2 0 1 7

(CBCS)

(1st Semester)

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)* Define centre of mass. Show that the ratio of distances of two particles from their centre of mass is in inverse ratio of their masses. 1+3

(b) Define gravitational potential. Obtain an expression for gravitational potential at a point inside and outside a thin spherical shell. 1+5

Or

(a) Obtain the expressions in plane polar coordinates for the radial and transverse components of velocities and accelerations for a particle moving in a plane. 6

(b) Two particles of masses m_1 and m_2 moving with speeds u_1 and u_2 undergo elastic collision and change their speeds to v_1 and v_2 respectively. Derive the expressions for v_1 and v_2 in terms of m_1, m_2, u_1 and u_2. 2+2

2. *(a)* Derive an expression for relativistic variation of mass with velocity. Hence show that material particles cannot have velocity equal to or greater than velocity of light. 5+1

(b) Calculate the moment of inertia of an elliptical disc about an axis passing through its centre and perpendicular to its plane. 4

Or

(a) State and prove the theorem of parallel axis for moment of inertia. 1+3

(b) A solid spherical ball rolls on a table. Find the ratio of its translational and rotational kinetic energies. What fraction of total energy is rotational? 3+1

(c) The intermolecular distance between two atoms of hydrogen molecule is 0·77 Å and mass of proton is $1 \cdot 67 \times 10^{-27}$ kg. Calculate the moment of inertia of the molecule. 2

3. (a) Show that $\frac{9}{Y} = \frac{1}{K} + \frac{3}{\eta}$, where Y, K and η represent Young modulus, bulk modulus and modulus of rigidity respectively. 7

(b) Explain why a hollow cylinder is stronger than a solid cylinder of the same length, mass and material. 3

Or

(a) Derive an expression for the height h to which a liquid of surface tension T will rise in a capillary tube of radius r. 6

(b) Two capillary tubes of radii r_1 and r_2 and lengths l_1 and l_2 are joined in series. Using Poiseuille's formula, derive an expression for the rate of flow of liquid through the arrangement. 4

4. (a) What is a compound pendulum? Derive an expression for the time period of a compound pendulum. Hence, show that the time period of compound pendulum is minimum when the distance of the point of suspension from the centre of gravity is equal to the radius of gyration. 1+4+1

(b) What do you mean by standing waves? Discuss the formation of nodes and antinodes. 1+3

Or

(a) Obtain the differential equation of simple harmonic motion and hence obtain its solution. 2+5

(b) A simple pendulum of length 3 m and amplitude 0·02 m has energy 0·5 J. Find its energy when amplitude is 0·04 m, length remaining constant. 3

5. (a) Write the differential equation for free damped vibration and obtain its solution. Discuss the case of 'heavy damping'. 1+4+2

(b) What are acoustic requirements of a good auditorium? 2

(c) What do you mean by musical scale? 1

Or

(a) What do you mean by reverberation and reverberation time? Discuss Sabine's law of reverberation. 1+1+3

(b) Describe a method of producing ultrasonic wave. Give two applications. 4+1

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Subject Code : PHY/I/EC/01

Booklet No. A

Date Stamp ....

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To be filled in by the Candidate

CBCS

DEGREE 1st Semester

(Arts / Science / Commerce /

......................) Exam., **2017**

Subject ....

Paper ....

To be filled in by the Candidate

CBCS

DEGREE 1st Semester

(Arts / Science / Commerce /

......................) Exam., **2017**

Roll No. ....

Regn. No. ....

Subject ....

Paper ....

Descriptive Type

Booklet No. B ....

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, over-writing 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.**

Signature of Scrutiniser(s)

Signature of Examiner(s)

Signature of Invigilator(s)

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2 0 1 7

(CBCS)

(1st Semester)

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. Two masses M and m, ($M > m$) have the same momentum, then mass M will have

(a) less kinetic energy than that of m ( )

(b) same kinetic energy as that of m ( )

(c) more kinetic energy than that of m ( )

(d) Cannot be ascertained ( )

2. Newton's laws of motion are based on the assumption that the space is

(a) homogeneous ( )

(b) isotropic ( )

(c) invariant under rotation ( )

(d) both homogeneous and isotropic ( )

3. Moment of inertia is

(a) $2\ \mathrm{KE} \times \omega^2$ ( )

(b) $2\ \mathrm{PE} \times \omega^2$ ( )

(c) $\dfrac{2\ \mathrm{KE}}{\omega^2}$ ( )

(d) $\dfrac{2\ \mathrm{PE}}{\omega^2}$ ( )

4. If an electron of rest mass $9 \cdot 1 \times 10^{-31}$ kg moves with a speed of $0 \cdot 6 \times 10^{8}$ ms^{-1}, then the mass of the electron to an observer moving with the electron is

(a) $5 \cdot 5 \times 10^{-23}$ kg ( )

(b) $9 \cdot 1 \times 10^{-31}$ kg ( )

(c) $9 \cdot 1 \times 10^{-23}$ kg ( )

(d) zero ( )

5. Two balls of same material one having radius twice that of other are dropped in a tall jar filled with liquid. The ratio of the terminal velocities of the smaller ball to that of the larger ball will be

(a) 4 ( )

(b) 2 ( )

(c) $\frac{1}{4}$ ( )

(d) $\frac{1}{2}$ ( )

6. The viscous force on a small sphere of radius r moving in a fluid of density ρ and the coefficient of viscosity η is proportional to

(a) r ( )

(b) ρ ( )

(c) r^2 ( )

(d) $\frac{1}{r}$ ( )

7. The potential energy of a simple harmonic oscillator is maximum when its displacement is equal to

(a) zero ( )

(b) $\frac{\text{amplitude}}{\sqrt{2}}$ ( )

(c) amplitude ( )

(d) $\frac{\text{amplitude}}{2}$ ( )

8. A mass of 2 kg is attached to a spring of stiffness constant 18 Nm^{-1}, then its natural frequency is

(a) 0·25 Hz ( )

(b) 0·5 Hz ( )

(c) 0·05 Hz ( )

(d) 0·025 Hz ( )

9. In electrical damped oscillator, $\frac{R}{2L}$ has the units of

(a) displacement ( )

(b) reciprocal of time ( )

(c) time ( )

(d) reciprocal of frequency ( )

10. The quality factor is

(a) directly proportional to the damping resistance ( )

(b) inversely proportional to the square of the damping resistance ( )

(c) directly proportional to the square of the damping resistance ( )

(d) inversely proportional to the damping resistance ( )

SECTION—II

(*Marks* : 15)

Answer the following questions : 3×5=15

1. What is a Coriolis force? State the important applications of Coriolis force.

Or

Using Newton's law, prove that the angular momentum is conserved for a particle moving under central force.

2. Prove that $L^2 = 2EI$, where L, E and I are the angular momentum, kinetic energy and moment of inertia respectively.

Or

Calculate the percentage contraction in length of a rod moving with velocity $0 \cdot 6c$ in a direction 60° to its own length.

3. Show that the value of Poisson's ratio lies between – 1 and 0·5.

Or

A plate of metal 100 sq. cm in area rests on a layer of castor oil 2 mm thick whose coefficient of viscosity is 15·5 poise. Calculate the horizontal force required to move the plate with a speed of 3 cm s^{-1}.

4. Show that the resultant of two simple harmonic motions at right angle to each other and having equal periods and amplitude but with a phase difference of 90^o is a circle.

Or

Write a short note on Lissajous figure.

5. Show that at resonance, displacement lags behind the driving force by $\frac{\pi}{2}$.

Or

Write a short note on noise pollution and its implications.

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