**CHUKA**  **UNIVERSITY**

**UNIVERSITY EXAMINATIONS**

**EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF SCIENCE IN**

**CHIN 312: INTRODUCTION TO MATERIAL SCIENCE**

**STREAMS:** **TIME: 2 HOURS**

**DAY/DATE: TUESDAY 30/03/2021** **2.30 P.M – 4.30 P.M**

**INSTRUCTIONS:**

**Instructions: Answer QUESTION ONE and any OTHER TWO questions.**

**QUESTION ONE (3O MARKS)**

a) Briefly discuss two classification of solid materials using suitable example (4marks)

b) The atomic radii of $K^+$ and $Br^-$ are 0.138 and 0.196 nm respectively. Using the equation of the force of attraction between two ions

$F_A = \frac{dE_A}{dr}$, where $E_A = -\frac{A}{r}$ and constant $A = \frac{1}{4\pi\varepsilon_0}(|Z_1|e)(|Z_2|e)$

($e = 1.602 \times 10^{-19}$ C, $\varepsilon_0 = 8.85 \times 10^{-12}$ F/M)

i) Calculate the force of attraction between these ions at their equilibrium separation (4marks)

ii) What is the force of repulsion at this same separation distance (2marks)

c) Differentiate between i) Crystalline and amorphous materials (2marks)

ii) Polymorphism and allotropy (2marks)

d) i) Briefly explain the unit cell (3marks)

ii) Draw a hard-sphere unit cell representations of a Body-Centred Cubic (BCC) crystal structure and Simple Cubic Crystal (SCC)structure (4marks)

e) Briefly discuss the following type of crystal structure and give an example of each

i) AX-Type crystal structures (2marks)

ii) $A_mX_p$-Type crystal structures (2marks)

f) Give the five possible crystal systems and give their values of *a, b, c* and $\alpha$, $\beta$ and $\gamma$

(5marks)

**QUESTION TWO (20 MARKS)**

a) Discuss the following bonds using an example (4 marks)

i) Fluctuating Induced dipole bonds

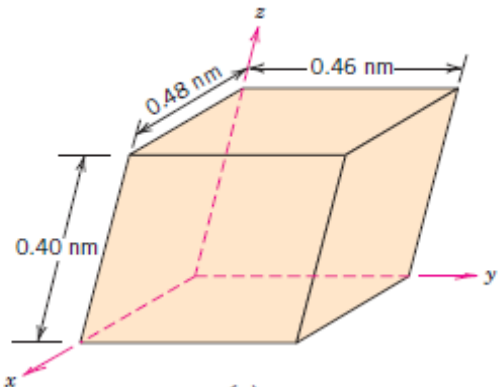
ii) Polar molecule-Induced dipole bonds

b) Compute the percent ionic character for the C-H bond (3 marks)

c) i) Using an equation explain the Atomic Packing Factor (APF) (2marks)

iii) Show that the atomic packing factor of the FCC crystal structure is 0.74 (4marks)

d) For the unit cell shown in the accompanying sketch, locate the point having coordinates $\frac{1}{4}\,1\,\frac{1}{2}$. (5mks)




e) Explain the linear density using an equation (2marks)

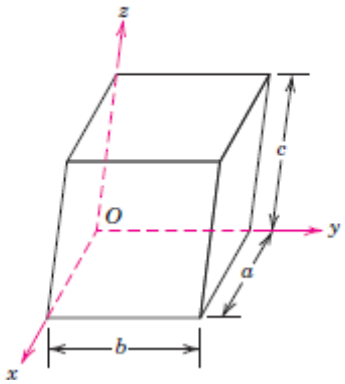
**QUESTION 3 (2O MARKS)**

a) Using suitable equation define the theoretical density and define the terms

(3marks)

b) Copper has an atomic radius of 0.128 nm, FCC crystal structure and atomic weight of 63.5 g/mol. Compute its theoretical density given its measured density = 8.94 g/cm. ( $N_A$= 6.022 x $10^{23}$ atoms /mol) (4 marks)

c) Construct a (101) plane within the following unit cell (5marks)




d) Explain the following terms

i) Polycrystalline ii) Grain boundary iii) Anisotropy iv) Diffraction v) Bragg's law (5mks)

e) Using a diagram differentiate between Frenkel and Schottky defects (3marks)

**QUESTION 4 (2O MARKS)**

a) i) Write the equation for equilibrium number of vacancies for a given quantity of material and define the terms (3marks)

ii) Calculate the equilibrium number of vacancies per cubic meter for copper at 1000 °C. The energy for vacancy formation is 0.9 Ev/atom; the atomic weight and density (at 1000 °C) for copper are 63.5 g/mol and 8.40 g/cm3 respectively (5mks)

b) Briefly explain the following terms: i) Solid solution (2mks) ii) dislocation (2marks)

c) Explain two Hume-Rothery rules (4marks)

d) Explain the two atomic diffusion mechanisms (4marks)

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