1S-PHY 101 - Physics Paper - I (Mechanics and Oscillations)

P. Pages : 3

Time : Three Hours

4 6 2 1

Max. Marks : 50

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Notes : 1. All questions are compulsory.
2. Draw neat labelled diagram wherever necessary.

1. Either :

a) i) What is meant by frame of reference? Distinguish between inertial and non-inertial frame of reference. Give one example of each. **3**

ii) A reference frame rotating with respect to another frame with an angular velocity $\vec{w}$. Find the relation for acceleration. **4**

iii) The position vector of a body is given by $\vec{r} = \left(8t^2 - 4t\right)\hat{i} + t^2\hat{j} + 9t\,\hat{k}$. Find the velocity and acceleration of a body at t = 4 sec. **3**

OR

b) i) State and explain Newton's law of gravitation. Give S.I unit of G. **2**

ii) What is gravitational potential? Derive an expression for gravitational potential due to a spherical shell at a point out side the spherical shell. **5**

iii) Calculate the gravitational potential of a thin spherical shell of mass 15 kg and radius 12 cm at a point **3**
a) 20 cm
b) 12 cm away from it's centre. $\left(G = 6.673 \times 10^{-11}\,\text{Nm}^2 / \text{kg}^2\right)$

2. Either :

a) i) What are Lissajou's figures? State any two applications of it. **2**

ii) A particle is subjected simultaneous to two SHMS at different amplitude and same frequency acting right angle to each other. Find the general expression for the resultant motion. **5**

iii) Obtain the expression for the resultant motion for the phase difference **3**
a) 0°   b) $\pi/4$ c) $\pi/2$.

OR

b) i) Explain damped and forced oscillations. **2**

ii) Establish the differential equation of damped harmonic oscillator and obtain it's general solution. **6**

iii) A mass of 25×10^{-3} kg is suspended from the lower end of a vertical spring having a force constant 25 N/m. What should be the mechanical resistance of the system so that the motion of the mass is critically damped. **2**

3. Either :

a) What are central and non-central forces? Give characteristics of each. **2½**

b) Two bodies of masses 2g and 10g have position vectors $\left(3\hat{i} + 2\hat{j} + \hat{k}\right)$ and $\left(\hat{i} - \hat{j} + 3\hat{k}\right)$ respectively. Find the position vector and the distance of centre of mass from the origin. **2½**

c) Discuss the necessary conditions for the interference of sound waves. **2½**

d) Define quality factor of a harmonic oscillator and find the equation of quality factor of a damped harmonic oscillator. **2½**

OR

e) State and explain Kepler's laws of planetary motion. **2½**

f) Show that velocity of centre of mass of a system remains constant in the absence of external forces. **2½**

g) Define moment of inertia and radius of gyration. Give it's unit and dimension. **2½**

h) Calculate the resonance frequency of an acoustic system having Q = 1.75 and the half power frequency are 200 Hz and 360 Hz respectively. **2½**

4. Either :

a) State Newton's laws of motion and discuss their limitations. **2½**

b) Explain the terms. **2½**

  i) Angular momentum.

  ii) Torque of a rigid body.

c) A body of mass 0.1 kg is rotating about an axis. If the centre of mass of body is at a distance 0.5 m from the axis of rotation. Calculate its moment of inertia. Also calculate the M.I of circular disc of mass 2 kg and radius 0.17 m. **2½**

d) Derive the equation of power dissipation in damped harmonic oscillations. **2½**

OR

e) A particle is moving along a curve in a plane. Derive an expression for radial and transverse component of velocity. **2½**

f) Prove that $\dfrac{d\vec{J}}{dt} = \vec{\tau}$ **2½**

g) Derive the differential equation of linear SHMs. **2½**

h) Explain the terms. **2½**
   i) Quality factor and band width.

5. Attempt **any ten** of the followings.

   a) Define centripetal force. **1**

   b) State the difference between conservative and non-conservative force. **1**

   c) Newton's first law of motion simply a special case of Newton's second law. Explain. **1**

   d) Define centre of mass. **1**

   e) State the principle of conservation of linear momentum. **1**

   f) Define gravitational self-energy of a body. **1**

   g) State the theorem of parallel axes for the moment of inertia. **1**

   h) What is beats? **1**

   i) State conservation of angular momentum. **1**

   j) What is meant by dead beat motion? **1**

   k) State differential equation for forced harmonic oscillations. **1**

   l) What is meant by sharpness of resonance? **1**

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