42

RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

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

Fourth Year – Semester II Examination – April/May 2016

PHY 4211 – NANOMATERIALS AND NANOTECHNOLOGY
PHY 4211 Nanomaterials and nanotechnology

Answer all four questions Time: Two hours
Use of non-programmable calculator is permitted.
Assume symbols have usual meaning.

1. (a) Compare the electric arc technique and the laser ablation method in the synthesis of CNTs. Your comparison should include the advantages and disadvantages of the methods. (13 marks)

(b) Nanoparticles (NP) with so many atoms on the surface compared to the volume, the surface-to-volume ratio is a good scaling parameter to estimate the effect of size confinement on material properties. To evaluate the effect of the nanoparticle size on the melting temperature;

(i) Calculate the surface-to-volume ratio as a function of the particle radius for spherical particles. (05 marks)

(ii) 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.

(07 marks)

2. (a) Nanotechnology can improve the environment. Comment

(06 marks)

(b) What is meant by nanoporous polymers? Discuss briefly the techniques involved in molecular imprinting in organic polymers and their applications in pollution abatement.

(08 marks)

(c) Give two chemical structures and names for each three different classes of persistent organic pollutants.

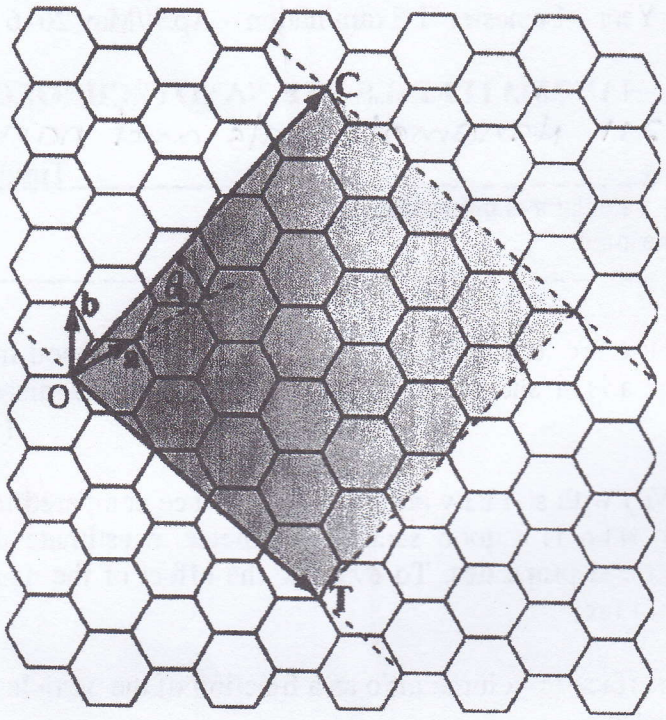
(06 marks)

(d) Discuss briefly the modification of cyclodextrin for efficient removal of pollutants

(05 marks)

3. (a) Write a description on Carbon Nanotubes (CNTs). Your description should include the types, structure, electrical, mechanical, chemical properties and applications of CNTs. (10 marks)

(b) The atomic arrangement of a grapheme sheet is shown in the figure below.



(i) Give the coordinates (n,m) of the chiral vector, if the CNT is formed by wrapping the sheet from O to C or from O to T. (04 marks)

(ii) Calculate the diameter of CNT for each wrapping. The C-C bond length is $1.41\,\text{Å}$. Are they metallic or semiconducting? Give reasons. (11 marks)

4. (a) Briefly explain the advantages of coupled semiconductor materials such as CdS/ TiO_2 in terms of the efficiency towards photocatalysis. (06 marks)

(b) What are the key reaction steps involved in the production of oxygen radicals in semiconductor photo catalytic systems? and how the size of the semiconductor material affects the efficiency of the process. (07 marks)

(c) Design an experiment to study the efficiency of intermolecular charge transfer process for a donor-acceptor type system (06 marks)

(d) State the potential problems in nanotechnology (06 marks)