RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

BSc Honours in Chemistry
Fourth Year - Semester I Examination – July / August 2023

CHE 4215 – SOLID STATE CHEMISTRY

Time: Two (02) hours

Answer all questions.

All symbols given are as of their usual meaning.

$k_B = 8.67 \times 10^{-5}$ eV K^{-1} $N_A = 6.023 \times 10^{23} mol^{-1}$ $h = 6.626 \times 10^{-34}$ J s,

$c = 3 \times 10^8$ m s^{-1}

Use of a non-programmable calculator is permitted.

1. a) Contrast the differences between Primitive unit cells and Non Primitive unit cells. (03 marks)

   b) Comment on the following solid types.
   i. Covalent solid – Diamond
   ii. Covalent solid – Graphite (06 Marks)

   c) i. Estimate the perpendicular distance between the two planes indicated by the Miller indices (1 2 1) and (2 1 2) in a unit cell of a cubic lattice with a lattice constant parameter 'a'. (06 Marks)
   ii. Gallium arsenide (GaAs) has the similar crystal structure of Zinc blende. Assuming that a (lattice constant) is 0.565 nm, calculate the density of GaAs unit cell in g/cm^3. (Ga = 69.72 u, As = 74.92 u , 1u = 1.660×10^{-27} kg) (10 Marks)

2. a) Distinguish the conductivity that you would expect when pure Si is doped with,
   i. Sb
   ii. B (06 Marks)

   b) A formation energy of 2.0 eV is required to create a vacancy in a particular metal. At 800 °C there is one vacancy for every 10,000 atoms. At what temperature will there be one vacancy for every 1,000 atoms? (15 Marks)

c) Demonstrate the followings only using the appropriate illustrations,
   i. abc arrangement covering octahedral voids
   ii. aba arrangement covering tetrahedral voids (04 Marks)

3. a) The decomposition of $CaC_2O_4.H_2O$ occurred in three steps. In each step, percentage of the weight losses are 12.57% (100 - 226 °C), 19.47% (346 - 420 °C) and 30.07% (600 - 840 °C) for the first, second and third steps respectively. The temperature range in which the weight losses are indicated in brackets. Draw the thermogram for the $CaC_2O_4.H_2O$ decomposition and predict the mechanism. (10Marks)

b) Outline the working principle of AFM with the use of a labeled diagram. (05 Marks)

c) Sketch the main components of a SEM apparatus and briefly discuss the advantages and disadvantages of SEM as an analyzing technique. (10 Marks)

4. a) $K_\alpha 1$ radiation of Fe is the characteristic X-rays emitted when one of the electrons in L shell falls into the vacancy produced by knocking an electron out of the K-shell, and its wavelength is 0.1936 nm. Obtain the energy difference related to this process for X-ray emission. (10 marks)

b) Some characteristic X-rays commonly utilized for X-ray diffraction analysis are given below with their wavelengths in nm.

Element	Kα
Fe	0.1937
Co	0.1790
Cu	0.1541

When an X-ray diffraction pattern for a powder sample of tungsten (crystal system: body-centered cubic and lattice parameter a = 0.31648 nm) is measured using these four characteristic radiations. Compute the angles of the possibly detected diffraction peaks corresponding to (220) plane. (15 Marks)

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