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RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

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

Fourth Year – Semester II Examination – September/October 2013

PHY 4211 – Nanomaterials and Nanotechnology

Answer **four** questions. Time: Two hours

Use of a non programmable calculator is permitted.

Symbols have their usual meaning.

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(1) i. "The properties of materials can be different at the nanoscale for two main reasons". Briefly explain the above statement. (10 pts.)

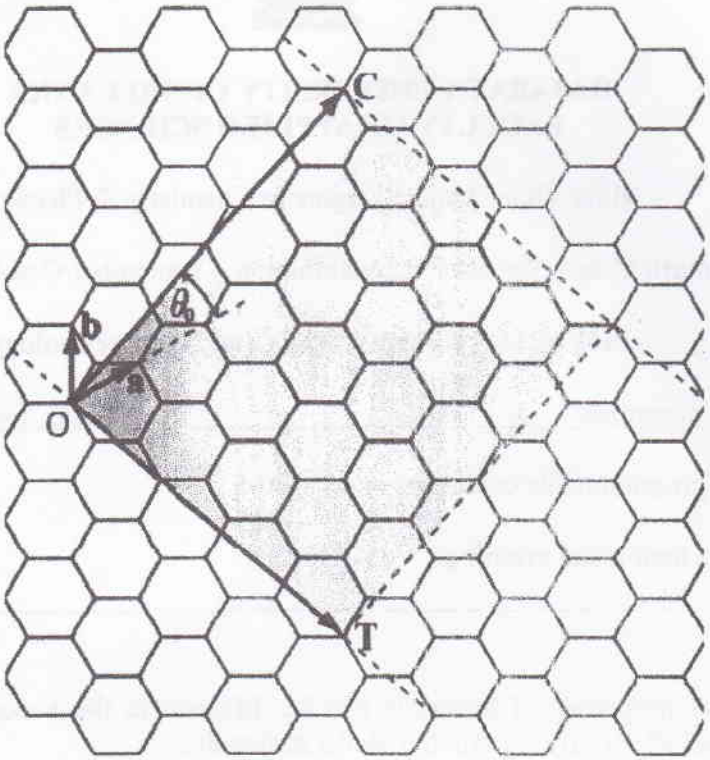
ii. What are the three groups of nanomaterials that can be distinguished by their geometry or shape? Write a brief account on "quantum dots" stating the applications, confinement and the electronic structure. (10 pts.)

iii What is meant by " bottom-up" and "top-down" approaches in nanotechnology? (5 pts.)

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

Contd.

ii. The atomic arrangement of a graphene 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 (i) from O to C (ii) from O to T. (4 pts.)

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

(3) i. Discuss briefly, the role of nanotechnology in pollution abatement. (10 pts.)

ii. Give two chemical structures and names for the toxic organic pollutants in water and air. (05 pts.)

iii. Nanomaterials may pose adverse effects on the environment and human health. Comment. (10 pts.)

(4) i. Give a detailed mechanism for the TiO_2 assisted photocatalytic destruction of organic pollutants. (10 pts.)

ii. Explain briefly 'charge recombination' in photoexcited systems. (05 pts.)

iii. Give two methods and explain how the charge recombination is minimized in photiexcited systems in (ii). (10 pts.)

(5) i. Nitrate is a priority pollutant in Sri Lankan drinking water resources. What are the health related consequences of nitrate pollution? (05 pts.)

ii. When a suitable electron donor is present, nitrate can be converted to ammonia. State the relevant half reaction. (04 pts.)

iii. Design a nitrate treatment method using nano zero valent iron (nZVi). Why this process is considered in compliance with green nanotechnology concepts? (08 pts.)

iv. What are the benefits of using nano iron particles in nitrate reduction? (05 pts.)

v. Why chlorination step is recommended after nitrate reduction step in nZVi based technology? (03 pts.)