

RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. THIRD SEMESTER EXAMINATION, DECEMBER 2015

SECOND YEAR [BATCH 2014-17]

PHYSICS [General]

Date : 21/12/2015

Time : 11 am – 1 pm

Paper : III

Full Marks : 50

[Use a separate Answer Book for each group]

Group – A

(Answer any six questions)

1. a) What do you mean by inertial frame of reference? [1]
b) Two observers, one at OXYZ coordinate system and another at O'X'Y'Z' coordinate system observe the same force on a particle. Show that the frames are connected by uniform velocity. [1]
c) Find the expression of velocity and acceleration on plane polar coordinates. [3]
2. Deduce an expression for the motion of a rocket with respect to some inertial frame of reference. [5]
3. In a rotating coordinate system the relation between the velocity of fixed frame and moving frame is given by $\left. \frac{d\vec{r}}{dt} \right|_F = \left. \frac{d\vec{r}}{dt} \right|_M + \vec{\omega} \times \vec{r}$ where \vec{r} is the position vector and $\vec{\omega}$ is the angular velocity.
a) Find the relation between the acceleration of the fixed frame and the acceleration of the moving frame. Identify different accelerations terms arises. [2]
b) Find the equation of motion of a particle to an observer on the earth's surface. Use suitable approximation to reduce the equation of motion. [3]
4. The radial equation of motion of a particle is given by $F(r) = m\ddot{r} - m r \dot{\theta}^2$. Hence show that the energy is conserved in this polar co-ordinates system. [5]
5. a) Show that the orbit of a particle moving under the attractive inverse square force will be a conic section. [2]
b) Derive an expression for eccentricity in terms of the total energy E of the particle. What will the shape of the orbit when $E < 0$, $E = 0$ and $E > 0$. [3]
6. a) What do you mean by gravitational self energy? [1]
b) Find the gravitational self energy of a sphere of radius R and mass M. [3]
c) If the acceleration due to gravity on the surface of a spherically shaped planet P is g_P , while the mean density and radius are given by σ_P and R_P respectively. Prove that $g_P = \frac{4}{3} \pi G R_P \sigma_P$, where G is the universal gravitation constant. [1]
7. a) State and prove parallel axes theorem for moment of inertia. [3]
b) Use this theorem to calculate moment of inertia of a solid cylinder about an axis passing through its centre and perpendicular to its own axis of symmetry. [2]
8. a) Define centre of mass for a system of particles and prove that centre of mass of the two masses is between the two masses and closer to the longer mass. [3]
b) Using x-y co-ordinate system, find the centre of mass of a rod making an angle θ with the x-axis. Consider the rod to be of uniform density. [2]

9. a) What do you understand by radius of gyration? Explain its physical significance. [2]
 b) A thin rod has length L and mass M . If the rod is not uniform but has a linear mass density λ , that varies with the distance x from the left end according to : $\lambda = \frac{\lambda_0}{L^2} x^2$. where λ_0 is a constant and has SI unit $[Kg \cdot m^{-1}]$. Find λ_0 and the position of the centre of mass with respect to the left end of the rod. [3]
10. a) What is pure rotation? [1]
 b) State and illustrate Routh's rule for the moments of inertia of the bodies of geometrical shapes about any one of their axes of symmetry. [4]

Group – B

(Answer **any four** questions)

11. a) Write two differences between interference and diffraction. [1]
 b) Find out the working principle of a zone plate. [3]
 c) How the zone plate differs from a convex lens? [1]
12. a) Distinguish between Fresnel and Fraunhofer diffraction. [2]
 b) Establish the condition maxima and minima in the interference pattern of double slit diffraction. [2]
 c) What is missing order in the spectrum of a double slit diffraction. [1]
13. a) What do you mean by the interference due to division of amplitude and division of wave front? [2]
 b) How is the wavelength of light is determined by Newton's ring method? Why are the rings circular? [2+1]
14. a) What is polarization of light? [1]
 b) State and prove Brewster's law. [2]
 c) Calculate the polarising angle for light travelling from water of refractive index 1.33 to glass of refractive index 1.55. [2]
15. a) What is double refraction and define E-ray and O-ray? [1+2]
 b) Calculate the thickness of a quartz half wave plate for the line 6563\AA for which the extraordinary and ordinary refractive indices are $\mu_e = 1.55085$, $\mu_o = 1.54184$. [2]
16. a) What are polaroid? [1]
 b) Write two uses of polaroid? [1]
 c) What is optical activity? [1]
 d) What are polariser and analyser? [2]

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