No. of Printed Pages : 4

Sem-V-Phy-CC-11
(Reg&Back)

2020-21

Time - 3 hours

Full Marks - 60

*Answer **both groups** as per instructions.*
Figures in the right hand margin indicate marks.
Candidates are required to answer
in their own words as far as practicable.

GROUP - A

1. Answer any five questions. [2 × 5

(a) What is de-Broglie matter wave concept ?

(b) State the nature of wave function.

(c) What are Hermitian operators ? Write their properties.

(d) Calculate de-Broglie wavelength associated with 10 eV electron.
($h = 6.67 \times 10^{-34}$ Js, $m = 9.1 \times 10^{-31}$ kg, 1 eV = 1.6×10^{-19} J)

(e) If $\mathbf{A} = \frac{d^2}{dx^2}$ and $\psi(x) = \alpha e^{-2x}$, then find the eigen value of $\psi(x)$.

(f) Does the parity operator $\hat{\pi}$ is Hermitian ?

(g) Define group velocity and phase velocity and when they are same ?

P.T.O.

GROUP - B

*Answer **ALL** questions.*

2. Derive the time dependent Schrödinger three dimensional wave equation. [10

OR

(a) Show that eigen functions of Hermitian operator belonging to different eigen values are orthogonal. [5

(b) If two operators **A** and **B** are commute then have simultaneous eigen functions. Prove it. [5

3. State and prove Ehrenfest theorem in operator method. [10

OR

(a) Show that the average value of the square of a Hamiltonian operator is positive. [5

(b) Show that for a three dimensional wave packet [5

$$\frac{d}{dx}\langle x^2 \rangle = \frac{1}{m}\left[\langle x P_x \rangle + \langle P_x x \rangle\right].$$

4. A particle is confined in a one-dimensional infinite square well

$$V(x) = \begin{cases} 0, & -a < x < a \\ \infty, & |x| \geq a \end{cases}$$ [10

where 'a' is a positive constant.

(a) Write down stationary state Schrödinger equation for $-a < x < a$.

(b) State the boundary conditions at $x = \pm a$.

(c) Obtain the energy eigen values and the eigen function.

OR

Show that the normalized wave function for an LHO in the nth state is [10

$$\psi_n(x) = \left[\frac{\sqrt{a}}{2^n\, n\, !\, \sqrt{\pi}}\right]^{\frac{1}{2}} e^{-ax^2/2} H_n(\sqrt{ax})$$

where $a = \frac{mw}{\hbar}$ and H_n is Hermite polynomial of order n.

5. Show that the energy eigen values of a particle in a one dimensional box of infinite depth are discrete and proportional to n^2. [10

OR

A particle of total energy 'E' is incident on a potential barrier described by [10

$$V = \begin{cases} 0, & \text{for } x < 0 \\ V_0, & \text{for } 0 < x < a \\ 0, & \text{for } a < x. \end{cases}$$

Obtain expressions for reflection coefficients and plot $|\ T\ |^2$ against E.

6. Describe Stom-Garlach experiment. Discuss how it explained space quantisation and electron spin. [10

OR

Write short notes on : [5 × 2

(a) Paschen back effect

(b) Larmor precessional frequency

No. of Printed Pages : 3

Sem-V-Phy-CC-12
(Reg&Back)

2020-21

Time - 3 hours

Full Marks - 60

*Answer **both groups** as per instructions.*
Figures in the right hand margin indicate marks.
Candidates are required to answer
in their own words as far as practicable.

GROUP - A

1. Answer any five questions. [2 × 5

(a) Why reciprocal lattice is so named ?

(b) What is the physical significance of Debye temperature ?

(c) Explain the use of Hysteresis curve.

(d) What is dielectric loss ?

(e) What do you mean by the term population inversion ?

(f) Define forbidden energy gap.

(g) What is a primitive cell ?

P.T.O.

GROUP - B

*Answer **ALL** questions.*

2. Define reciprocal lattice. Derive the expression for the primitive translation vectors of the reciprocal lattice. Give the graphical representation of reciprocal lattice in two dimensions. [10

OR

What are Laue's equation for the diffraction of X-rays by a crystalline solid ? Show that these equations lead to Bragg's law for X-ray diffraction. [10

3. Obtain an expression for the dispersion relation for the lattice vibration of monoatomic linear chain. [10

OR

Derive an expression for lattice specific heat according to Debye theory. [10

4. (a) Explain atomic theory of magnetism. [2

(b) Discuss Langevin's theory of diamagnetism and obtain the expression for diamagnetic susceptibility. [8

OR

(a) Explain the use of hysteresis curve. [4

(b) Discuss the ferromagnetism on the basis of Domain theory. [6

5. (a) Define polarizability. Establish the relation between polariizability and dielectric constant. [4

(b) Show that for non-uniform polarization [6

$$\vec{\nabla} . \vec{P} = -\rho_p.$$

OR

Explain the working, construction and energy level diagram for Ruby laser. [10

6. Explain Hall effect. Derive an expression for the Hall coefficient of semiconductors on two band model of carriers. [10

OR

What do you mean by Meissner effect ? Explain how Meissner effect proves the superconductivity to perfect diamagnetism. [10

No. of Printed Pages : 3

Sem-V-Phy-DSE-1
(Reg&Back)

2020-21

Time - 3 hours

Full Marks - 60

*Answer **both groups** as per instructions.*
Figures in the right hand margin indicate marks.
Candidates are required to answer
in their own words as far as practicable.

GROUP - A

1. Answer any five questions. [2 × 5

(a) What is Generalized Velocity ?

(b) What is D' Alembert's principle ?

(c) What is Hamiltonian principle ?

(d) Write down the postulates of Special theory of relativity.

(e) What is Minkowski's space ?

(f) What is Doppler effect ?

(g) Define 'generalised momenta'.

P.T.O.

GROUP - B

*Answer **ALL** questions.*

2. What is D' Alembert's principle ? Deduce Lagrange's equation from D' Alembert's principle. [2 + 8

OR

(a) Deduce Newton's law from Lagrange's equation. [5

(b) Deduce the equation of Simple harmonic motion from Lagrange's equation. Hence find its time period. [5

3. State Hamilton's principle. Deduce Lagrange's equations of motion from it. [2 + 8

OR

OR

Write Euler-Lagrange equations of motion of a system. Using generalized coordinates, define generalised momenta. Use the definition to find the angular momentum of a particle moving under the influence of a central force. [2 + 2 + 6

4. Derive Lagrange's equation of motion for a charged particle in an external electric field and magnetic field. [5 + 5

OR

What is Hamilton's equation of motion ? Then find the equation of motion for Harmonic oscillator using this equation. [2 + 8

5. State and prove Lorentz transformation equations. [2 + 8

OR

Write short notes on : [5 × 2

(a) Length contraction

(b) Time dilation

6. Define four vector. What are four momentum and four velocity vectors ? [2 + 4 + 4

OR

Write short notes on : [5 × 2

(a) Doppler effect

(b) Conservation of four momentum

No. of Printed Pages : 3

Sem-V-Phy-DSE-2
(Reg&Back)

2020-21

Time - 3 hours

Full Marks - 60

*Answer **both groups** as per instructions.*
Figures in the right hand margin indicate marks.
Candidates are required to answer
in their own words as far as practicable.

GROUP - A

1. Answer any five questions. [2 × 5

   (a) What are odd parity and even parity ?

   (b) Calculate the energy equivalent to rest mass of electron.

   (c) Explain the process electron capture.

   (d) Write down the assumptions of Shell model.

   (e) What are the functions of electric and magnetic fields in a cyclotron ?

   (f) State the basic difference between baryons and mesons.

   (g) Show that nuclear density is independent of mass number.

P.T.O.

GROUP - B

*Answer **ALL** questions.*

2. (a) Explain the properties of nuclear force. [4

(b) Show that concept of binding energy is related to the stability of atomic nucleus. [3

(c) Discuss how binding energy varies with mass number. [3

OR

(a) What are the intrinsic properties of nucleus ? Explain the terms magnetic dipole moment and electric dipole moment. [4

(b) Explain the term packing fraction. What is the difference between mass defect and packing fraction ? [4

(c) Derive relation between mass number and radius of nucleus. [2

3. (a) What are the drawbacks and assumptions of liquid drop model of nucleus ? [3

(b) What is semiempirical mass formula ? Explain significance of various terms. [2 + 5

OR

(a) Give the salient features of nuclear Shell model. [3

(b) What are magic numbers ? Give experimantal evidence for their existence. [7

4. Discuss the theory of α-decy and obtain the expression for the probability of emission of α-particle per second. [10

OR

Write short notes on <u>any two</u> : [5 × 2

(a) Internal pair production

(b) Geiger-Nuttal law and its importance

(c) Nutrino hypothesis of β-decay

5. Give the construction, theory and applications of Scintillation counter. [10

OR

State the basic principles of photomultiplier tube. Also explain the construction and working of it. [10

6. What are linear accelerators ? Give its detailed principle and working. [10

OR

What are the conservation laws for strong and electromagnetic interactions ? Discuss. [10