

RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College under University of Calcutta)

FIRST YEAR

B.A./B.SC. SECOND SEMESTER (January – June) 2013

Mid-Semester Examination, March 2013

Date : 04/03/2013

PHYSICS (Honours)

Time : 11 am – 1 pm

Paper : II

Full Marks : 50

Answer five questions from Gr-A , Gr-B and Gr-C.

Use three separate scripts, one for each group.

Group – A [Mechanics-I]

Answer any two questions :

1. a) Obtain a relation the linear momentum of a moving particle as viewed from two inertial frames S and S' in uniform relative motion. 3

b) A particle moves on a circle of constant radius b. If the speed of the particle varies with time t according to the equation $v = Ar^2$, for what value or values of t does the acceleration vector make an angle of 45° with the velocity vector ? 4

c) The bob of a pendulum moves on a vertical circle of radius b, and when the string is at an angle θ to the vertical, the speed of the bob is given by $v^2 = 2gb\cos\theta$, where g is a positive constant. Find the acceleration of the bob at an angle θ . 3

2.a) Establish the work energy theorem for a particle moving in a force field $\vec{F}$. Hence show that if $\vec{F}$ is conservative, the total mechanical energy is a constant of motion. 4

b) Use the work energy theorem to obtain an expression for the time period of a simple pendulum. [Do not solve the equation of motion]. 3

c) Show that the force $\vec{F} = -kr^3 \hat{r}$ is conservative, and find the corresponding scalar potential. 3

3. A particle of mass m is projected vertically upwards with an velocity v in a medium that offers a resistance proportional to the speed. Find the following :

a) speed v as a function of time t during ascent ;

b) time to reach maximum height:

c) the maximum height reached;

d) the work done by the resistive force.

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Group – B [Gen. Properties of matter.]

Answer any one question :

4. a) Derive a relation among Young's modulus, rigidity modulus and bulk modulus of a solid homogeneous body. 5
- b) A solid cylinder of length L and radius R is fixed at its upper end and a twist is applied at the free end. Derive an expression for moment of twisting couple acting on it. 5
5. a) What do you understand by 'bending of beam'. Derive an expression for it. 2+3
- b) A cantilever is clamped at one end and loaded at any point (P). Show that the depression at free end (Q) is same as the depression at P with load at Q. 5

Group – C [Waves and vibrations.]

Answer any two questions :

- 6 a) Find an expression for instantaneous potential energy per unit volume of the acoustic wave. 5
- b) i) Define specific acoustic impedance. Derive an expression of it 1+2
- iii) Find the acoustic impedance of air at STP, where velocity of sound is $3.32 \times 10^4 \text{ cm/s}$, excess pressure $= 1.01 \times 10^6 \text{ dyne/cm}^2$, $\rho_0 = 1.29 \times 10^{-3} \text{ gm/cm}^3$ 2
7. a) Find an expression for velocity of sound in gas medium. 6
- b) Find the sound energy density in air of free plane progressive acoustic wave having an intensity of 80 dB and frequency 1 KHz. Given the velocity of sound in air is 340 m/s and reference intensity 10^{-12} Wm^{-2} . 4
8. a) Explain temporal coherence in connection with interference. 4
- b) Starting from the equation of motion of a particle subjected to a periodic force and a damping force, proportional to velocity, discuss i) underdamped, ii) overdamped and iii) critically damped conditions. 6