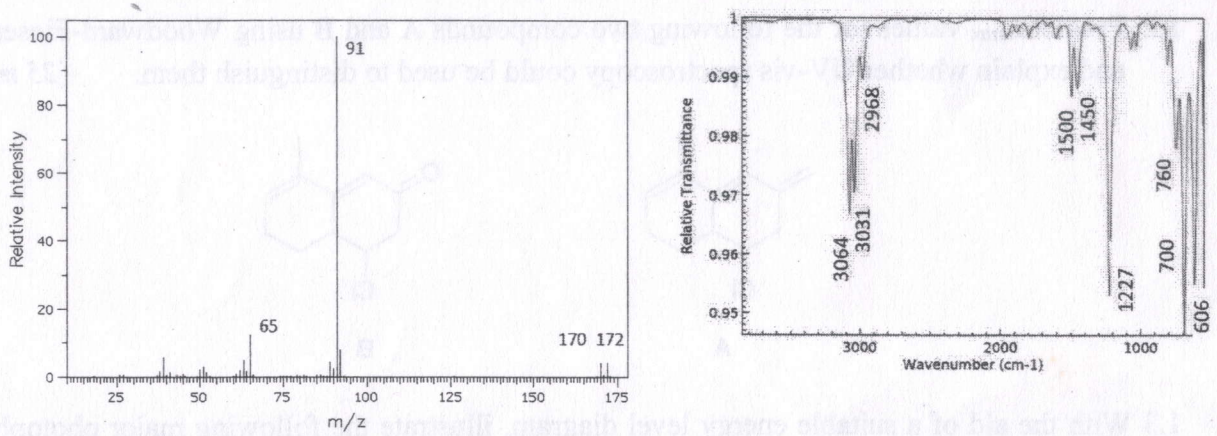
2.1 What characteristic absorptions in the IR spectra allow you to distinguish between the following pairs of compounds? Give the approximate frequencies of those absorptions.

(10 marks)

2.1.1 $(CH_3)_3C$ and $(CD_3)_3C$ 2.1.2 $CH_3CH_2NH_2$ and $(CH_3CH_2)_2NH$

2.2 Explain how propyl benzene ($PhCH_2CH_2CH_3$) and isopropyl benzene ($PhCH(CH_3)_2$) could be distinguished by using their mass spectra. ***(10 marks)***

2.3 Mass and IR spectra of an organic compound are shown below:



2.3.1 Identify the parent and base peaks in the mass spectrum. ***(10 marks)***

2.3.2 What is the molecular structure of the most stable fragment? ***(05 marks)***

2.3.3 Deduce the structure of the compound giving reasons. ***(10 marks)***

2.3.4 Assign as many bonds as possible to their corresponding bands in the IR spectrum.

(05 marks)

PART B

2.4

2.4.1 Define the term chemical shift used in NMR spectroscopy. (***05 marks***)

2.4.2 Two ^1H NMR peaks for methanol appeared at 1461 and 996 Hz in a 300 MHz NMR spectrometer. Calculate the chemical shifts of these two peaks. (***10 marks***)

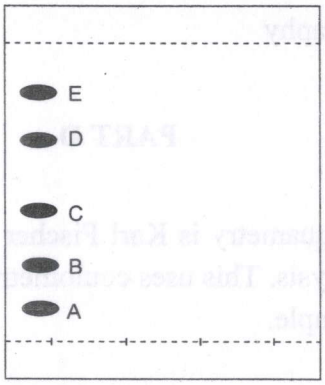
2.4.3 It was observed that one peak of the above NMR spectrum is absent in D_2O. What would be the reason for this? (***05 marks***)

2.5 How would you distinguish the two molecules of *aniline* and *4-hydroxyaniline* using ^1H NMR spectroscopy? (***10 marks***)

2.6 ^1H NMR spectrum of the molecule **X** with the formula of $C_4H_6O_2Br_2$ shows three NMR peaks at 1.45 (*t*, 3H), 3.05 (*q*, 2H), and 10.65 (*s*, 1H) with the intensity ratio of 3:2:1, respectively. Giving reasons derive the chemical structure of the molecule **X**. (***20 marks***)

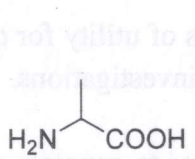
PART C

03. A mixture of five amino acids was separated using C_{18} reversed phase TLC plate and 60% aqueous acetonitrile as the mobile phase. Resulting chromatogram is shown below:

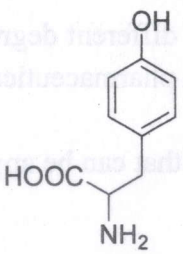


3.1 Name a reagent that can be used to visualize these spots. (***05 marks***)

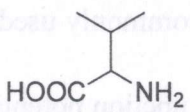
3.2 If the mixture contained the following amino acids, match each spot (**A-E**) to one of the amino acids. (***10 marks***)



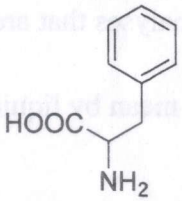
Alanine



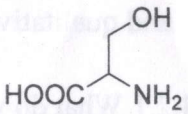
Tyrosine



Valine

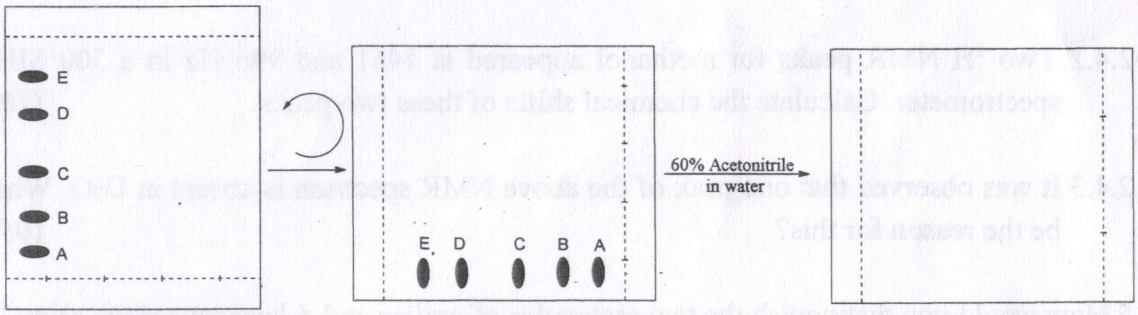


Phenyl alanine



Serine

3.3 Assume that you have rotated the above TLC plate by 90° and developed it again using the same mobile phase (60% aqueous acetonitrile) as shown below. Draw the chromatogram that you would expect from this 2D TLC. (*20 marks*)



3.4 List five detectors used in Gas chromatography. (*10 marks*)

3.5 Briefly explain how you can quantify a drug present in a urine sample using HPLC. (*25 marks*)

3.6 Briefly explain following chromatographic techniques giving stationary phase and suitable mobile phase and uses. (*30 marks*)

3.6.1 Paper chromatography
3.6.2 Affinity chromatography
3.6.3 Size exclusion Chromatography

PART D

04.

4.1 One of the methods used in aquametry is Karl Fischer titration which is a classical titration method in pharmaceutical analysis. This uses coulometric or volumetric titration to determine trace amounts of water in a sample.

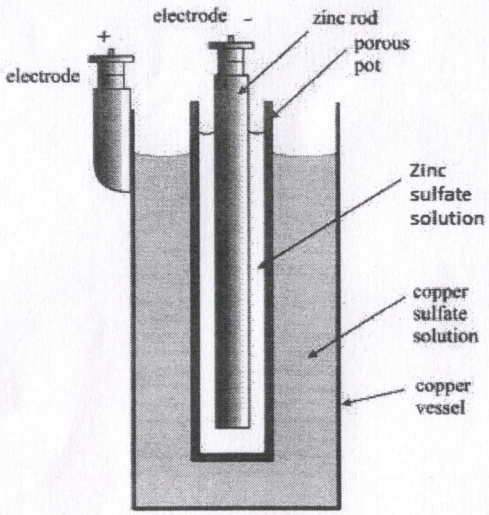
4.1.1 State the importance of aquametry in pharmaceutical industry. Give examples wherever applicable. (*20 marks*)

4.1.2 Briefly discus a spectroscopic and an electrochemical method used in aquametry of pharmaceutical analysis. (*20 marks*)

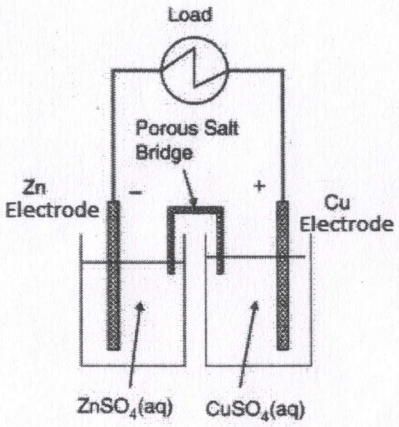
4.2 There are variety of electrochemical methods with different degrees of utility for quantitative and qualitative analyses that are commonly used in pharmaceutical investigations.

4.2.1 What do you mean by liquid junction potential that can be applied to generate electricity? (*10 marks*)

4.2.2 Give cell notation for each of the following cells **A** and **B**. (***24 marks***)

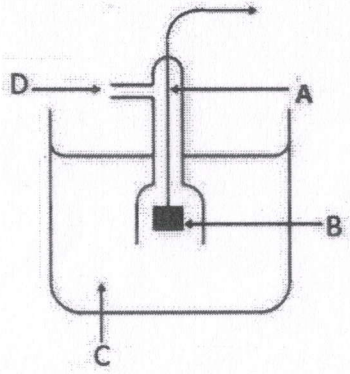


A



B

4.2.3 A schematic illustration of a standard hydrogen electrode is given below: Name the parts of the electrode marked as **A**, **B**, **C** and **D**. (***16 marks***)



4.3 Discuss briefly the role and the purpose of a secondary standard electrode. (***10 marks***)

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