MACHAKOS UNIVERSITY

University Examinations 2021/2022

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FOURTH YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE (ANALYTICAL CHEMISTRY)

SCH 406: SURFACE AND COLLOID CHEMISTRY

DATE: x/12/2022 **TIME: 2 Hours**

INSTRUCTIONS:

- The paper consists of **two** sections.
- Section **A** is **compulsory** (30 marks).
- Answer any **two** questions from section **B** (each 20 marks).

SECTION A

QUESTION ONE (30 MARKS)

a) Briefly, explain the meaning of the following terms: (5 marks)

i. Physisorption

ii. Chemisorption

iii. Polydispersity index (PDI)

iv. Catalysis

v. Surfactants

b) Discuss four useful applications of adsorption. (4 marks)

c) Discuss five applications of colloids. (5 marks)

d) Differentiate between the following terms: (6 marks)

i. Surface tension and interfacial tension

ii. Adsorption and absorption

iii. Soap and detergent

e) Provide reasons why the BET equation for determination of specific surface area works within relative pressure (P/P_0) of 0.05 to 0.35. (2 marks)

f) Discuss two electric properties of colloids. (4 marks)

g) Define the term emulsion and provide the two types of emulsion. (4 marks)

SECTION B

QUESTION TWO (20 MARKS)

a) Using diagrams, explain how the following factors affect adsorption of gaseous compounds:

i) Temperature (3 marks)

ii) Pressure (2 marks)

b) Discuss five assumptions of the Langmuir proposed adsorption isotherm. (5 marks)

c) Derive an expression for Langmuir adsorption isotherm that depicts the relationship between the number of active sites on the surface undergoing adsorption and pressure. (5 marks)

d) Give the expression describing the modified Langmuir equation for Adsorption from solutions and define all the terms involved. (5 marks)

QUESTION THREE (20 MARKS)

a) Discuss the useful application of BET adsorption isotherm. (2 marks)

b) The data below relates to the adsorption of N_2 on activated charcoal at 70K.

P/Torr	**1**	**7.0**	**22.9**	**43.8**	**63.9**	**100**
V/cm^3	118	280	325	360	395	430

At 70 K, P_O is 290 Torr. The volumes have been corrected to 1 atm and 273 K and refer to 1g of substrate

i. Confirm the data fits the BET isotherm in the range of pressures reported and calculate the BET constants V_m and C. (10 marks)

ii. Given that the A for nitrogen is 0.162 nm^2, calculate the specific surface area of the charcoal. (8 marks)

QUESTION FOUR (20 MARKS)

a) With the help of a diagram explain the role of catalysts in chemical reactions. (2 marks)

b) Explain the theory of heterogeneous and homogeneous catalysis (5 marks)

c) Explain the steps involved in heterogeneous catalysis. (5 marks)

d) Explain the action of promoters and poisons in catalysis and provide examples in each case. (3 marks)

e) The reaction between ethanedioic acid and a solution of potassium permanganate (VII) acidified with dilute sulphuric acid is a good example of autocatalysis.

$$2MnO_4^- + 6H^+ + 5\begin{matrix}COOH\\|\\COOH\end{matrix} \longrightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$$

i. Using this reaction as an example, explain what is meant by autocatalysis. (2 marks)

ii. If you plotted the concentration of the permanganate (VII) ions against time as the reaction happened, sketch the graph you would expect to get. (3 marks)

QUESTION FIVE (20 MARKS)

a) Give the state of the dispersed phase and the dispersion medium (gas, liquid, solid) for the following colloidal dispersion. (4 marks)

i) smoke

ii) mist

iii) milk

iv) gels

b) Describe any three methods used in preparation of lyophobic colloids. (6 marks)

c) Describe the cleansing action of detergents. (2 marks)

d) (i) Define the number average molecular weight and weight average molecular weight. (2 marks)

(ii) For the Data shown below, calculate the number average molecular weight and weight average molecular weight. (6 marks)

Number of Molecules, N_i	**Mass of Each Molecule, M_i**
1	800,000
3	750,000
5	700,000
8	650,000
10	600,000
13	550,000
20	500,000