Total No. of Questions :7]

SEAT No. :

P1917

[Total No. of Pages :3

[4922]-11
M.Sc.
PHYSICS
PHY UT-501: Classical Mechanics
(2008 Pattern) (Semester - I)

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

Instructions to the candidates:

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

Q1) Attempt any four of the following:

a) What do you mean by velocity dependent potential? Where velocity dependent potential is applicable. **[4]**

b) Obtain the Hamiltonian and Hamilton's equations of motion for an ideal spring mass system. **[4]**

c) Write equations of constraint for **[4]**

i) Simple pendulum with variable length.

ii) A particle moving on or outside surface of sphere.

d) Obtain Lagrangian of a free particle in **[4]**

i) Cartesian co-ordinates and

ii) Spherical polar coordinates

e) Show that Poisson Bracket of two constants of motion is itself constant of motion. **[4]**

f) Show that for the function F = $\sum_k q_k Q_k$, the transformations are $p_k = Q_k$, $P_k = -q_k$ and $H' = H$. **[4]**

P.T.O.

Q2) a) What do you mean by pseudo force? Obtain an expression for coriolis acceleration for rotating coordinate system. **[8]**

b) Using Euler -Lagrange equation determine the path which requires least time to travel from a point at higher level to a point at lower level in a plane under uniform gravitational field. **[8]**

Q3) a) Show that for a particle moving under central force f (r), the equation of orbit is given by **[8]**

$$\frac{d^2u}{d\theta^2}+u=-\frac{m^2}{l^2u^2}.f\left(\frac{1}{u}\right)$$

Where $u=\frac{1}{r}$ and l is angular momentum.

b) i) Explain scleronomous and rheonomous constraints by giving one example of each. **[4]**

ii) Using variational principle, show that shortest distance between two points in a plane is straight line. **[4]**

Q4) a) What is symmetry? Explain concepts of homogeneity of space, homogeneity of time and isotropy of space. **[8]**

b) A bullet is fired horizontally in a north direction with a velocity of 500 m/s at 30^{o} N latitude. Calculate the horizontal component of Coriolis acceleration and the consequent deflection of the bullet as it hits a target 250 m away. Also determine the vertical displacement of bullet due to gravity. If the mass of bullet is 10 gm, find the coriolis force. **[8]**

Q5) a) Show that for a relativistic free particle, Hamiltonian is given by

$$H(r,p)=\sqrt{p^2c^2+m_0^2c^4}+V(r).$$ **[8]**

b) Using Poisson bracket, show that the transformation **[8]**

$$Q=(e^{-2q}-p^2)^{1/2}$$

$P=\cos^{-1}(pe^{q})$ is canonical.

Q6) a) Show that Poisson brackets are invarient under canonical transformations (q, p) to (Q, P). **[8]**

b) A mass, m, moves in a circular orbit of radius r_o under the enfluence of a central force whose potential is $\frac{-k}{r^n}$. Show that the circular orbit is stable under small oscillations if $n < 2$. **[8]**

Q7) a) A wire is bent in the form of a parabola $z = ar^2$, and a bead slides on it smoothly. The wire is rotated by means of an external agency with a constant angular acceleration, α. Find the equation of motion of bead. **[8]**

b) i) An inextensible string of negligible mass hanging over a smooth peg connects one mass m_1 on a frictionless inclined plane of angle θ to another mass m_2. Using D' Alembert's principle, prove that the masses will be in equilibrium if $m_1 \sin\theta = m_2$. **[4]**

ii) If $[\phi,\psi]$ be the Poisson bracket, then prove that **[4]**

$$\frac{\partial}{\partial t}[\phi,\psi] = \left[\frac{\partial \phi}{\partial t},\psi\right] + \left[\phi,\frac{\partial \psi}{\partial t}\right].$$

EEE

Total No. of Questions :7]

SEAT No. :

P1918

[Total No. of Pages :3

[4922]-12
M.Sc.
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 questions from the remaining.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic table and calcualtor is allowed.***

Q1) Attempt any four of the following:

a) Design first order high pass filter for higher cutoff frequency of 5kHz. **[4]**

b) Design a divide by 8 counter using IC 7490. **[4]**

i) Using only $R_o(1)$ and $R_o(2)$ and

ii) Using only $R_g(1)$ and $R_g(2)$.

c) Explain the working of sample and ~~hold~~ circuit using proper circuit diagram. Define the aparature time and ~~hold~~ time. **[4]**

d) Explain any four parameters of OPAMP. Compare the ideal values and practical values of IC 741. **[4]**

e) Design of 10ms pulse width using monostable multivibrator using IC 555. **[4]**

f) Explain the working of single slope A/D converter. Discuss the short comings of converter. **[4]**

g) Design I 5V voltage regulator using IC 7805 and IC 7905 three pin regulators. **[4]**

P.T.O.

Q2) a) Explain how K-map can be used in designing a combinational logic circuit which multiplies 3-bit binary number by 2 by using K-map. **[8]**

b) How a decade counter using IC 7490 can be designed for **[8]**

i) 2- bit binary counter and

ii) With symmetrical and asymmetrical outputs.

Q3) a) Derive an output relation for 4-bit Binary weighted resistor ladder DAC with the necessary circuit diagram. Explain its working. What are the limitations on number of bits used. **[8]**

b) Draw circuit diagram of an asymmetric square wave using IC 741 Astable multivibrator. Explain its operation. Design if to generator a rectangular wave of 40% duty cycle with 10kHz frequency.

(Given: $V_{CC} = \pm$ 10V, β= 0.4) **[8]**

Q4) a) Write BCD to gray code truth table. Simplify using Karnaugh -map to convert BCD to Gray code. Draw a necessary circuit diagram for same.**[8]**

b) Give a circuit diagram of CVCC power supply using two OPAMPs and explain its operation. Also give its output characteristics. **[8]**

Q5) a) Explain the working of IC 8038 using its internal block diagram in detail. Also give circuit diagram of function generator to design a generator of frequency 20kHz using single resistor R. **[8]**

b) Design 5V regulator output with current limit of 0.5 amp. Using IC 723 and external current booster transistor.

How $\pm$ 5V be obtained from single 10V regulated output? **[8]**

Q6) a) Explain the internal block diagram of 3-pin voltage regulator in detail. Give advantages of three pin regulator. Design adjustable voltage regulator using LM 317 to have output voltage variable from 5 to 10V. **[8]**

b) Give the block diagram of PLL IC 565 and explain its operation. Define **[8]**

i) Free running frequency

ii) Lock in range and

iii) Capture range

Discuss application of PLL as frequency division.

Q7) Write short notes on any four of the following: **[16]**

a) Square wave generator using OPAMPs.

b) Astable multivibrator using IC 555.

c) Voltage controlled oscillator using IC 566.

d) Monostable multivibrator IC 74121.

e) Sample and Hold circuit.

f) Decade counter IC 7490.

EEE

Total No. of Questions :7]

SEAT No. :

P1919

[Total No. of Pages :3

[4922]-13
M.Sc.
PHYSICS
PHY UTN-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.***
2) ***Attempt any four out of the remaining questions.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables and calculators is allowed.***

Q1) Attempt any four:

a) The Legendre differential equation is $(1-x^2)u'' - 2xu' + n(n+1) = 0$ show that it is in the self-adjoint form. **[4]**

b) Prove that $e^x(\cos y + i \sin y)$ is an analytic function. **[4]**

c) Show that the set {(1, 1, 1), (1, 2, 3), (2, –1, 1)} is the basis of R^3. **[4]**

d) Find the Laplace transform of $\{t^3 \cdot e^t\}$. **[4]**

e) Let F be a mapping $F : R^2 \to R$ defined by $F(x, y) = xy$. Show that F is not linear mapping. **[4]**

f) Define $\|v\|$ and find $\|v\|$ if $v = (1+i, 3-2i) \in C^2$. **[4]**

Q2) a) State and prove the convolution theorem for Fourier transform. **[8]**

b) Solve the differential equation using Laplace transform

$$X''(t) + 4X'(t) + 4X(t) = 4e^{-2t} \quad X(0) = 1, \quad X'(0) = 4.$$ **[8]**

P.T.O.

Q3) a) Find the eigen values and orthonormal eigen vectors of **[8]**

$$A=\begin{bmatrix}1 & 0 & 1\\ 0 & 1 & 0\\ 1 & 0 & 1\end{bmatrix}$$

b) Define inner product, the projection and the angle between two vectors. find cosθ where θ is the angle between **[8]**

$u=(1,3,-5,4),\ v=(2,-3,4,1)\in R^4$.

Q4) a) Show that the eigenvalues of a self-adjoint operator are real and the eigen vectors corresponding to non-degenerate eigen value are orthogonal.**[8]**

b) Let D be the differential operator $D(f)=\frac{df}{dt}$. Find the matrix of D in the following bases **[8]**

i) $\{e^t, e^{2t}, te^{2t}\}$

ii) $\{1, t, \sin 3t, \cos 3t\}$

Q5) a) State and prove Cauchy's integral formula **[8]**

$$\oint \frac{f(z)}{z-z_0}dz = 2\pi i\ f(z_0).$$

b) Using calculus of residue, prove that **[8]**

$$\int_0^{2\pi} \frac{d\theta}{2+\cos\theta} = \frac{2\pi}{\sqrt{3}}$$

Q6) a) Write the generating function for Bessel's function. Using that obtain the recurrence relations **[8]**

$$J_{n-1}(x)+J_{n+1}(x)=\frac{2n}{x}J_n(x)$$

$$J_{n-1}(x)-J_{n+1}(x)=2J_n'(x).$$

b) Prove the orthonormality condition for Legendre polynomial

$$\int_{-1}^{+1} P_n(x)P_m(x)dx = \delta_{mn}\left(\frac{2}{2n+1}\right). \quad \textbf{[8]}$$

Q7) a) Subspace W of P(t) is spanned by **[4]**

$u = t^3 + 2t^2 - 2t + 1,\ v = t^3 + 3t^2 - t + 4$ and $w = 2t^3 + t^2 - 7t - 7$.

Determine whether they are linearly dependent or independent.

b) The generating function for Hermite polynomial is $g(x,t) = \exp(2xt - t^2)$. Show that $H_n(x) = (-1)^n H_n(-x)$. **[4]**

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

d) Draw the region representing $|z| < 1$ in z plane. **[4]**

EEE

Total No. of Questions :7]

SEAT No. :

P1920

[Total No. of Pages :2

[4922]-14
M.Sc.
PHYSICS
PHYUT-504: Quantum Mechanics - I
(2008 Pattern) (Semester - I) (Old Course)

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 table and calculator is allowed.***

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

a) Show that momentum operator is Hermitian.

b) Evaluate the commutator $[L^2, L_z]$.

c) For Pauli's matrices, prove that

i) $[\sigma x, \sigma y] = 2i\,\sigma z$

ii) $\sigma x \sigma y\,\sigma z = i$

d) Show that for any arbitrary operator $A, \langle A^+ A \rangle \geq 0$.

e) What are ladder operators? Why are they called so?

f) Show that if two operators commute with each other then they have common set of eigen functions.

Q2) a) Using the abstract operator method, obtain the eigen value spectrum of simple harmonic oscillator. **[8]**

b) What are observables? Show that **[8]**

i) Eigen functions belonging to continuous eigenvalues are of infinite norm.

ii) Eigen functions belonging to discrete eigen values are normalizable.

P.T.O.

Q3) a) What are Dirac's bra and ket vectors? With respect to these vectors define Hilbert space. Write expressions for the norm and scalar product in this space and define the basis of Hilbert space. **[8]**

b) Describe Heisenberg picture and show that

$$\frac{d}{dt}A_H = \frac{i}{\hbar}[H, A_H] + \frac{\partial A_H}{\partial t}$$ **[8]**

Q4) a) Explain completeness property and prove the closure relation. **[8]**

b) Define projection operator. Show that the sum of all projection operators leaves any state vector $|\psi\rangle$ unchanged. **[8]**

Q5) a) Obtain the matrix of Clebsch-Gorden coefficients for a system of two non-interacting particles with angular momenta $j_1 = 1/2$ and $j_2 = 1/2$. **[8]**

b) State fundamental postulates of quantum Mechanics. **[8]**

Q6) a) Obtain eigen values of L^2 and L_z using L_+ and L_- operators. **[8]**

b) Describe change of basis by using unitary transformations. **[8]**

Q7) a) Using Dirac notations, prove that eigenvalues of Hermitian operator are real. **[4]**

b) For any Hermitian operator $\hat{A}$, show that $e^{i\alpha A}$ is unitary, where α is real number. **[4]**

c) Show that $(A\,B)^+ = B^+\,A^+$. **[4]**

d) What do you understand by 'spin of an electron'? **[4]**

EEE

Total No. of Questions :7]

SEAT No. :

P1921

[Total No. of Pages :2

[4922]-21
M.Sc.
PHYSICS
PHYUTN-601: Electrodynamics
(Old Course) (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 labelled diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of log- tables & calculator is allowed.***

Q1) Attempt any four of the following:

a) Prove that **[4]**

$$\vec{E}\cdot\frac{\partial\vec{D}}{\partial t}=\frac{\partial}{\partial t}\left(\frac{1}{2}\vec{E}\cdot\vec{D}\right) \text{ and } \vec{H}\cdot\frac{\partial\vec{B}}{\partial t}=\frac{\partial}{\partial t}\left(\frac{1}{2}\vec{H}\cdot\vec{B}\right).$$

b) Describe magnetic interaction between two current loops. **[4]**

c) Calculate the electric field associated with a LASER beam having energy density 10^6 g/cm^3. **[4]**

d) Show that the ratio of electrostatic and magnetostatic energy densities $\left(\frac{\mu_e}{\mu_m}\right)$ is equal to unity. **[4]**

e) Write Maxwell's equations in differential and integral form. **[4]**

f) At what speed will the mass of a proton became double its rest mass. **[4]**

P.T.O.

Q2) a) What is linear quadrupole? Derive an expression for potential at a distant point due to a small linear quadrupole. **[8]**

b) Derive the Lorentz relativistic transformation equations. **[8]**

Q3) a) State and prove Poyntings theorem. **[8]**

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

Q4) a) Starting from Maxwell's equation, derive inhomogeneous wave equation in terms of scalar potential (ϕ) and vector potential $(\vec{A})$. **[8]**

b) Define Hertz Dipole vector. Using potential for dipole, obtain radiation dipole field which is given by $E_\theta = \frac{\sin\theta}{4\pi \in_0} \frac{e^{ikR}}{R}\left[(\vec{P}_1 \times \vec{K}) \times K\right]$. **[8]**

Q5) a) The magnetic field intensity $\vec{B}$ at a point is given by:

$\vec{B} = \left(\frac{\mu_0}{4\pi}\right)\int \frac{\vec{j} \times \vec{r}}{r^3} d\tau$ show that $\vec{\nabla} \times \vec{B} = \mu_0 \vec{j}$. **[8]**

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

Q6) a) Explain the term 'Electromagnetic field tensor'. Hence, obtain an expression for e.m. field tensor $F_{\mu\nu}$. **[8]**

b) Obtain Faraday's law of induction in differential form for a stationary medium and show how it can be modified if the medium is moving with velocity $(\vec{\mu})$. **[8]**

Q7) Write notes on <u>any Two</u> of the following: **[16]**

a) Boundary conditions on $\vec{E}$ and $\vec{B}$, $\vec{D}$ and $\vec{H}$ at the interface between two media.

b) Law of relativistic addition of velocities.

c) Minkowsky force.

d) Four vector potential.

EEE

Total No. of Questions :7]

SEAT No. :

P1922

[Total No. of Pages :3

[4922]-22
M.Sc.
PHYSICS
PHYUT-602: Atoms, Molecules & 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 table and electronic pocket calculator is allowed.***

Given:

i) ***Rest mass of the electron = 9.109×10^{-31} kg.***
ii) ***Charge on the electron = 1.6021×10^{-19} coulomb.***
iii) ***Plank's constant = 6.626×10^{-34} Js.***
iv) ***Boltzman constant = 1.38054×10^{-23} Jk^{-1}.***
v) ***Avogadros Number = 6.02252×10^{26} $(k\ mole)^{-1}$.***
vi) ***Bohr Magneton = 9.27×10^{-24} $amp.m^2$.***
vii) ***1 eV = 1.6021×10^{-19} J.***

Q1) Attempt any four of the following:

a) Show that when Laue's conditions are satisfied the reciprocal lattice vcector is equal to the scattering wave vector. **[4]**

b) If 1 eV energy is required to move an atom from the interior of the crystal to the surface. What is the proportion of vacancies present in the crystal at 1000^oC & at 300^oC. **[4]**

c) The 19F nucleus has spin quantum no. $I = \frac{1}{2}$ and the magnetic moment of 2.6273 μ_N. What is the value of nuclear g_N factor in this case. **[4]**

P.T.O.

d) A free electron is placed in a magnetic field of 1.3 Tesla calculate resonance frequency if g= 2.0023. **[4]**

e) The Debye temperature of a solid in 2000K. Calculate its specific heat at room temperature. **[4]**

f) The vibrational structure of the absorption spectrum of O_2 becomes continuous at 56,876 cm^{-1}. The upper electric state dissociates into one ground state atom and one excited state atom which has excitation energy 15,875 cm^{-1}. From this data estimate the dissociation energy of the ground state of O_2 in kJ/mole. **[4]**

Q2) a) Explain the theory of geometrical structure factor for FCC lattice, derive the expression for it. **[8]**

b) Derive the dispersion relation between w & k for a linear diatomic lattice. Represent it diagramatically. Write expression for optical mode and acoustic mode. **[8]**

Q3) a) Explain defects in crystal with special reference to Schottkey and Frankel pair. **[8]**

b) Using Debye model derive an expression for the specific heat of solids. Consider the cases at high and low temperatures. **[8]**

Q4) a) In the context of rotational fine structure of electronic vibration spectra. What are P,Q and R branches. Explain with the help of diagram of complete rotational spectrum. **[8]**

b) What do you mean dissociation energy, dissociation product and dissociation limit? Obtain expression for γ_{max} in this case. **[8]**

Q5) a) What are the applications of ESR spectroscopy? Describe working of a simple ESR spectrometer with the help of a block diagram. **[8]**

b) State and explain Frank- Condon principle with the help of neat diagrams. **[8]**

Q6) a) Explain Paschen-Back effect for 2p -2s transition. **[8]**

b) Explain with suitable diagrams **[8]**

i) Edge dislocation &

ii) Screw dislocaiton.

Q7) a) What are normal and unklapp processes. **[4]**

b) Obtain an expression for configurational entropy. **[4]**

c) Explain concept of phonon and quantization of elastic waves. **[4]**

d) In pure rotational spectrum the spectral lines are equidistant. Comment. **[4]**

EEE

Total No. of Questions :7]

SEAT No. :

P1923

[Total No. of Pages :3

[4922]-23
M.Sc.
PHYSICS
PHY UT-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. Attempt any four of the remaining questions.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables and electronic pocket calculator is allowed.***

Constants:

i) ***Boltzmann constant $K_B = 1.38 \times 10^{-23}$ J/^{o}k***
ii) ***Planck's constant h = 6.623×10^{-34} Js.***
iii) ***Avogadro's number N = 6.023×10^{23} cgs units.***
iv) ***Mass of electron $m_e = 9.1 \times 10^{-31}$ kg.***
v) ***Velocity of light C = 3×10^8 m/s***
vi) ***Gas constant R = 8.314 J/ mole /^{o}k***

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

a) Calculate the probability that the speed of oxygen molecule lies between 100 and 101 meter per second, at 200^{o}K. **[4]**

b) In a system in thermal equilibrium at absolute temperature T, two states with energy difference 4.83×10^{-21} J occur with relative probability e^2. Deduce the equilibrium temperature. **[4]**

c) The r.m.s. velocity of molecules of hydrogen gas at certain temperature is 1600 m/s. What will be the r.m.s. velocity of molecules of oxygen at the same temperature. **[4]**

d) A particle of unit mass is executing simple harmonic motion. Determine it's trajectory in phase space. **[4]**

P.T.O.

e) The molar mass of Lithium is 0.00694 and its density is 0.53×10^3 kg/m^3. Calculate the Fermi energy and Fermi temperature of electrons. **[4]**

f) The table given below shows the energy parameters and corresponding accessible states for two systems 1 and 2: **[4]**

System 1 : $E_1 = 2, 3, 4$ units and $\Omega_1 = 5, 25, 75$

System 2 : $E_2 = 5, 6, 7$ units and $\Omega_2 = 100, 150\ 200$

The system are kept in contact and undergo thermal interactions only. Obtain the distribution for 9(nine) units of energy in the equilibrium state.

Q2) a) State and prove Liouville's theorem. **[8]**

b) Discuss the behaviour of sharpness of the probability curve and show that the functional width of maximum in P(E) is given by **[8]**

$$\frac{\Delta^* E}{\bar{E}} = \frac{1}{\sqrt{f}}.$$

Q3) a) On the basis of canonical distribution obtain the law of atmosphere

$P(z) = P(0)\ e^{-mgz/kT}$ **[8]**

b) Show that the electronic specific heat of a strongly degenerate fermi gas is given by **[8]**

$c_v = \frac{\pi^2}{2} R \frac{T}{T_f}$ where symbols have their usual meaning.

Q4) a) For an ideal monoatomic gas, obtain an expression for classical partition function z', in the form **[8]**

$$z' = \frac{v^N}{h^{3N}} \left(\frac{2\pi m}{\beta} \right)^{3N/2}$$

b) What is Gibb's paradox? How is it resolved? **[8]**

Q5) a) Show that for photons, the mean pressure $\langle P \rangle$ is related to its total energy E by the relation **[8]**

$$\langle P \rangle = \frac{1}{3}\frac{\langle E \rangle}{V}.$$

b) On the basis of canonical distribution, obtain Curie's law of paramagnetism. **[8]**

Q6) a) Discuss Bose-Einstein condensation of bosons. **[8]**

b) For canonical ensembles show that the probability of finding the system in a particular microstate 'r' having energy E_r is given by **[8]**

$$P_r = \frac{e^{-\beta E_r}}{\sum_r e^{-\beta E_r}}.$$

Q7) a) Obtain an expression for mean energy of Fermions at T = 0^oK. **[4]**

b) Prove the following relation of entropy S. **[4]**

$$S = C_v \ln T + R \ln V + \text{ constant.}$$

c) Prove the relation $\overline{(\Delta E)^2} = KT^2 C_v$. **[4]**

d) Discuss any two properties of partition function. **[4]**

EEE

Total No. of Questions :7]

SEAT No. :

P1924

[Total No. of Pages :2

[4922]-24
M.Sc.
PHYSICS
PHY UT-604: Quantum Mechanics - II
(2008 Pattern) (Semester - II)

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

Instructions to the candidates:

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

Q1) Attempt any four of the following:

a) Show that there is no first order stark effect in the ground state of atom. **[4]**

b) Find the eigen value of exchange operator P_{12} for identical particles 1 and 2. **[4]**

c) Determine the form of antisymmetric total eigen function for a system of three particles in which the interaction between the particles can be ignored. **[4]**

d) Show that total energies in laboratory and centre of mass system are related by **[4]**

$$E_{lab} = \left(\frac{m_1 + m_2}{m_2} \right) E_{cm} .$$

e) Use perturbation theory to obtain the first order correction to n^{th} energy level of an anharmonic oscillator with Hamiltonian **[4]**

$H = \frac{P^2}{2m} + \frac{1}{2} kx^2 + bx^4$ for very small b.

f) Using variation principle obtain expression for ground state energy of hydrogen atom. **[4]**

P.T.O.

Q2) a) Discuss classical and quantum mechanical picture of collision between identical particles. **[8]**

b) Develop time dependent perturbation theory to obtain first order correction to amplitude $a_m^{(1)}(t)$. **[8]**

Q3) a) Obtain the slaters determinant for a system of N particles. **[8]**

b) Obtain an expression for the Fermi golden rule (transition probability) for harmonic perturbation. **[8]**

Q4) a) Using Born approximation obtain expression for differential cross section for a screened coulomb field. **[8]**

b) What is dipole approximation in time dependent perturbation theory? Discuss selection rule for electric dipole transition. **[8]**

Q5) a) Using Green's function obtain an expression for scattering amplitude. **[8]**

b) Use WKB theory to obtain transmission coefficient for α particle. **[8]**

Q6) a) Using method of partial waves, obtain an expression for the cross section for scattering by a perfectly rigid sphere. **[8]**

b) What is Zeeman effect? Obtain expression for change in energy value of ground state when second order effect is considered. **[8]**

Q7) a) Obtain Bohr's quantization condition that bound state satisfy. **[4]**

b) Describe vectors and pseudovectors in terms of intrinsic parity. **[4]**

c) State conditions for validity of WKB approximation. **[4]**

d) Discuss concept of symmetry in quantum mechanics. **[4]**

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Total No. of Questions :7]

SEAT No. :

P1925

[Total No. of Pages :3

[4922]-31
M.Sc.
PHYSICS
PHYUT-701: Solid State Physics
(2008 Pattern) (Semester - III)

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) ***Figures to the right indicate full marks.***
3) ***Draw neat labelled diagram wherever necessary.***
4) ***Use of logarithmic tables and pocket calcultor is allowed.***

Given:

Rest mass electron = 9.109×10^{-31} kg.
Charge of electron = 1.6021×10^{-19} C.
Plank's constant = 6.626×10^{-34} J-s.
Boltzmann constant = 1.3805×10^{-23} J k^{-1}.
Avogadros Number = 6.0225×10^{26} (kilomole)$^{-1}$.
Bohr Magneton = 9.27×10^{-24} A-m^2.
Permeability of free - space = $4\pi \times 10^{-7}$ Henry /m.
Permittivity of free - space = 8.85×10^{-12} c^2 /N-m^2.

Q1) Attempt <u>any four</u> of the following: **[16]**

a) Estimate the fraction of electrons excited above the Fermi level at room temperature for Na.

Given: $E_f = 3.1$ *eV* for Na

b) Calculate the thermal conductivity of copper at 27°C if the electrical resistivity is 1.65×10^{-8} Ωm and it is obeying Wiedmann -Franz law.

c) The momentum of electron at the boundary of first Brillouin zone is 1.1×10^{-24} kg m/s. Calculate the lattice constant of the crystal using this data.

d) A magnetic material has a magnetization of 3300 A/m and magnetic flux density of 4.4×10^{-3} T. Calculate the magnetizing force.

P.T.O.

e) Calculate the critical current density which can flow through a long thin superconducting wire of Al of diameter 10^{-3} m. The critical magnetic field for Al is 7.9×10^3 A/m.

f) A paramagnetic substance has 10^{28} atoms/m^3. The magnetic moment of each atom is 1.8×10^{-23} A–m^2. Calculate the paramagnetic susceptibility at 300K.

Q2) a) Explain with the help of neat diagrams reduced, periodic and extended zone schemes. **[8]**

b) For an atom placed at general lattice site, derive an expression of local electric field E local. Explain each term in the expression. **[8]**

Q3) a) Describe the origin of band-gap using nearly free electron model. **[8]**

b) What are longitudinal plasma oscillations ? Derive expression for the frequency of these oscillations. Draw necessary diagrams. **[8]**

Q4) a) Discuss the origin of diamagnetism in a free atom. Obtain Langevin's diamagnetism equation for the diamagnetic susceptibility. **[8]**

b) Derive London's equation for superconducting state and obtain an expression for the penetration depth. **[8]**

Q5) a) Describe the Weiss molecular field theory of ferromagnetism with reference to Curie point. Hence derive the relation for Curie - Weiss law. **[8]**

b) Explain the assumptions of BCS theory of superconductivity. **[8]**

Q6) a) Explain Antiferromagnetism with reference to the Neel temperature and susceptibility. Hence describe ferrimagnetism. **[8]**

b) Distinguish between type-I and type - II superconductors. **[4]**

c) Explain flux quantization in a superconducting ring. **[4]**

Q7) a) The relative permittivity of Ar at zero ^{o}C and 1 atmosphere is 1.000435. Calculate the polarizibility. **[4]**

b) Write the expression for Fermi-Dirac statistics and explain its temperature dependence with the help of neat diagram. **[4]**

c) A superconducting material has a critical temperature of 3.7 K in zero magnetic field and a critical field of 0.0306 Tesla at zero K. Find the critical field. **[4]**

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

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Total No. of Questions :7]

SEAT No. :

P1926

[Total No. of Pages :2

[4922]-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.***
2) ***Attempt any four from the remaining.***
3) ***Draw neat diagrams wherever necessary.***
4) ***Figures to the right indicate full marks.***
5) ***Use of logarithmic tables and packet calcultor is allowed.***

Q1) Attempt any four of the following:

a) Calculate the total cross section for n-p scattering of neurtrons having energy 2 MeV. **[4]**

Given a_t = 5.38 F a_s = – 23.4F.

r_{ot} = 1.70 F r_{os} = 2.40 F.

b) Calculate the scattering length a_t and a_s where σ_{para} = 4.19 barns and $\sigma_{ortho.}$ = 128 barns. **[4]**

c) Which of the following reactions arc allowed or torbidden under the conservation of strangeness, conservation of baryon number, and conservation of charge. **[4]**

i) $\pi^+ + n \rightarrow \overline{k^o} + \Sigma^+$

ii) $\pi^- + p \rightarrow \pi^0 + \wedge^0$

d) Calculate the half value thickness for β absorption in aluminium for the β spectrum with E_{max} = 1.17 MeV. Density of Aluminium = 2.7 gm/cm^3. **[4]**

P.T.O.

e) Calculate the range of 9 MeV particles in aluminium if the relative stopping power of aluminium is 1700. Also calculate the thickness of aluminium that is equivalent in stopping power to1 meter air. $\rho_{Al} = 2700$ kg/m^3. **[4]**

f) For energy filters in mass-spectrometers, show that $\frac{1}{2}mv^2 = \frac{neV\ R_o}{2d}$ where the symbols have usual meaning. **[4]**

Q2) a) What are different ways for classification of Nuclear reactor? Give the classification of Nuclear reactor according to its purpose. **[8]**

b) Describe the construction and working of Bainbridge and Jordon mass spectrometer. **[8]**

Q3) a) Describe the electron scattering method to measure the radius of the nucleus. **[8]**

b) Write the principle, construction and working of a microtron. **[8]**

Q4) a) Derive Bethe's formula for 'stopping power' of charged particles moving through matter. Write the expression for relativistic effect. **[8]**

b) Give important features of Gamow's theory of α decay. **[8]**

Q5) a) Explain compton effect. **[4]**

b) Define and explain the term: effective range. **[4]**

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

Q6) a) Show that for low energy n-p scattering $\sigma_o = \frac{4\pi}{k^2}\sin^2\delta_o$ where symbols have usual meaning. **[8]**

b) Evaluate the maximum energy shift that can be observed for a body whose quadrupole moment is Q. **[4]**

c) Explain the concept of Isospin associated with elementary particles. **[4]**

Q7) a) What is nuclear chain reaction? Obtain four factor formula for the chain reaction. **[8]**

b) Explain high energy nucleon-necleon reaction in scattering. Obtain an expression for scattering amplitude using Born - approximation. **[8]**

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