B.Sc. 1st Semester (Honours) Examination, 2020-21

PHYSICS

Course ID: 12412 **Course Code: SH/PHS/102/C-2/T-2**

Course Title: Mechanics

Time: 1 hour 15 minutes **Full Marks: 25**

The figures in the margin indicate full marks.
Candidates are required to give their answers in their own words as far as practicable.

Section-I

1. Answer *any **five*** of the followings: 1×5=5

a) For a particle of mass 15 gm, the position vector $\vec{r} = (10\hat{\imath} + 6\hat{\jmath})$ cm and velocity $\vec{v} = 6\hat{\imath}$ cm/s. Find the angular momentum of the particle about origin.

b) At what angle the range of a projectile will be maximum?

c) What is the internal bending moment?

d) What do you mean by the term 'GPS'?

e) Is a laboratory at rest on the earth's surface really an inertial frame of reference?

f) Consider a force $\vec{F} = \frac{500}{r^{10}}\hat{r}$. Can we say that it is a central force?

g) Can the torque on a particle be zero without the force being zero? Explain.

h) How mass of a relativistic particle varies with velocity of the particle?

Section-II

Answer any ***two*** of the followings: 5×2=10

2. A solid cylinder is rotating about its symmetry axis aligned in the vertical direction.

Measuring 'z' from the bottom of the cylinder along the axis, the density of the body is given by

$$\rho(z) = \rho_0\left(1 - \frac{1}{2}\frac{z}{l}\right)$$

where ρ_0 is a constant, and 'l' is the length of the cylinder. If 'R' be the radius of the cylinder then calculate the moment of inertia of the cylinder.

3. Consider the motion of a rocket under the external force $\vec{F}$. Let any instant of time 't', the mass of the rocket is 'M' and velocity $\vec{v}$ relative to a fixed coordinate system. Let the fuel be shot out

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with constant velocity $\vec{v}_0$ relative to the rocket in motion. Derive an expression for the equation of motion of the rocket. Find the thrust on the rocket. [4+1=5]

4. Write briefly the outcomes of Michelson-Morley's experiment.

Show that for two successive Lorentz transformations with velocity parameters β_1 and β_2 in same direction are equivalent to a single Lorentz transformation of parameter $\beta = \frac{\beta_1 - \beta_2}{1 - \beta_1 \beta_2}$ [2+3=5]

5. Set up Euler's equation of motion for continuous flow of an ideal fluid. Calculate the velocity of efflux of water from an orifice in a tank which is at a depth 10 ft. from the surface of water.

[4+1=5]

Section-III

Answer any ***one*** of the followings: 10×1=10

6. i) Prove that $\vec{F} = (2xy + z^3)\hat{\imath} + x^2\hat{\jmath} + 3xz^2\hat{k}$ is a conservative force field. Find the corresponding scalar potential function V and the work done in moving an object in this field from A (1, -2, 1) to B (3, 1, 4).

ii) Derive the expression of gravitational potential due to a spherical shell of radius 'a' inside and outside of the shell. [(2+2+2) +4=10]

7. i) Derive the expression of the pseudo forces in a rotating frame of reference S_1, which is rotating with respect to an inertial frame S about their common origin O with an instantaneous angular velocity ω.

ii) If a planet were suddenly stopped in its orbit, (supposed it a circular) show that it will fall into the sun, in a time which is $\frac{\sqrt{2}}{8}$ times the period of planet's revolution.

iii) If the momentum of a photon is 0.7 MeV/c, what are its velocity and energy? [6+2+2=10]
