M.Sc. 4th Semester Examination, 2013

PHYSICS

PAPER – PHS-401(A + B)

Full Marks : 40

Time : 2 hours

The figures in the right-hand margin indicate marks

Candidates are required to give their answers in their own words as far as practicable

Illustrate the answers wherever necessary

Use separate scripts for Gr. – A & B

GROUP – A

[*Marks* : 20]

Time : 1 hours

Answer **Q. No. 1** and any **one** from the rest

1. Answer any *five* : 2 × 5

(*a*) Write and interpret the integral equation showing the causal relationship between the

(*Turn Over*)

wave functions at two different times via a Green's function.

(*b*) Write the antisymmetric wave function of n non-interacting electrons in the form of a determinant and show that it is consistent with Pauli's exclusion principle.

(*c*) Explain the reason behind the fact that five of the six $3d$ electrons in iron have parallel spins so that each iron atom has a large resultant magnetic moment.

(*d*) What is the difference between the Hartree and the Hartree-Fock methods so far as the many-electron wave function is concerned ?

(*e*) State Koopmans' theorem.

(*f*) Estimate the Zeeman splitting $\Delta\nu$ of hydrogen spectral lines in a magnetic field of 1 weber/m^2.

[Given, $\frac{e\hbar}{2m} = 9 \cdot 3 \times 10^{-24}$ J / weber / m^2

$h = 6 \cdot 6 \times 10^{-34}$ J.s]

(*g*) What do you mean by phase shift in a scattering experiment ? Explain the nature of phase shift in case of attractive and repulsive scattering potentials.

(*h*) Establish the selection rules for electric dipole transition.

2. Consider the scattering of a particle by a potential $V(\vec{r})$.

(*a*) Write the Lippmann-Schwinger integral equation for the wave function of the scattered particle.

(*b*) Set up the Born series as a solution of the Lippmann-Schwinger equation. What is the drawback of this procedure of solution ?

(*c*) Discuss the fredholm method of solution of the Lippmann-Schwinger equation. 2 + (2 + 1) + 5

3. (*a*) Establish the expression of a plane wave in terms of spherical waves.

(*b*) In the partial wave analysis of scattering find the criterion for determining the significant number of spherical waves.

(*c*) Obtain an expression for the phase shift δ_0 for *s*-wave scattering by the potential

$$V(r) = \begin{cases} \infty & \text{for } 0 \le r \le a \\ 0 & \text{for } r > a \end{cases}$$ 5 + 2 + 3

GROUP – B

[*Marks* : 20]

Time : 1 hours

Answer **Q. No. 1** and any **one** from the rest

1. Answer any *five* : 2 × 5

(*a*) Draw entropy and specific heat as a function of temperature for 1st order and 2nd order phase transitions.

(*b*) Explain phase transition in the light of Lee and Yang's theory.

(*c*) In what limit do the B-E and F-D gas behave as classical gases and why ?

(*d*) What are critical exponents ?

(*e*) Explain the term 'symmetry breaking' for para-ferro transition.

(*f*) Explain the term 'degenerate' electron gas.

(*g*) Distinguish between condensed matter and B-E condensation.

(*h*) Explain 'mean field' theory in context of Bragg William's approximation for Ising model.

2. (*a*) Find out an expression of the carrier statistics for two dimensional Fermi gas.

(*b*) From Planck's radiation law formulate Rayleigh-Jean's and Wien's laws respectively.

(*c*) Write down the expression for free energy of FD gas under magnetic quantization. Prove that degree of degeneracy is given by

$$g = AH \Big/ \frac{hc}{e}$$

for a two-dimensional system of area A with magnetic field H. 3 + 3 + 1 + 3

3. (*a*) Prove that one dimensional Ising system does not show Ferromagnetian at $T = 0$ K.

(*b*) For a 2nd order-phase phase transition Gibb's free energy is given by

$$G(T, m) = G_0(T) + a(T)m^2 + b(T)m^4 + \cdots$$

where m is the order parameter obtain the possible values of m for stable phase.

Prove that entropy is continuous at T_c with the help of *G-L* theory. 4 + 3 + 3
