EASTERN UNIVERSITY, SRI LANKA

SPECIAL DEGREE EXAMINATION IN SCIENCE – 2012/2013

(SEPTEMBER/OCTOBER - 2016)

PHS 15 INTRODUCTION TO NANOTECHNOLOGY

02 hour

er ALL Questions

. Nano materials offer numerous solutions to attain low energy surface states.

(a) The surface energy of nano particles can be reduced by surfactants.

(i) What are surfactants?

(ii) How do they minimize surface energy?

(iii) What are "micelles"?

(iv) Name four major types of surfactants.

(b) Derjaguin, Landau, Verwey, and Overbeek (DLVO) theory of colloids suggests that the stability of a particle solution is dependent upon its total potential energy U_T. Assume that U_T is composed with two terms and is given by, $U_T = -\frac{A_H}{12\pi d^2} + 2\pi\varepsilon a\xi^2 e^{-kd}$, where the notions have their usual meaning.

(i) State the basic assumptions of DLVO.

(ii) Identify all the symbols in the equation for U_T.

(iii) With the aid of an appropriate diagram, explain what is ξ?.

(iv) What kinds of forces are responsible for the origination of the two terms in U_T?

(v) Sketch the variation of U_T with d.

(vi) Give an expression for the ionic strength.

(vii) Using your sketch of U_T with d and the definition of ionic strength, discuss the stability of a dispersion at low ($\sim 10^{-3}$ M) and high ($>10^{-3}$ M) molar concentrations of ions.

02. Quantum dots (QDs) have received considerable attention after they were first dis at the beginning of the 1980's.

(a) What is a QD?

(b) Explain why Gold (Au) QDs show semiconducting properties.

(c) Explain about "Coulombic Staircase" behavior.

(d) In nanoparticles, with a relatively large number of atoms on the surface com the volume, the surface to volume ratio (S/V) is a good scaling parameter to the size-dependent physical properties. To evaluate the effect of the nanopar on the melting temperature, T_m , consider spherical nanoparticles with surface area S and volume V.

(i) Determine the surface-to-volume ratio (S/V) of a spherical part function of its radius (r).

(ii) Assuming that the relative change in the melting temperature, T_m , gi

$$T_m = \frac{T_{m,bulk} - T_{m,NP}(r)}{T_{m,bulk}},$$

cales linearly with surface-to-volume ratio S/V, show that the temperature of nanoparticles with radius r is given by,

$$T_{m,NP}(r) = T_{m,bulk}\left[1 - \frac{A}{r}\right]$$

where $T_{m,bulk}$ is the melting temperature of the bulk material a material dependent constant.

03. (a) Write a short description on Graphite. Your description should contain its a structural information, physical and chemical properties .

(b) Calculate the density of C60 fullerene.

You may assume the following:

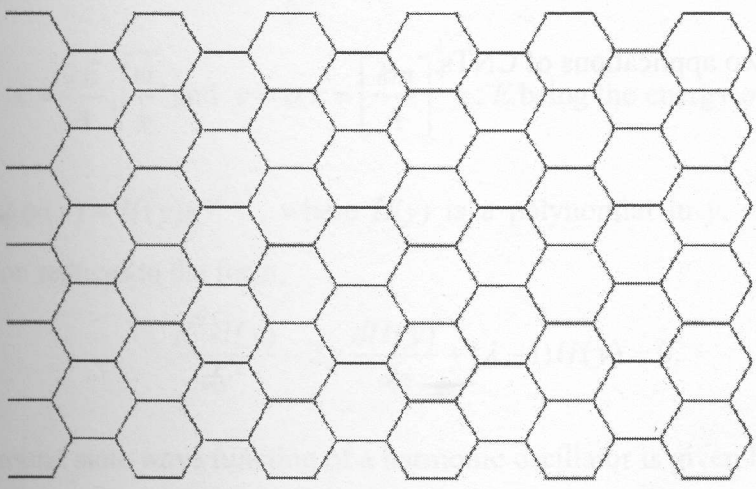
- C60 buckyball molecule has a diameter of 6.8 Å and arranged in centered cubic) Bravais lattice.
- Each lattice site occupies one C60 buckyball.
- The atomic mass of carbon is 12 g/mol
- The Avagadro's constant is 6.0×10^{23} mol^{-1}.

(c) What type of defects can be found in carbon nanotubes (CNTs)?

(d) (i) If one of the CNTs is a zig zag, draw three CNTs that can be fixed to the zig zag CNT, having a bent angle of 30 degrees.

(ii) Write down the relation among (n_1,m_1) and (n_2,m_2) of two nanotubes to have a 30 degree sharp bend between them.

(a) In the following diagram, sketch three chiral vectors of your choice belonging to the three types of nanotubes. Name and give the coordinates of the chiral vectors sketched.



(b) The figure below shows the optical absorption curve obtained for a semiconducting nanotube. A, B, and C are absorption peaks. Calculate the diameter of the nanotube. (Hopping parameter is 2.5 eV and the C-C bond length is 1.42 Å)