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Reg. No. : .....

Name : .....

Sixth Semester B.Sc. Degree Examination, April 2022

First Degree Programme under CBCSS

Physics

Elective Course

PY 1661.4 — NANOSCIENCE AND TECHNOLOGY

(2018 & 2019 Admission)

Time : 3 Hours Max. Marks : 80

SECTION – A

Answer **all** questions. Answer should not exceed **two** sentences. Each question carries **1** mark.

1. Write the size regime in nanometres or angstrom for

   (a) size of atom

   (b) size of carbon dioxide molecule.

2. Give two examples for one dimensional nanostructure.

3. Define fermi temperature.

4. Define free electron fermi gas.

5. What do you mean by band gap of a semi-conductor?

6. Define quantum confinement.

P.T.O.

7. Explain ball milling process.

8. What is the principle of X-ray diffraction analysis?

9. Name any three allotropes of carbon used in nano technology

10. Write any two applications of nanotechnology

(10 × 1 = 10 Marks)

SECTION – B

Answer any **eight** questions in a paragraph. **Each** question carries **2** marks.

11. Explain the properties of zero dimensional nano structures. Give any two examples of zero dimensional nanostructures.

12. Explain the term-density of states.

13. What are the postulates of free electron model?

14. Explain Schottky effect.

15. Explain the band structure of semiconductors.

16. What are excitons?

17. Explain the size effects of Nano systems.

18. Explain the transport of electron in one dimensional system and its quantum mechanical effects.

19. Distinguish between top down and bottom up methods for the synthesis of nanostructures.

20. Explain the principle of STM.

21. Write a note on electrode position method.

22. Explain the properties of Buckminster fullerene.

23. Write and explain Debye-Scherer formula.

24. Explain any two applications of nanotechnology in energy physics.

25. Explain potential applications of nanotechnology in medical field.

26. List the challenges of nanotechnology in the real situation.

(8 × 2 = 16 Marks)

SECTION – C

Answer any **six** questions in a sentence or **two**. **Each** question carries **4** marks.

Fundamental data which can be used to solve the numerical problems are given below. Charge on an electron $e = 1.6 \times 10^{-19}$ C, Boltzmann constant $k_B = 1.38 \times 10^{-23} JK^{-1}$, $m_e = 9.1 \times 10^{-31}$ Kg.

27. A metallic cube of 1 cm in side is subdivided into cubes of 10 nm lengths. Calculate Change in surface area of the system?

28. Derive the density of states for 2D structures.

29. The Fermi energy of a metal which obeys free electron model is 2.76 eV. Calculates its Fermi velocity and Fermi temperature.

30. Calculate the ratio of the current density due to thermionic emission of tungsten at 1500 K to 2500K. The work function of Tungsten is 4.52 eV.

31. Derive the expression for the energy levels in an infinite potential well.

32. Explain the confinement of electrons trapped in a 2D plane nano sheet.

33. Write a note on nanolithography process.

34. Explain the principle of thermal evaporation and the experimental conditions required for thermal evaporation.

35. Explain the working of Scanning Tunneling Microscope.

36. Explain the properties of Carbon nanotubes and their uses.

37. Write a note on the application of nanotechnology in security or in defence technology.

38. What are BN nanotubes? Explain their structure and properties.

(6 × 4 = 24 Marks)

SECTION – D

Answer any **two** questions. **Each** question carries **15** marks.

39. Explain the classification of Nano structures based on their dimensions. Give one examples each and compare their properties.

40. Explain various conduction mechanisms in thin films.

41. Explain the size effects of Nano systems. Explain the quantum mechanical behaviour of a nano system whose electrons are trapped in all 3 dimensions.

42. With the help of a neat schematic diagram explain the chemical vapour deposition techniques.

43. Write a note on the principle, working and applications of Scanning Electron Microscopy.

44. Write detailed notes on :

(a) single electron transistor and

(b) molecular machines and examples of molecular machines.

(2 × 15 = 30 Marks)
