B.Sc. CHEMISTRY
First Semester
GENERAL PHYSICS-I
(BSC – 102 A)

Duration: 3Hrs. **Full Marks: 70**

Part-A (Objective) =20
Part-B (Descriptive) =50

(PART-B: Descriptive)

Duration: 2 hrs. 40 mins. **Marks: 50**

Answer any *four* from *Question no.* 2 to 8
***Question no.* 1 is compulsory.**

1. A plane progressive harmonic wave propagating along the positive direction is represented by

$$\xi = A\sin\omega\left(t - \frac{x}{c}\right),$$

where the notations have their usual significance. Calculate its instantaneous kinetic and potential energies per unit volume. Hence find the total energy density of the wave. (8+2=10)

2. (a) What do you mean by centripetal and centrifugal forces? Show that the period of revolution of a satellite around the Earth is $T = \frac{2\pi r}{R}\sqrt{\frac{r}{g}}$ (where r, R and g have standard meaning).

(b) Find the time of revolution and orbital velocity of a satellite close to Earth surface (given, $R = 6400\ km$, $g = 9.8\ ms^{-1}$).

(2+4+4=10)

3. (a) Define conservative force. Prove that central force is an example of conservative force.

(b) A particle moves along half the circumference of a circle of 1 m radius. Calculate the work-done if the force of magnitude 5 N, at any point is inclined at 60^{o} to the tangent at that point.

(c) Show that the force $\vec{F} = (2xy + yz^2)\hat{\imath} + (x^2 + z^2)\hat{\jmath} + xyz\hat{k}$ is conservative.

(6+2+2=10)

4. (a) Define the divergence and curl of a vector point function. Write the conditions for a vector field to be solenoidal and irrotational.

(b) Prove that $(x^2 - z^2 + 3yz - 2x)\hat{\imath} + (3xz + 2xy)\hat{\jmath} + (3xy - 2xz + 2z)\hat{k}$ is both solenoidal and irrotational.

(4+6=10)

5. State: (a) Green's theorem, (b)Stoke's theorem and (c) Gauss's theorem. Using Green's theorem, evaluate $\int_c x^2ydx + x^2dy$, where c is the boundary described counterclockwise of a triangle with vertices (0,0), (1,0), (1,1). (6+4=10)

6. (a) Determine the moment of inertia of a solid sphere about its diameter.

(b) Calculate the moment of inertia and the angular momentum of the earth abo its diameter, taking it to be a sphere of mass $10^{25}\ kg$ and diameter $12800\ km$.

(6+4=10)

7. (a) A solid cylinder of mass $5\ kg$ and radius $30\ cm$ is rolling down an inclined plane at an angle of $45°$ with the horizontal. Calculate:

(i) linear acceleration of the cylinder along the plane and

(ii) total kinetic energy of the cylinder after $5\ sec$.

(b) A flywheel of mass $25\ kg$ has a radius of $0.2\ m$ is mounted on an axel of mass $10\ kg$ and radius $5\ cm$. If it acquires an angular velocity of $5\ rad/s$, calculate its kinetic energy of rotation?

(6+4=10)

8. (a) What is simple harmonic motion? A particle vibrates simple harmonically with amplitude of 13 cm. The time period of oscillation is 2π sec. Calculate the velocity of the particle at any instant when displacement is 5 cm.

(b) Write the differential equation of simple harmonic motion. Show that for a particle executing simple harmonic motion, the instantaneous velocity is

$$\frac{dy}{dt} = \omega\sqrt{a^2 - y^2}\,.$$

(5+5=10)

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Duration: 20 minutes **Marks – 20**

(PART A - Objective Type)

I. Choose the correct answer: **1×20=20**

1. In ..... frames, Newton's first and second laws are valid.
   (a) accelerated (b) inertial
   (c) non-inertial (d) all of these

2. Motion of a projectile as seen from another projectile will always be
   (a) parabola (b) ellipse
   (c) circle (d) straight line

3. A stone is allowed to fall under gravity from the top of a high tower at the equator. The horizontal displacement of the stone due to the rotation of earth will be along
   (a) east (b) west (c) north (d) south

4. Work-done by a closed path in conservative force is
   (a) zero (b) positive
   (c) negative (d) directly proportional to the path length

5. Mass of oxygen atom is *'m'*, the reduced mass of O_2 will be
   (a) m (b) $2m$ (c) $m/2$ (d) $4m$

6. In the circular orbit of a satellite around the Earth, which force balances the force of gravitational attraction?
   (a) coulomb force (b) centripetal force
   (c) centrifugal force (d) nuclear force

7. Work-done by all the forces acting on a system is equal to
   (a) kinetic energy (b) potential energy
   (c) total energy (d) none of these

8. Inverse square law force is defined as
   (a) $F = -\frac{K}{r}$, (b) $F = -\frac{K^2}{r^2}$,
   (c) $F = -\frac{K}{r^2}$, (d) $F = -Kr^2$

9. The conditions for two vectors A and B, to be orthogonal is
   (a) $A.B = 0$ (b) $A \times B = 0$
   (c) $A.(A \times B) = 0$ (d) $B.(A \times B) = 0$

10. Gradient of a scalar quantity is always a
(a) scalar quantity (b) vector quantity
(c) null vector (d) none of these

11. Dimensional formula of radius of gyration is
(a) $M^1L^2T^{-1}$ (b) $M^0L^1T^0$ (c) $M^1L^{-1}T^1$ (d) $M^1L^2T^0$

12. Moment of inertia of a cylinder of radius R, along its axis is
(a) mR^2 (b) $\frac{3MR^2}{2}$ (c) $\frac{2MR^2}{5}$ (d) $\frac{MR^2}{2}$

13. A circular ring of mass m and radius r rotates about an axis passing through its center and perpendicular to its plane with angular velocity ω. Its kinetic energy is
(a) $\frac{1}{2}mr^2\omega^2$ (b) $mr\omega^2$ (c) $mr^2\omega^2$ (d) $\frac{1}{2}mr\omega^2$

14. Identify the vector quantity among the following:
(a) distance (b) angular momentum
(c) moment of inertia (d) energy

15. Moment of inertia of a uniform circular disc about a diameter is I. Its moment of inertia about an tangential axis perpendicular to its plane will be
(a) $5I$ (b) $3I$ (c) $6I$ (d) $4I$

16. A body executes simple harmonic motion. Its potential energy (P.E), kinetic energy (K.E) and total energy (T.E) are measured as a function of displacement x. Which of the following statement is true?
(a) K.E is maximum at $x = 0$ (b) T.E is zero at $x = 0$
(c) K.E is maximum at maximum x (d) P.E is maximum at $x = 0$

17. The average kinetic energy of a simple harmonic oscillator of mass m, oscillating with amplitude a and frequency f is
(a) $2\pi^2mfa^2$ (b) $\pi^2mf^2a^2$ (c) π^2mfa (d) $4\pi^2mf^2a^2$

18. If a simple pendulum oscillates with an amplitude 5 cm and time period 2 sec, then its maximum velocity is
(a) 15.7 cm/s (b) 10 cm/s (c) 80 cm/s (d) 16.4 cm/s

19. In a dispersive medium the phase velocity and group velocity is related as
(a) group velocity is greater than phase velocity.
(b) group velocity is less than phase velocity.
(c) group velocity is equal to phase velocity.
(d) none of the above.

20. When two simple harmonic waves of same amplitude and frequency having a phase difference of $\frac{\pi}{2}$ superimpose at right angles on a particle, then the resultant motion of the particle will be described by
(a) an ellipse (b) a straight line
(c) a circle (d) a parabola

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