Total No. of Printed Pages—7

1 SEM TDC PHY M 1

Phy - 101
Bot - 101
Zoo - 101
Stat - 101
Geo - 101
Math - 101
Chemi - 101
Arts - G

2019

(November)

PHYSICS

(Major)

Course : 101

(Mechanics and Properties of Matter)

Full Marks : 80

Pass Marks : 32/24

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct option from the following : 1×8=8

(a) If a torque acting on a particle is zero, what is conserved?

(i) Angular momentum

(ii) Energy

(iii) Linear momentum

(iv) None of the above

(b) When the temperature increases, the angle of contact of a liquid

(i) increases

(ii) decreases

(iii) remains same

(iv) first increases and then decreases

(c) In case of a linear harmonic oscillator, the potential energy versus displacement curve will have the form of a/an

(i) ellipse

(ii) parabola

(iii) circle

(iv) straight line

(d) For a rigid body, the number of degrees of freedom is

(i) 1

(ii) 2

(iii) 3

(iv) 6

(e) The theoretical limits of Poisson's ratio are

(i) 0·5 and 1

(ii) 0·5 and –1

(iii) – 0·5 and –1

(iv) – 0·5 and 1

(f) The constraint of rigidity is

(i) conservative

(ii) scleronomic

(iii) holonomic

(iv) All of the above

(g) Newton's law of motion is represented by a differential equation which is of

(i) first order and first degree

(ii) second order and first degree

(iii) second degree and first order

(iv) second order and second degree

(h) The linear velocity of a body is

(i) same in both inertial and non-inertial frames of references

(ii) greater in inertial frame

(iii) less in inertial frame

(iv) always constant

2. (a) What are inertial and non-inertial frames? Show that the basic laws of physics are invariant under Galilean transformations. 2+3=5

(b) Show how a two-body problem can be reduced to a single-body problem. Explain the concept of reduced mass. 4+1=5

(c) Show that the angular momentum $\vec{J}$ of a system of particles can be expressed in the form $\vec{J} = \vec{J}_{cm} + \vec{R} \times \vec{P}$, where

$\vec{J}_{cm}$ = angular momentum about the centre of mass

$\vec{R}$ = position vector of centre of mass

$\vec{P}$ = total linear momentum 4

(d) Show that the reduced mass of hydrogen atom is

$$m\left(1-\frac{1}{1836}\right)$$

where m is the mass of a proton. 3

3. (a) State Kepler's laws of planetary motion. 2

(b) Derive the expression for gravitational potential at a point inside a solid sphere. What is the value of gravitational intensity at the centre of the sphere? 4+1=5

4. (a) State and prove perpendicular axes theorem on moment of inertia. 1+2=3

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

(c) Define surface tension. Obtain the relationship between surface tension and surface energy. 1+2=3

(d) Show that the excess pressure inside a curved surface is given by

$$P = T\left(\frac{1}{r_1} + \frac{1}{r_2}\right)$$

where the symbols have their usual meanings. 5

(e) Derive the relation between the elastic constants. 5

5. (a) What are constraints? Distinguish between holonomic and non-holonomic constraints. 1+2=3

(b) What is d'Alembert's principle? Use this principle to derive Lagrange's equation of motion of a conservative system. 1+5=6

(c) What are fictitious forces? Show that the total Coriolis forces acting on a body of mass m in a rotating frame is $-2m\vec{\omega}\times\vec{v}$, where $\vec{\omega}$ is the angular velocity of rotating frame and $\vec{v}$ is the velocity of the body in rotating frame. 2+5=7

(d) What is a Foucault pendulum? Using Foucault pendulum, show that the earth is rotating. 1+3=4

(Continued)

6. Write short notes on any *two* of the following : 4×2=8

(a) Moment of inertia

(b) Lagrangian

(c) Capillarity

★★★