[This question paper contains 4 printed pages.]

Sr. No. of Question Paper : 1793 **GC-3** **Your Roll No.....**

Unique Paper Code : 32221102

Name of the Paper : Mechanics

Name of the Course : **B.Sc. (Hons.) Physics : Choice Based Credit System**

Semester : I

Duration : 3 Hours Maximum Marks : 75

Instructions for Candidates

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt any **Five** questions.
3. Question No. **1** is compulsory.
4. Use of Non-programmable scientific calculator is allowed.

1. Attempt **any five** of the following questions :

(i) A galaxy moves away from the earth at 0.2c. What is the natural wavelength of a spectral line whose wavelength measured in a laboratory is 600 nm ?

(ii) Calculate the minimum velocity with which a body may be projected so that it may become a satellite of the earth assuming it takes a circular orbit around earth.

(iii) A particle executing a S.H.M. has a maximum displacement of 4 cm and its acceleration at a distance of 1cm from its mean position is 3 cm/s^2. What will its velocity be when it is at a distance of 2 cm from its mean position ?

P.T.O.

(iv) Two objects, one initially at rest, undergo a one dimensional elastic collision. If half the kinetic energy of the initially moving object is transferred to the other object, what is the ratio of their masses ?

(v) Show that the force field $F = (y^2z^3 - 6xz^2)i + 2xyz^3j + (3xy^2z^2 - 6x^2z)\,k$ is a conservative force field. Hence, find the work done in moving a particle from the point A (–2, 1, 3) to (1, –2, –1) in the given force field.

(vi) Find the centre of mass of a homogeneous semi-circular plate of radius R.

(vii) Distinguish between inertial and gravitational mass of a body.

(viii) A hoop of radius 100cm and mass 19 Kg is rolling along a horizontal surface, so that its centre of mass has a velocity of 20 cms^{-1}. How much work will have to be done to stop it ? (5×3)

2. (i) Setup the differential equation of motion of a damped harmonic oscillator subjected to a sinusoidal force, $F = F_0 Sin\omega t$. Discuss its steady state solution and obtain an expression for its maximum amplitude.

(ii) What is sharpness of resonance ? Explain the effect of damping on sharpness of resonance. (12,3)

3. (i) What is reduced mass ? Reduce two body problem to one body problem and obtain equation of motion for equivalent one body problem for two masses.

(ii) A uniform sphere of mass M and radius R and a uniform cylinder of mass M and radius R are released simultaneously from rest at the top of an inclined plane. Which body reaches the bottom first if both roll without slipping ? Find the velocity of both at the bottom. (9,6)

4. (i) What are Inertial and Non-Inertial frames ? Explain giving an example of each.

(ii) How does the rotation of Earth about its axis affect the acceleration due to gravity experienced by a body at rest at a point on the surface of earth ? Support your answe with a suitable derivation and diagram. (6,9)

5. (i) Deduce the mathematical expression for the law of addition of relativistic velocities. Hence, show that in no case the resultant velocity of a material particle can be greater than c and that the Lorentz velocity transformation equations reduce to Galilean ones for values of $v << e$.

(iii) A spaceship moving away from the earth with velocity 0.6c fires a rocket (whose velocity relative to the spaceship is 0.7c),

(a) away from the earth

(b) towards the earth.

What will be the velocity of the rocket, as observed from the earth in the two cases. (10,5)

6. (i) A projectile launched at an angle θ to the horizontal reaches a maximum height h. Show that its horizontal range is $4h/\tan\theta$.

(ii) Prove that in the Centre of mass frame of reference, magnitude of velocities of the two particles remain unaltered in an elastic collision between them.

(iii) A head-on elastic collision between two particles with equal initial speeds v leaves the more massive particle at rest. Find the ratio of the particle masses. (6,4,5)

7. (i) Obtain expressions for gravitational potential at a point inside and outside a thin uniform spherical shell of radius R and mass M. Also depict your results graphically.

(ii) (a) Find the moment of inertia of a solid cylinder of length L, radius R and mass M about an axis passing through its centre and perpendicular to its geometrical axis.

(b) Calculate the radius of gyration of the solid cylinder of min 34, length 24 cm and radius 8 cm about an axis through its centre and perpendicular to its geometrical axis. (7,6,2)