2017/2018 ACADEMIC YEAR

THIRD YEAR SECOND SEMESTER

MAIN EXAMINATIONS

FOR THE DEGREE OF BACHELOR OF SCIENCE IN CHEMISTRY

COURSE CODE: SCH 343

COURSE TITLE: CRYSTALLOGRAPHY

DATE: 12/10/2018   **TIME:11:30-1:30 Pm**

INSTRUCTIONS TO CANDIDATES

Answer question ONE and any other two questions

This paper consists of 2 printed pages. Please Turn over

QUESTION ONE

a) Define the following terms

i) Crystalline solid (2mks)

ii) Crystal Lattice (2mks)

iii) Unit cell (2mks)

iv)Motif (2mks)

b) By X-ray diffraction, it is found that Nickel crystals are face-centered cubic. The edge of the unit cell is 3.52 Å. The atomic mass of nickel is 58.7 and its density is 8.94 g/cm³. Calculate the avagadro's number from this data. (3mks)

c) Determine the Miller indices for a plane when the intercepts along the axes are 2a,-3b, and –c. (3mks)

d) i) Derive the Bragg's equation $n\lambda = 2dsin\theta$ as used in crystallography (4mks)

ii) Find the interplannar distance in a crystal in which a series of planes produce a first order reflection from a copper x-ray tube (λ=1.539 Å) at an angle of 22.5 °C (3mks)

e) Explain the terms **Point groups** and **space groups** (4mks)

f) Copper crystal has fcc cubic lattice structure. It's density is 8.93g/cm³. What is the length of the unit cell? {N_o=6.023×10²³; Cu=63.5} (3mks)

g) Identify the crystal system to a solid having the following dimensions for their unit cell belong. Give an example of the solid

a≠b≠c; α≠β≠Y≠90° (2mks)

QUESTION TWO (20 MARKS)

a) What is X-ray crystallography? (2mks)

b) Briefly describe the theory of Bragg's method of crystal analysis (4mks)

c) Different between the cubic close packing (ccp) and hexagonal close packing (hcp) of spheres (6 mks)

d) Explain the following crystal defects (6mks)

       i) Vacancy defect

       ii) Interstitial defect

       iii) Impurity defect

e) Draw a simple structure to represent a body centered cubic cell (2mks)

QUESTION 3 (20 MARKS)

a) Using the CF_4 molecule, explain what rotational inversion means (4mks)

b)   i)What is Stereogrsphic projection? (2mks)

            ii) Illustrate [100][110][111]and [112] planes in cubic lattices (8mks)

c) Write brief notes on the following instruments as used in x-ray crystallography (6mks)

       i) The source

       ii) Holder for sample

       iii) Signal converter.

QUESTION 4 (20 MARKS)

a) Briefly explain how the diffraction angle can be measured using the following methods

       i) The rotating crystal (6mks)

       ii) The powder method (6mks)

b)   i) Explain how neutron diffraction occurs (4mks)

       ii) Show that the momentum of the particles ρ can be calculated using the expression

$$\rho = \frac{h}{2d\sin\theta}$$

       Where h=plancks constant

          d= Interplannar distance (4mks)

QUESTION 5 (20 MARKS)

a) What do you understand by packing efficiency of a crystal? (2mks)

b) Explain the difference between ionic crystals and molecular crystals (4mks)

c) The ionic radii of Cs is 169 pm and that of Br is 195 pm. What kind of unit cell would be expected for CsBr crystal? Calculate the unit cell dimensions and the density of CsBr crystal [Cs=133;Br=80] (5mks)

d) What do you understand by

       i) axis of four fold symmetry? (2mks)

       ii) axis of three fold symmetry?(2mks)

e) What is 'phase problem' and how is it solved? (5mks)