Section–III

3. Answer any *one* question : 10×1 =10

(a) (i) A homogeneous sphere of mass M has a radius r. Consider a point P, distant x from the centre of the sphere O. Show that the gravitational potential at point P is

$$V_P = -\frac{GM}{x}, x \geq r$$

$$= -\frac{GM}{2r^2}\left(3r^2 - x^2\right), x \leq r$$

Draw graphs showing the variation of the intensity and potential vs x, ranging from 0 to ∞.

(ii) Define gravitational self-energy. Prove that the gravitational self-energy of earth, a homogeneous sphere of mass M and radius R is $-\frac{3}{5}\frac{M^2G}{R}$.

5+(2+3)

(b) What is meant by an ideal fluid? 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. 2+6+2

B.Sc. 1st Semester (Honours) Examination-2022-23

PHYSICS

Course ID : 12412 Course Code: SH/PHS/102/C-2/T2

Course Title : Mechanics (New)

Time : 1 Hour 15 Minutes *Full Marks :* 25

The figures in the right hand 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* questions : 1×5 =5

(a) Show that Newton's 2nd law remains co-variant under Galilean transformation.

(b) Why the horizontal motion of a projectile is constant?

(c) Under what condition both the linear and angular momentum of a moving particle are constant?

(d) Why does the suspended spring stretch more at the top than at the bottom?

(e) Explain why a small object falling from a great height reaches a steady terminal speed?

(f) How does the viscosity of liquids vary with temperature?

(g) Can you have negative torque? Explain.

(h) Two soap bubbles of unequal sizes are blown at the ends of a capillary tube. Which one will grow at the expense of the other and what does it show?

Section–II

2. Answer any *two* questions : 5×2 =10

(a) Derive the expression for velocity of a particle moving in a plane polar coordinate system.

(b) Explain the physical significance of the negative result of Michelson-Morley experiment. State and explain the basic postulates of Einstein's special theory of relativity. The total energy of a particle is exactly twice its rest mass energy. Calculate its speed. 2+2+1

(c) How does the capillary rise of a liquid depend upon the radius of the capillary tube? The surface tension of pure water at 21°C is $72{\cdot}75\times10^{-3}$ Nm^{-1}. A solution of ethanol in water has surface tension of $33{\cdot}24\times10^{-3}$ Nm^{-1} at the same temperature. How much less will the alcohol solution rise in the same capillary compared to the pure water? Given density (solution) = 0.9614×10^{3} kgm^{-3}, density (water) = $0{\cdot}9982\times10^{3}$ kgm^{-3} and angle of contact $\theta = 0°$.

(d) (i) A particles moves under the influence of a force field given by, $\vec{F} = a\left(\hat{i}\sin\omega t + \hat{j}\cos\omega t\right)$. If the particle be initially at rest, prove that at an instant *t*, work done on the particle is given by $\frac{a^2}{m\omega^2}(1-\cos\omega t)$.

(ii) If a planet suddenly stops rotation in its circular orbit, then show that the planet will fall into the sun in a time interval $\frac{\sqrt{2}}{8}$ times the time period of revolution of the planet. 3+2