RAMSADAY COLLEGE, AMTA

Class: B.Sc. Part-I **Full Marks: 50** **Subject: Physics (Hons.)**

Model Question Paper: 2018

Paper-Second

Paper- IIA

1. Answer the following questions:- 2×7
   (a) A particle moves with S.H.M of amplitude 20 cm and period 4 sec. The displacement at t=0 is +20 cm. Find the position of the particle at t = 0.5 sec.
   (b) Prove that $d\vec{L}$ /dt = $\vec{\tau}$ where $\vec{\tau}$ is torque and $\vec{L}$ is the angular momentum.
   (c) A block slides down a smooth inclined surface at θ = 30^0 to the horizontal. Calculate the velocity of the block after it slides down a distance of 0.5 m.
   (d) Find the centre of mass of a thin homogeneous semi–circular disc of radius '**a**' and surface mass density **σ**.
   (e) Estimate the average speed of molecule of a gas in terms of velocity of sound in the gas.
   (f) The operation temperature of a tungsten filament in a 60 w incandescent lamp is 2250 K and its total emissivity is 0.3. Determine the surface area of the filament.
   (g) Under constant pressure, calculate the temperature at which rms (root mean square) velocity of an ideal gas molecule becomes twice its value at 273 K.

2. (a) A particle of mass m moves along the perimeter of an ellipse defined by $\vec{r}$ = a cosωt $\hat{\imath}$ + b sinωt $\hat{\jmath}$
      (i) Calculate the force required to move the particle.
      (ii) Check whether the force above is conservative.
      (iii)Calculate the angular momentum of the particle with respect to the origin.
   (b) Show that the time derivative of a vector $\vec{A}$ in a fixed and in a rotating coordinate system are related as

$$\left(\frac{d\vec{A}}{dt}\right)_{\text{fixed}} = \left(\frac{d\vec{A}}{dt}\right)_{\text{rot}} + \vec{\omega} \times \vec{A}$$

(3+1+2)+4

3.
   a) Show that angular momentum of a system of particle with respect to an arbitrary origin is equal to the vector sum of the angular momentum of a single particle of total mass M situated at the centre of mass together with the angular momentum of system of particle with their motion relative to centre of mass.

b) Prove that if the total momentum of a system is conserved then the centre of mass is either rest or in uniform motion.

c) What do you mean by pseudo force? How pseudo forces appear in a rotating frame of reference?

4+2+ (1+3)

4.

a) Find the moment of inertia of a rigid body, rotating about an arbitrary axis.

b) For a cylinder of mass M, radius r and height h, find the relation between r and h. So that the ellipsoid of inertia becomes a sphere.

c) Establish Euler's equation of motion for a rotating rigid body.

4+3+3

5.

a) What is the potential associated with the force, $\overrightarrow{F} = (1\text{-}x^2)\,\hat{\imath}$?

b) The coordinate of a particle moving in the X-Y plane are given by x(t)=at and $y(t)=bt^2$ where a=2 m/s and b=0.5 m/s^2. Find the velocity and acceleration of the particle at t=3s. Find an equation for the trajectory of the particle.

c) Find the component of velocity and acceleration of a particle in a cylindrical coordinates.

2+ (3+2) + 3

6.

a) State the basic assumption of kinetic theory of ideal gas.

b) Show that the mean energy of transition is $\frac{3}{n}$ of their total energy, where n= number of degrees of freedom.

c) Show that for an ideal gas $\gamma = \frac{C_p}{C_v} = 1 + \frac{2}{f}$ where symbols are of usual meanings.

d) Using pressure equation show that $C_{rms} = \sqrt{(\frac{3RT}{M})}$

2+3+3+2

7.

a) State Newton's law of cooling.

b) Define emissive power and absorptive power of a black body. State Kirchoff's law.

c) The energy density of radiation at a wavelength λ is given by

$$u(\lambda) = \frac{8\pi\lambda c}{\lambda^5} \frac{1}{\exp\left(\frac{\lambda c}{\lambda KT}\right) - 1}$$

Plot the density distribution for two temperature T_1 and T_2. Find an expression for the wavelength λ_{max}, at which the energy density is maximum.

2+ (1+1+1) + (2+3)

8.

a) Obtain Fourier's heat conduction equation in three dimensions in an infinite medium in steady state. What modification will be required in case of a finite body?
b) Use equation in part (a) to determine the temperature distribution within a cylinder tube having inner and outer radii r_1 and r_2 maintained at u_1 and u_2 respectively. At what distance from the axis the temperature will be $\frac{1}{2}(u_1+u_2)$?
c) The diameter of the sun subtends an angle 0.009 radians at a point on the earth's surface. If the amount of solar radiation incident on earth be 1.36Kw/m^2 and Stefan's constant = 5.7 $\times 10^{-11}$ $Kwm^{-2}K^{-4}$, then estimate the surface temperature of the sun assuming it to be a black body.

(3+1)+3+3