RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES
B.Sc. (Honours) Degree in Chemistry
Third Year Semester II – Examination Feb/ March –2019

CHE 3212 – Solid State Chemistry

Answer ALL Questions **Time: Two (02) hours**

The use of non-programmable calculator is permitted

1.

a) The metal M has a face centered cubic lattice structure with a unit cell edge 'L nm'. The density of metal M is X g cm^{-3}. The molar mass of the metal M is Y g mol^{-1}. Using these parameters, construct a relationship in order to find the Avogadro number 'A'.

(50 marks)

b) X-rays of wavelength 0.150 nm are diffracted from a crystal at an angle of 30.17° Assuming that n= 2, what is the distance (in m) between layers in the crystal? Calculate the minimum interlayer spacing that can be measured with X-ray.

(50 marks)

2.

a)

i. Unit cell of the CsCl ionic crystal and gold lattice are primitive and body centered crystals,-respectively. Draw the crystal structure of the both unit cells?

ii. What is the coordination number of each crystal structure?

iii. Calculate the radius ratio of CsCl crystal structure.

iv. If unit cell volumes of both crystals are 0.08 nm^3 calculate the packing fraction of both unit cells separately. **(15x4 = 60 marks)**

b) For potassium chloride (KCl), (i) Determine the crystal structure and (ii) Calculate the packing factor. (r^+- 0.133 nm, r^- - 0.181 nm).

ρ	Coordination number
≥ 0.732	8:8
0.414-0.732	6:6
0.225-0.414	4:4

(40 marks)

3.

a) Born equation for lattice energy may be stated as:

i. $U_L = -[(N_0 A Z^+Z^-e^2)/(4\pi\varepsilon_0 d_0)] (1 - 1/n)$ Identify all terms in the equation.

ii. Calculate the standard heat of formation of zinc(II) oxide in the wurtzite structure using the fallowing data.

$N_0 = 6.022\times10^{23}$, Z+ = +2, Z– = –2, e = 1.602×10^{-19}, A = 1.641 for the wurtzite structure, $4\pi\varepsilon_0 = 1.113\times10^{-10}$, d_0 = 75 + 124 = 199 pm (for coordination number = 4) = 1.99×10^{-10} m, n = 8.

i.	$Zn(s) \longrightarrow Zn(g)$	S = 130.4 kJ mol^{-1}
ii.	$Zn(g) \longrightarrow Zn^+(g)$	IE_1 = 906.3 kJ mol^{-1}
iii.	$Zn^+(g) \longrightarrow Zn^{2+}(g)$	IE_2 = 1733 kJ mol^{-1}
iv.	$O_2(g) \longrightarrow O(g)$	D = 497 kJ mol^{-1}
v.	$O(g) \longrightarrow O^-(g)$	EA_1 = 141 kJ mol^{-1}
vi.	$O^-(g) \longrightarrow O^{2-}(g)$	EA_2 = –780 kJ mol^{-1}

(50 marks)

b)

i. Define each term in the of fallowing equation and calculate the number of vacancies in one cm^3 of Cu metal at room temperature (27 °C)

$$N_v = N_s \exp^{\left(\frac{-Q_v}{k_b T}\right)}$$

$k_b = 8.62 \times 10^{-5}$ eV $atom^{-1}$ K^{-1}, Q_v = 0.9 eV $atom^{-1}$, $N_A = 6.023 \times 10^{23}$ atoms mol^{-1}, ρ = 8.4 g cm^{-3}, A_{cu} = 63.5 g mol^{-1}

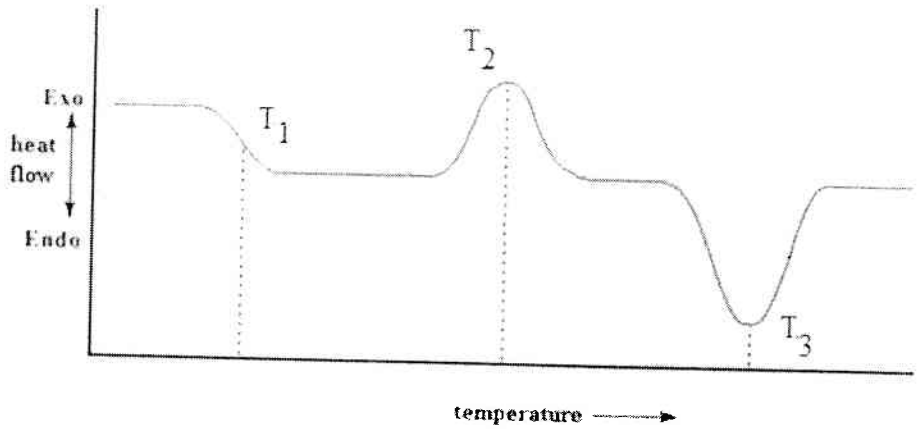
ii. Briefly discuss the 0D **or** 1D defects in crystal lattices.

(50 marks)

4.

a) Explain the basic principle of Differential Scanning Calorimetry (DSC). **(10 marks)**

b) DSC curve for amorphous polymer sample is given below. Explain this DSC curve using respective chemical or physical transformations at positions T_1, T_2 and T_3



(20 marks)

c) What are the main components of Differential Thermal Analysis (DTA) instrument?

(15 marks)

d) Explain the basic principles of DTA

(15 marks)

e) Write the advantages and disadvantages of the electron microscopy

(20 marks)

f) In a thermogravimetric analysis of pure $AgNO_3$ (50 mg) weight remains constant up to a temperature of 473 °C. At 473 °C it starts losing its weight and this indicates that the decomposition starts at this temperature. It decomposes to NO_2, O_2 and Ag. The loss in weight continues up to 608°C and beyond this temperature the weight of the sample remains constant. Draw the thermogram of pure $AgNO_3$.

(20 marks)

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