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University Examinations 2022/2023

FIRST YEAR, SECOND SEMESTER EXAMINATION FOR THE DEGREE OF MASTERS OF SCIENCE IN CHEMISTRY

SCH 7147: NANOMATERIALS AND NANOTECHNOLOGY

DATE: AUGUST 2023 **TIME: 3 HOURS**

INSTRUCTIONS: *answer question one and any other two questions*

QUESTION ONE (20 MARKS)

a) State two research areas or opportunities to contribute to nanoscience/nanotechnology (2 mark)

b) Discuss nanotechnology under the subheading

i. Define the term nanotechnology (1 mark)

ii. What are the requirements that has to be fulfilled by a technology in order for it to be considered as "Nanotechnology"? (2 mark)

iii. Briefly explain the reasons for nanotechnology growth (2 mark)

iv. List out challenges faced by Nanotechnology (2 mark)

v. Explain the four distinct generations in the development of nanotechnology products (4 mark)

c) Nano-particles are often proposed for applications in life-science.

i. Explain how hybrid gold nano-particles can be utilized for simple optical biomarker detection. (2 mark)

ii. Give an example of how liposomes can be used for drug delivery. (2 mark)

iii. Explain how DNA can be used in a bottom-up method for self-assembly of hybrid nanostructures containing inorganic nanoparticles? (2 mark)

d) (i) Explain three different purposes for using capping layers on nano-particles. (3 marks)

(ii) How is the melting point of metal nanoparticles influenced by reduced particle size? (1 marks)

(iii) What is the physical reason for the change in melting point (as you answered in e (i)) of metal nanoparticles? (1 marks)

e) State the effects of size reduction of nano particles. mark) (2 marks)

f) State the differences between quantum wire and quantum well. (2 marks)

g) Describe two methods of synthesis of nanoparticles. (2 marks)

QUESTION TWO (20 MARKS)

a) Discuss the Classification of Nanomaterials in detail. (4 marks)

b) Briefly explain top down and bottom up approaches for producing nanomaterials. (3 marks)

c) Explain Synthesis of Nanoparticles through Homogenous and Heterogenous nucleation (3 marks)

d) Explain the lithography method to fabricate nanomaterials. (3 marks)

e) List two applications of Nanomaterials and neatly explain them (3 marks)

QUESTION THREE (20 MARKS)

a) Discuss the fabrication and applications of quantum dots and quantum wires. (5 marks)

b) Distinguish between scanning tunneling and atomic force microscopy used in nanotechnology (5 marks)

c) Several microscopy techniques exist for imaging of structures at the nanoscale and smaller.

i. Make a sketch and explain the general principle for how the SEM works. (2 marks)

ii. Mention one specimen property that always must be fulfilled for SEM analyses? (1 mark)

iii. How can non-conducting samples be analyzed in the SEM. (2 marks)

QUESTION FOUR (20 MARKS)

a) Discuss carbon nanotubes under the following subheadings

(I) What are carbon nanotubes? (1 mark)

(II) Explain in detail these properties of carbon nanotubes

i. Electrical Properties (2 marks)

ii. Mechanical Properties (3 marks)

iii. Vibrational Properties (3 marks)

(III) State three applications of carbon nanotubes (3 marks)

b) Write the basic principles of sol-gel process. (3 marks)