

Module Title: Bioanalytical Science II CA

Module Code: BIOL 6004

School: Science

Programme Title: Bachelor of Science in Applied Sciences – Year 1
Bachelor of Science in Nutrition and Health – Year 1
Bachelor of Science in Pharmaceutical Biotechnology – Year 1

Programme Code: CR_SBIOS_7_Y1
CR_SNHSC_8_Y1
CR_SPHBI_8_Y1

External Examiner: Prof. G. Walsh

Internal Examiners: Ms. R. Kiernan, Dr. M. Sheahan

Instructions: Answer **TWO** questions from each section
Question 4 is **compulsory**
Use **separate answer book** for each section

Duration: 2 hours

Sitting: Autumn 2010

Section A

Q1.

A series of potassium permanganate standards were prepared from a 100ppm stock solution. The absorbance of each standard was measured in a 1cm cuvette at the λ_{max} ; results are given in the table. A 5cm³ aliquot of a potassium permanganate solution of unknown concentration was transferred to a 25cm³ volumetric flask and diluted to the mark; the absorbance of this solution was found to be 0.052

Conc. of standards (ppm)	1	5	10	15	20
Absorbance	0.008	0.039	0.073	0.117	0.160

- (a) In spectrophotometry, what do you understand by the terms λ_{max} and absorptivity? (4 marks)
- (b) What volume of the stock solution is required to prepare 50cm³ of the 15ppm standard? Show your calculations (2 marks)
- (c) Use the data in the table to construct the appropriate calibration plot and determine the concentration (in ppm) of the unknown solution of KMnO₄ (6 marks)
- (d) Calculate a value for the absorptivity of KMnO₄ at this wavelength. Assign units to the absorptivity (4 marks)
- (e) Give a step-by-step description of how the stock solution should be prepared to ensure accuracy in its concentration. (5 marks)
- (f) Identify the possible sources of error in the experiment and outline the precautions that need to be taken to minimize such errors (4 marks)

Q2.

- (a) Perform the appropriate calculations to show that 30cm³ of 0.15M Na₂CrO₄ and 40cm³ of 0.075M Na₃PO₄ have the same concentration of Na⁺ ions (5 marks)
- (b) If 2.5g of (NH₄)₂SO₄ are dissolved in enough water to make a 500cm³ solution, what is the molarity of the solution? (3 marks)
- (c) In the case of the following reaction



- (i) Calculate the weight of sodium chloride (NaCl) that is produced when 25.0g of Cl₂ are used? (3 marks)
- (ii) Theoretically how much (in g) sodium hydroxide (NaOH) is required to react with the 25g of Cl₂ (3 marks)
- (iii) In the context of this reaction, explain your understanding of the term 'percentage yield' i.e. % yield? (3 marks)
- (d) Distinguish between the terms *accuracy* and *precision* in scientific measurements. A sample was analyzed for sodium content and the analysis was repeated three times. The results obtained were 30.8, 28.8 and 29.5ppm. Determine the absolute error and the percentage error associated with each reading assuming the true content of sodium in the sample is 30ppm (8 marks)

Q3.

Under the headings provided, write informative notes on

- (a) Errors in scientific measurements:
- (i) Different types of errors (3 marks)
- (ii) Sources of errors (4 marks)
- (iii) Reducing or eliminating errors (5 marks)
- (b) IR, UV and visible spectrophotometry
- (i) Types of transitions involved (3 marks)
- (ii) Appearance of spectra (use sketches & label x- and y- axes) (4 marks)
- (iii) Sample holders, sample preparation and obtaining a spectrum (6 marks)

Section B

Q4. Answer all parts

- (a) List two safety precautions that should be observed when working with a strong acid in the laboratory. (2 marks)
- (b) What is the weight in grams of (i) 1 ml of water and 1ml HCl (spec. gravity 1.19). (4 marks)
- (c) Give two applications of thin layer chromatography. (2 marks)
- (d) Name two adsorbants used in TLC. (2 marks)
- (e) What solution can be added to an amino acid to give its pK_2 value? (2 marks)
- (f) What is the function of the electrophoresis buffer in gel electrophoresis (2 marks)
- (g) (i) Convert 0.07ml to microlitres
(ii) Comment on the precision of the following set of data (units are in grams);
5.0, 4.99, 5.01, 5.0, 4.98, 4.99, 5.0, 5.0, 5.02, 5.03 (5 marks)
- (h) Give labeled diagrams to illustrate the appearance of a suspension of bacteria **before** and **after** centrifugation at 10 000 rpm for 10 minutes (4 marks)
- (i) Give two applications of distillation. (2 marks)

Q5.

- (a) Explain what a buffer is and list three buffers commonly used in biological systems. (5 marks)
- (b) Calculate the weight of Tris (121.14g/mol) required to prepare 200cm³ of 0.2M solution. (5 marks)
- (c) Write an essay on the major sources of error in laboratory analyses. Comment on how these errors can be minimized to guarantee the quality of the results produced. (15 marks)

Q6. Write a comprehensive note on each of the following: *each note carries five marks.*

- (a) The autoclave
- (b) The analytical balance
- (c) The pH meter
- (d) The spectrophotometer
- (e) The centrifuge

Periodic Table of Elements

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39.1	40.1	45.0	47.9	50.9	52.0	54.9	55.9	58.9	58.7	63.5	65.4	69.7	72.6	74.9	79.0	79.9	83.8																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																
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