Total No. of Questions :8]

SEAT No. :

P2661

[Total No. of Pages :3

[5022] - 1001

M.Sc.

PHYSICS

PHYUT - 501: Classical Mechanics

(2014 Pattern) (Credit System) (4 - Credits) (Semester - I)

Time : 3 Hours] *[Max. Marks :50*

Instructions to the candidates:

1) ***Attempt any <u>five</u> questions out of <u>Eight</u> questions.***
2) ***Neat diagram must be drawn wherever necessary.***
3) ***Figures to the right side indicate full marks.***
4) ***Use of calculator is allowed.***

Q1) a) Write down the Lagranges equation of motion for a particle of mass 'm' falling freely under gravity near the surface of the earth. **[4]**

b) Prove that [F, GS] = [F, G] S + G [F, S]. **[3]**

c) Write the types of constraints for **[3]**

i) Deformable bodies.

ii) Gas filled hollow sphere.

Q2) a) A bead slides without friction on a wire which is rotating with angular velocity 'ω' in the force free space. Write down the Lagrange's equation of motion. **[4]**

b) A particle of mass 'm' moves under the action of central force whose potential is v (r) = kmr^3 (k > 0) then for what kinetic energy and angular momentum will the orbit be a circle of Radius R about the origin? **[3]**

c) Using Poisson Bracket, prove that **[3]**

$[L_z, L_x] = L_y$

P.T.O.

Q3) a) Show that the transformation defined by **[4]**

$q = \sqrt{2P}\sin Q$

$p = \sqrt{2P}\cos Q$ is canonical

b) Define **[3]**

i) Configuration space

ii) Phase space

iii) State space

c) Obtain the Lagrangian and equation of motion for simple pendulum. **[3]**

Q4) a) Using variational principle, explain Brachistochrone problem. **[4]**

b) Describe the Hamiltonian and Hamilton's equation for an ideal spring mass arrangement. **[3]**

c) Calculate the reduced mass of the following systems: **[3]**

i) Positronium

ii) H_2 molecule

Q5) a) A particle is moving under a central force field. Prove that **[4]**

$$F\left(\frac{1}{u}\right) = -\frac{J^2}{m}\left(u^3 + 2c^2u^5\right).$$

b) Consider a system of two masses connected by an inextensible string passing over a small smooth pulley. Calculate the acceleration of the system if the pulley is a disc of radius R and moment of Inertia I about an axis through its centre and perpendicular to its plane. **[3]**

c) Show that the transformation **[3]**

$Q = q \tan p$

$P = \log(\sin p)$ is canonical.

Q6) a) For certain canonical transformation it is known that **[4]**

$$Q = \sqrt{(q^2 + p^2)}$$

$$F = \frac{1}{2}(q^2 + p^2)\tan^{-1}\frac{q}{p} + \frac{1}{2}qp$$

Find P (q, p) and F (q, Q).

b) A particle moving in a central force field located at r = 0, describes a spiral $r = e^{-\theta}$. Prove that the magnitude of force is inversely proportional to r^3. **[3]**

c) Show that, A function whose Poisson bracket with Hamiltonian vanishes is a constant of motion. **[3]**

Q7) a) The ends of uniform Flexible wire are attached to the points on the same level and separated by a horizontal distance 'b'. The wire has a length 'L' (line supported by series of poles of electricity board, is a similar case). Find the equation describing the shape of the wire. Use the fact that, the potential energy is minimum. **[5]**

b) A curve passing through two end points (x_1, y_1) and (x_2, y_2) has been rotated about y-axis. Find a curve which on revolving about a certain axis forms geometry of minimum surface area. **[5]**

Q8) a) Show that for a spherical surface, the geodesic are the great circles. **[5]**

b) Describe the Hamiltonian and Hamilton's equation of motion for charged particle in an electromagnetic field. **[5]**

Total No. of Questions :8]

SEAT No. :

P2662

[Total No. of Pages :3

[5022] - 1002

M.Sc.

PHYSICS

PHY UT - 502: Electronics

(2014 Pattern) (4 - Credits) (Semester - I)

Time : 3 Hours] *[Max. Marks :50*

Instructions to the candidates:

1) ***Solve any FIVE questions out of the Eight questions.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of calculator is allowed.***

Q1) a) Give the internal block diagram of IC 555 timer and explain its working. **[4]**

b) Explain the internal block diagram of a 3-pin voltage regulator and explain its working. **[3]**

c) Explain with a neat diagram the working of a 4-bit up-down counter. **[3]**

Q2) a) What is fold back current limiting? Draw a circuit diagram of fold back power supply using IC 723. Explain its operation. **[4]**

b) Give the circuit diagram of monostable multivibrator using IC 741. Explain its operation. **[3]**

c) Place the truth and map the function. **[3]**

$$R=\bar{A}\bar{B}\bar{C}D + A\bar{B}C\bar{D} + A\bar{B}\bar{C}\bar{D}$$

Q3) a) Give the circuit diagram of shift register using IC 7495, to explain SIPO and PIPO operation. **[4]**

b) Give the circuit diagram of R-2R Ladder type counter. Discuss the advantages and disadvantages of R-2R type counter. **[3]**

c) Draw the circuit diagram of DC-DC converter. Explain its operation. What are its applications? **[3]**

P.T.O.

Q4) a) Give internal circuit diagram for decade counter using IC7490 and explain its working and also give its applications. **[4]**

b) Draw block diagram of CVCC. Explain its operation. **[3]**

c) What are the advantages and disadvantages of SMPS. **[3]**

Q5) a) Draw a neat circuit diagram of a series voltage regulated power supply using discrete components. Explain the role of each block. **[4]**

b) Discuss the working of a successive approximation type ADC. **[3]**

c) Explain how symmetrical square waveform can be obtained using IC741 as an Astable multivibrator. **[3]**

Q6) a) How capacity 'C' charges in voltage controlled oscillator using IC 566? Find the output frequency with the following data. **[4]**

$V_t = 10V$, $V_C = 8V$, $R_1 = 10K\Omega$ and $C_1 = 0.1\,\mu F$

b) Minimize the following Boolean expression using K-map and realize it using the logic gate. **[3]**

$Y = \sum m\ (1, 3, 5, 9, 11, 13)$

c) Design a monostable multivibrator IC 555 timer for $V_{CC} = 12V$ and pulse width of 1msec. **[3]**

Q7) a) Calculate the output frequency f_o, lock range Δf_L and capture frequency range Δf_C of IC 565 PLL, if $R_T = 10\ K\Omega$, $C_T = 0.01\ \mu F$ and $C_F = 10\ \mu F$, $V_{CC} = \pm 10$ V. **[5]**

b) What is K - map? Write a truth table using 4 bit K - map, for 4 input variable has a high output for an input of 0000, low output for 0001 to 1001 and don't care for 1010 to 1111. What is the simplest Logic circuit with this truth table? **[5]**

Q8) a) Calculate the value of R_1 and C_T of a IC 555 timer as an astable mode, if $R_2 = 500\,\Omega$ and whose clock frequency duty cycle are 1.5 MHz and 70% respectively. **[5]**

b) Explain 2-bit simultaneous A/D converter with Logic diagram and give its comparator output for input voltage range. **[5]**

Total No. of Questions : 8]

SEAT No. :

P2663

[Total No. of Pages : 3

[5022]-1003
M.Sc.
PHYSICS
PHY UT - 503 : Mathematical Methods in Physics
(2014 Pattern) (4 Credits) (Credit System) (Semester - I)

Time : 3 Hours] *[Max. Marks :50*

Instructions to the candidates:

1) ***Answer ANY FIVE questions out of eight questions.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of calculator is allowed.***

Q1) a) Let - $V = R^3$. Determine whether W is a subspace of V where:

i) $W = \{(a,b,0) : a,b \in R\}$

ii) $W = \{(a,b,c) : a \geq 0\}$ **[4]**

b) Find Laplace transform of $\sin(\omega t)$. **[3]**

c) Obtain the first three Legendre polynomials using generating function. **[3]**

Q2) a) State and Explain Dirichlet conditions. **[4]**

b) Determine whether or not the following form a basis for the vector space R^3 : {(1,1,1), (2,0,0), (0,2,0), (0,0,2)}. **[3]**

c) Prove that: $L_{n+1}(x) = (2n + 1 - x)L_n(x) - n^2L_{n-1}(x)$. **[3]**

Q3) a) Let V be the vector space of polynomials with inner product given by

$$< f,g >= \int_0^1 f(t)g(t)dt$$

Let $f(t) = t+2$ and $g(t) = t^2-2t-3$.

Find <f,g> and $\| f \|$. **[4]**

P.T.O.

b) Let W be the space generated by the polynomials:

$v_1 = t^3 - 2t^2 + 4t + 1$

$v_2 = 2t^3 - 3t^2 + 9t - 1$

$v_3 = t^3 + 6t - 5$

$v_4 = 2t^3 - 5t^2 + 7t + 5$

Find a basis and dimension of W. **[3]**

c) What are odd and even functions? Determine the Fourier coefficients for odd functions. **[3]**

Q4) a) Diagonalize the following matrix:

$$A=\begin{pmatrix} 2 & -2 \\ -2 & 5 \end{pmatrix}$$ **[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 operation of addition: (a,b) + (c,d) = (a+c,b+d) in V and scalar multiplication: k(a,b) = (ka,b) on V. **[3]**

c) Prove that: $J'_n(x)=\frac{1}{2}\left[J_{n-1}(x)-J_{n+1}(x)\right]$. **[3]**

Q5) a) Using the Rodrigue's formula for Hermite's polynomials, obtain the first three Hermite polynomials $H_0(x)$, $H_1(x)$, $H_2(x)$. **[4]**

b) Prove that the Laplace transform operator L is linear. **[3]**

c) For what value of k is (1,k,5) a linear combination of vectors u = (1,–3,2) and v = (2,–1,1). **[3]**

Q6) a) Obtain the Fourier series corresponding to the function:

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

$f(x) = 3, \quad 0 < x < 5$ period = 10 **[4]**

b) Prove that:

$H_{n+1}(x) = 2xH_n(x) - 2nH_{n-1}(x)$ **[3]**

c) Define Basis and dimension of a vector space. Is dimension of a vector space unique? Explain. **[3]**

Q7) a) Let T be the linear operator on R^3 defined by T(x,y,z) = (2y+z, x–4y, 3x).

i) Find the matrix T in the basis

$\{f_1 = (1,1,1), f_2 = (1,1,0), f_3 = (1,0,0)\}$

ii) Verify that $[T]_f [V]_f = [T(V)]_f$ **[5]**

b) State and prove the orthogonality property of Hermite's functions. **[5]**

Q8) a) Find $L^{-1}\left\{\frac{5S^2 - 15S + 7}{(S+1)(S-2)^3}\right\}$ **[5]**

b) Let $A = \begin{pmatrix} 1 & -3 & 3 \\ 3 & -5 & 3 \\ 6 & -6 & 4 \end{pmatrix}$

Find eigenvalues and eigenvectors of matrix A. **[5]**

Total No. of Questions : 8]

SEAT No. :

P2664

[Total No. of Pages : 2

[5022]-1004
M.Sc.
PHYSICS
PHYUTN - 504 : Atoms and Molecules
(2014 Pattern) (4 - Credits) (Semester - I)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Solve any five questions.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to right indicates full marks.***
4) ***Use of Lagarithmic table and electronic pocket calculator is allowed.***

Given:

1)	Rest mass of $\bar{e}$	=	9.11×10^{-31} kg
2)	Charge on $\bar{e}$	=	1.6021×10^{-19} coulomb
3)	Plank's constant	=	6.626×10^{-34} J-sec
4)	Boltzmann Constant	=	$1.38054 \times 10^{-23} Jk^{-1}$
5)	Bohr Magneton	=	9.27×10^{-24} amp.m^2
6)	Avogadro's number	=	$6.02252 \times 10^{+26}$ (kmole)$^{-1}$
7)	1 ev	=	$1.6021 \times 10^{-19} J$
8)	μ_N - Nuclear Mageton	=	$5.05 \times 10^{-27} JT^{-1}$

Q1) a) Explain the concept of photon? **[4]**

b) What are N & U processes? **[3]**

c) Discuss origin of spectral line. **[3]**

Q2) a) State difference between atomic and molecular spectra. **[4]**

b) Find Lande's g factor for the state $^2 F_{712}$. **[3]**

c) Explain Lane theory of X.ray diffraction. **[3]**

Q3) a) State and explain Frank - Condon principale. **[4]**

b) The Debye temperature of Diamond is 2230 k calculate the highest possible lattice vibrational frequency. **[3]**

c) Write a note on vibrational course structure. **[3]**

P.T.O.

Q4) a) What are the basic requirements of NMR spector meter, explain with block diagram. **[4]**

b) What are the different selection rules for different quantum numbers. **[3]**

c) Calculate the differences in the energies of proton oriented with and against a magnetic field of strength 1.5T. What is the frequency of radiation that has photons with this energy $g_N = 5.5857$. **[3]**

Q5) a) Derive an expression for shift in wavelength in normal Zeeman effect. **[4]**

b) The Zeeman component of 500 nm spectral line are 0.0106 nm apart when the magnetic field is 0.40 Tesla. Find the ratio e/m for the electron. **[3]**

c) Write a note on chemical shift. **[3]**

Q6) a) Draw hyperfine structure for an unpaired electrons capling with two non equivalent Nuclei each of spin I = ½. **[4]**

b) What are the applications of NMR? **[3]**

c) Explain Hund's rule & Pauli's exclusion principle. **[3]**

Q7) a) Derive Disperson relation for 1 D linear monoatomic Lattice. **[5]**

b) Define dissociation energy for a diatomic moleule obtain an expression for ν_{max} corresponding to the dissociation energy. **[5]**

Q8) a) Derive an expression for geometrical structure factor for a bcc structure. **[5]**

b) Explain Einstein model of specific heat, Derive expression for specific heat for the same. **[5]**

Total No. of Questions : 8]

SEAT No. :

P2665

[Total No. of Pages : 2

[5022]-1005
M.Sc.
PHYSICS
PHYUT - 505 : Experimental Techniques in Physics - I
(2014 Pattern) (4 Credits) (Semester - I)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Attempt any five questions.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables and pocket calculator is allowed.***

Q1) a) With the help of neat diagram explain the principle, construction and working of Rotary pump. **[4]**

b) Describe various types of errors in brief. **[3]**

c) Define the terms: throughput impedance and conductance of a vacuum line. **[3]**

Q2) a) With the help of neat diagram, explain the principle, construction and working of diffusion pump. **[4]**

b) Write the principle of sputter ion pump. **[3]**

c) Calculate pump down time to reduce the pressure 190 Torr to 10^{-2} Torr if volume of chamber is 10 lit and pump speed is 30 lit/min. **[3]**

Q3) a) What is throttle process? Prove that entropy remains constant in a throttling process. **[4]**

b) The intake port of diffusion pump has diameter 5 cm and its speed is 60 lit/sec. It is connected to a chamber by a tube of conductance 56.5 lit/sec. Calculate an effective pump speed. **[3]**

c) With the help of neat diagram, explain the principle of Pirani gange. **[3]**

P.T.O.

Q4) a) Derive an expression for pump down time. **[4]**

b) Give the important applications of vacuum. **[3]**

c) Differentiate the term: viscous flow and molecular flow. **[3]**

Q5) a) Explain auto and cross signal processing. **[4]**

b) Write the advantages of thermocouple (Pirani) gange. **[3]**

c) Explain vacuum system design with the help of schematic diagram. **[3]**

Q6) a) With the help of neat diagram explain the principle and working of McLeod gange. **[4]**

b) Discuss the term 'Spactral Analysis'. **[3]**

c) Give the properties of pump fluid used in diffusion pump. **[3]**

Q7) a) Discuss basic principle and applications of optical tweezers. **[5]**

b) With the help of neat diagram, explain the principle and working of molecular drag pump. **[5]**

Q8) a) With neat diagram, explain the principle and working of penning gange. **[5]**

b) With the help of neat diagram explain the construction of optical tweezers. **[5]**

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Total No. of Questions : 8]

SEAT No. :

P2666

[Total No. of Pages : 2

[5022]-2001
M.Sc.
PHYSICS
PHYUT - 601: Electrodynamics
(2014 Pattern) (New Course) (4 - Credits)
(Credit Based System) (Semester - II)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Attempt any five questions from the following.***
2) ***Draw neat labelled diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***All questions carry equal marks.***
5) ***Use of calculator is allowed.***

Q1) a) Derive the expression for potential at a distant point using multipole expansion for a localized charge distribution in free-space. **[4]**

b) Explain Minkowski's space-time diagram. **[3]**

c) Given the e.m. wave: **[3]**

$$\vec{E} = \hat{i}\, E_o \cos\omega\left(\sqrt{\in \mu}\, z - t\right) + \hat{j}\, E_o \sin\omega\left(\sqrt{\in \mu}\, z - t\right),$$

where E_o is constant. Find the corresponding magnetic field.

Q2) a) Obtain the expression for electromagnetic field tensor $F_{\mu\gamma}$. **[4]**

b) Explain the term 'vacuum displacement current'. **[3]**

c) Find the velocity at which the mass of the particle is double it's rest mass. Given: $C = 3\times10^8$ m/s. **[3]**

Q3) a) Show that power transferred to the e.m. field through the motion of charge in volume V is given by: **[4]**

$$-\int_V \vec{j}\cdot\vec{E}\, dv = \frac{d}{dt}\int_V \frac{1}{2}\left(\vec{E}\cdot\vec{D} + \vec{B}\cdot\vec{H}\right) dv + \int_{c.s.} \left(\vec{E}\times\vec{H}\right)\cdot\vec{ds}$$

b) Write and explain Lorentz's & Coulomb's conditions. **[3]**

c) Show that $\left(\vec{E}\cdot\vec{B}\right)$ is invariant under Lorentz transformations. **[3]**

P.T.O.

Q4) a) Derive Faraday's law of induction for moving medium. **[4]**

b) Write Maxwell's equations in differential and integral forms. **[3]**

c) An electron is accelerated from the rest to a speed of 0.9995 C in a particle accelerator. Determine the total energy of electron, if it's rest mass energy is 8.2×10^{-14}J. **[3]**

Q5) a) Derive inhomogeneous wave equations in terms of scalar potential ϕ and vector potential $\vec{A}$. **[4]**

b) Explain the term Hertz potential. Show that the electric field can be expressed in terms of Hertz potential as $\vec{E}=\vec{\nabla}\times\left(\vec{\nabla}\times\vec{Z}\right)$. **[3]**

c) Show that a combined space-time interval $x^2+y^2+z^2-c^2t^2$ is Lorentz invarient. **[3]**

Q6) a) Write the expression for magnetic field intensity $\vec{B}$ at a point and show that it's curl equals to $\mu_o \vec{j}$. **[4]**

b) Explain the term 'momentum space' with the help of suitable example. **[3]**

c) Calculate the frequency at which the skin-depth in sea water is 1 meter. **[3]**

Given: $\mu = \mu_o = 4\pi\times10^{-7}\,\frac{wb}{A-m}$ and $\sigma = 4.3\frac{mh_o}{m}$.

Q7) a) A plane e.m. wave is incident obliquely on an interface between the two non-conducting dielectric media. Obtain an expression for Snell's law. **[5]**

b) Draw a suitable diagram and explain the magnetic interaction between two current loops. **[5]**

Q8) a) Draw a neat labelled diagram of Michelson-Morlay experiment. Hence obtain the formula for fringe shift. **[5]**

b) Derive the Lorentz relativistic transformation equations. **[5]**

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Total No. of Questions : 8]

SEAT No. :

P2667

[Total No. of Pages : 3

[5022]-2002
M.Sc.
PHYSICS
PHYUT - 602 : Solid State Physics
(New Course) (2014 Pattern 4 - Credits) (Semester - II)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) *Attempt any five questions.*
2) *Draw neat & labelled diagrams wherever necessary.*
3) *Figures to the right indicate full marks.*
4) *Use of logarithmic tables & calculators is allowed.*

Constants:

1)	*Boltzmann Constant*	:	1.38×10^{-23} J/K
2)	*Plank's Constant*	:	6.623×10^{-34} JS
3)	*Avagadro's Number*	:	6.023×10^{23} /mole
4)	*Mass of electron*	:	9.1×10^{-31} Kg
5)	*Charge on electron*	:	1.6×10^{-19}C
6)	*Bohr magneton*	:	9.27×10^{-24} A.m^2
7)	*Permeability of free space*	:	$4\pi \times 10^{-7}$ H/m

Q1) a) Obtain an expression for the diamagnetic susceptibility on the basis of the classical theory. **[4]**

b) What are cooper pairs? How are they important in super conductors? **[3]**

c) An isulating material absorbs all wavelengths shorter than 1800 $\mathring{A}$. Find the width of the band gap for this material. **[3]**

Q2) a) Show that the effective mass of electron in an energy band is

$$m^* = \hbar^2 \left[\frac{d^2 E}{dk^2} \right]^{-1}.$$ **[4]**

b) Show that the number of possible wave functions / levels in any energy band is equal to the number of unit cells in the crystal. **[3]**

c) The magnetic field in copper is 10^6 A/m. If the magnetic susceptibility of copper is -0.8×10^{-5}, calculate the flux density and magnetization in copper. **[3]**

P.T.O.

Q3) a) If a material has zero resistance, it does not necessarily mean that it will be a super conductor. Explain. **[4]**

b) Distinguish between the ferromagnetic & the antiferromagnetic order. **[3]**

c) A two dimensional square lattice has a side 0.3 nm. Calculate the momentum & energy of electron at the boundary of the first Brillouin zone. **[3]**

Q4) a) What is saturation magnetization? Discuss the temperature dependence of saturation magnetization. **[4]**

b) Explain the following for a super conductor. **[3]**

i) Critical field

ii) Critical Temperature &

iii) Critical current

c) Calculate the London penetration depth for a super conductor with $n = 4 \times 10^{26}\ m^{-3}$. **[3]**

Q5) a) Explain the cyclotron resonance in metals. Obtain an expression for the cyclotron resonance frequency in metals. **[4]**

b) Explain the anisotropy energy and the Bloch wall for a magnetic material. **[3]**

c) A super conductor has a critical temperature of 3.7 K when there is no external magnetic field. It has a critical field of 0.0306 T at 0K. Find the critical field at 2 K. **[3]**

Q6) a) What is the London penetration depth? Obtain an expression for it. **[4]**

b) Draw a typical hysterisis curve and explain various terms involved in it. **[3]**

c) A paramagnetic substance has 10^{28} atoms per m^3. The magnetic moment of each atom is $1.8 \times 10^{-23}\ Am^2$. Find out the paramagnetic susceptibility at 300 K. **[3]**

Q7) a) Write down the equation of motion for a free electron gas exposed to a time dependent electric field. Use the solution of this equation and obtain an expression for plasma frequency of the free electron gas. **[5]**

b) Explain the molecular field approximation. Using this derive an expression for the Curie-Weiss law for ferromagnetic material. Discuss the significance. **[5]**

Q8) a) Show that the paramagnetic susceptibility of conduction electrons is independent of temperature. **[5]**

b) State and prove the Bloch theorem. **[5]**

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Total No. of Questions :8]

SEAT No. :

P2668

[Total No. of Pages :3

[5022] - 2003

M.Sc. (Physics)

PHYUT - 603 : QUANTUM MECHANICS

(2014 Pattern) (4 Credit Based System) (Semester - II)

Time : 3 Hours] *[Max. Marks :50*

Instructions to the candidates:

1) ***Attempt any five out of eight questions.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the rigth indicate full marks.***
4) ***Use of logarithmic tables and electronic calculators is allowed.***

Q1) a) State and explain postulates of quantum mechanics. **[4]**

b) Show that det $e^{A} = e^{trA}$. **[3]**

c) Define : **[3]**

i) Adjoint of an operator $\hat{A}$

ii) Hermitian operator and show that $\left(\hat{A}\,\hat{B}\right)^{+} = \hat{B}^{+}\,\hat{A}^{+}$

Q2) a) Using ladder operators, obtain the energy eigen values of 1D- harmonic oscillator. **[4]**

b) The operators for angular momentum are $J_{+} = J_x + iJ_y$ and $J_y = J_x - iJ_y$ show that

i) $[J_{+}, J_{-}] = 2\hbar J_z$

ii) $[J_z, J_{-}] = -\hbar J_{-}$ **[3]**

c) State the conditions of validity of WKB approximation. **[3]**

P.T.O.

Q3) a) Explain the principle of variational. method. show that it leads to better estimation. **[4]**

b) If $\cup$ is unitary and if $\langle\psi|\psi\rangle = 1$, show that $\langle \cup\psi | \cup\psi\rangle = 1$. **[3]**

c) Define spin operator S and obtain pauli spin matrices σ_x, σ_y and σ_z. Show that the matrices are unitary. **[3]**

Q4) a) Show that $\sum_a \phi_a(x)\phi_a(x) = \delta(x - x')$ by using completeness theorem and δ - function. **[4]**

b) An arbitrary state $|\alpha\rangle$ is expanded in terms of $|w_\mu\rangle$ given by $|\alpha\rangle = \sum_\mu a_\mu |w_\mu\rangle$ what is a_μ ? Define the probability of $|w_\mu\rangle$ state . **[3]**

c) For $j = \frac{1}{2}$, obtain matrices for J_z and J^2 . **[3]**

Q5) a) Give physical significance of **[4]**

i) Operators

ii) Eigen values

iii) Eigen functions

iv) Expansion coefficients

b) Write notes on Hilbert space and Dirac's Bra and Ket notations. **[3]**

c) The anharmonic Hamiltonian of oscillator is $H = \frac{p^2}{2m} + \frac{1}{2} mw^2 x^2 + bx^3$ show that the first order correction to the ground state is 0. **[3]**

Q6) a) Given that $L \pm |l, m_l\rangle = C_{lm}^{\pm} |l, m \pm 1\rangle$, where L_+ and L_- are raising and lowering angular momentum operators. Obtain an expression for $C_{lm}^{\pm}$, where $|l, m\rangle$ are simultaneous eigen states of L^2 and L_z operators. **[4]**

b) Define Dirac delta function. Represent it graphically and discuss its properties. **[3]**

c) Prove that $(\hat{A} + \hat{A}^+)$ and $i(\hat{A} - \hat{A}^+)$ are Hermitian for any operator $\hat{A}$. **[3]**

Q7) a) A particle of energy $E > V_o$ is incident on a rectangular potential barrier of height V_o. Write expression for reflection and transmission coefficients. Plot a graph of T against $\frac{\alpha L}{\Pi}$ and interprete it. **[5]**

b) In time dependent perturbation theory obtain the expression for first order transition amplitude $a_m^{(1)}(t)$. **[5]**

Q8) a) Obtain Clebsch- Gorden coefficients by adding the angular momentam of two non-interacting electrons with $j_1 = \frac{1}{2}$ and $j_2 = \frac{1}{2}$. **[5]**

b) Discuss the Fermi - Golden rule. **[5]**

Total No. of Questions :8]

SEAT No. :

P2669

[Total No. of Pages :2

[5022] - 2004

M.Sc. (Physics)

PHYUT - 604 : LASERS

(2014 Pattern - 4 Credit) (Semester - II)

Time : 3 Hours] *[Max. Marks :50*

Instructions to the candidates:

1) ***Solve any FIVE questions out of eight questions.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of calculator is allowed.***

Q1) a) Explain basic three processes with neat diagrams in brief. **[4]**

b) What is pumping? Explain different pumping methods. **[3]**

c) State the requirements of active medium in laser. **[3]**

Q2) a) Deduce the expression for threshold condition for lasing in optical resonator. **[4]**

b) What are the characteristics of laser beam? Explain beam divergance. **[3]**

c) Calculate the wavelength of beam at which rate of spontaneous emission is equal to rate of stimulated emission for the temperature of 700 ^{o}k **[3]**

Q3) a) A material used in laser resonator of length 10 cm has a gain factor of 0.005 per cm. The reflectivity of one mirror is 100%. What would be the reflectivity of other mirror **[4]**

b) State and explain the condition for steady state oscillation. **[3]**

c) What is Holography? How it differs from photography. **[3]**

P.T.O.

Q4) a) Distinguish between three-level and four-level laser system. **[4]**

b) Explain the term monochromaticity. **[3]**

c) Calculate the intensity of laser beam of 1 mw power of He-Ne laser having wavelength 6328 $\mathring{A}$. **[3]**

Q5) a) Deduce the expression for threshold pumping power for four level laser using rate equations. **[4]**

b) With reference to energy level diagram explain the transitions of Ruby laser. **[3]**

c) Explain the experiment used for measurement of wavelength of laser beam. **[3]**

Q6) a) Explain the principle, construction and working of Co_2 laser. **[4]**

b) The gain profile of He-Ne laser has width of about 2×10^{-3} nm. If the length of the cavity is 30 cm how many longitudinal modes can be excited? The emission wavelength of He-Ne laser is 6328 $\mathring{A}$. **[3]**

c) Explain the principle and working of Dye laser. **[3]**

Q7) a) Find the ratio of population of the two levels in a He-Ne laser that produces light of wavelength 6328 $\mathring{A}$ at 27 ºC. **[5]**

b) What is excimer laser? Explain it in details. **[5]**

Q8) a) Explain the principle, construction and working of He-Ne laser. **[5]**

b) Explain the application of laser in bar code scanners in brief. **[5]**

Total No. of Questions :8]

SEAT No. :

P2670

[Total No. of Pages :3

[5022] - 2005

M.Sc.

PHYSICS

PHY UT - 605 : Experimental Techniques In Physcis - II

(2014 Pattern) (4 Credit Based System) (Semester - II)

Time : 3 Hours] *[Max. Marks :50*

Instructions to the candidates:

1) ***Attempt ANY FIVE questions.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables & calculator is allowed.***

Constants:

1. Boltzmann constant $k_B = 1.38\times10^{-23}$ J/K
2. Planck's constant $h = 6.63\times10^{-34}$ JS
3. Avogadro's number $N = 6.02\times10^{23}$/gm mole
4. Mass of electron $m_e = 9.1\times10^{-31}$ kg
5. Charge on electron $e = 1.6\times10^{-19}$ C
6. Velocity of light $C = 3\times10^{8}$ m/s

Q1) a) Explain different modes of Atomic Force Microscope (AFM) in detail. **[4]**

b) Write short note on microwave generator. **[3]**

c) Write short note on Laue's method. **[3]**

Q2) a) Calculate the exciting frequency of an ESR spectrometer, if the static magnetic field of 3400 G is used for excitation .

[Given: electron magnetic moment

$\mu_e = 9.285\times10^{-24}$ JT^{-1} and the angular momentum number can have values +½ or -½] **[4]**

P.T.O.

b) Explain the principle of operation of pressure sensors with examples. **[3]**

c) What will be the resolution of an optical microscope, whose numerical aperture is 1 and suppose wavelength used is 400 nm? Also, comment on the result. **[3]**

Q3) a) Explain principle, construction and working of X-ray diffraction (XRD) spectrometer. **[4]**

b) Discuss different high energy interactions of electrons with solid in SEM. **[3]**

c) Write short note on nuclear detectors. **[3]**

Q4) a) Write note on Nuclear Magnetic Resonance (NMR) **[4]**

b) What are the advantages of Field Emission Scanning Electron Microscope (FESEM) ove Scanning Electron Microscope (SEM)? **[3]**

c) Explain the techniques for IR radiation production. **[3]**

Q5) a) Explain the principle, instrumentation and working of Thermo-Gravimetric Analysis (TGA). **[4]**

b) Calculate the wavelength of electrons in an Electron Microscope, if the accelerating voltage is 30 kV. **[3]**

c) Write short note on sensor's characteristics. **[3]**

Q6) a) Write range of wavelengths and corresponding energies for all the electromagnetic radiations. **[4]**

b) Explain the principle of Neutron Diffraction. **[3]**

c) Write short note on Diffused Reflectance Spectroscopy (DRS). **[3]**

Q7) a) Explain the principle, construction and working of Fourier Transform Infra Red (FTIR) spectrometer. **[5]**

b) Explain principle, construction and working of Transmission Electron Microscope (TEM). **[5]**

Q8) a) Calculate the average nanoparticle size using scherrer formula. **[5]**
[Given : Wavelength used for diffraction is Cu kα - 0.154 nm, full width at half maxima (FWHM), $\beta = 0.05$, $\theta_B = 60^o$]

b) Explain the principle and instrumentation of XPS. **[5]**

Total No. of Questions : 8]

SEAT No. :

P2671

[Total No. of Pages : 3

[5022]-3001

M.Sc.

PHYSICS

PHY UT-701 : Statistical Mechanics in Physics

(2013 Pattern) (4 Credits) (Semester-III) (Credit System)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Attempt any five questions out of eight questions.***
2) ***Draw neat diagrams wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of electronic pocket calculator is allowed.***

Constants:

Boltzmann constant,	$k_B = 1.38 \times 10^{-23}$ J/K
Planck's constant,	$h = 6.623 \times 10^{-34}$ J/s
Avogadro's number,	$N = 6.023 \times 10^{23}$ cgs unit
Mass of electron,	$m_e = 9.1 \times 10^{-31}$ kg
Charge on electron,	$e = 1.6 \times 10^{-19}$ C
Gas constant,	R = 8.314 J/mole/ok

Q1) a) The partition function for ideal monotomic gas of N identical particles is expressed as $Z = V^N \left(\frac{2\pi m}{h^2 \beta} \right)^{3N/2}$

Calculate mean energy $(\bar{E})$ **[4]**

P.T.O.

b) Show that entropy in canonical distribution is given by $S = -k\sum_r P_r \ln P_r$ **[3]**

c) Calculate pressure of black body radiation at 300°k **[3]**

Q2) a) Discuss the behaviour of sharpness of probability curve and show that functional width of maximum in p(E) is given by $\frac{\Delta^* E}{E} = \frac{1}{\sqrt{f}}$ **[4]**

b) Show that mean square energy in canonical ensemble is $\bar{E}^2 = \frac{1}{z}\frac{\partial^2 z}{\partial \beta^2}$ **[3]**

c) The mass of Argon atom is 6.64×10^{-24}kg. Find chemical potential of a mole of Argon at T=273°k and p=1 atmosphere **[3]**

Q3) a) Using Quantum mechanical treatment show that magnetic susesptibility is inversely proportional to temperature, when temperature is high enough **[4]**

b) For a phase space representing single particle of mass m in volume V, show that number of phase cells in energy range o to E is given by

$$N = \frac{4\Pi V}{3h^3}(2mE)^{3/2}$$ **[3]**

Here h- is volume of phase cell.

c) State and prove equipartition theorem. **[3]**

Q4) a) Write a note on white Dwarfs **[4]**

b) Explain the terms- phase space, μ space and Γspace. **[3]**

c) A system has three energy states with energy values o, $\in$ and $2\in$. Find mean energy of system. **[3]**

Q5) a) Using relation for accessible state, $\Omega = B(v-b)^N F(E)$, here F(E)- is function of energy only obtain equation of state $p(v-b) = NK\Gamma$ **[4]**

b) Calculate number of photons in an enclosure of 22.4 litre at 273°k **[3]**

c) Frequency of vibration of copper atoms in asolid is 4.8×10^{12} cycles per second. Calculate Einstein's characteristics temperature **[3]**

Q6) a) What is Gibb's paradox? How it is resolved? **[4]**

b) Find out mean energy of Fermions at absolute zero temperature. **[3]**

c) Show that menan pressure is given by $\bar{P} = \frac{1}{\beta}\frac{\partial \ln z}{\partial v}$ **[3]**

Q7) a) State and prove Liouville's theorem **[5]**

b) Calculate root mean square velocity of hydrogen molecule at 27°c, if mass of hydrogen molecule is 3.34×10^{-27}kg. Also find most probable speed. **[5]**

Q8) a) For grand canonical ensemble, show that probability of finding a system in particular microstate r having energy E_r and number of molecules N_r is given by $P_r = \frac{e^{-\beta E_r - \alpha N_r}}{\sum_r e^{-\beta E_r - \alpha N_r}}$ **[5]**

b) Show that for vibrational motion of diatomic molecule. **[5]**

$$C_v(vib) = NK\left(\frac{\theta_v}{T}\right)^2 .e^{-\theta_v/T}$$

when $\frac{\theta_v}{T} >> 1$

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Total No. of Questions : 8]

SEAT No. :

P2672

[Total No. of Pages : 5

[5022] - 3002
M.Sc.
PHYSICS
PHYUT -702 : Quantum Mechanics-II
(2014 Pattern) (Semester - III)(4Credits)

Time : 3 Hours] *[Max. Marks : 50*

Instructions to the candidates:

1) ***Figures to the right indicate full marks.***
2) ***Attempt any five questions.***
3) ***Use of calculator allowed.***

Q1) a) Using variational method, obtain ground state energy of hydrogen atom for which trial wave function is $\psi(r) = e^{-\alpha r}$, α is variational parameter. **[4]**

b) State and explain conditis for validity of W.K.B. approximation. **[3]**

c) Discuss selection rules for electric dipole transition. **[3]**

Q2) a) Find the total cross-section for low energy (s-wave) scattering by a potential barrier such that

$$V(r) = \begin{cases} V_o & r < a \\ 0 & r > a \end{cases}$$ **[4]**

b) Discuss the concept of symmetry in quantum mechanics. **[3]**

c) Show that no stark effect in ground state of hydrogen atom is observed. **[3]**

Q3) a) Using time- dependent perturbation theory obtain first order transition amplitude $a_m^{(1)}(t)$ **[4]**

b) Show that the variational method gives an upper bound to the ground state energy. **[3]**

c) What is parity? Show that eigen values of parity operator are +1 and –1. **[3]**

P.T.O.

Q4) a) Interpret the concept of identical particles. Construct symmetric and antisymmetric wave functions for two identical particles. **[4]**

b) Explain Laboratory and CM reference frames. **[3]**

c) Obtain energy levels of harmonic oscillator by W.K.B. method. Use $V(x)=\frac{1}{2} mw^2x^2$. **[3]**

Q5) a) Using W.K.B. approximation, obtain the transmission coefficient of a particle penetrating through barrier. **[4]**

b) Using Born Approximation, calculate differential cross-section for potential

$V= -V_o e^{-r/a} (r = 0 \text{ to } \infty)$ **[3]**

c) Explain the collision of identical particles in detail. **[3]**

Q6) a) Discuss Heisenberg picture. Show that for an operator A, the equation of motion is

$$\frac{dA}{dt} = \frac{1}{i\hbar}[A, H] + \frac{\partial A}{\partial t}$$ **[4]**

b) Explain basic principles in variational method. **[3]**

c) Expalin time translations in detail. **[3]**

Q7) a) Harmonic oscillator is perturbed by $H^1=bx^4$. Obatin correction in the first order of energy. **[5]**

b) State and prove optical theorem. **[5]**

Q8) a) Using partial wave analysis, obtain scattering cross- section for perfectly rigid sphere. **[5]**

b) What is harmonic perturbation? Obtain the expression for transition probability. **[5]**

Total No. of Questions : 8]

P2672

[5022] - 3002
M.Sc.
PHYSICS
PHYUT - 702: Physics of Semiconductor Devices
(2014 Pattern) (Semester - III)(4 Credits)

Time : 3 Hours] ***[Max. Marks : 50***

Instructions to the candidates:

1) ***Attempt any Five questions out of eight questions.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right sides indicate full marks.***
4) ***Use of logarithmic tables and eletronic calculator is allowed.***

Given physical constants:

1) Permittivity in vacuum $\varepsilon_o = 8.854 \times 10^{-12} C^2/N–m^2$
2) Thermal voltage at 300 K= 0.0259 V
3) Elementary charge = $1.602 \times 10^{-19} C$
4) Boltzman constant $K_B = 1.3806 \times 10^{-23}$ J/K

Q1) a) Show that fermi energy in case of intrinsic semiconductor lies between the conduction and valance band under thermal equilibrium. **[4]**

b) What do you mean by excess carriers and their carrier life time? Explain the different kind of recombination processes occurs in semiconducting materials. **[3]**

c) Calculate the diffusion coefficient it the thermal voltage and mobility are 30 mV and 0.15 m^2/V.sec. **[3]**

Q2) a) Explain the "Hall Effect" phenomenon. Derive the equation for Hall coefficient. **[4]**

b) Derive an expression for the diffusion current density. **[3]**

c) A Si sample is doped with 10^{16} Boron atoms/cm^3. What is the electron concentration n_o at 300K? Given:- intrinsic concentration n_i for Si=1.5×10^{10}/cm^3 **[3]**

Q3) a) Using suitable schematic and energy band diagram of one-sided abrupt p+ -n junction, **[4]**

show that $W_{Dp}+W_{Dn} = \sqrt{\frac{2\varepsilon_s}{q}\left(\frac{N_A + N_D}{N_A N_D}\right)\psi_{bi}}$

b) Draw the energy band diagram of an abrupt p-n junction under the thermal equilibrium, forward bias and reverse bias. **[3]**

c) Calculate the capacitance of Germanium (Ge)p-n junction having an area 1 mm^2 and space charge width 2μm and dielectric constant of Ge = 16 **[3]**

Q4) a) Derive an expression for diffusion capacitance of p-n junction under low frequency condition. **[4]**

b) Compare between the zener breakdown and avalanche multiplication phenomenon. **[3]**

c) Calculate the built-in - potential of a Si p-n junction which consists of n-side with donor concentrations of 10^{16}/cm^3 and p region of 10^{15} acceptors/cm^3, Given intrinsic carrier concentration $n_i = 2.2\times10^{13}$/cm^3. **[3]**

Q5) a) Using energy band diagram for n-p-n bipolar junction transistor under common base configuration, obtain the approximate expressions for

i) Emitter injection efficiency

ii) Base transport factor. **[4]**

b) Draw and explain the different regions of the characteristics of Unipolar Junction Transistor (UJT). **[3]**

c) Obtain a relationship between breakdown voltages of n-p-n transistor under common base and common emitter configuration. **[3]**

Q6) a) Explain the switching action of transistor operating in a common-emitter configuration. **[4]**

b) Derive an expression for the drain current in Junction-Field Effect Transistor(JFET) **[3]**

c) Compare Field Effect Transistor (FET) and Bipolar Junction Transistor(BJT) **[3]**

Q7) a) Draw a neat representation of energy-band diagrams of metal with p-type and n-type semiconductor contacts under **[5]**

i) thermal equlibrium

ii) forward bias and

iii) reverse bias conditions

b) Based on the assumptions of thermionic emission theory, derive an expression for total current density. **[5]**

$$J_n = A^* T^2 \exp\left(-\frac{q\phi_{Bn}}{kT}\right)\left[\exp\left(\frac{qv}{kT}\right)-1\right]$$

Q8) a) Based on the assumptions of diffusion theory, derive an expression for total current density. **[5]**

$$J_n \approx q\mu_n N_c \xi_m \exp\left(-\frac{q\phi_m}{kT}\right)\left[\exp\left(\frac{qv}{kT}\right)-1\right]$$

b) Describe any one known method to measure the barrier heights of metal-semiconductor contacts. **[5]**

Total No. of Questions :8]

SEAT No. :

P2673

[Total No. of Pages :2

[5022] - 4001

M.Sc.

PHYSICS

PHYUT 801 - Nuclear Physics

(New Course) (2014 Pattern) (4 Credits) (Semester - IV)

Time : 3 Hours] *[Max. Marks :50*

Instructions to the candidates:

1) ***Attempt any five out of eight questions.***
2) ***Neat diagrams must be drawn wherever necessary.***
3) ***Figures to the right indicate full marks.***
4) ***Use of logarithmic tables & electronic calculator is allowed.***

Q1) a) Discuss the method of measurements of nuclear radii based on the principle of electron scattering. **[4]**

b) Explain the internal pair conversion process. **[3]**

c) Calculate the activity of 10g of ^{232}Th. Given : λ of ^{232}Th = 1.58×10^{-18} S^{-1}. **[3]**

Q2) a) What is beta decay? Describe neutrino hypothesis of β- decay. **[4]**

b) Write a short note on nuclear magnetic moment. **[3]**

c) Find the energy required in joules to break ^{12}C into 3 alpha particles. The atomic mass of ^{12}C = 12 amu & ^{4}He = 4.0026 amu. **[3]**

Q3) a) Discuss the principle, construction & working of a Ge (Li) detector. **[4]**

b) Give two experimental evidences of magic numbers. **[3]**

c) In a scintillation detector, the 662 keV photopeak of ^{137}Cs source is observed at 6 V & the full width at half maximum of the photo peak is 0.72V. Find the % resolution of the detector. Also find its resolution in keV. **[3]**

P.T.O.

Q4) a) Explain the shell model of nucleus by discussing the role of spin-orbit coupling. **[4]**

b) What will be the threshold energy for the following reaction. **[3]**

$^{238}U\ (^{4}He,\ 3\ ^{1}n)\ ^{239}Pu$

Given : M (^{238}U) = 238.050785 amu

M (^{4}He) = 4.002603 amu

M (^{239} Pu) = 239.052158 amu

M (^{1}n) = 1.00866501 amu.

c) What are the conservation laws of nuclear reactions. **[3]**

Q5) a) On the basis of chain reaction derive the Four Factor formula for the Finite size reactor. **[4]**

b) Explain the principle, working of Van-de-Graff accelerator. **[3]**

c) What is an electron synchrotron? Discuss its theory. **[3]**

Q6) a) What is nuclear reactor? Name the reactor materials and their uses. **[4]**

b) Explain the concept of phase stability in the microton. **[3]**

c) The proton synchrotron can produce protons of nominal total energy 3 GeV. What is the kinetic energy of charge 6^{+} ^{14}N ions accelerated by this accelerator. **[3]**

Q7) a) Discuss P-P scattering & also the phase shift anaysis of it. **[5]**

b) Explain in detail the quark model & explain the various types of quarks along with their properties. **[5]**

Q8) a) Explain which of the following reactions are allowed or forbidden under the conservation of strangeness, baryon numbers & charge. **[5]**

i) $\Pi^{+} + p \rightarrow k^{0} + k^{+}$

ii) $\Pi^{-} + p \rightarrow \Lambda^{0} + k^{0}$

b) Explain: **[5]**

i) Isospin

ii) Gell-Mann - Nishijima scheme.

Total No. of Questions :8]

SEAT No. :

P2674

[Total No. of Pages :2

[5022] - 4002

M.Sc.

PHYSICS

PHYUT - 802 : Materials Science

(2014 Pattern, 4 - Credits) (Semester - IV)

Time : 3 Hours] *[Max. Marks :50*

Instructions to the candidates:

1) ***Attempt any five questions.***
2) ***Figures to the right indicate full marks.***
3) ***Draw neat labelled diagrams wherever necessary.***
4) ***Use of logarithmic tables and pocket calculator is allowed.***

Given :

Avogadro's number = 6.0225×10^{26} (Kilo mole)$^{-1}$

Boltzmann constant = 1.3805×10^{-23} JK^{-1}.

Q1) a) Explain any four electrical properties of materials. **[4]**

b) Define defects in solid. Explain any one of volume defect in brief. **[3]**

c) Explain Fick's first and second law of diffusion. **[3]**

Q2) a) Explain a binary phase diagram in brief. **[4]**

b) Explain the different diffusion mechanisms occured in solid solutions. **[3]**

c) State Lever rule. Explain with an illustration how it is useful in determination for weight fractions of liquids and solids. **[3]**

Q3) a) Explain Gibb's phase rule. What are the degree's of freedom of a system of two components when the number of phases is one, two and three? **[4]**

b) Explain the concept of regular solution. **[3]**

c) Draw a Burger circuit around a negative screw dislocation and determine its Burger vector. **[3]**

P.T.O.

Q4) a) Make two neat sketches to show the climbing up and climbing down of an edge dislocation. What happens to the vacancy concentration in the crystal during each process? **[4]**

b) What is solid solution? What are the factors governing solid solubility? **[3]**

c) Calculate the spacing between dislocations in a tilt boundary in FCC crystal when angle of tilt is 2°. Given Burgers Vector b = 4.50 A°. **[3]**

Q5) a) Derive the expression for energy of a screw dislocation by using the geometrical mode. **[4]**

b) Explain Vegard's law for solid solution. **[3]**

c) Draw a flow chart of defects. **[3]**

Q6) a) Find the equilibrium concentration of vacancies in nickel at 0K, 300 K and 900 K. (E_{Ni} = 1.74eV). **[4]**

b) Explain Hume-Rothery rule with examples. **[3]**

c) Define the following terms: **[3]**
Specific heat, thermal conductivity and coefficient of thermal expansion.

Q7) a) What is Frenkel defect? Obtain an expression for equilibrium concentration of Frenkel defect in crystals. **[5]**

b) Estimate the shift of the electron cloud with respect to the nucleus in a Xenon (Xe) atom, when a field of 10^5 Vm^{-1} is applied. (Atomic number of Xe = 54, electronic polarizability of Xe = 3.54×10^{-40} F m^2). **[5]**

Q8) a) Aluminium crystal has a dislocation density of 10^{10} m^{-2}. The shear modulus of Aluminium is 25.94 GN m^{-2}. Calculate the elastic energy of the line imperfection stored in the crystal. **[5]**

Given : a = 4.05 A°.

b) Calculate the increase in enthalpy and the entropy of copper, as it is heated from room temperature (300 K) to 1000 K. Specific heat in this temperature range is given by **[5]**

$Cp = 22.61 + 6.27 \times 10^{-3}$ TJ mol^{-1} K^{-1}.