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( CBCS )

PHYSICS

FIRST PAPER

( Properties of Matter, Oscillations and Acoustics )

Full Marks : 75

Time : 3 hours

( PART : B—DESCRIPTIVE )

( Marks : 50 )

*The figures in the margin indicate full marks for the questions*

1. (a) A particle is moving in  $XY$  plane. Show that, if the motion is circular, velocity  $\vec{v}$  of the particle is given by  $\vec{v} = \omega r \hat{\theta}$  where,  $\hat{\theta}$  is the unit vector along transverse direction,  $r$  and  $\omega$  are radius of the path and angular velocity of the particle respectively. If the motion is circular, what will be the expression for velocity? 6
- (b) State and prove the principle of conservation of linear momentum. 4

Or

- (a) A reference frame  $S'$  rotates with respect to another reference frame  $S$  with an angular velocity  $\vec{\omega}$ . If  $\vec{r}$ ,  $\vec{v}$  and  $\vec{F}$  represent the position, velocity and force of a particle of mass  $m$  in the frame  $S$  and  $\vec{F}'$  represents the force of the particle in the frame  $S'$ , then show that

$$\vec{F} = \vec{F}' - 2m\vec{\omega} \times \vec{v} - m\vec{\omega} \times (\vec{\omega} \times \vec{r}) - m \frac{d\vec{\omega}}{dt} \times \vec{r} \quad 6$$

- (b) Explain the variation of mass with velocity. 4

2. (a) Obtain the expression for moment of inertia of a hollow sphere of mass  $M$ , radius  $R$  about its diameter and about the axis passing through the edge. 7
- (b) Show that, numerically moment of inertia of a body is twice its kinetic energy, when its angular velocity is unity. 3

Or

- (a) Show that total energy  $E$  of a body of mass  $m$  is given by  $E = mc^2$ , where  $c$  is the speed of light in vacuum,  $m$  is moving mass of the body. 7

( 3 )

- (b) Obtain the expression for length contraction, when an object moves with high speed. 3
3. (a) Show that, a shear is equivalent to a compression and an extension at right angles to each other. 4
- (b) A light cantilever is clamped at one end and loaded at the other. Obtain the relation between the load and depression at the loaded end. 6
- Or
- (a) A wire 300 cm long and 0.625 sq. cm in cross-section is found to stretch by 0.3 cm under a tension of 1200 N. What is the Young's modulus of the material of the wire? 3
- (b) Using the method of dimensional analysis, derive Stokes' law and hence obtain an expression for terminal velocity of a body falling freely through a viscous medium. What is the significance of terminal velocity? 6+1
4. (a) Let two masses  $m_1$  and  $m_2$  be connected by a spring of spring constant  $k$ . One of the masses is fixed to a rigid support and the other mass is displaced through a distance  $x$  and is released. Show that the

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- motion of the spring is simple harmonic, and hence obtain the frequency and time period of the motion. 7
- (b) Two SHMs are given by  $x_1 = 10 \cos 100t$  and  $x_2 = 10 \sin 100t$ . Calculate their resultant amplitude, when they interfere. 3
- Or
- (a) Two simple harmonic motions  $x = A \sin(\omega t + \phi)$  and  $y = B \sin \omega t$  superposed each other at right angle. Obtain the general equation for the resultant simple harmonic motion after they superposed each other and hence discuss the case when—
- (i)  $\phi = \frac{\pi}{2}$
- (ii)  $\phi = \pi$ . 5+1+1
- (b) Displacement of a particle is given by  $x = x_0 \sin \omega t$ , show that it performs simple harmonic motion. 3
5. (a) Show that in forced vibration, the resultant amplitude is given by
- $$A = \frac{f}{\sqrt{(\omega^2 - p^2)^2 + 4b^2 p^2}}$$
- where  $b$  is damping coefficient and  $p$  is frequency of driving force. 7

( 5 )

- (b) Write down the difference between free and forced vibrations. 3

*Or*

- (a) Obtain the condition for maximum amplitude in forced vibrations. What do you mean by resonance? Explain sharpness of resonance. 4+1+2
- (b) What is intensity level? Calculate the change in intensity level when the intensity of sound increases 1000 times its original intensity. 3

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**Subject Code :**  
**PHY/I/EC/01 (CBCS)**

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**Booklet No. A**

Date Stamp .....

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**To be filled in by the Candidate**

CBCS  
DEGREE 1st Semester  
(Arts / Science / Commerce /  
..... ) Exam., **2016**  
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Subject .....

Paper .....

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**INSTRUCTIONS TO CANDIDATES**

- 1. The Booklet No. of this script should be quoted in the answer script meant for descriptive type questions and vice versa.**
- 2. This paper should be ANSWERED FIRST and submitted within 1 (one) Hour of the commencement of the Examination.**
- 3. While answering the questions of this booklet, any cutting, erasing, overwriting or furnishing more than one answer is prohibited. Any rough work, if required, should be done only on the main Answer Book. Instructions given in each question should be followed for answering that question only.**

**To be filled in by the Candidate**

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DEGREE 1st Semester  
(Arts / Science / Commerce /  
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**PHY/I/EC/01 (CBCS)**

**2 0 1 6**

( CBCS )

**PHYSICS**

FIRST PAPER

**( Properties of Matter, Oscillations and Acoustics )**

( PART : A—OBJECTIVE )

( Marks : 25 )

*The figures in the margin indicate full marks for the questions*

SECTION—I

( Marks : 10 )

Put a Tick (✓) mark against the correct answer in the brackets provided : 1×10=10

**1.** The condition for the force  $\vec{F}$  to be conservative is

(a)  $\vec{\nabla} \cdot \vec{F} \neq 0$  ( )

(b)  $\vec{\nabla} \times \vec{F} \neq 0$  ( )

(c)  $\vec{\nabla} \cdot \vec{F} = 0$  ( )

(d)  $\vec{\nabla} \times \vec{F} = 0$  ( )

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2. Angular momentum of a system is conserved

(a) when angular momentum on the system is zero ( )

(b) when external force on the system is zero ( )

(c) when external torque on the system is zero ( )

(d) always under any circumstances ( )

3. A meson has a lifetime of  $2.2 \times 10^{-6}$  s ( $= \Delta t_0$ ) in its own frame. It travels with the speed of  $0.98 c$ , then its lifetime measured from the earth is

(a)  $5\Delta t_0$  ( )

(b)  $2\Delta t_0$  ( )

(c)  $10\Delta t_0$  ( )

(d)  $7\Delta t_0$  ( )

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( 3 )

4. Moment of inertia for a ring of radius  $R$ , mass  $M$  about the axis passing through its diameter is

(a)  $\frac{3}{5} MR^2$  ( )

(b)  $\frac{7}{5} MR^2$  ( )

(c)  $\frac{1}{2} MR^2$  ( )

(d)  $\frac{4}{5} MR^2$  ( )

5. If  $Y$  be the Young's modulus and  $S$  be the stress, then the strain energy per unit volume is

(a)  $YS$  ( )

(b)  $Y^2S$  ( )

(c)  $\frac{1}{2} Y^2S$  ( )

(d)  $\frac{S^2}{2Y}$  ( )

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( 4 )

6. A vertical wire is loaded (within the limit of Hooke's law) by weights, which produce a total extension of 3 mm and 5 mm respectively. The ratio of the respective work done is

(a)  $9 : 25$  ( )

(b)  $3 : 5$  ( )

(c)  $27 : 125$  ( )

(d)  $5 : 3$  ( )

7. The average kinetic energy of a particle of mass  $m$  executing simple harmonic motion of frequency  $f$  and amplitude  $a$  is

(a)  $2\pi^2 ma^2 f^2$  ( )

(b)  $\pi^2 ma^2 f^2$  ( )

(c)  $\frac{\pi^2 ma^2 f^2}{2}$  ( )

(d)  $\frac{\pi^2 ma^2 f^2}{\sqrt{2}}$  ( )

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8. Let  $g$  be acceleration due to gravity,  $l$  be length of simple pendulum, its frequency of oscillation is

(a)  $f = 2\pi \frac{l}{g}$  ( )

(b)  $f = 2\pi \sqrt{\frac{l}{g}}$  ( )

(c)  $f = \frac{1}{2\pi} \sqrt{\frac{l}{g}}$  ( )

(d)  $f = \frac{1}{2\pi} \sqrt{\frac{g}{l}}$  ( )

9. If  $b$  is the damping constant,  $\omega$  is the natural frequency of the oscillating system, then the frequency of vibration is

(a)  $\frac{\sqrt{\omega^2 - 2b^2}}{2\pi}$  ( )

(b)  $\frac{\sqrt{\omega^2 - b^2}}{2\pi}$  ( )

(c)  $\frac{\sqrt{\omega^2 + b^2}}{2\pi}$  ( )

(d)  $\frac{\sqrt{\omega^2 + 2b^2}}{2\pi}$  ( )

( 6 )

**10.** When two or more notes are sounded simultaneously, the combined note producing a pleasing effect on the ear is called

(a) harmony ( )

(b) melody ( )

(c) noise ( )

(d) interval ( )

( 7 )

SECTION—II

( Marks : 15 )

Answer the following questions :

3×5=15

1. What do you mean by collision? Write down the differences between elastic and inelastic collisions.

*Or*

Show that, motion of a system of particles is simply the motion of its centre of mass.

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2. State and prove perpendicular axes theorem of moment of inertia.

*Or*

State the two postulates of special theory of relativity. Find the speed of relativistic particle, whose mass is found to be 10 times its rest mass.

( 9 )

3. Calculate the height to which a liquid will rise in a capillary tube of radius 0.2 mm, if the angle of contact is  $0^\circ$ . (Given : Surface tension of the liquid =  $26 \times 10^{-3}$  N / m and density  $800 \text{ kg / m}^3$ ).

*Or*

Write down Bernoulli's equation and explain the significance of different terms in it.

( 10 )

4. Show that for a simple harmonic motion, given by the equation  $y = A \sin \omega t$ , velocity of the particle at any instant is given by  $v = \omega \sqrt{A^2 - y^2}$ . What is the expression for maximum speed? Where does it occur?

*Or*

What do you mean by simple harmonic motion (SHM)?  
Obtain the differential equation for SHM.

( 11 )

5. What do you mean by ultrasonic waves? Write three applications of ultrasonic waves.

*Or*

What is reverberation? Write down Sabine's law of reverberation. Define live room and dead room.

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