SOUTH EASTERN KENYA UNIVERSITY

UNIVERSITY EXAMINATIONS 2016/2017

SECOND SEMESTER EXAMINATION FOR THE DEGREES OF

BACHELOR OF SCIENCE (CHEMISTRY)

SCH 406: SOLID STATE CHEMISTRY

DATE: 10ᵀᴴ APRIL, 2017   **TIME: 10.30-12.30 P.M**

INSTRUCTIONS TO CANDIDATES

(a) Answer **question One** and any other **Two questions**

(b) Question 1 **carries 30 marks** while the other questions **carry 20 marks** each

(c) Illustrate your answers with well labeled diagrams where appropriate

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Question 1 (30 marks)

a.) Define the following terms;

    i.)   Electron density   (1 mark)

    ii.)   Ionization potential   (1 mark)

    iii.)   Space Lattice   (1 mark)

    iv.)   Packing efficiency   (2 marks)

b.) Give the set of four quantum numbers (n, l, m_l, m_s) for each of the three (3) electrons in lithium.   (3 marks)

c.) Name two factors that dictate which structure is preferred for a given combination of metal and anion.   (2 marks)

d.) Explain why some isotopes, for instance, of uranium are unstable and hence radioactive (2 marks)

e.) Name four intermolecular forces and briefly explain what causes them. (8 marks)

f.) Name two types of close packing in materials and their coordination number (4 marks)

g.) Explain the significance of materials imperfection in our daily life. (6 marks)

Question 2 (20 marks)

a.) Explain the formation of closely packed structures from metallic bond perspective. (4 marks)

b.) In separate unit cells, draw the following crystallographic features: <0,0,1> and (1,1,2). (2 marks)

c.) Give the "nearest neighbor distance, number of nearest neighbor, and for a face-centered cubic crystal (FCC). (4 marks)

d.) Outline the four steps followed in determining the miller indices of a plane of atoms (4 marks)

e.) On each of three separate drawings of one face of an FCC unit cell, indicate one of each of the following: (1) substitutional impurity; (2) vacancy; (3) interstitial impurity. *Assume close-packed hard sphere model of atom packing.* (6 marks)

Question 3 (20 marks)

a.) Give three (3) planes belonging to the {010} family of planes (3 marks)

b.) What fraction of an atom belong to a given unit cell if the atom is positioned: i) center ii) face iii) edge iv) corner (4 marks)

c.) Body-centered cubic lattice has the following possible reflections: {2,2,0}, {1,1,2}, {0,1,2}, {1,1,1}, {1,1,0}, {0,0,1}. Which of these reflections represents true diffraction peaks. (3 marks)

d.) Calculate the fraction of space occupied by spheres in a face-centered unit cell (4 marks)

e.) Name six of the seven crystal systems (just the names, not the lattice parameters). (3 marks)

f.) Name three types of planar 2-D lattices (3 marks)

Question 4 (20 marks)

a.) For "hydrogen-like atoms with atomic number "Z" (containing one electron only), write the Rydberg equation for wave number of the emitted radiation associated with a particular electron transition

(6 marks)

b.) From the equation question #, n) explain how X-ray energy relates with " Z".

(3 marks)

c.) Calculate the wave number of characteristic L_α series of spectral lines corresponding to electronic transition from n = 3 to n = 2, for an X-ray target material with Z = 56 and electron screening effect σ = 0.74

(5 marks)

d.) Explain why glass is colourless/transparent. Cartoons are encouraged.

(4 marks)

e.) Name two types of defects in materials. (2 marks)

Question 5 (20 marks)

a.) Briefly describe Crown Process as is used in glass wool production.

(10 marks)

b.) Briefly describe three ways by which glass is made colored

(6 marks)

c.) Calculate the *d*-spacing for (2,2,2) planes of a cubic crystal structure with lattice constant "*a*" = 16 Angistrom. (4 marks)