



RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. (Joint Major) Degree in Chemistry & Physics

Fourth Year – Semester II Examination – October/November 2014

PHY 4211 – NANOMATERIALS AND NANOTECHNOLOGY

Answer all four questions.

Time: Two hours

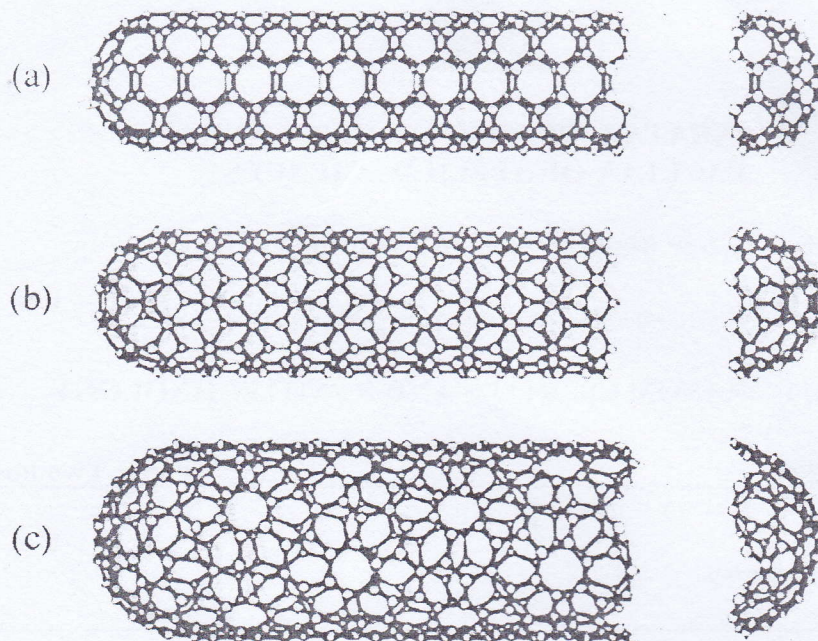
Use of a non programmable calculator is permitted.

Symbols have their usual meaning.

- (1) (i) What are the three groups of nanomaterials that can be distinguished by their geometry or shape? Write a short note on quantum dots stating the applications, confinement and the electronic structure. (10 marks)
- (ii) In nanoparticles (NP) with a large number of atoms on the surface compared to the volume, the surface-to-volume ratio is a good scaling parameter to estimate the effect of size constraints on material properties. To evaluate the effect of the nanoparticle size on the melting temperature;
- determine the surface-to-volume ratio as a function of the particle radius for spherical particles. (07 marks)
 - obtain an expression for the size dependence of the melting temperature ($T_{m,NP}(r)$), considering that the relative change of the melting temperature T_m , i.e. $\frac{T_{m,bulk} - T_{m,NP}(r)}{T_{m,bulk}}$ scales linearly with the surface-to-volume ratio. (08 marks)

Contd.

- (2) (i) Name the following three types of nanotubes and discuss the electrical properties of each type. (06 marks)



- (ii) Sort the following carbon nanotubes into the three types above. Which of them will show the metallic properties?

(7,7), (0,5), (3,6), (8,0), (4,4)

(06 marks)

- (iii) "The Young's modulus of the multiwall nanotubes (MWNT) is higher than that of single wall nanotubes (SWNT) and the Young's modulus of the SWNT is greater than that of SWNT bundle". Justify the statement. (06 marks)

- (iv) A (12,7) nanotube is used to make a laser. What would be the wavelength of the emitted laser beam? The C-C bond length is 1.41 \AA and hopping parameter is 3.5 eV . The diameter D of the tube is equal to $\frac{\sqrt{3} a_{cc} \sqrt{m^2 + n^2 + mn}}{\pi}$.

(07 marks)

- (3) (i) Briefly state how nanotechnology could improve the environment? (05 marks)
- (ii) Give names and chemical structures of three priority organic toxicants in the environment. (05 marks)
- (iii) Discuss briefly the techniques involved in Hierarchical imprinting in organic polymers and their applications in pollution abatement. (10 marks)
- (iv) Explain why nanoparticles are potentially dangerous? (05 marks)
- (4) (i) Cr is a common pollutant found in industrial waste sites. Briefly explain the chemistry behind the removal of hexavalent Cr using nano zerovalent iron (08 marks)
- (ii) Give two reasons for the low efficiency of converting photons of light into desired product in semiconductor photocatalysis. (04 marks)
- (iii) Explain the key reaction steps involved in the production of radical oxygen species by nano zero-valent iron in the presence of oxygen? (08 marks)
- (iv) pH strongly influences the redox reactions occurring at nanozerovalent iron. Explain briefly. (05 marks)

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