PSG COLLEGE OF ARTS & SCIENCE
(AUTONOMOUS)

MSc DEGREE EXAMINATION MAY 2023
(Fourth Semester)

Branch – PHYSICS

PROBLEMS IN CORE PHYSICS

Time: Three Hours   Maximum: 50 Marks

SECTION-A (5 Marks)
Answer ALL questions
ALL questions carry EQUAL marks   (5 x 1 = 5)

1   div curl A =....................
    (i) 0   (ii) 1   (iii) 1n   (iv) 1n-12

2   If A and B are idempotent matrices, then A+B will be idempotent if
    (i) AB=BA =0   (ii) AB=BA =-1   (iii) AB=BA =A   (iv) AB=BA =B

3   Find the energy of the neutron in units of eV whose de Broglie wavelength is
     $(2 \times 10^{-10}$ m)
    (i) 0.2353 eV   (ii) 0.0735 eV   (iii) 0.0813 eV   (iv) 0.0324 eV

4   An electron gas obeys the Maxwell-Boltzmann statistics. Calculate the average
     thermal energy (in eV) of an electron in the system at 300K
    (i) 0.336 eV   (ii) 0.039eV   (iii) 0.6986eV   (iv) 0.0420eV

5   Calculate the vibrational energy levels of an HCl molecule assuming the force
     constant to be 516 N/m
    (i) 0.37eV   (ii) 0.037eV   (iii) 0.186eV   (iv) -0.678eV

SECTION - B (15 Marks)
Answer ALL Questions
ALL Questions Carry EQUAL Marks   (5 x 3 = 15)

6   a)   Find a unit vector perpendicular to the surface $x^2 + y^2 - z^2 = 11$ at the point
           (4, 2, 3).
                              OR
     b)   An object of mass 2kg is taken to a height 5m from the ground (g=10m/s^2)
           calculate the potential energy stored in the object.

7   a)   Solve the equations by using matrix methods
           $x + y + z = 6$ $x - y + z = 2$ $2x + y - z = 1$
                              OR
     b)   Give answers to the following transpose property of a matrix.
           (i) $(A^T)^T$ (ii) $(A + B)^T$ (iii) $(AB)^T$

8   a)   A ball of mass 10g has velocity 1 m/s .calculate the wavelength associated
           with it why does not this wave nature shown up in our daily observations.
           Given h= 6.62×10^{-34} js.
                              OR
     b)   Calculate the energy difference between the ground state and the first excited
           state for an electron in 1D rigid box of length 10^{-8} cm.

9   a)   If the energy input to a Carnot engine is thrice the work it performs then,
           Calculate the efficiency of the engine.
                              OR
     b)   For a given gas molecule at a fixed temperature calculate the area under the
           Maxwell Boltzmann distribution curve.

10 a) Find the (i) Angular momentum (ii) velocity of the electron revolving in the 5th orbit of hydrogen atom.

(or)

   b) Which of the following reactions are allowed and which are forbidden by the conservations laws appropriate to weak interactions?

$$V_u + p \text{------} u^+ + n$$

SECTION - C (30 Marks)
Answer ALL questions
ALL questions carry EQUAL Marks   (5 x 6 = 30)

11 a) If r is the position vector with magnitude r, calculate curl grad rn.

OR

   b) Set up the Lagrangian for a simple pendulum and hence obtain equation describing its motion.

12 a) For what values of (S) the equations are satisfied

$x + y + z = 1$ $x + 2y + 4z = s$ $x + 4y + 10 z = s2$.

OR

   b) (i) What are the steps to be followed to diagnolize a matrix?
       (ii) Take a 3X3 matrix as an example and diagonalize it.

13 a) The energy of a linear harmonic oscillator in its third excited states is 0.1 eV. Find the frequency of vibration.

OR

   b) The normalized state of free particle is represented by a wave function

$(x, 0) = Ne^{-(x2 / 2a2)} + ik0 x$ (i) Find the factor N.

14 a) A man starts bicycling in the morning at a temperature around 250 C, he checked the pressure of tyre which is equal to be 500 Kpa, afternoon he found that the absolute pressure in the tyre is increased to 500 Kpa, by assuming the expansion of type is negligible, what is the temperature of tyre at afternoon?

OR

   b) One mole of monatomic gas is mixed with 3 moles of a diatomic gas what is the molar specific heat of the mixture at constant volume (Cv).

15 a) The lines in the pure Rotational spectrum of HCl are spaced at 20.8×10^2 per Metre. Calculate the moment of inertia and the internuclear distance.
       Mass of proton = 1.67 x 10-27 kg
       Mass of chlorine = 58.5 x 10-27 kg.

OR

   b) Find the fine structure of LS and jj coupling in configurations $1P^2$.
       $1D^2$, $3P^2$, $3P^1$, $3P^0$, $1S^0$.

Z-Z-Z   END