

Cork Institute of Technology

Higher Certificate in Science in Applied Biosciences-Award
(NFQ – Level 6)
Autumn 2007

Bioanalytical Science 2
(Time: 3 Hours)

Answer **FIVE** questions.

Question 1 is compulsory.

TWO questions from Section B, ONE from Section C and a fifth questions from Section B or C

Examiners: Dr. R. Hourihane

Ms. A. Ward

Dr. C. Farrell

Prof. R. Fitzgerald

Section A

Q1. Attempt 10 parts. All carry equal marks.

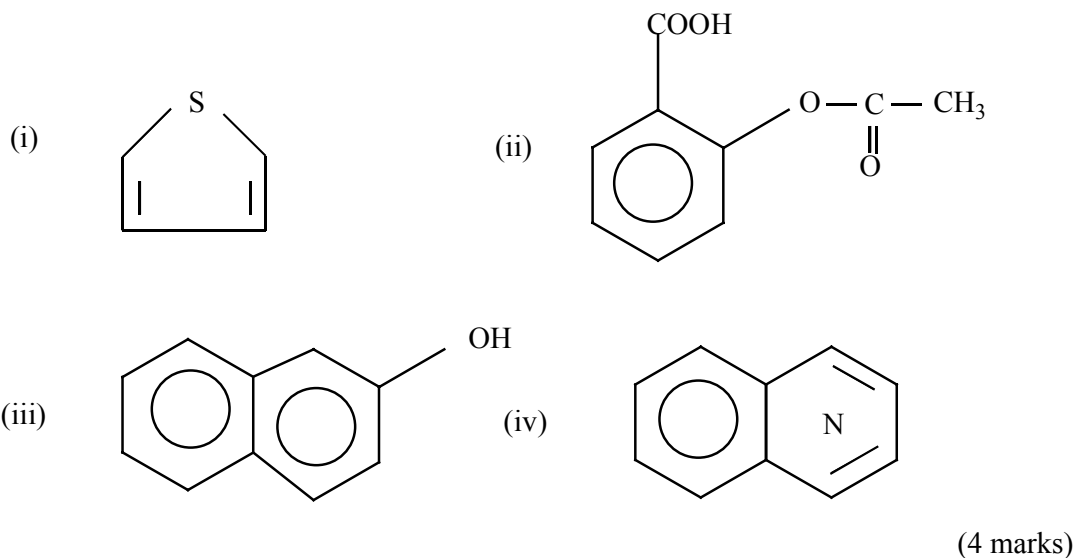
- (i) Molecules can rotate, vibrate or undergo electronic transitions, when they absorb electromagnetic radiation. Match the molecular motion to particular areas of the electromagnetic spectrum
- (ii) List three properties of an ideal solvent suitable for use in spectroscopy.
- (iii) Give Beer's Law. Identify each of the symbols. Which has no units?
- (iv) Explain the following chromatographic terms: stationary phase; mobile phase; elution and partition.
- (v) In atomic absorption spectroscopy, what is meant by the term nebulisation?
- (vi) Draw a simple diagram illustrating the principle of immunoaffinity chromatography.
- (vii) Define each of the following terms: (a) Epitope (b) Paratope.
- (viii) List TWO statistics commonly used to plot control charts.
- (ix) Define what is meant by the primary and secondary immune responses.
- (x) In relation to gel filtration chromatography define each of the following terms:
 - (a) Void volume (V_o)
 - (b) Elution volume (V_e)
- (xi) Name the different types of centrifuge instruments available.

- (xii) A laboratory centrifuge operates at a rotational speed of 5,500rpm.
- (a) What is the magnitude of the centripetal acceleration on a red blood cell at a radial distance of 6.50cm from the centrifuges axis of rotation?
 - (b) How does this acceleration compare to g?
- (xiii) If a diffraction grating has 1100 grooves/mm, what wavelength (in nanometres) is it optimised for?
- (xiv) Name the 4 components that make up a spectrophotometer.
- (xv) Name the components of and sketch a typical setup for a monochromator?
- (xvi) What type of light source and what region of the electromagnetic spectrum are these components optimised for:
- (a) Laser
 - (b) Deuterium lamp
 - (c) Tungsten Filament
 - (d) Heated Inert Solids

Section B

- Q2. (a) (i) What are potentiometric methods?
(ii) Ion selective electrodes (ISE) are used to make potentiometric measurements.
Name the four classifications of such electrodes
Explain how ISEs operate in general. Diagrams required. (8 marks)
- (b) The pH electrode is one type of ISE. Even though it is probably the most common of the ISEs, it is not without problems.
(i) Name and explain briefly three common errors associate with pH measurements.
(ii) Explain the sensitivity of pH values to temperature of the solution. (7 marks)
(c) List at least two advantages and two disadvantages, associated with ISEs. (5 marks)

- Q3. (a) (i) Draw an energy level diagram to illustrate the fluorescence emission process.
(ii) Describe briefly the three energy processes involved.
Which of the three is most energetic? (7 marks)
- (b) (i) What is meant by the term 'quantum yield'?
(ii) What is its possible range of values?
(ii) What is the symbol for this quantity? (3 marks)
- (c) What specific structural features must a molecule ideally possess in order to engage in fluorescence? Hence, which of the following would you expect to fluoresce?



(Q3. cont...)

- (d) Fluorescence is a very sensitive technique. It therefore, has many requirements practically.

Name and explain briefly at least three of these practical requirements, which must be observed to ensure fluorescence measurements can be taken. (6 marks)

Q4. Attempt three of the following:

- (i) Electric arc and electric spark are two types of emission spectroscopy.

Write a brief note on the methods.

In your answer include:

- Atomization temperature
- Sample type
- Sample preparation required
- Methods of detection of results

- (ii) A solution containing 20 mg of potassium in 250 ml of water was observed to transmit 75% of the incident light compared to the appropriate blank.

(a) What is absorbance of the solution of this wavelength?

(b) What would be the transmittance value of the solution of potassium which is twice as concentrated?

- (iii) Write a note on the method of adsorption chromatography. Diagram required.

Name two other chromatography classifications.

- (iv) Illustrate a typical conductimetric titration graph obtained for a strong acid strong base titration.

- Show how the end point such as titration may be obtained.
- Explain the shape of the graph giving the ions present in solution before, at, and after the end point.

- (v) Electronic transitions involve absorption of ultra violet or visible light.

- Identify the types of electrons involved typically.
- Draw a simple energy level diagram showing the usual electronic transitions
- Distinguish between chromophore and chromogen. Give examples of each.

(20 marks)

- Q5. (a) Flame atomic emission is a low temperature flame method.
- (i) List the steps in the flame process from aspiration to measurement
 - (ii) What is the function of the flame in this method?
 - (iii) What sample types is this method most suited to?
 - (iv) What is the typical flame temperature? (7 marks)

- (b) A food sample was analysed for sodium content using flame atomic emission spectroscopy. To this end a series of standards were prepared from a 500 ppm sodium stock solution. The food sample was treated similarly to the standards. The emission values were measured; the data and results are contained in the table below:

Na Conc / ppm	Emission
2	15
4	40
8	84
16	176
32	360
Food Sample	500
Diluted Food Sample	250

As can be seen from the data the food sample's emission reading is outside the range of the standards. The sample was diluted by 50% and re-analysed.

- (i) Construct an appropriate calibration plot
 - (ii) Determine the concentration of the original undiluted food sample (9 marks)
- (c) What volume of stock solution is required to prepare:
- (i) 50 ml of 8 ppm standard
 - (ii) 25 ml of 32 ppm standard? (4 marks)

On the basis of the calculated volumes, make a suggestion as to how these dilutions may be carried out in practice.

Section C

- Q6. (a) Distinguish between each of the following general classifications of immunoassay:
- (i) Heterogeneous
 - (ii) Homogeneous (6 marks)
- (b) Using a detailed diagram for illustration, outline the principle of a typical non-competitive sandwich Enzyme Linked Immunosorbent Assay (ELISA). (14 marks)
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- Q7. (a) Describe, with the use of a diagram, one immunoanalytical technique which involves immunoprecipitation (6 marks)
- (b) Write short notes on **TWO** of the following as they apply to a bioanalytical laboratory:
- (i) Internal Quality Control
 - (ii) Quality Control charts
 - (iii) Potential sources of error
 - (iv) External Quality Assessment (14 marks)