



Indian Institute of Technology Patna
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DEPARTMENT OF PHYSICS

MID-SEMESTER EXAMINATION M.M. 30 DURATION: 2 HOURS
COURSE: INTRODUCTION TO NANOMATERIALS (PH401) DATE: 16/09/2015
Attempt all Questions

- 1) Explain the gist of the talk entitled “There is plenty of room at the bottom” by Richard Fynman at Caltech 1959. [2]
- 2) What are the differences between conventional engineering and nanoengineering ? What is the relation between human scale and conventional engineering ? [2]
- 3) Section of a transparent polymer with 200nm, 250nm and 300nm thick are floating on the water. There are two microscopes to observe the surface of the water. One is from the top (perpendicular to the water surface) and another is at 45° with the water surface. What will be the colours at the polymers section observed by microscope independently? [refractive index of water, polymer and air is 1.33, 1.48 and 1 respectively. Range of visible light wavelength 390 to 700 nm]. [4]
- 4) Plot the curve between length scale (nm) and surface to volume ratio (m^{-1}) for plane, cylinder and cube and, explain its significance in nanoscience. [2]
- 5) Calculate the first 7 magic numbers, surface atoms and surface to volume ratio for cubohedral magic cluster. [4]
- 6) Calculate the weak, intermediate and strong confinement length for GaAs semiconductor ($m_e=0.067m_0$, $m_h=0.5m_0$, $v_e \sim v_h \sim 10^5 m/s$). Also calculate the electron confinement length for Cu ($m_e=0.98m_0$, $v_e=2.8 \times 10^8 m/s$). What are the significant in your results ? [3]
- 7) Define bulk(3D system), Quantum well(2D system) and nanowire (1D system) and quantum dot(0D system). Give one example from each category. [2]
- 8) What happen to the following properties if the size of the particle reduce from micro to nanoscale: Catalytic, electrical, magnetic, mechanical and optical. [2]
- 9) Write five top-down methods and five bottom-up methods to prepare nanomaterials. Give three examples where both approaches are used. [3]
- 10) Explain the three general kinds of photolithography. What is the resolution of a projection lithography system that employs an electron source with 5nm wavelength? Refractive index of the medium with respect to electron source is 0.95. Maximum possible angle of projection is 70° . Experimental arrangement constant (proportionality constant) is 0.4. [3]
- 11) Write short note on TEM. What will be the theoretical resolution of a 200KV? What is the approximate resolution available for commercial 200KV TEM? Why there is difference in above values ? [3]

-----BEST OF LUCK-----