PSG COLLEGE OF ARTS & SCIENCE
(AUTONOMOUS)

MSc DEGREE EXAMINATION MAY 2022
(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 x 1 = 10)

1   Find the rate of change of $\phi = x^2 y + yz$ at $(1,2,-1)$ in the direction of
$\vec{i} + 2\vec{j} + 3\vec{k}$.....

   (i) $\dfrac{10}{\sqrt{11}}$ (ii) $\dfrac{10}{\sqrt{12}}$

   (iii) $\dfrac{10}{\sqrt{13}}$ (iv) $\dfrac{10}{\sqrt{14}}$

2   When a ball is thrown vertically in the air with an initial velocity 3.5 m/s.
   what is the maximum height of the ball?
   (i) h = 0.620m   (ii)   h = 0.625m
   (iii) 0.610m   (iv) 0.640m

3   Find the rank of the matrix $\begin{bmatrix} 1 & 1 & 1 \\ 2 & -1 & 3 \\ 5 & -1 & 7 \end{bmatrix}$

   (i) 2   (ii) 3
   (iii) 1   (iv) 4

4   Find the eigen value of $\begin{bmatrix} 1 & 0 \\ 2 & 4 \end{bmatrix}$

   (i) 1,3   (ii) 1,2
   (iii) 1,4   (iv) 1,5

5   What voltage must be applied to an electron microscope to produce electron
   of wave length of 0.50A.
   (i) 602.4 volts   (ii) 603.4 volts
   (iii) 601.4 volts   (iv) 605.4 volts

6   The energy of linear harmonic oscillator in third excited state is 0.1 ev. Find
   the frequency of the vibration.
   (i) 7.6×10^{12} Hz   (ii) 6.9×10^{12} Hz
   (iii) 8.6×10^{12} Hz   (iv) 9.2×10^{12} Hz

7   Heat input Q_H= 3000 J and heat output Q_L= 1000 J. What is the efficiency of
   the heat engine?
   (i) 5000J   (ii) 4000J
   (iii) 3000J   (iv) 2000J

8   Determine the volume of 2 moles of gases at standard temperature and
   pressure.
   (i) 44.8 times   (ii) 54.8 times
   (iii) 64.8 times   (iv) 74.8 times

9   The value of Bohr radius is

   (i) 0.5415 $\overset{o}{A}$ (ii) 0.5315 $\overset{o}{A}$

   (iii) 0.5515 $\overset{o}{A}$ (iv) 0.5615 $\overset{o}{A}$

10   A neutral pion decays into two gamma rays. $\pi^{o} \rightarrow \gamma + \gamma$. Calculate
     wavelength of gamma rays produced by decay of neutral pion at rest
     (i) 4.8 fm   (ii)   3.84 fm
     (iii) 2.84 fm   (iv) 1.84 fm

SECTION - B (35 Marks)
Answer ALL Questions
ALL Questions Carry EQUAL Marks (5 x 7 = 35)

11 a   Prove that $(y^2 - z^2 + 3yz - 2x)\vec{i} + (3x^2 + 2xy)\vec{j} + (2z + 3xy - 2xz)\vec{k}$ is
       solenoidal and irrotational.

                          OR

   b   Find the unit normal at $\left(\dfrac{a}{\sqrt{3}}, \dfrac{b}{\sqrt{3}}, \dfrac{c}{\sqrt{3}}\right)$ on the surface

       $\phi = \left[\dfrac{x^2}{a^2} + \dfrac{y^2}{b^2} + \dfrac{z^2}{c^2}\right] = 1.$

12 a   Find the eigen values and eigen vactors of $\begin{bmatrix} 8 & -6 & 2 \\ -6 & 7 & -4 \\ 2 & -4 & 3 \end{bmatrix}$.

                          OR

   b   The Hamiltonian of the system is given by $H = \begin{bmatrix} 1+\lambda & 0 & 0 & 0 \\ 0 & 8 & 0 & 0 \\ 0 & 0 & 3 & (-2\lambda) \\ 0 & 0 & (-2\lambda) & 7 \end{bmatrix}$

       solve the above matrix.

13 a   A Particle of mass m is in 1D box. Find the energy ratio of $\Delta E_n \Big/ E_n$.

                          OR

   b   Find the normalization constant of 1D box wave function
       $\varphi = A \sin\left(\dfrac{\pi x}{2}\right)$ $0 \leq x \leq L$

14 a   The entropy function of a system is given by $S(E) = aE(E_0 - E)$. Find the
       temperature of the system.

                          OR

   b   There are 10 identical particles each of mass m to be accommodated in a
       cubical box of side L. Find the lowest energy of the system, if the particles
       obey (i) BE and (ii) FD statistics.

15 a   The first line of the sharp series of atomic cesium is a doublet with
       wavelength 1358.8 nm and 1469.5nm. Find the frequency intervals
       between the components of the sequent lines of that series.

                          OR

   b   Find the possible terms for the configuration 2p3p4d under L- S coupling.

SECTION - C (30 Marks)
Answer any **THREE** Questions
ALL Questions Carry **EQUAL** Marks (3 x 10 = 30)

16 (i) If $V = xy - x^2y + y^2z^2$. Find the value of div greed V.

(ii) Find the curl of $\bar{A} = \rho \sin\theta \, \hat{\rho} + \rho z \, \hat{\phi} + z\cos\phi \, \hat{z}$.

17 Consider a particle of mass 'm' moving in three dimensional potential. Find the frequencies of small oscillation.

18 (i) If $L_z = -i\hbar \dfrac{\partial}{\partial\theta}$. Find the value of Commutator. $[L_z L]$.

(ii) Find the value of Commutator of $[L_-, R_+]$.

19 Show that for n moles of an ideal gas
$F = \int c_v dT - T\int \dfrac{C_v}{T} dT - nRT l_{nV} - a_1 T + a_2$.

20 (i) Find the types of interaction for the reaction, (i) $n \rightarrow p + \bar{e} + \gamma \bar{e}$.

(ii) Find whether the following interaction can occur through strong interaction $\bar{K} + P \rightarrow K^+ + \boxed{}^-$, $\pi^- + P \rightarrow \Sigma^\circ + K^\circ$.

Z-Z-Z   END