RAMAKRISHNA MISSION VIDYAMANDIRA
(Residential Autonomous College under University of Calcutta)
THIRD YEAR
B.A./B.SC. SIXTH SEMESTER (January – June) 2013
Mid-Semester Examination, March 2013

Date   : 05/03/2013   **PHYSICS** (Honours)

Time   : 12 noon – 2 pm   Paper : VII   Full Marks : 50

Answer five questions from Gr-A , Gr-B and Gr-C.
Use three answer scripts, one for each group.

Group – A [Nucl. Phys. and Particle Phys.]
Answer any one question :

1.a) Discuss, with necessary theory, the mirror nuclei method for determining the size of a nucleus.   4

b) A nucleus with A= 235 splits into two fragments whose mass numbers are in the ratio 3:2. Find the separation between the fragments at the time of splitting. Take $r_o = 1.4 \, fm$.   3

c) Argon ions (singly charged) suitably accelerated are mass analysed by a Bainbridge mass spectrograph. The electric and magnetic fields in the velocity filter are 15 KV per metre and 0.4T respectively. If the ions then enter the magnetic field of 0.9T what will be the distances between the ion focus lines on the photographic plate for the three isotopes Ar^{36}, Ar^{38} and Ar^{40} ?   3

2.a) Describe the principle of acceleration of an ion by a fixed frequency cyclotron and obtain the energy expression.   7

b) Write down   limitations of this machine.   3

Group – B [Statistical Mechanics.]
Answer any one question :

3.a) State Liouvilles' theorem and Ergodic hypothesis.   2
b) Show that the relative probability R (with respect to the most probable state) of getting a macrostate , in which n+s particles out of 2n spin $\frac{1}{2}$ particles, are in the up state, is $R = e^{-\frac{s^2}{n}}$, where s$\ll n$.   4
c) Consider a set of N localized non interacting one dimensional harmonic oscillations with the same fundamental frequency ω. Calculate the number of eigenstates associated with system energy E.   4

4.a) Find the phase space volume for a classical ideal gas of N particles in a volume V and having total energy between $E - \Delta E \, to \, E$. Hence obtain the number of microstates and the expression for entropy.   4+2

b) What is Gibb's paradox ? Does the above expression for entropy help in resolving the paradox? If not, make the correction and get the correct expression for entropy.   1+3

Group – C [Solid State Physics.]

Answer any three questions :

5.a) A particle having charge Q ($= 2 \times 10^{-19}\ C$) and mass m ($= 2 \times 10^{-30}\ Kg$) is moving in a circular orbit with angular velocity ω ($= 10^{12}\ rad/sec$). A magnetic field B ($= 10$ T) is applied perpendicularly to orbit plane.
Find an expression for the change of angular velocity of the particle and estimate fraction of change of it. Will radius of the orbit alter? Justify your answer.   6
b) Neon is found to be diamagnetic in character – explain.   2
c) Na^+ is less diamagnetic than Na – why?   2

6. a) Prove that charge particle moving in a circular orbit caries a magnetic moment.   2
b) How do you differentiate paramagnetic material from diamagnetic one in laboratory?   2
c) Using Langvin's theory, show that the paramagnetic susceptibility is inversely proportional to temperature.   6

7.a) Explain the difference between a unit cell and a primitive cell for a crystal.   2
b) Find the number of lattice points per unit cell in case of i) a simple cubic, ii) a body-centred cubic and iii) a face-centred cubic structure.   3
c) KBr crystal has a cubic structure. If its density is $2.75 \times 10^3\ Kg.m^{-3}$ and molecular weight is 119.01, calculate its lattice constant.   3
d) Show that packing fraction in case of fcc crystal is 0.74.   2

8.a) What are Miller indices?   2
b) Find an expression for the distance between adjacent planes with Miller indices (h,k,l) in a cubic crystal of lattice constant 'a'.   3
c) Explain what do you mean by reciprocal lattice?   2
d) Show that the reciprocal of a reciprocal lattice is a direct lattice.   3

9.a) On the basic of Quantum free electron theory derive an expression for the electrical conductivity in terms of Fermi surface(S_F).   5
b) Copper has a mass density, $D_m = 8.95$g/cm^3 , atomic weight M = 65.5 and electrical resistivity $\rho = 1.55 \times 10^{-8}$ Ω.m at temperature 300K. Calculate, i) the concentration of the conduction electron, ii) the relaxation time, iii) the Fermi energy, iv) the Fermi velocity and v) the mean free path at Fermi level. (Mass of electron: 9.11×10^{-31}kg).   5

10. a) What is Hall effect? Show that the Hall coefficient is independent of the applied magnetic field direction and is inversely proportional to the electron concentration.   1+4+1

b) Calculate the Hall coefficient of sodium based on free electron model. Sodium has bcc structure and the side of the cube is 42.8 nm.   4