



RAJARATA UNIVERSITY OF SRI LANKA
FACULTY OF APPLIED SCIENCES

B.Sc. (Four Year) Degree in Applied Sciences
Fourth Year - Semester II Examination – June/July 2018

PHY4211 – NANOMATERIALS AND NANOTECHNOLOGY

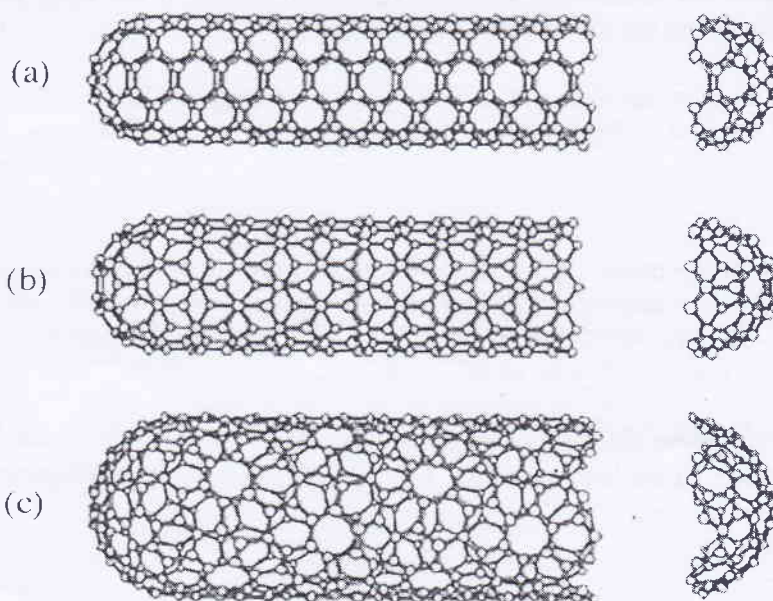
Time: Two (02) hours

Answer **only four (04)** questions. Answer **all** the questions in **PART A** and **any two (02)** questions from **PART B**.

Use of a non-programmable calculator is permitted.
All the symbols have their usual meaning.

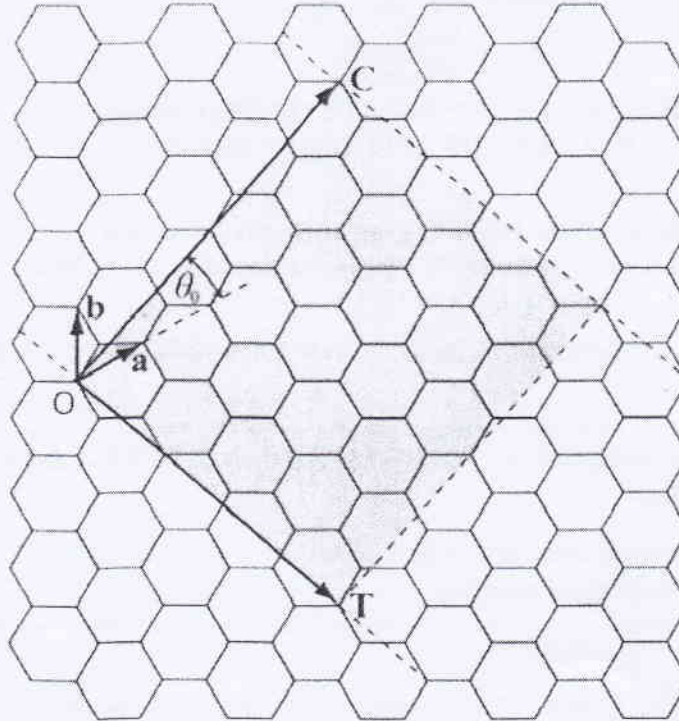
PART A

1. a) Name the following three types of nanotubes and discuss the electrical properties of each type.



(09 Marks)
Contd.

b) 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 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 \AA . Are they metallic or semiconducting? Give reasons. (12 Marks)

2. a) To ensure high quality, i.e. low contamination and scattering in vapour deposition methods, one requirement is a low pressure atmosphere. Normally, the pressure of high vacuum is considered to be in $10^{-1} - 10^{-5} \text{ Pa}$ and the pressure of ultrahigh vacuum is considered to be in $10^{-6} - 10^{-10} \text{ Pa}$.
 - i. Determine the mean free paths for 10^{-5} Pa and 10^{-10} Pa in both an air ($d \approx 0.37 \text{ nm}$) and a helium ($d \approx 0.2 \text{ nm}$) atmosphere at temperature 300 K . (10 Marks)

Contd.

Hint: Based on kinetic theory, the mean free path, i.e. the distance a gas molecule is traveling between collision is $\lambda = \frac{kT}{\pi\sqrt{2}Pd^2}$ with the effective molecular diameter d , the pressure P and the absolute temperature T . The Boltzmann constant k is equal to $1.38 \times 10^{-23} \text{ m}^2 \text{ kg s}^{-2} \text{ K}^{-1}$.

- ii. For a spherical deposition chamber with a diameter of 10 cm, estimate how many times the gas molecules in (i) will collide with the chamber before colliding with other gas molecules. (06 Marks)
 - iii. How many gas molecules are in the chamber for the pressures mentioned in (i)? (04 Marks)
- b) "Catalytic chemical vapour deposition synthesis of CNT's has been shown to be of more industrial interest". Justify the statement. (05 marks)

PART B

3. a) Relate specific structural and geometric characteristics of nanoporous polymers to their functions. (05 marks)
 - b) Discuss the following techniques.
 - i. Track etching
 - ii. Micellar imprinting
 - iii. Thermally induced phase separation (TIPS) (3×04 marks)
 - c) Explain the role of biodegradable polymers in self assembled diblock copolymer nanoporous polymer synthesis. (08 marks)
4. Fuel cells produce electricity through a chemical reaction
 - a) Use a schematic diagram to describe a fuel cell. (06 marks)
 - b) State advantages and disadvantages of polymer electrolyte materials in fuel cells. (04 marks)
 - c) Explain how the nanoporous polymer can be used to avoid above mentioned disadvantages. (05 marks)
 - d) Describe the synthesis of nanoporous polymer electrolyte using a suitable example. (10 marks)

5. a) Heavy metals and organic pollutants are the main factors affect in water pollution. Membrane filters are widely used in water purification.
- i. Write down the advantages of membrane filters in water purification. (03 marks)
 - ii. Summarize the specific characteristics of nanoporous membranes used in water purification. (03 marks)
 - iii. Discuss the preparation and application of bio-inspired block copolymer nanoporous membrane for heavy metal filtering (10 marks)
- b) Write a short note on risk of nanomaterials. (09 marks)

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