B.Sc./1st Sem (H)/PHS/22(CBCS)

2022

1st Semester Examination

PHYSICS (Honours)

Paper : C 2-T

(Mechanics)

[CBCS]

Full Marks : 40 Time : Two Hours

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

Group - A

Answer any *five* of the following : 2×5=10

1. What do you mean by "centre of mass" and "laboratory" frame of references?
2. Define elastic and non-elastic collisions.
3. Write down the Kepler's laws of planetary motion.
4. Define Coriolis force and explain its physical significance.
5. Calculate the momentum of an electron whose velocity is 0.8c.

P.T.O.

6. Show that a central force is conservative and the angular momentum of a body under the influence of a central force is a constant of motion.

7. In a one dimensional motion of a mass 10gm, it is acted on by a restoring force 10 dynes/cm, and a resisting force 2 dynes-sec/cm. Find whether the motion is aperiodic or oscillatory.

8. What are "flow lines" and "streamlines"? What is the difference between them?

Group - B

Answer any *four* of the following : 5×4=20

9. (a) Show that the differential expression $ds^2 = c^2dt^2 - dx^2 - dy^2 - dz^2$ is invariant under Lorentz transformations.

   (b) A particle has a total energy of 6×10^3 MeV and a momentum of 3×10^3 *MeV/c*. What is its rest mass energy? 3+2

10. If ω_1 and ω_2 be the half-power frequencies and ω_0 is the resonant frequency of a forced system, show that $\omega_0^2 = \omega_1\omega_2$. 5

11. A particle moving under a central force describes a spiral orbit given by $r = ae^{b\theta}$, where a and b are constants. Obtain the force law. 5

12. (a) For rotational motion of rigid bodies, derive an expression for the kinetic energy in terms of moment of inertia.

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   (b) A cylinder has a mass M, length l and radius r. Find the ratio of l to r, if the moment of inertia about an axis through the centre and perpendicular to its length, is a minimum. 2+3

13. A particle of mass m moves in the xy plane so that its position vector is $\vec{r} = a\cos\omega t\,\hat{i} + b\sin\omega t\,\hat{j}$ where a, b and ω are positive constants and $a > b$. (a) Show that the particle moves in an ellipse. (b) Show that the force acting on the particle is always directed toward the origin. 2+3

14. Calculate the kinetic and potential energy of a particle executing a simple harmonic motion. Hence show that the total energy is constant. 2+2+1

Group - C

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

15. (a) Find an expression for the gravitational potential due to thin spherical shell at a point outside the shell.

   (b) Write down the expression for the total energy of forced vibration and hence discuss the sharpness of resonance.

   (c) Define stable and unstable equilibriums. 4+4+2

P.T.O.

16. (a) Prove that the total energy E of a particle of mass m acted on by a central force is given by $E=\frac{L^2}{2m}\left[\left(\frac{du}{d\phi}\right)+u^2\right]+V(r)$, where $V(r)$ is the potential energy, L is the angular momentum of the particle, $u=\frac{1}{r},(r,\phi)$ being the polar coordinates of the particles.

(b) A particle of mass m moves along the x axis under the influence of a conservative force field having potential $V(x)$. If the particle is located at positions x_1 and x_2 at respective times t_1 and t_2, prove that if E is the total energy

$$t_2-t_1=\sqrt{\frac{m}{2}}\int_{x_1}^{x_2}\frac{dx}{\sqrt{E-V(x)}}.$$

(c) Find the kinetic energy of a particle of mass 20 moving with velocity $3\hat{i}-5\hat{j}+4\hat{k}$. 4+4+2
