

RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. SECOND SEMESTER EXAMINATION, MAY 2018

FIRST YEAR [BATCH 2017-20]

PHYSICS (General)

Paper : II

Date : 26/05/2018

Time : 11 am – 1 pm

Full Marks : 50

[Use a separate Answer Book for each group]

Group - A

(Answer any seven questions)

[7×5]

1. a) What do you mean by the centre of mass of a system of particles? Deduce expressions for instantaneous position vector and velocity vector of the centre of mass of such a system. [1+2]
b) Define angular momentum of a rigid body. Find the relationship between angular momentum and torque acting on a rigid body. [2]
2. a) A body is rotating about a fixed axis. Derive relations between its linear and angular variables. Write down the tangential and radial components of acceleration of any arbitrary point in the body. [2+2]
b) What is non-conservative force. Give one example. [1]
3. a) What is the physical significance of moment of inertia. [1]
b) Calculate the moment of inertia of rectangular plate about an axis perpendicular to its plane and passing through its centre. [4]
4. a) When a particle moves under a central force, prove that—
i) the angular momentum is conserved. [1]
ii) the particle moves in a fixed plane. [2]
b) A satellite revolves around a planet in an elliptical orbit. Its maximum and minimum distances from the planet are $1.5 \times 10^7 \text{ m}$ and $0.5 \times 10^7 \text{ m}$ respectively. If the speed of the satellite at the farthest point is $5 \times 10^3 \text{ m/s}$, calculate the speed at the nearest point. [2]
5. a) Deduce the equation of motion of a particle moving under central force in plane polar coordinates by substituting $u = \frac{1}{r}$, where r is the position vector of the particle. [3]
b) Prove that if a planet is to revolve around the sun in an elliptical path with the sun at one of its focus the central force necessarily varies inversely as the square of the distance of the planet from the sun. [2]
6. a) What do you mean by gravitational field and gravitational potential for a massive body. [2]
b) Find out the expression of gravitational self-energy of a sphere of uniform density. [3]
7. Derive a general expression for the velocity of longitudinal waves in a gaseous medium. Discuss Newton's formula for the velocity of sound in air. [3·5+1·5]
8. If the displacement of a particle at any instant is given by $x = a \cos \omega t + b \sin \omega t$, show that that motion of the particle is simple harmonic. If $a = 3 \text{ m}$, $b = 4 \text{ m}$ and $\omega = 2 \text{ rad/sec}$, find the time period, amplitude and initial phase of the particle. [2+3]
9. a) Write down the differential equation for the motion of a particle executing damped simple harmonic motion along x-axis. Explain each term. [2]
b) What is resonance and give one suitable example. Discuss sharpness of resonance. [3]

10. Write down the equation of a progressive wave. Explain mathematically the formation of stationary waves by the superposition of two progressive waves. Find the distance between two consecutive anti-nodes. [1+3+1]
11. a) Find an expression for the energy density of an one dimensional plane progressive wave. [4]
 b) Define decibel. [1]

Group - B

(Answer **any three** questions)

[3×5]

12. a) How do you get bright spot at the centre of Newton's ring experiment? [2]
 b) In a Newton's ring apparatus, the radius of curvature of the lower surface of the convex lens is 10 meter. The K^{th} and $(K+6)^{\text{th}}$ dark rings are found to have radii 3mm and 7mm respectively. Find the wavelength of the light used. [3]
13. What do you mean by Fresnel's half-period zone? Discuss the construction of zone plate and find an expression of its focal length. [1+1+3]
14. a) Distinguish between Fresnel and Fraunhofer class of diffraction. [2]
 b) A parallel beam of monochromatic light is incident perpendicularly on the surface of a plane diffraction grating. Find the condition of principal maxima. [2]
 c) Write down the expression of resolving power of above grating. [1]
15. a) What are quarter wave plates? [3]
 b) Calculate the thickness of quarter wave plate of quartz for $\lambda = 5.8 \times 10^{-7} \text{ m}$.
 For Quartz, $\mu_e = 1.553$, $\mu_o = 1.544$. [2]
16. a) What do you mean by plane polarized light and circularly polarized light? [1+1]
 b) State Brewster's law. [1]
 c) Explain double refraction of light. [2]

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