



NCD-003-020201 Seat No. _____

M. Sc. (Sem. II) (CBCS) Examination

April/May – 2017

Physics : Paper - CT-5

(Quantum Mech. - II & Stat. Mech.)

(Old Course)

Faculty Code : 003

Subject Code : 020201

Time : $2\frac{1}{2}$ Hours]

[Total Marks : 70

Instructions :

- (1) Attempt all questions.
- (2) All questions carry equal marks.
- (3) Assigned marks are indicated on RHS.
- (4) Mathematical symbols have usual meaning.

1 Answer any seven :

- (a) If u_{sc} is scattered wave given as $u_{sc} = f(\theta, \phi) \frac{e^{ikr}}{r}$ and e^{ikz} **2**

is in-coming plane wave, to calculate the scattering cross-section there is a need to determine the particular stationary wave function

$u(\vec{x})$ fulfilling the asymptotic form (at infinity), write that form.

- (b) Why Green's function is used in scattering theory ? **2**

- (c) Using the following expression of differential scattering cross-section 2

$$\frac{d\sigma(\theta)}{d\Omega} = \frac{1}{K^2} \sum_{l=0}^{\infty} \sum_{l'=0}^{\infty} (2l+1)(2l'+1) e^{i(\delta_l - \delta_{l'})} \sin \delta_l \sin \delta_{l'} P_l(\cos \theta) P_{l'}(\cos \theta)$$

obtain the following form for $l=1, l'=0$.

$$\frac{d\sigma(\theta)}{d\Omega} = \frac{3}{K^2} e^{i(\delta_1 - \delta_0)} \sin \delta_1 \sin \delta_0 \cos \theta.$$

- (d) Why Eikonal approximation is superior to Born approximation ? 2
- (e) What is quasi-static thermodynamic transformation ? How the inverse absolute temperature T^{-1} is defined ? 2
- (f) In the following expression the volume in Γ space enclosed by energy surface of energy E is given 2

$$\Sigma(E) = \frac{1}{h^{3N}} \int d^3 p_1 d^3 p_2 \dots d^3 p_N d^3 q_1 d^3 q_2 \dots d^3 q_N$$

What is the role of h ? What is its dimension ? Why it is used ?

- (g) Using the following Helmholtz free energy expression

$$A(N, V, T) = Na(v), \text{ where } v = \frac{V}{N}, \text{ if}$$

$$\mu = \frac{\partial Na(v)}{\partial N} \text{ then prove that } \frac{\partial \mu}{\partial v} = -v \frac{\partial^2 a(v)}{\partial v^2}.$$

- (h) Write postulates of quantum statistics. 2
- (i) With figure explain Andronikashvili experiment to know the relative amount of normal and super fluid. 2
- (j) What is the concept of lattice gas ? Where it is used ? 2

2 Attempt any two :

- (a) Using the Green's function obtain the following expression 7

$$G_{\pm}(x^{-1}, x^{-11}) = \frac{\exp\left[\pm ik |x^{-1} - x^{-11}| \right]}{-4\pi |x^{-1} - x^{-11}|}$$

- (b) Explain the screened Coulomb potential with necessary derivations. 7

- (c) To check the validity of Born approximation for the square well potential, solve the following given equation for 7

- (i) $\rho \ll 1$ and (ii) for $\rho \gg 1$, where $\rho = 2ka$

$$\frac{m}{k\hbar^2} \left| \int_0^{\infty} (e^{ikr} - 1) V(r) dr \right| \ll 1$$

- 3 (a) Obtain the following expression for partial wave analysis. 7

$$f(\theta) = k^{-1} \sum_{l=0}^{\infty} (2l+1) e^{i\delta_l} \sin \delta_l P_l(\cos \theta)$$

- (b) Explain, how the optical theorem is used in scattering theory. 7

OR

- 3 (a) Obtain the following expression for equipartition theorem using 7

$$\text{Virial theorem } \left\langle \sum_{i=1}^{3N} q_i \dot{p}_i \right\rangle = -3NKT$$

- (b) For classical ideal gas derive following equation 7

$$S = NK \log \left[V \left(\frac{4\pi m E}{3h^2 N} \right)^{3/2} \right] + \frac{3}{2} NK$$

4 Answer any two :

(a) In the grand canonical ensemble obtain the following expression 7

$$\rho(p, q, N) = \frac{Z^N e^{-\beta \sum p - \beta (p, q)}}{N! h^3 N}$$

(b) Explain micro-canonical ensemble in quantum statistics. 7

(c) Draw the figure to count the interaction between different pairs in 2-D lattice in Ising model and derive the following expression, 7

$$E_I(N_+, N_{++}) = -4 \epsilon N_{++} - \left(\frac{1}{2} \gamma \epsilon - H \right) N + 2(\epsilon \gamma - H) N_+.$$

5 Write notes on any two :

(a) Gibbs Paradox. 7

(b) Born Series. 7

(c) Tiszals two Fluid Model. 7

(d) Density Matrix. 7
