Total No. of Questions : 7]

SEAT No. :

P1423

[Total No. of Pages :2

[5222] - 11

M.Sc.

PHYSICS

PHY UTN- 501: Classical Mechanics

(Semester -I) (2008 Pattern) (Credit System)

Time : 3 Hours] *[Max. Marks :80*

Instructions to the candidates:

1) *Question No.1 is compulsory, and any four from the remaining.*
2) *Draw neat diagram wherever necessary.*
3) *Figures to the right indicates full marks.*
4) *Use of log table & calculator is allowed.*

Q1) Attempt any four of the following:

a) Show that Lagrangian for a relativistic particle moving through a potential v(r) is given by $L(\bar{r},\vec{v}) = -moc^2\sqrt{1-v^2/c^2} - V(\vec{r})$ **[4]**

b) Explain the concept of generalised coordinates **[4]**

c) Explain the effect of Coriolis force on cyclones & anticyclones **[4]**

d) Evaluate the following Poisson's bracket $[\bar{a}.\bar{r}, \overline{b}.\overline{p}]$, where $\bar{a}$ & $\bar{b}$ are constant vectors **[4]**

e) Compare Newtonian & Lagrangian formulation **[4]**

f) State different properties of central force **[4]**

Q2) a) Show that the following transformations are canonical **[8]**

i) $Q = \bar{P}^1$ $P = qp^2$

ii) $Q = q\tan p$ $P = \log(\sin p)$

b) With the help of example explain the concept of constraint & degrees of freedom **[4]**

c) What do you mean by closure & stability of orbits under central forces? State their necessary conditions. **[4]**

P.T.O.

Q3) a) Solve the problem of simple pendulum by using Hamilton's equation of motion. Show that the phase space is an ellipse **[8]**

b) State & prove any four properties of Poisson's bracket **[8]**

Q4) a) Show that the shortest distance between two points in a plane is straight line **[8]**

b) Obtain a Lagrangian & Solve the Lagrange's equation of motion for a planet moving around the sun in an elliptical orbit. **[8]**

Q5) a) Define virial of the system. Using virial theorem obtain Boyle's law. **[8]**

b) Show that Lagrange's equation of motions are invariant under Galilean transformation. **[8]**

Q6) a) State & prove Poisson's first theorem . **[8]**

b) Show that the period of rotation of the plane of oscillation of Foucault's pendulum is given by $T = \dfrac{2\pi}{\omega \sin \lambda}$ **[8]**

Q7) a) Obtain Hamiltonian for following Langrangians

i) $L(x,\dot{x}) = \frac{1}{2}\dot{x}^2 - \frac{1}{2}w^2x^2 - \alpha x^3 + \beta x\dot{x}^2.$

ii) $L(r,Q) = \frac{1}{2}\mu(\dot{r}^2 + r^2\dot{Q}^2)\frac{-k}{r}$ **[8]**

b) Draw a phase space & state space for one dimensional harmonic oscillator **[4]**

c) Show that

$$[u, q_i] = -\frac{\partial u}{\partial p_i} \quad \& \quad [u, p_i] = \frac{\partial u}{\partial p_i}$$ **[4]**

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Total No. of Questions : 7]

SEAT No. :

P1424

[Total No. of Pages : 2

[5222]-12
M.Sc. - I
PHYSICS
PHYUTN - 502 : Electronics
(2008 Pattern) (Semester - I)

Time : 3 Hours] ***[Max. Marks : 80***

Instructions to the candidates:

1) ***Question No. 1 is compulsory. Attempt any four from the remaining.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables and non-programmable calculator is allowed.***

Q1) Attempt <u>any four</u> of the following.

a) State atleast four parameters of an op-amp and explain any two in detail. **[4]**

b) What is PLL? Draw it's block diagram. Define it's capture range and locking range. **[4]**

c) What are shift registers? How are they used? State the different types of shift registers. **[4]**

d) An op-amp is used in the inverting and non inverting mode with $R_1 = 2K\Omega$ and $R_F = 100K\Omega$. If $V_{cc} = \pm 15V$ and rms input voltage $V_i = 20mV$; calculate the output voltage in each case. **[4]**

e) Design second order Butterworth low pass filter for higher cuttoff frequency of 5KHz. **[4]**

f) If logic '1' = 16V and '0' = 0V, determine the following for R-2R type DAC. **[4]**

i) Analog output for digital input of 1111

ii) Resolution

Q2) a) Draw circuit diagram of an asymmetric astable multivibrator. Explain its operation. Design it to generate a generater a rectangular wave of 80% duty cycle and 1KHz frequency at output.

[Given : $+V_{cc} = +10V$ and $-V_{cc} = -10V$ and $\beta = 0.4$] **[8]**

b) With neat block diagram, explain the working of switching regulator. State its advantages and two applications. **[8]**

P.T.O.

Q3) a) Draw circuit diagram of full wave precision rectifier. Explain its action. Derive expression for its output voltage. **[8]**

b) Explain the concept of foldback current limiting. How it can be implemented for low-voltage regulator using IC723. **[8]**

Q4) a) Draw circuit diagram of an instrumentation amplifier using three op-amps. **[8]**

b) Draw functional block diagram of IC 7495. State its various operating modes. **[8]**

Q5) a) Sketch a block diagram of IC8038. State the function of each component. **[8]**

b) Draw circuit diagram of first order Butterworth Low-pass filter and explain. Calculate the cutt-off frequency if R = KΩ and C = 0.001 μF. **[8]**

Q6) a) Draw block diagram of 3-pin voltage regulator. Explain function of each block. Design adjustable voltage regulator using LM317 to have an output voltage variable from 5 to 15V. **[8]**

b) Given the logic equation $Y = ABC + B\bar{C}D + \bar{A}BC$ make a truth table. Simplify using Karnaugh-map and sketch the necessary logic diagram. **[8]**

Q7) Write short note on any four of the following. **[16]**

a) Successive approximation ADC.

b) Satellite communication.

c) Voltage controlled oscillator using IC566.

d) DC to DC converter.

e) Function generator using two OPAMPS.

f) UPS and Inverters.

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Total No. of Questions : 7]

SEAT No. :

P1425

[Total No. of Pages : 3

[5222] - 13

M.Sc.

PHYSICS

PHYUTN-503 : Mathematical Methods in Physics

(2008 Pattern) (Semester - I)

Time : 3 Hours] *[Max. Marks :80*

Instructions to the candidates:

1) ***Question No. 1 is compulsory. Attempt any four questions from the remaining.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic table and calculator is allowed.***

Q1) Attempt any four of the following :

a) Find Laplace transform of $\sinh(at)$. **[4]**

b) Let V be the set of ordered pairs of real numbers : $V = \{(a, b); a, b \in R\}$. Show that V is not a vector space over R with respect to the following operations of addition in V and scalar multiplication on V :

$(a, b) + (c, d) = (a, b)$ and $K(a, b) = (ka, kb)$ **[4]**

c) State and prove the Parseval's Identity for Fourier series. **[4]**

d) Define Basis and Dimension of a vector space. **[4]**

e) Prove that : $H_{n+1}(x) = 2xH_n(x) - 2nH_{n-1}(x)$. **[4]**

f) Evaluate $\oint_C \frac{e^z}{z(z+1)} dz$ where C is the circle $|z-1| = 3$. **[4]**

Q2) a) Define Inner product space. Verify that $\langle u,v \rangle = x_1y_1 - x_1y_2 - x_2y_1 + 3x_2y_2$, where $u = (x_1, x_2)$ and $v = (y_1, y_2)$ is an inner product in R^2. **[8]**

b) Find the Fourier coefficients a_n and b_n in the interval (–L, +L) for odd and even functions. **[8]**

P.T.O.

Q3) a) Find $L^{-1}\left\{\frac{5s^2-15s+7}{(s+1)(s-2)^3}\right\}$. **[8]**

b) Consider the following basis of Euclidean space R^3.

$\{v_1 = (1, 1, 1), v_2 = (0, 1, 1), v_3 = (0, 0, 1)\}$

By using Gram-Smidt orthogonalization process transform $\{v_i\}$ into an orthonormal basis $\{u_i\}$. **[8]**

Q4) a) State and prove the orthogonality property of Hermite functions. **[8]**

b) State and prove Cauchy Riemann equations for a function to be analytic. **[8]**

Q5) a) Obtain the Associated Legendre functions $P_2^1(x)$ and $P_3^2(x)$. **[8]**

b) Find Laurent series about the indicated singularity for each of the following functions. Name the singularity in each case and give the region of convergence of each series. **[8]**

i) $\frac{e^z}{(z-1)^2}$; $z = 1$

ii) $z\cos\frac{1}{z}$; $z = 0$.

Q6) a) Let $A=\begin{pmatrix}1 & -3 & 3\\ 3 & -5 & 3\\ 6 & -6 & 4\end{pmatrix}$. Find a (real) orthogonal matrix P for which $P^{-1}AP$ is diagonal. **[8]**

b) Obtain the Fourier series corresponding to the function :

$f(x) = 0, -5 < x < 0$

$f(x) = 3, 0 < x < 5$, period = 10. **[8]**

Q7) a) Prove that : $J'_n(x)=\frac{1}{2}\left[J_{n-1}(x)-J_{n+1}(x)\right]$. **[4]**

b) State and prove Laurent's theorem. **[4]**

c) Prove that : $L_{n+1}(x) = 2(n + 1 - x)\, L_n(x) - n^2 L_{n-1}(x)$. **[4]**

d) Determine the region in the z plane represented by $1<|z+2i|\leq 2$. **[4]**

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Total No. of Questions :7]

SEAT No. :

P1426

[Total No. of Pages : 3

[5222]-14
M.Sc.
PHYSICS
PHYUTN - 504 : Quantum Mechanics-I
(2008 Pattern) (Semester - I)

Time : 3 Hours] *[Max. Marks : 80*

Instructions to the candidates:

1) ***Question No.1 is compulsory and solve any four questions from the remaining.***
2) ***Draw neat diagram wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables and electronic pocket calculator is allowed.***

Q1) Attempt any four of the following:

a) If L and A are linear operators then prove that

$$e^{L}Ae^{-L} = A + [L,A] + \frac{1}{2!}[L,[L,A]] + ...$$ **[4]**

b) If an arbitrary state $|\psi\rangle$ is expanded in terms of complete set of eigen functions $|a\rangle$ by an equation $|\psi\rangle = \sum_{a} C_a |a\rangle$, hence define a projection operator $\hat{P}_a$. **[4]**

c) Using uncertainty relation, estimate the size of hydrogen atom in the ground state. **[4]**

d) Write note on Dirac δ-function. **[4]**

e) State four postulates of quantum mechanics. **[4]**

f) In momentum space, show that $\left[x_{0p}, P_{0p}\right] = i\hbar$. **[4]**

Q2) a) Obtain coefficients $C^{\pm}_{lm}$ in equation $L_{\pm}|l,m\rangle = C^{\pm}_{lm}|l,m\pm1\rangle$, where $|l,m\rangle$ are simultaneous eigen states of L^2 and L_z operators and L_+ and L_- are raising and lowering operators. **[8]**

b) What is unitary transformation? By using it explain the transformation of one complete orthonormal set of basis to other basis. **[8]**

Q3) a) Describe Schrodinger and Heisenberg pictures during the evolution of system with time. **[8]**

b) i) If $\hat{A}$ and $\hat{B}$ are operators, then prove that **[4]**

1) $(A^{+})^{+}=\hat{A}$

2) $(\hat{A}\,\hat{B})^{+} = \hat{B}^{+}\,\hat{A}^{+}$

ii) Consider a one - dimensional physical system described by Hamiltonian. $H=\frac{p^2}{2m}+1/(x)$

Then show that $[H,x]=\frac{1\hbar}{m}P$ and for a stationary state find <p>.**[4]**

Q4) a) Show that i) $\left(\frac{L_z}{\hbar}\right)$ play a role of the generator of infinite simal rotations and ii) For finite rotations through an angle θ, when $M \to \infty$ then $\psi'(x) = e^{i\theta\hat{n}.\bar{L}/\hbar}\,|\psi(x)\rangle$, where N=number of infinitesimal rotations and $\hat{n}$ is unit vector about an arbitrary axis of rotation. **[8]**

b) Obtain eigen values and eigen functions of simple harmonic oscillator by abstract operator method. **[8]**

Q5) a) Obtain eigen value spectrum of J^2 and J_z operators. **[10]**

b) What are observables? Use expansion postulate to show that **[6]**

i) Eigen functions belonging to discrete eigen values are normalizable and

ii) Eigen - functions belonging to continuous eigen-values are of infinite norm.

Q6) a) Write notes on

i) Matrix representation of an operator. **[4]**

ii) Change of basis. **[4]**

b) For a particle of mass m, moving in a ID potential well of finite width obtain expressions for energy and normalized eigen function. Also write expressions for energy and eigen function for a 2D case. **[8]**

Q7) a) If $\overline{A}, \overline{B}$ are operators which commute with $\overline{\sigma}$ then show that $(\overline{\sigma}.\overline{A})(\overline{\sigma}.\overline{B}) = \overline{A}.\overline{B} + i\overline{\sigma}.(\overline{A} \times \overline{B})$ **[4]**

b) Give physical significance of eigen values, eigen functions and expansion coefficients. **[4]**

c) Find the values of $[J_z, J_+], [J_z, J_-], [J_+, J_-]$ and $[J_x, J^2]$. **[4]**

d) Prove that eigen values of Hermitian operator are real. **[4]**

Total No. of Questions :7]

SEAT No. :

P1427

[Total No. of Pages :3

[5222] - 21
M.Sc.
PHYSICS
PHY UTN 601: Electrodynamics
(2008 - Pattern) (Semester - II)

Time : 3 Hours] ***[Max. Marks :80***

Instructions to the candidates:

1) ***Question No. 1 is compulsory and solve any four questions from the remaining.***
2) ***Draw neat labelled diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of lorgarithmic tables and pocket calculator is allowed.***

Q1) Attempt any four of the following: **[16]**

a) Find the skin-depth in sea water with conductivity $\sigma = 5\ (\Omega m)^{-1}$ at a frequency $10\ ^{10}H_z$. For sea water $\mu = \mu_0 = 4\Pi \times 10^{-7}$Wb/A-m.

b) Show that the ratio of electrostatic and magnetic energy densities $\left(\frac{u_e}{u_m}\right)$ is equal to unity.

c) Compute the electric field associated with a LASER beam having energy per unit volume is 100 J/m^3.

d) Find the velocity at which the mass of the particle is double it's rest mass. Given: $C = 3 \times 10^8$m/sec.

e) Calculate the magnitude of poynting's vector at the surface of the sum. Given that the power radiated by sum is equal to 3.8×10^{26} watt and radius of the sum is equal to 7×10^8m.

f) Explain Minkowski's space - time diagram.

Q2) a) If a medium is moving with a velocity $\vec{u}$, then show that the Faraday's law has the form $\vec{\nabla} \times \left(\vec{E}' - \vec{u} \times \vec{B}\right) = -\frac{\partial \vec{B}}{\partial t}$. **[8]**

P.T.O.

b) Show that the operator.

$\Box^2 \equiv \nabla^2 - \frac{1}{c^2}\frac{\partial^2}{\partial t^2}$ is invariant under Lorentz transformations.

where as $\nabla^2 \equiv \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2}$ is not Lorentz invariant. **[8]**

Q3) a) Explain the term 'multipole moments'. Hence derive an expression for potential at a distant point using multipole expansion for a localized charge distribution in free-space. **[8]**

b) Show that (C^2 B^2 $-E^2$) and $\left(\vec{E}\cdot\vec{\mathrm{B}}\right)$ are invariant under Lorentz transformations. **[8]**

Q4) a) Explain the term electromagnetic field tensor. Hence obtain an expression for e.m. field tensor $F\mu\gamma$. **[8]**

b) The magnetic field intercity $\vec{\mathrm{B}}$ at a point is given by $\vec{\mathrm{B}} = \left(\frac{\mu_0}{4\pi}\right)\int \frac{\vec{j}\times\vec{r}}{r^3}\,d\tau.$

Show that $\vec{\nabla}\times\vec{\mathrm{B}} = \mu_0\,\vec{j}.$ **[8]**

Q5) a) What is Hertz potential? Show that the electric and magnetic fields can be expressed in terms of Hertz potential as $\vec{E} = \vec{\nabla}\times\left(\vec{\nabla}\times\vec{Z}\right)$ and $\vec{B} = \frac{1}{c^2}\;\frac{\partial}{\partial t}\left(\vec{\nabla}\times\vec{Z}\right)$, where $\vec{\mathrm{Z}}$ is the Hertz potential. **[8]**

b) Describe Michelson - Morley experiment with reference to special theory of relativity. Derive the necessary formula for the fringe shift and comment on the result. **[8]**

Q6) a) Show that the Maxwell's equations in a charge free region lead to:

$$\nabla^2\vec{\mathrm{E}} - \frac{kk_m}{c^2}\;\frac{\partial^2\vec{\mathrm{E}}}{\partial t^2} - \mu\sigma\frac{\partial\vec{\mathrm{E}}}{\partial t} = 0$$

Explain which term can be ignored in a nonconducting medium. **[8]**

b) A plane e.m. wave is incident on an interface between the two non-conducting dielectric media. Obtain expressions for Fresnel's equations if the electric field vectors are perpendicular to the plane of incidence. **[8]**

Q7) a) Write Maxwell's equations in differential and integral forms. **[4]**

b) Write in short about the electric dipole radiation and explain the term 'radiation resistance'. **[4]**

c) Calculate the rest mass energy of an electron in eV if it's rest mass is equal to 9.11×10^{-31}kg. **[4]**

d) Find the phase velocity of a plane e.m. wave at a frequency of 10 GHz in polyethelene material. **[4]**

Given: $\mu \simeq \mu_0 = 4\Pi\times10^{-7}\dfrac{wb}{\text{A}-m}$,

$\in_r = 2.3$,

$\in_0 = 8.85\times10^{-12}\dfrac{c^2}{\text{N}-m^2}$

and $\sigma = 2.56\times10^{-4}\dfrac{\text{mho}}{\text{m}}$.

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Total No. of Questions : 7]

SEAT No. :

P1428

[Total No. of Pages : 3

[5222]-22
M.Sc.
PHYSICS
PHYUTN - 602 : Atoms, Molecules and Solids
(2008 Pattern) (Semester - II)

Time : 3 Hours] *[Max. Marks : 80*

Instructions to the candidates:

1) *Question No. 1 is compulsory. Solve any four questions from the remaining.*
2) *Draw neat diagrams wherever necessary.*
3) *Figures to the right indicate full marks.*
4) *Use of logarithmic tables and electronic calculator is allowed.*

Given :

Rest mass of e	$= 9.109\times10^{-31}$ kg
Charge on the e	$= 1.6021\times10^{-19}$ Coulumb
Planck's constant	$= 6.626\times10^{-34}$ Js
Boltzman constant	$= 1.38054\times10^{-23}$ JK^{-1}
Avogadro's number	$= 6.022\times10^{26}$(K mole)$^{-1}$
Bohr magneton	$= 9.27\times10^{-24}$ amp-m^2
1 eV	$= 1.6021\times10^{-19}$ J

Q1) Solve any four of the following.

a) A spectral line wavelength 5000Å when placed in a magnetic field of 10 Tesla, is observed to be a normal Zeeman triplet. Calculate wavelength separation between composition of triplet. **[4]**

b) The values of $\overline{\gamma}_e$ and x_e for lower and upper states of CO are 2,170.21 cm^{-1}, 0.0062 and 1,515.61 cm^{-1}, 0.0114 respectively. The (0,0) transition is observed at 64746.55 cm^{-1}, calculate the energy difference of the two electronic states. **[4]**

c) Determine Lande's g factor for $^2f_{5/2}$. **[4]**

P.T.O.

d) The highest possible lattice frequency is $11.85 \times 10^{12}\ s^{-1}$ in case of Silicon. Estimate the Debye temperature for Silicon. **[4]**

e) The concentration of Schottkey defects in an ionic crystal is 1 in 10^{10} at temperature 500 K. Estimate the energy of the vacancy pair. **[4]**

f) Show that the maximum radius of the sphere that can just fit into the void at the body centre of the fcc structure confined by the facial atoms is 0.414r. Where r is the radius of the atom. **[4]**

Q2) a) What is the geometrical structure factor? Derive an expression for geometrical structure factor for a fcc structure. **[8]**

b) Explain in detail the Frankel defects occurring in an crystal. **[8]**

Q3) a) Deduce the expression for the specific heat of a solid based on Debye model. **[8]**

b) Discuss the vibrational modes of 1– D monoatomic lattice of identical atoms hence obtain the dispersion relation. **[8]**

Q4) a) In the context of rotational fine structure of electronic vibration spectra explain band origin and band head. **[8]**

b) Explain with diagrams the vibrational course structure showing v'' progression. **[8]**

Q5) a) Explain the principle and working of NMR spectrometer and state its applications. **[8]**

b) State and explain Frank-Condon principle. **[8]**

Q6) a) Explain the experimental arrangement to study normal Zeeman effect. Derive the formula for change in wavelength. **[8]**

b) Explain Screw and Edge dislocations in solids. **[8]**

Q7) a) Obtain expression for configurational entropy. **[4]**

b) What is line broadening. State the factors responsible for broadening of spectral line. **[4]**

c) What are normal and Umklapp processes. **[4]**

d) What is Phonon? Its role on quantization of elastic waves. **[4]**

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Total No. of Questions :7]

SEAT No. :

P1429

[Total No. of Pages : 3

[5222]-23
M.Sc.
PHYSICS
PHY UTN - 603 : Statistical Mechanics in Physics
(2008 Pattern) (Semester - II)

Time : 3 Hours] *[Max. Marks : 80*

Instructions to the candidates:

1) ***Question No.1 is compulsory; Solve any four questions of the remaining.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the rightside indicate full marks.***
4) ***VSC of Logarithmic tables and electronic pocket calculator is allowed.***

Constants:

1) ***Boltzmann constant, $K_B = 1.38\times10^{-23}$ J/K.***
2) ***Gas constant R = 1.987 cal / deg./mole.***
3) ***Avogadro's number, $N = 6.023\times10^{23}$/gm.mole.***
4) ***Planck's constant h = 6.625×10^{-34} J.sec.***
5) ***Mass of electron. $m_e = 9.1\times10^{-31}$ Kg***

Q1) Attempt Any Four of the following.

a) Explain the concept of phase space. **[4]**

b) A system of 3 particles has energy levels with energies 0,1,2,3 units. The total energy of the system is 3 units. List the accessible microstates if the particles are i) indistinguishable ii) distinguishable. **[4]**

c) Show that the energy in canonical ensemble can be represented as $S = -k\sum P_r \ln P_r$ **[4]**

d) Compare the basic postulates of B.E. & F.D. statistics. **[4]**

e) Show that at high temperature Bose-Einstein and Fermi-Dirac distribution reduce to maxwell-Boltzman distribution. **[4]**

f) Explain, what do you mean by mechanical and thermal interaction. **[4]**

Q2) a) Show that for classical monoatomic ideal gas having N particles contained in volume V. The number of states $\Omega(E)$ to the system in the energy range $E \& E+\delta E$ is given by

$$\Omega(E)=BV^{N}\ E^{3N/2}$$ **[8]**

b) For grand canonical ensemble show that probability of finding the system in a particular microstate *r* having energy E_r and number of particles N_r is given by

$$P_r = \frac{e^{-\beta E_r - \alpha Nr}}{\sum_r e^{-\beta E_r - \alpha Nr}}$$ **[8]**

Q3) a) On the basis of canonical distribution, obtain the law of atmosphere $P(z)=P(o)e^{-mg\,2/KT}$ **[8]**

b) State the partition function for B.E statistics and obtain the B.E distribution in the form

$$\bar{n}s=\frac{1}{e^{\beta(\in s-\mu)}-1}$$

Where μ is the chemical potential. **[8]**

Q4) a) In case of Bose - Einstein condensation for $T<T_b$, Prove that

$$N = No + N\left(\frac{T}{T_b}\right)^{3/2}$$

Where N= total number of particles

No= number of particles in ground state. **[8]**

b) Show that the Fermi energy of fermions is

$$\in_F=\frac{\hbar^2}{2m}\left(\frac{3\pi^2 N}{v}\right)^{2/3}$$ **[8]**

Q5) a) Show that for photons, the mean pressure $\overline{P}$ is related to its total energy $\overline{E}$ by the relation $\overline{P}=\frac{1}{3}\frac{\overline{E}}{V}$ **[8]**

b) Consider a system of N diatomic molecules each having vibrational energy levels. $E=\left(n+\frac{1}{2}\right)\hbar w$.

where n = 0,1,2,3,.....

Write down the partition function and derive an expression for mean energy. Hence show that at low temperature, the specific heat is given by

$C_v = 3R\left(\frac{\theta_E}{T}\right)^2 e^{-\theta_E/T}$. **[8]**

Q6) a) Show that Maxwell's distribution of speed is given by **[8]**

$F(v)dv=4\pi n\left(\frac{m}{2\pi KT}\right)^{3/2} v^2 e^{\frac{-mv^2}{2KT}} dv$

b) State and prove Liouville's theorem. **[8]**

Q7) a) State and explain the postulate of equal-a-prior probability. **[4]**

b) Write a note on white Dwarf. **[4]**

c) Calculate the mean values $\overline{E}$ and $\overline{E^2}$ for canonical ensemble in terms of partition function. **[4]**

d) State the equipartition theorem; hence findout mean energy for solid consisting of N molecules. **[4]**

Total No. of Questions : 7]

SEAT No. :

P1430

[Total No. of Pages : 3

[5222] - 24

M.Sc.

PHYSICS

PHYUT-604 : Quantum Mechanics - II

(2008 Pattern) (Semester - II)

Time : 3 Hours] *[Max. Marks :80*

Instructions to the candidates:

1) *Question 1 is compulsory.*
2) *Attempt any four questions from remaining.*
3) *Figures to the right indicate full marks.*
4) *Use of calcualtors is allowed.*

Q1) Attempt any four of the following : **[16]**

a) Discuss the conditions of validity of Born approximation.

b) One dimensional harmonic oscillator is perturbed by H' = λx^3. Obtain the first order correction in energy in first excited state.

c) Using harmonic perturbation explain induced absorption and spontaneous emission.

d) Obtain antisymmetric wave functions for a system of two electrons.

e) List the connection formulae used in WKB approximation.

f) Obtain the relation between angles of scattering in Laboratory frame and centre of mass frame.

Q2) a) Obtain the expression for scattering amplitude using Green's function. **[8]**

b) State and prove Fermi Golden rule for the rate of transitions induced by constant potential. **[8]**

Q3) a) Using trial wave function $\psi(x) = Ae^{-\alpha x^2}$, estimate the ground state energy of harmonic oscillator. α - is variational parameter. **[8]**

b) A particle of charge q, in simple harmonic motion along x-axis, is acted on by a time-dependent homogeneous electric field.

$$\varepsilon(t) = \varepsilon_0 . \exp\left(-t^2/\tau^2\right)$$

where ε_0 and τ are constants. If the oscillator is in its ground state at $t = -\infty$, find the probability that it will be found in omited state as $t \to \infty$.

$$\left(\text{Use: } \int_{-\infty}^{+\infty} e^{-\alpha u^2} e^{-\beta u}\, du = \left(\frac{\pi}{\alpha}\right)^{1/2} e^{\beta^2/4\alpha}\right)$$ **[8]**

Q4) a) Discuss time-independent perturbution theory for a degenerate energy level. **[8]**

b) Using WKB approximation, obtain expression for transmission coefficient. **[8]**

Q5) a) Using partial wave analysis, show that the scattering cross-section is given as $\sigma_t = \frac{4\pi}{k^2} \sum_l (2l+1)\sin^2 \delta_l$. **[10]**

b) Discuss concept of idential particles. Show that exchange operator and Hamiltonian operator commute with each other. **[6]**

Q6) a) Find the total cross-section for low-energy (s-wave) scattering by a potential barrier such that $V(r) = \begin{cases} -V_0 & \text{for } r \leq a \\ 0 & \text{for } r > a \end{cases}$. **[8]**

b) Discuss field emission of electrons from a metal using WKB approximation. **[8]**

Q7) a) Explain the selection rules for electric dipole transitions. **[4]**

b) Show that the variational method gives an upper bound to the ground state energy. **[4]**

c) Explain the collision process between identical particles. **[4]**

d) Show the stark effect is zero in the ground state of hydrogen atom. **[4]**

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Total No. of Questions : 7]

SEAT No. :

P1431

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M.Sc.

PHYSICS

PHY UTN- 701: Solid State Physics

(Semester - III) (2008 Pattern)

Time : 3 Hours] *[Max. Marks :80*

Instructions to the candidates:

1) *Question No.1 is compulsory. Solve any Four questions from the remaining.*
2) *Figures to the right indicate full marks.*
3) *Draw neat labelled diagram wherever necessary*
4) *Use of logarithmic table and scientific calculator is allowed.*

Given:

Rest mass of electron = 9.1×10^{-31} Kg.

Electronic charge = 1.602×10^{-19} C.

Planck's constant = 6.62×10^{-34} J-S.

Boltzmann constant =1.38×10^{-23} JK^{-1}.

Avogadro's Number = 6.023×10^{26} atoms per kgmole.

Bohr Magneton = 9.27×10^{-24} A-m^2

Permeability of free space = $4\pi\times10^{-7}$ Henry/m

Permittivity of Free space = 8.85×10^{-12} $c^2/N\text{-}m^2$

Q1) Attempt any four of the following: **[16]**

a) A Copper wire of length 0.5 m and diameter 0.3 mm has a resistance 0.12 Ω at 20°C. It the thermal conductivity of copper at 20°C is 390 $Wm^{-1}k^{-1}$. Determine Lorentz number.

b) Show that for a 2- dimensional square Lattice, the kinetic energy of a free electron at a corner of the first Brillouin zone is higher than that of an electron at mid point of a side face of zone by a factor of 2.

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c) Estimate the temperature at which there is 1% probability that a state with an energy 0.5 eV above the fermi energy will be occupied by an electron.

d) Determine the critical current which can flow through a long thin super conducting wire of Al of diameter 10^{-3}m. The critical magnetic field for aluminium is $7.9 \times 10^{+3}$ A/m.

e) A magnetic material has a magnetization of 3300 A/m and flux density of 0.0044 wb/m^2. Calculate the magnetizing force and the relative permeability of the material.

f) For a He atom in its ground state (1s), the mean radius in the Langevin's formula may be approximated by the Bohr radius 0.53 nm. Density of He is 0.178 kg/m^3. Calculate the diamagnetic susceptibility of He atom,

Q2) a) Discuss the nearly free electron model and explain how it leads to the formation of forbidden gap and band structure. **[8]**

b) Explain the concept of reduced, extended and periodic zone schemes used for the representation of energy bands with neat diagrams. **[8]**

Q3) a) For an atom placed at general Lattice site, obtain an expression for local electric field E_{local}' Explain physical significance of each term in the expression. **[8]**

b) Define dielectric function $\in$ (w,k). For the long wavelength region, derive the expression,

$\in (w) = 1 - \frac{wp^2}{w^2}$, where symbols have usual meanings. On the basis of plot of this equation explain attenuation of the wave. **[8]**

Q4) a) Explain the equation theory of paramagnetism and obtain Curie law. **[8]**

b) Derive London equation for super conducting state and obtain an expression for penetration depth. **[8]**

Q5) a) Discuss the origin of diamagnetism in a free atom. Obtain Langevin's diamagnetism formula. **[8]**

b) Distinguish between ferromagnetism, ferrimagnetism and antiferromagnetism. **[8]**

Q6) a) Prove that the entropy of a superconducting material is lesser than that of a normal metal. **[8]**

b) Draw a suitable diagram for the hysteresis loop for a magnetic material and explain it with the help of domain theory. **[4]**

c) Discuss the term 'Anisotropy Energy' with reference to magnetization. **[4]**

Q7) a) Define Bloch function and write a note on it. **[4]**

b) What is Fermi- Dirac statistics. With neat diagram, explain its temperature dependence. **[4]**

c) Describe the term 'Bloch wall' with reference to magnetism. **[4]**

d) The critical temperature (T_c) for Hg with isotopic mass 199.5 is 4.185 K. Calculate its critical temperature when its isotopic mass changes to 203.4. **[4]**

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Total No. of Questions :7]

SEAT No. : [ ]

P1432

[Total No. of Pages :3

[5222] - 41
M.Sc.
PHYSICS
PHY UTN 801: Nuclear Physics
(2008 Pattern) (Semester - IV)

Time : 3 Hours] ***[Max. Marks :80***

Instructions to the candidates:

1) *Question No. 1 is compulsory, attempt any four questions from the remaining.*
2) *Draw neat figures wherever necessary.*
3) *Figures to the right indicate full marks.*
4) *Use of logarithmic tables and pocket calculater is allowed.*

Q1) Attempt any four of the following. **[16]**

a) For energy filters in the mass spectrometers, show that $\frac{1}{2}\text{mV}^2 = \frac{neVR_o}{2d}$ where symbols carry usual meaning.

b) Chlorine - 33 decays by position emmission with maximum energy of 4.3 MeV. Calculate the radius of nucleus from this.

c) Discuss the following reactions using conservation of Isotopic spin.

i) $\text{P} + \text{P} \rightarrow \text{P} + \text{P} + \Pi^{\text{o}}$

ii) $\Pi^{+} + \text{P} \rightarrow \Pi^{+} + \text{P}$

d) Explain weak and strong interactions with suitable examples with reference to elementary particles.

e) Explain the concept of isospin associated with elementary particle.

f) Calculate the half value thickness of β absorption in Aluminium for β spectrum with E_{max} = 1.17 MeV. Given = Density of Aluminium = 2700 kg/m^3.

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Q2) a) What is straggling? Derive the formula for straggling when a charged particle is moving through the matter. **[8]**

b) What are quarks? Explain how quarks are treated as Buiding blacks of hadrons and mesons? **[8]**

Q3) a) Explain important features of Gamow's theory of α decay. **[8]**

b) Explain the concept of quadropole moment and derive an expression for the same and show that it is zero for spherial distribution of charges. **[8]**

Q4) a) Draw a diagram of the electron synchroton accelerator state its working principle and action. Explain how maximum energy of the electron depends on the radius of orbit. **[8]**

b) With the help of suitable diagram describe the construction and working of Bainbridge and Jordan Mass spectrometer. **[8]**

Q5) a) Explain the working of proportional counter. state its advantages and applications. **[8]**

b) For p - p scattering at law energies, derive an expression for differential cross section in Laboratory system. **[8]**

Q6) a) Derive Bethe's formula for 'stoping power' of charged particles moving through the matter. Write the expression for relativistic effects. **[8]**

b) Write a note on Graphite moderated Reserach Reactor. **[4]**

c) Verify the following reaction and state whether it is allowed or forbidden on the basis of laws of conservation of strangeness, baryon number and charge. $\Pi^{+} + P \rightarrow \wedge^{o} + k^{o}$. **[4]**

Q7) a) Explain weak and strong interactions with suitable examples with reference to elementary particles. **[4]**

b) Write a short note on mirror nuclei. **[4]**

c) Explain the concept of ISO - spin associated with elementary particles. **[4]**

d) Discuss in brief production and properties of pion. **[4]**

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