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RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. (Joint Major) Degree in Chemistry and Physics
Fourth Year - Semester II Examination – February/March 2019

PHY4211 – NANOMATERIALS AND NANOTECHNOLOGY

Time: Two (02) hours

Answer **all** questions.

Use of a non-programmable calculator is permitted.

1. a) "The properties of materials can be different at the nanoscale for two main reasons". Briefly explain the statement. (40 Marks)

   b) Name three groups of nanomaterials that can be distinguished by their geometry or shape. Write a short note on fullerenes stating the bonding types, structure, physical and chemical properties and their applications. (40 Marks)

   c) What is it meant by "bottom-up" and "top-down" approaches in nanotechnology? (20 Marks)

2. a) Discuss the basic concepts of environmental nanotechnology. (20 Marks)

   b) What are the potential risks of nanomaterials to human health and to the environment? (20 Marks)

   c) What is meant by a persistent organic pollutant? Give two examples with chemical structures. (20 Marks)

   d) State the attributes of nanoparticles compared to that of the same bulk material. Explain the mechanism involved in the destruction of organic pollutants by zerovalent iron nanoparticles. (40 Marks)

Contd.

3. a) i. List the three types of Carbon nanotubes? Sort the following Carbon nanotubes into the three types.

(5,5), (7,1), (8,0), (6,3), (10,2), (9,0) (36 Marks)

ii. Which ones of the above Carbon nanotubes will show metallic properties? (20 Marks)

b) 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 $1.41\,\mathring{A}$ and hopping parameter is 3.5 eV. The diameter D of the tube is equal to $\frac{\sqrt{3}\,a_{cc}\sqrt{m^2+n^2+mn}}{\pi}$, with their usual meaning. (24 Marks)

c) "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. (20 Marks)

4. a) Charge recombination is one of the major issues in photoexcited semiconductors. Discuss briefly the strategies that could employ to enhance charge separation efficiency of photogenerated electron–hole pairs. (40 Marks)

b) Explain band bending of an n-type semiconductor when it is in contact with an aqueous solution. (20 Marks)

c) Describe the surface behavior of TiO_2 with pH. (20 Marks)

d) Discuss briefly the size dependent bang gap of a semiconductor. (20 Marks)

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