

SET - I

Unique Paper Code : 42221101  
Name of the Paper : Physics-I: Mechanics  
Name of the Course : B. Sc. (Prog) CBCS Old Course  
Semester : I  
Medium : English  
Duration: 3 hours

Max Marks: 75

**Instructions for Candidates**

- Write your Roll No. on the top immediately on receipt of this question paper.
- All questions carry equal marks. Attempt any **four** questions in all.
- Deduce the condition for the coplanarity of three vectors  $\vec{a}$ ,  $\vec{b}$  and  $\vec{c}$ . Show that the vectors  $a\vec{a} - b\vec{b}$ ,  $b\vec{b} - c\vec{c}$ ,  $-2a\vec{a} - 3b\vec{b}$ ,  $b\vec{b} - 2c\vec{c}$  are coplanar, where  $a, b, c$  are unit vectors.  
Solve the differential equation  $\frac{d^2y}{dx^2} + \frac{dy}{dx} + 5y = 0$ , subject to  $y = 2$  and  $\frac{dy}{dx} = \frac{d^2y}{dx^2}$  when  $x = 0$ .
- Two bodies of different masses are moving with the same kinetic energy of translation. Which has greater momentum?  
A ball of mass 'm' at rest breaks into three fragments each of equal mass. Out of three, two fragments are moving with same speed 'v' making an angle  $90^\circ$  with each other. Find the total kinetic energy of the three fragments after the explosion.  
A torque of 2 Nm is applied to a wheel of mass 10 kg and radius of gyration 50 cm. What is the resulting translational acceleration?
- What is meant by a central force? Explain with the help of examples. Prove that under the influence of central force, the areal velocity is constant and the motion of a particle is always confined to a plane.  
A satellite revolves around a planet of mean density  $10^5 \text{ kg/m}^3$ . If the radius of its orbit is only slightly greater than the radius of the planet, find the time of revolution of the satellite.
- Define Young's modulus (Y), Bulk modulus (K) and modulus of rigidity ( $\eta$ ). Prove the relation:  $Y = \frac{9a}{3n + \eta}$   
Find the greatest length of a steel wire that can hang vertically without breaking. Breaking stress for steel =  $7.9 \times 10^9$  dynes/sq. cm. Density of steel = 7.9 gm/c.c.
- Define Simple Harmonic Motion (SHM) with examples. In a SHM, what fraction of the total energy is the kinetic energy and potential energy when the displacement (x) is (i) one half of the amplitude (ii) one-third of the amplitude (iii) one-fourth of the amplitude.  
Calculate the frequency of the oscillator for a particle of mass 20 gm is placed in a potential field given by  $V = (50x + 100) \text{ erg/gm}$ .
- Obtain the relativistic formula for the addition of velocities. Hence, show that the velocity of light is an absolute constant independent of the frame of reference, and that the addition of the velocity of light merely reproduces the velocity of light.  
Consider a spaceship moving away from the earth with velocity  $c/5$  fires a rocket whose velocity relative to spaceship is  $c/2$ . What will the velocity of the rocket be as observed from the earth by an observer O in two cases (i) away from the earth (ii) towards the earth?