



(University of Choice)

**MASINDE MULIRO UNIVERSITY OF  
SCIENCE AND TECHNOLOGY  
(MMUST)**

**MAIN CAMPUS**

**SUPPLEMENTARY/SPECIAL EXAMINATIONS**

**2021/2022 ACADEMIC YEAR**

**THIRD YEAR SECOND SEMESTER EXAMINATIONS**

**FOR THE DEGREE  
OF**

**BACHELOR OF SCIENCE (CHEMISTRY) AND BACHELOR  
OF SCIENCE (INDUSTRIAL CHEMISTRY)**

**COURSE CODE: SCH 343E**

**COURSE TITLE: CRYSTALLOGRAPHY**

**DATE: THURSDAY 4<sup>th</sup> AUGUST 2022  
PM**

**TIME: 11.00 AM-1.00**

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INSTRUCTIONS TO CANDIDATES

Total Marks: 70

Answer all the Questions

TIME: 2 Hours

MMUST observes ZERO tolerance to examination cheating

This Paper Consists of 2 Pages. Please Turn Over

**Question One****(19 Marks)**

Explain the following terms as used in Crystallography

(6 Marks)

- i. Crystal twinning
  - ii. Crystalline solids
  - iii. Backscattering
- b. Using appropriate examples describe the THREE classes of molecular crystalline solids (6 Marks)
- c. I Explain the term miller indices (2 Marks)
- ii. Determine the Miller Indices of a simple cubic unit cell plane  $1, \infty, \infty$  (2 Marks)
- d. In a diffractometer, X-rays with a wavelength of 0.1315 nm were used to produce a diffraction pattern for copper. The first order diffraction ( $n = 1$ ) occurred at an angle  $2\theta = 50.50^\circ$ . Determine the spacing between the diffracting planes in copper (3 Marks)

**Question Two****(17 Marks)**

- a. State any THREE applications of single crystal x-ray diffraction (3 Marks)
- b. Briefly explain the TWO distinctive properties of neutron diffraction (4 Marks)
- c. Explain how the following types of crystals can be mounted for crystallographic studies (6 Marks)
- i. Air stable crystals
  - ii. Mildly air unstable compounds
  - iii. Very reactive compounds
- d. What do you think are qualities for a good crystal for crystallographic analysis (4 Marks)

**Question Three****(18 Marks)**

- a. State and explain any THREE corrections that are done during crystallographic data collection (6 Marks)
- b. State any FOUR special properties of protein crystals (4 Marks)

c. The wavelength of the X-rays is 0.071 nm which is diffracted by a plane of salt with 0.28 nm as the lattice constant. Determine the glancing angle for the second-order diffraction. Assume the value of the salt plane to be 110, and the given salt is rock salt (4 Marks)

d. Crystallization methods are divided into TWO broad categories. State these classes (2 Marks)

e. Name TWO types of detectors used in X-ray diffractometers (2 Marks)

**Question Four (16 Marks)**

a. Differentiate between hard and soft x-rays (2 Marks)

b. Briefly describe how x-rays are produced in an x-ray tube (6 Marks)

b. State FOUR ways in which powder x-ray diffraction can be used to characterize thin films samples (4 Marks)

c. The scattering factor ( $f$ ) of an atom is related to the electron density distribution in the atom,  $\rho(r)$ , by

$$f = 4\pi \int_0^{\infty} \rho(r) \frac{\sin kr}{kr} r^2 dr \quad k = \frac{4\pi}{\lambda} \sin \theta$$

Show that in the forward direction (for  $\theta = 0$ ),  $f$  is equal to the total number of electrons in the atom (4 Marks)