2019

PHYSICS

(Honours)

Paper : PHYH-DC - 2

[CBCS]

Full Marks : 25 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.

1. Answer any *five* questions : 2×5=10

   (a) If a force $\vec{F}$ acts on a particle at right angles to its velocity $\vec{v}$, prove that $|\vec{v}|$ = constant.

   (b) Show that the gravitational force is conservative.

   (c) Two particles A and B, each of mass m, and another particle C of mass M are kept on the x-axis in the order $A\ B\ C$. Particle A is given a velocity $v\hat{i}$. Consequently there are two collisions, both of which are completely inelastic so that the three particles get embedded into

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one another to form a composite mass. If the net energy loss due to these collisions is $\frac{7}{8}$ of the initial energy, prove that $M = 6m$. Ignore frictional losses.

(d) A particle moves in a force field given by $\vec{F} = r^2\vec{r}$, where $\vec{r}$ is the position vector of the particle. Prove that the angular momentum of the particle about the origin is conserved.

(e) A solid cylinder of mass M and radius R rolls down an inclined plane of vertical height 'h'. If the body starts from rest at the top of the incline, prove that its velocity at the bottom will be $v = \left(\frac{4}{3}gh\right)^{1/2}$.

(f) Show that a non-inertial frame of reference gives rise to fictitious forces.

(g) Differentiate between Newtonian and non-Newtonian fluids giving specific examples of each.

(h) With the help of a diagram, explain the meaning of the 'neutral surface' in case of bending of beams.

2. Answer any *three* questions : 5×3=15

(a) Define radius of gyration of a rotating body about its axis of rotation.

The surface density of a disc of mass M and radius R is given by $\rho(r)=\rho_0\left(1-\frac{r}{R}\right)$ for $0 \le r \le R$, where ρ_0 is a constant. Prove that the radius of gyration of the disc about an axis perpendicular to its plane and passing through its centre is $k=\sqrt{\frac{3}{10}}R$. 1+4=5

(b) 'The gravitational potential of a body at any point is negative'— What is the physical significance of this statement?

Find the gravitational potential at any point in the material of a thick spherical shell of mass M, having internal and external radii as 'a' and 'b' respectively. 1+4=5

(c) What is meant by a central force?

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The path of a particle of a mass 'm', moving under the influence of a central force, in plane polar co-ordinates, is given by $r = r_0 e^{k\theta}$, where r_0 and k are positive constants of appropriate dimensions. The angular momentum of the particle is $\vec{L}$ and its total energy is zero. Show that the potential energy $V(r)$ of the particle is given by $V(r) = -\frac{(k^2+1)L^2}{2mr^2}$. 1+4=5

(d) Calculate the limiting values of Poisson's ratio (σ) of an elastic body.

A gold wire, 0.32 mm in diameter, elongates by 1.0 mm when stretched by a force of 330 gm-wt and twists through one radian, when equal and opposite torques of 145 dyne cm are applied at its ends. Taking g=981 cmsec^{-2}, show that $\sigma = 0.429$ for gold. 2+3=5

(e) With necessary assumptions, deduce Poiseuille's formula for the viscous flow of a liquid in a capillary tube. 5
