

Major Exam
Nanostructured Materials PHL 726
IIT Delhi

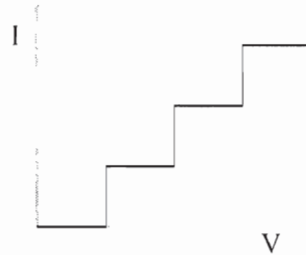
Marks: 50
Time: 2 hours

May 04, 2007

Q1. What is an exciton? How does an exciton form? Find out the value of first energy level $n=1$ of exciton for Silicon (use permittivity $= 10^{-10}$ F/m, effective mass of electron $= 0.26 m_0$ effective mass of hole $= 0.36$).

Write briefly what are two different types of excitons? Why does Bohr-exciton radius is defined as the meter stick to judge the quantum confinement in low dimensional systems?

Q2. What is Coulomb blockade (CB)? Write conditions to observe the CB effect? What are the step height and step width (in terms of capacitance C) of the following I-V curve for Quantum dot



Q3. What are the differences between SEM and TEM?

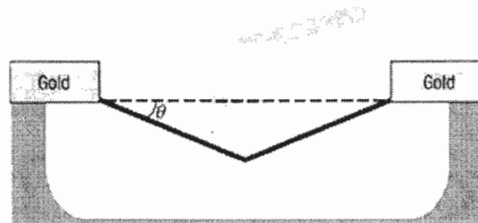
Q4. Why in ferromagnetic materials domains exist? Plot a magnetization M and magnetic field H curve for a single domain particle. What is superparamagnetism? Plot a curve showing the dependence of coercivity on particle size?

Q5. What is giant magnetoresistance (GMR)? What is its origin?

Q6. Find out which CNT's will be metallic in nature a) (3,0), b) (2,4), c) (3,2) and (3,3)?

Q7. Draw a schematic diagram of CNT FET? What are the advantages of using CNT in FET device?

Q8. In an electromechanical actuation experiment, CNT was suspended between two gold electrodes and was pressed in centre by an AFM tip. The conductance of the CNT decreases as θ increases, why?



Q9. What is a critical nucleation radius? How much will be the energy required to nucleate a spherical particle of critical radius R ?

Q10. The activation required in heterogeneous nucleation is lower than homogenous nucleation. Why?

Q11. Nanoparticles are predicted as almost vacancy free. Why? Prove that elastic energy per unit length for an edge dislocation is given by following expression, where G is bulk modulus, r_0 is core radius, r is crystal radius and ν is poisson's ratio.

$$E_{elastic} = \frac{Gb^2}{4\pi(1-\nu)} \ln\left(\frac{r}{r_0}\right)$$

Q12. Plot on the same graph both lateral as well as longitudinal resistances for a) normal Hall effect and b) quantum Hall effect measurements.

Q13. ATP is fuel of bio-motor. The conversion of ATP to ADP yields about 7 kcal/mole of energy. How?

Q14. Make a schematic of DNA molecule and name all of its constituents?