RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College under University of Calcutta)

FIRST YEAR

B.A./B.SC. SECOND SEMESTER (January – June), 2012

Mid-Semester Examination, March 2012

Date : 19/03/2012 **PHYSICS (Honours)**

Time : 11 am – 1 pm Paper : II Full Marks : 50

[Use separate Answer Books for each group]

Group – A : Mechanics- I

Answer <u>any two</u> questions.

1.a) Show that the two dimensional motion of a particle of mass m in a central potential V(r) is equivalent to a one dimensional radial motion in an effective potential, $U_{eff}(r)$ given by

$U_{eff}(r) = \frac{m\,h^2}{2r^2} + V(r)$ where h is twice the areal velocity. [4]

b) Obtain an expression for the potential V(r), if the central orbit is given by $r = c\theta^2$, c is constant and the particle has an energy E and angular momentum L. [3]

c) In (b) above, show that θ varies with time t as $\theta = At^{\frac{1}{5}}$, A is constant. [3]

2.a) A bug crawls outward with constant speed v along the spoke of a wheel which is rotating with constant angular velocity $\vec{\omega}$ about a vertical axis.

i) Find all the forces acting on the bug.

ii) If the coefficient of friction between the bug and spoke is μ, find how far the bug crawls before it starts to slip ? [3+1]

b) Write down the equation of motion of a particle moving near the surface of the rotating earth, neglecting all ω^2 –terms.

i) In terms of a suitable coordinate system at latitude λ, obtain an expression for angular velocity $\overrightarrow{\omega}$.

ii) A particle is dropped at rest from the top of a tower of height H. Show that the coriolis force drifts it eastward and find the eastward deflection as it reaches the ground. [6]

3.a) A noninertial frame O_{xyz} is accelerating with unit acceleration along the x-axis and is also rotating with unit angular velocity about the x-axis. A particle moves along the y-axis with unit speed. Find the absolute acceleration of the particle in terms of its distance from the origin.

(assume all necessary formulas) [5]

b) A comet is going in aparabolic orbit lying in the plane of the earth's orbit, which is a circle of radius a. The nearest distance of the comet from the sun is p, and occurs at θ = 0. Sketch the orbits of the earth and comet and hence show that the points where the two orbits intersect are given by cos θ= -1+$\frac{2\,p}{a}$. (assume all necessary formulas) [5]

Group – B : General properties of Matter

Section- I. Answer <u>any one</u> question.

4.a) What do you mean by Surface tension of a liquid ? [2]

b) Prove that $E = S - T\frac{dS}{dT}$ where the symbols have their usual meanings. [5]

5.a) Define angle of contact. [2]

b) Derive an expression of capillary rise of a liquid in term of surface tension, angle of contact. [5]

Section- II. Answer <u>any one</u> question.

6.a) Calculate the work done to form a uniform sphere of radius R and mass M. [4]

b) Find the potential at a point in the material of a thick spherical shell of mass M, internal radius a and external radius b. [4]

7.a) If the density inside the earth increases in direct proportional to the depth, prove that the intensity would be maximum at a depth equal to $\frac{1}{3}$ of the radius and that its magnitude would be $\frac{4}{3}$ times that on the surface of the earth. [5]

b) Calculate the gravitational force of attraction between two hemispheres of a uniform sphere. [3]

Group –C : Waves and Vibrations

Answer <u>any one</u> question.

8.a) Set up the equation of motion for damped simple harmonic oscillator. Assuming the motion starts at t=0 from x=A with zero velocity, solve the equation. [2+4]

b) Distinguish between amplitude resonance and velocity resonance. [2]

c) A vibrator of mass 10 gm is acted upon by a restoring force of 10^7 dyne/cm, a retarding force of $4\,x\,10^3$ dyne/velocity and a driving force of $10^5 \cos pt\ dynes$. Find the value of maximum amplitude. [2]

9.a) Deduce the differential equation for a progressive wave. Show that the energy density of a plane progressive wave is proportional to square of both amplitude and frequency. [3+4]

b) Find the condition for weakly damped, critically damped and over damped motion. In which case the motion will be oscillatory? [3]