RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. THIRD SEMESTER EXAMINATION, DECEMBER 2016

SECOND YEAR [BATCH 2015-18]

Date : 21/12/2016 **PHYSICS [General]**

Time : 11 am – 1 pm **Paper : III** Full Marks : 50

(Use Separate Answer Book for each Group)

Group-A

(Answer any six questions) [6×5]

1. a) What is central force? Give an example. [2]
   b) Show that curl of a central force vanishes. [3]

2. a) A particle while moving with velocity $10\hat{i}+50\hat{j}$ unit bursts into two fragments. A fragment of mass 'm' shot out with a velocity of $20\hat{i}+50\hat{j}$ unit. What is the velocity of the other fragment of mass '$3m$'? [3]
   b) A rocket of man 50 kg and fuel 450 kg is projected vertically. The maximum velocity of gas ejection is 2 km/s. What is the rate of burning of fuel if the rocket is projected with initial acceleration of 20 m/s^2? [2]

3. An object of mass m initially at rest is dropped to the earth's surface from a height which is small compared to the earth's radius. Assuming that the angular speed of the earth about its axis is ω (constant). Prove that after time t the object will deflected towards east by an amount of $\frac{1}{3}\omega\, gt^3 \sin\lambda$, where λ is the colatitude of the place. [Hint: The equation of motion of a particle near earth's surface is given by $\frac{d\vec{r}}{dt} = \vec{g} - 2(\vec{\omega}\times\vec{v})$] [5]

4. a) What is angular momentum? Write the unit and dimension of angular momentum? [3]
   b) Define centre of mass of a rigid body. [2]

5. Find an expression for moment of inertia of a solid sphere rotating about any of its diameters. [5]

6. a) Show that under attractive inverse square force, the trajectory of the particle describes a conic section. [2]
   b) Show that the total energy of moon revolving around the earth is negative. [1]
   c) What is the time period of an artificial satellite revolving around the earth at a height h from the surface of the earth. [2]

7. a) What do you mean by gravitational field and gravitational potential? [2]
   b) State Gauss's theorem of gravitational field. [1]
   c) Using Gauss's theorem find the gravitational field inside and outside of a uniform solid sphere. [2]

8. a) Show that the total angular momentum of a system about the fixed or the reference point is the vector sum of angular momentum of centre of mass about that point and the angular momentum of the system about the centre of mass. [3]

b) Show that in centre of mass frame the particles move towards one another along the same straight line. [2]

9. a) State the law of conservation of angular momentum with two examples. [3]
   b) If the earth suddenly contract to half of its present radius, what would be the length of a day? [2]

10. a) Define moment of inertia and radius of gyration. Explain their physical significance. [3]
    b) Moment of inertia of a bigger solid about its diameter is I. 64 smaller equal spheres are made out of bigger sphere. What will be the moment of inertia of such smaller spheres about their diameters. [2]

Group-B

(Answer any four questions) [4×5]

11. How bright and dark rings are formed in Newton's ring experiment? Find the radius of the *n*-th dark ring. [2+1½+1½]

12. a) What are Zone plates? [2]
    b) Show that Zone plate behaves as a convex lens. [3]

13. a) What is resolving power of a grating? [2]
    b) What is Brewter's law? Prove it. [3]

14. a) What are retardation plates? [1]
    b) What are positive and negative crystals? [2]
    c) Why the light of longer wavelengths are focussed at nearer point in a Zone plate? [2]

15. a) What is specific rotation? Write the factors on which specific rotation depends. [1+2]
    b) A certain length of 5% solution causes an optical rotation of 20^0. How much length of 20% solution of the same substance will cause a rotation of 35^0? [2]

16. In a single slit Fraunhofer diffraction pattern find the condition of principal maxima and secondary minima. [1+2+2]

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