

BOWEN UNIVERSITY IWO, OSUN STATE
COLLEGE OF AGRICULTURE, ENGINEERING AND SCIENCE
INDUSTRIAL CHEMISTRY PROGRAMME
2022/2023 SESSION B.SC DEGREE SECOND SEMESTER EXAMINATION

Course Code: CHM 212 Course Title: Introductory Analytical Chemistry Credit: 2
Date: 26/06/2023 Time Allowed: 2½ Hours

Instructions: Answer at least ONE question from each section and four questions in all.

SECTION A

QUESTION ONE

- a. i. What is Analytical Chemistry? (2 marks)
ii. State the main purpose and principal applications of analytical chemistry. (3 marks)
- b. Briefly discuss:
 - i. qualitative,
 - ii. quantitative and
 - iii. structural analysis. (5 marks)
- c. List three ways by which systematic error can be detected and corrected. (3 marks)
- d. Five replicate measurements of an analyte gave the following results 1.13, 1.14, 1.17, 1.19 and 1.29. On inspection it seems that 1.29 may be an outlier. Should the value be retained or rejected. Q_{tab} at 90% confidence limit is 0.64. (5 marks)
- e. Ten replicate analyses of the concentration of Cd in a sample of water gave the following results: 23.3, 22.5, 21.9, 21.5, 19.9, 21.3, 21.7, 23.8, 22.6, and 24.7 mL. Calculate the mean, standard deviation, relative standard deviation and 95% confidence limit. Note that $T_{\text{tab}} = 2.26$ (7 marks)

QUESTION TWO

- a. Differentiate between the following:
 - i. Random and systematic errors
 - ii. Accuracy and precision
 - iii. End point and equivalence point (6 marks)
- b. Justify this statement: "sampling is the key to a successful analysis". (2 marks)
- c. The following data give the recovery of bromide from spiked samples of vegetable matter measured using a Gas-Liquid Chromatography method. The same amount of bromide was added to each specimen. Note that $F_{\text{tab}} = 4.28$ and $T_{\text{tab}} = 2.18$

Tomato	777	790	759	790	758	764	770 $\mu\text{g/g}$
Cucumber	782	773	778	765	789	797	782 $\mu\text{g/g}$

- i. Test whether the recoveries from the two vegetables have variance which differs significantly.
- ii. Test whether the mean recovery rate differ significantly. (10 marks)
- d. Chromatographic techniques are based on four sorption mechanisms. Name them. (2 marks)
- e. Acetic acid is the principal ingredient in vinegar that provides its sour taste. At equilibrium, a solution contains $[\text{CH}_3\text{CO}_2\text{H}] = 0.0787 \text{ M}$ and $[\text{H}_3\text{O}^+] = [\text{CH}_3\text{CO}_2^-] = 0.00118 \text{ M}$. What is the value of K_a for acetic acid? (5 marks)

QUESTION THREE

- a. Briefly discuss the following methods of separation:
 - i. Ion-exchange
 - ii. Distillation
 - iii. Chromatography (6 marks)
- b. What is an oxidizing agent and a reducing agent? Give one examples in each case. (3 marks)
- c. The following numbers are the numerical parts of physical quantities. After the indicated mathematical operations are carried out, how much can the results be expressed? Round off to the correct number of significant figures.
 - i. $\frac{5.61 \times 7.891}{9.1}$
 - ii. $6.81 - 6.730$
 - iii. $(2.765 \times 10^3) \times (2.3 \times 10^5)$
 - iv. $(4.351 \times 10^{-5}) \times (1.05 \times 10^{-6})$
 - v. $38.91 \times (6.81 - 6.730)$ (5 marks)
- d. Give concise meaning of the following terms:
 - i. Coning and Quartering
 - ii. Molecular-absorption analysis
 - iii. Standard Solution
 - iv. Fluorimetry (4 marks)
- e. With the aid of a schematic diagram, outline the necessary components of a typical spectrophotometer. (5 marks)
- f. Define the mathematical relationship between absorbance and transmittance. (2 marks)

SECTION B

QUESTION FOUR

- a. Explain the principle behind gravimetric analysis. (2 marks)
- b. Briefly describe:
 - i. Precipitation gravimetry
 - ii. Volatilization gravimetry and (5 marks)

- c. Outline and explain the basic practical steps involved in gravimetric analysis. (5 marks)
- d. Differentiate between inorganic and organic precipitating agents. Give examples. (3 marks)
- e. 644 mg of a sample containing Mg ($M_w = 24$) was dissolved in water and the magnesium content of the sample precipitated as $MgNH_4PO_4 \cdot 6H_2O$ and ignited and weighed as $Mg_2P_2O_7$ ($M_w = 222$). If this weight is 290 mg, calculate the percentage of Mg in the sample. (5 marks)
- f. 0.8 g sample containing sulphur ($M_w = 32$) was dissolved and the sulphur precipitated as $BaSO_4$ ($M_w = 233$). If the weight of the precipitate is 0.3 g, calculate the percentage of sulphur in the sample. (5 marks)

QUESTION FIVE

- a. State the Beers law and the Lamberts law and give their mathematical representations. Hence state the Beer-Lambert's law. (5 marks)
- b. Solutions of fluorene in benzene can be analysed by making use of its absorbance at 301nm, where the molar absorptivity $\epsilon = 1.10 \times 10^4$. If a solution of fluorene of unknown concentration in benzene exhibits an absorbance of 0.720 in a 1.00cm cell. What is the concentration of fluorene? (3 marks)
- c. Show diagrammatically with proper labelling the basic set up of a colorimeter and explain the functions of each component. (14 marks)
- d. Tobi the Chemist needs to determine the concentration of a deep blue copper sulphate solution. First, he transfers 25.00 mL of the solution by pipette into a 100.00 mL volumetric flask and makes the solution up to the mark with distilled water. Next, Chris prepares copper sulphate solutions of known concentration and measures their absorbance in order to establish a calibration curve from which he determined the absorbance of the diluted solution to be 0.506. If the concentration extrapolated from the calibration curve is 0.18 Mol L^{-1} . Determine the amount concentration (molarity) of the original copper sulphate solution. (3 marks)