

**CORK INSTITUTE OF TECHNOLOGY
INSTITIÚID TEICNEOLAÍOCHTA CHORCAÍ**

Semester 1 Examinations 2008/09

Module Title: Bioanalytical Science III

Module Code: CHEA 6003

School: Science

Programme Title: Bachelor of Science in Applied Biosciences – Stage 2

Programme Code: SBIOS_7_Y2

External Examiner(s): Dr. B. O'Regan

Internal Examiner(s): Dr. R Hourihane, Dr. L McDonnell, Mr. C O'Farrell

Instructions: Attempt both sections A and B. All questions carry equal marks. Section A is compulsory

Duration: 2 Hours

Sitting: Winter 2008

Requirements for this examination:

Note to Candidates: Please check the Programme Title and the Module Title to ensure that you have received the correct examination paper.
If in doubt please contact an Invigilator.

Section A

Q1. Attempt any 8 of the following 10 parts.

All carry equal marks.

- (i) Identify two similarities and one difference between atomic and molecular orbitals.
- (ii) On a simple energy level diagram illustrate the following molecular orbitals, π , π^* , σ , σ^* and n . Identify the bonding and anti-bonding molecular orbitals and two possible allowed transitions.
- (iii) Illustrate a typical pH titration curve obtained for a titration between a strong acid and a strong base. Label the axes and show how the end point may be obtained.
- (iv) Draw a typical TLC plate, on it label the two reference points, and hence or otherwise explain what is meant by R_f value.
- (v) What are luminescence methods? Give an example.
- (vi) If a sample is found to transmit 75% of the incident radiation, how much radiation is absorbed?
- (vii) Name the four key components that make up a spectrophotometer and provide an appropriate diagram.
- (viii) For the following light sources: (a) Laser; (b) Deuterium Lamp; and (c) Heated Inert Solids, state whether they are line-type or continuous-type and identify the region of the electromagnetic spectrum that they are utilised.
- (ix) Why is (a) the shape and (b) the material of a sample cuvette important?
- (x) List three key properties of an ideal detector for use in spectroscopy. (25 Marks)

Section B

Attempt any **three** of the following questions.

- Q2. (i) Compare and contrast molecular Ultra violet Visible spectroscopy and Fluorimetry under the following headings
- (a) sample type
 - (b) method sensitivity and limit of detection
 - (c) qualitative and quantitative applications.
- (ii) A food sample was analysed for iron content according to literature methods. A series of standards were prepared from a 0.05gdm^{-3} iron stock solution. Their absorbance values were determined and are given in the table below. The absorbance of the sample was determined in triplicate and is also included below. As can be seen the samples absorbance values are outside the range of the standards. The sample was diluted to bring it on scale, by taking 5cm^3 of it and diluting it to 25cm^3 in a volumetric flask. This diluted sample was reanalysed.
- (a) Draw the appropriate calibration curve and determine the concentration of iron in the food sample.
 - (b) What volume of the stock solution is required to prepare 100cm^3 of the 0.025gdm^{-3} standard solution?

Absorbance	Concentration / gdm^{-3}
0.098	0.005
0.408	0.015
0.725	0.025
1.040	0.035
1.538	0.050

1.758

Food sample

1.760

1.755.

0.525

Diluted food sample

0.526

0.527.

(25 Marks)

Q3. Attempt **three** of the following

- (i) Provide a labelled sketch of a typical monochromator.
- (ii) Illustrate, with a well labelled diagram, the conductimetric titration curve obtained when a weak acid is titrated against a strong base. Detail the ions responsible for the conductivity before, at and after the endpoint of the titration. Show on your graph how the endpoint is determined.
- (iii) Chromatography peaks/bands broaden as they move through a column. Describe three methods of band broadening giving appropriate diagrams in each case. How does each method depend on flow rate?
- (iv) (a) What is analytical chemistry? Outline the steps involved in any analytical process.
(b) Sampling is the process of selecting a representative bulk sample from the lot. Sample preparation is the process that converts a bulk sample into a homogenous laboratory sample. Sometimes in analysis it is necessary to mask an interfering species. Explain the underlined terms.
- (v) Describe the process of fluorescence emission. Draw an energy level diagram to illustrate the process. In your diagram include also the two non-radiative processes, which compete with fluorescence. Identify situations when these processes are most successful. (25 Marks)

- Q4. (a) Conjugated systems and aromatic systems interact similarly with ultraviolet and visible radiation. Explain the basis for these interactions; include examples in your discussion.
- (b) Explain the term auxochrome. What effect does its inclusion in a molecule have on the absorption position and intensity of a chromophore? Give at least one example to illustrate these effects.
- (c) State Beer's law; explain each of the symbols. Deviations from Beer's law are often called real and apparent deviations. Describe **one** such variation in each case. (25 Marks)

- Q5. (i) Describe in detail the method of partition chromatography, identify the mobile and stationary phases used and typical sample type. A simple diagram is required.
- (ii) List three other chromatographic separation methods, giving the appropriate sample type in each case.
- (iii) What is an internal standard and why is it included in chromatographic analysis? Hence or otherwise explain the terms relative peak area and response factor.

(25 Marks)