



MACHAKOS UNIVERSITY

University Examinations 2022/2023 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

FOURTH YEAR SECOND SEMESTER EXAMINATION FOR

BACHELOR OF SCIENCE IN ANALYTICAL CHEMISTRY

SCH 406: SURFACE AND COLLOID CHEMISTRY

DATE: /12/2023

TIME:

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) In the case of chemisorption, adsorption increases first and then decreases with temperature. Explain. (3 marks)
- b) Ammonia (critical temperature, 405.5 K) adsorbs more readily on the surface of charcoal than O₂ (critical temperature, 154.6 K). Explain. (3 marks)
- c) Describe four useful applications of adsorption. (4 marks)
- d) Discuss the thermodynamics equation shown below in relation to adsorption. (4 marks)
$$\Delta G = \Delta H - T\Delta S$$
- e) Distinguish between the term's adsorption and absorption. (8 marks)
- f) Explain why desorption is important for a substance to act as good catalyst (2 marks)
- g) The volume of nitrogen gas required to cover 1 g of silica sample is 130 cm³ at STP. Calculate the surface area per gram of the adsorbent if the area occupied by nitrogen molecule is $16.2 \times 10^{-20} \text{ m}^2$ (4 marks)
- h) By use of a diagram, explain the role of catalysts in chemical reactions. (2 marks)

SECTION B

QUESTION TWO (20 MARKS)

- a) Distinguish between the following adsorption isotherms Langmuir, BET, Temkin, and Freundlich. Indicate when and why each is likely to be appropriate. (8 marks)
- b) Discuss six assumptions of the Langmuir proposed adsorption isotherm. (6 marks)
- c) Derive an expression for Langmuir adsorption isotherm explaining every term used. (6 marks)

QUESTION THREE (20 MARKS)

- a) Provide reasons why the BET equation for determination of specific surface area works within relative pressure (P/P⁰) of 0.05 to 0.35. (2 marks)

- b) The data given below is for the adsorption of nitrogen on 1 g of alumina at 77.3 K.

P/Torr	37.67	74.20	114.54	142.0	185.34
V/cm ³ /g; STP	23.14	28.1	33.1	36.35	41.49

At 77.3 K, saturation pressure is 733.59 Torr

- Show that the data fits the BET isotherm the range of pressures reported and hence calculate the BET constants V_m and C . (10 marks)
- Given that the area occupied by nitrogen molecule is 0.162 nm^2 , calculate the specific surface area of alumina. (8 marks)

QUESTION FOUR (20 MARKS)

- Explain intermediate compound formation theory of catalysis with an example. (4 marks)
- Explain the steps involved in heterogeneous catalysis (5 marks)
- The reaction between ethanedioic acid and a solution of potassium permanganate (VII) acidified with dilute sulphuric acid is a good example of autocatalysis.



- Using this reaction as an example, explain what is meant by autocatalysis. (2 marks)
 - Plot the expected graph for the concentration of the manganese (VII) ions against time as the reaction proceeds. (3 marks)
- d) Catalytic converters use metals such as platinum, palladium and rhodium deposited in thin layers on a ceramic honeycomb.
- Explain the reasons for making the catalytic converter in this way. (2 marks)
 - Write an equation to show how a catalytic converter might remove carbon monoxide and nitrogen monoxide from exhaust gases. (2 marks)
 - Why is it essential not to use leaded petrol with a catalytic converter? (2 marks)

QUESTION FIVE (20 MARKS)

- Write short notes on:
 - Electroosmosis
 - Catalytic Poison
 - Tyndall effect
 - Electrophoresis
 (8 marks)

- b) Describe why lyophilic colloidal sols are more stable than lyophobic colloidal sol. (4 marks)
- c) Describe what happens when a colloidal sol of $\text{Fe}(\text{OH})_3$ and As_2S_3 are mixed. (2 marks)
- d) Given that the surface tension of an organic liquid is 25 ergs/cm^2 , the surface tension of water is 72.8 ergs/cm^2 , and the interfacial tension between the two liquids is 30 ergs/cm^2 at 20°C , determine the work of cohesion of the organic liquid and the work of adhesion between the liquid and water at 20°C . (4 marks)
- e) Differentiate between the number average molecular weight and weight average molecular weight. (2 marks)