PSG COLLEGE OF ARTS & SCIENCE
(AUTONOMOUS)
MSc DEGREE EXAMINATION MAY 2025
(Fourth Semester)

Branch - **PHYSICS**

PROBLEMS IN CORE PHYSICS

Time: Three Hours   Maximum: 75 Marks

SECTION-A (10 Marks)
Answer ALL questions

ALL questions carry EQUAL marks $(10 \times 1 = 10)$

Module No.	Question No.	Question	K Level	CO
1	1	A particle in a linear potential (L →H), whose mass m moves under the potential V=-Fx. The Lagrangian is L=$\frac{1}{2}$ m$\dot{x}^2$+Fx. Find its Hamiltonian. (a) H=$\frac{p}{2m}$ + Fx (b) H=$\frac{p2}{2m}$ + Fx (c) H=$\frac{p}{2m}$ − Fx (d) H=$\frac{p2}{2m}$ − Fx	K1	CO1
	2	Condition for a system to be solenoidal (a) $\nabla \times \vec{F}=\infty$ (b) $\nabla \times \vec{F}=1$ (c) $\nabla . \vec{F}=\infty$ (d) $\nabla . \vec{F}=0$	K2	CO1
2	3	Find the Eigen value of the matrix $\begin{bmatrix} cos\theta & -sin\theta \\ sin\theta & cos\theta \end{bmatrix}$ (a) $e^{i\theta}$ (b) $e^{-i\theta}$ (c) $e^{\pm i\theta}$ (d) e^{θ}	K1	CO2
	4	If the eigenvalues of A of order 3×3 are 2.3 and 1, then find the eigenvalues of adjoint of A. (a) (3,2,6) (b) (3,2,1) (c) (3,2,3) (d) (6,2,6)	K2	CO2
3	5	Energy of linear harmonic oscillator in its 3rd state is 0.1 eV. Find its frequency of vibration. (a) 5.1×10^{12} Hz (b) 6.9×10^{12} Hz (c) 6.8×10^{13} Hz (d) 5.9×10^{13} Hz	K1	CO3
	6	Which of the following voltage applied in an electron microscope can produce a electron wavelength of 0.50 ? (a) 502.4 V (b) 600V (c) 602.4 V (d) 1 KV	K2	CO3
4	7	Calculate the entropy change for 1.00 mol of an ideal gas expanding isothermally from a volume of 24.4 L to 48.8 L. (a) 5.76J/K (b) 6.75 J/K (c) 7.65 J/K (d) 7.765 J/K	K1	CO4
	8	A refrigerator operates between 273 K and 303 K. If it removes 500 J of heat from the cold region, Calculate the least work required. (a) 60.24 J (b) 84.63 J (c) 56.45J (d) 54.95J	K2	CO4
5	9	Identify the velocity of electron in 3rd orbit of hydrogen. (a) 8.892×10^5 m/s (b) 7.338×10^5 m/s (c) 9.919×10^6 m/s (d) 4.462×10^6 m/s	K1	CO5
	10	In Geiger Muller experiment on α-particle experiment from gold foil. The K.E of α-particle was 7.68 MeV. Calculate the distance of closest approach of α-particle. (a) 3.26×10^{-15} m (b) 3.96×10^{-14} m (c) 2.96×10^{-14} m (d) 4.162×10^{15} m	K2	CO5

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SECTION - B (35 Marks)
Answer ALL questions
ALL questions carry EQUAL Marks   (5 × 7 = 35)

Module No.	Question No.	Question	K Level	CO
1	11.a.	A simple pendulum of mass m and length l swings under the influence of gravity. The goal is to determine the equation of motion.	K2	CO1
		(OR)		
	11.b.	A double pendulum consists of two masses $m1$ and $m2$ each attached by massless rods of lengths $l1$ and $l2$, respectively. The first pendulum swings with $\theta1$ and the second attached to its end swings with $\theta2$. Find its Lagrangian.		
2	12.a.	Find the Eigen values and Eigen vectors of A= $\begin{bmatrix} 2 & 1 & -1 \\ 1 & 1 & -2 \\ -1 & -2 & 1 \end{bmatrix}$	K2	CO2
		(OR)		
	12.b.	Consider two identical bosons in 1D well. What is symmetry of wavefunction and how does it affect possible wavefunction?		
3	13.a.	A particle of mass m is in 1D box, find the energy ratio $\Delta E_n/E_n$.	K3	CO3
		(OR)		
	13.b.	Electrons are accelerated through a film of graphite with potential difference of 40 V. The spacing between graphite atoms is 2.1×10^{-10}. Calculate the angle of the first minimum of diffraction pattern.		
4	14.a.	An ideal gas at pressure P is adiabatically compressed. Show that its density becomes 'n' times the initial value. The final pressure of the gas will be..	K4	CO4
		(OR)		
	14.b.	There are 10 identical particles each of mass m to be accommodated in a cubical box of side L. what is the lowest energy of the system, if the particles obey (i) B.E (ii) F.D statistics.		
5	15.a.	According to Bohr's theory, how many revolutions will an electron make in the 1st excited state of hydrogen if the lifetime in that state is 10^{-8} s.	K5	CO5
		(OR)		
	15.b.	The spin parity assignments for the ground and first excited state of isotope $^{57}_{28}Ni$, in the single particle shell model, are....		

SECTION -C (30 Marks)
Answer ANY THREE questions
ALL questions carry EQUAL Marks   (3 × 10 = 30)

Module No.	Question No.	Question	K Level	CO
1	16	A dynamical system has the Lagrangian $L=\dot{q}_1^2+\frac{\dot{q}_{21}^2}{a+bq_1^2}+K_1q_1^2+K_2\dot{q}_1\dot{q}_2$, where a, b, K_1, K_2 are constants. Find the equations of motion in Hamiltonian formalism.	K4	CO1
2	17	Diagnolize (i) $\begin{bmatrix} 4/3 & \frac{\sqrt{2}}{3} \\ \frac{\sqrt{2}}{3} & 5/3 \end{bmatrix}$ (ii) $\begin{bmatrix} cos\theta & -sin\theta & 0 \\ sin\theta & cos\theta & 0 \\ 0 & 0 & 1 \end{bmatrix}$	K5	CO2
3	18	Find the expectation values of energy when the state of harmonic oscillator is $\psi(x,t) = \frac{1}{\sqrt{2}}[\psi_0(x,t) + +\psi_1(x,t)]$, where ψ_0, ψ_1 are the wavefunctions of ground and first excited states.	K4	CO3
4	19	The boiling point of a liquid P_0 is T_0. Its molar latent heat of vapourization is L and molar volume of liquid phase is negligible as compared to vapour phase. The vapour phase obeys perfect gas equation. Find the boiling point T at temperature at pressure P.	K5	CO4
5	20	Atomic lithium concentration n = 3.6×10^{16}/cm^3 is at a temperature T = 1500 . In this case the power emitted at the resonant line whose wavelength λ= 671 nm. (2p →2s) per unit volume of gas is equal to P=0.30 W/cm3. Find the mean lifetime of Li atoms in their resonace excitation state.	K5	CO4