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

2022

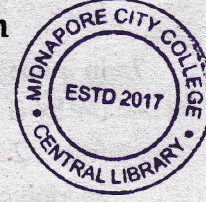
1st Semester Examination

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 : $2 \times 5 = 10$

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.

(2)

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 $ds^2 = c^2 dt^2 - dx^2 - dy^2 - dz^2$ 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.

(3)

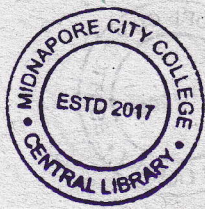
- (b) A cylinder has a mass M , length l and radius r . Find the ratio of l to r , if the moment of inertia about an axis through the centre and perpendicular to its length, is a minimum. 2+3
13. A particle of mass m moves in the xy plane so that its position vector is $\vec{r} = a \cos \omega t \hat{i} + b \sin \omega t \hat{j}$ 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



16. (a) Prove that the total energy E of a particle of mass m acted on by a central force is given by

$E = \frac{L^2}{2m} \left[\left(\frac{du}{d\phi} \right)^2 + u^2 \right] + V(r)$, where $V(r)$ is the potential energy, L is the angular momentum of the particle, $u = \frac{1}{r}$, (r, ϕ) 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
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