

RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. THIRD SEMESTER EXAMINATION, DECEMBER 2017

SECOND YEAR [BATCH 2016-19]

PHYSICS [General]

Paper : III

Date : 19/12/2017

Time : 11 am – 1 pm

Full Marks : 50

[Use a separate Answer Book for each Group]

Group – A

Answer **any six** questions; each carrying 5 marks:

[6 × 5]

1. Find the expression for velocity and acceleration for a particle in plane polar coordinates. 5
2. a) Deduce the equation of motion for the rocket moving in constant gravitational field by burning fuel at constant rate. 3
b) Integrate the equation of motion to determine the velocity of the rocket at any time. 2
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 acceleration terms arises. 2
b) Find the equation of motion for a particle to an observer on the earth's surface. Use suitable approximation to reduce the equation of motion. 3
4. Show that for a particle moving in a central force field
a) the orbit of the particle must be confined in a plane; 2
b) the total energy is a 'constant of motion'. 3
5. Calculate the gravitational potential and intensity at any point inside a solid sphere of mass 'M' and radius 'a'. What will be the gravitational intensity at any point outside the sphere? 4+1
6. a) What is the relation between angular momentum and torque on a particle? Find the condition for the conservation of angular momentum of a particle. 1+1
b) Define conservative and non-conservative forces. Give examples of conservative and non-conservative forces. 1+1+1
7. a) Show that the centre of mass of two particles is on the line joining them at a point whose distance from each particle is inversely proportional to the mass of that particle? 3
b) Two particles each of mass 2 kg are moving with velocities $2\hat{i} + 4\hat{j}$ m/s and $5\hat{i} + 6\hat{j}$ m/s respectively. Find the kinetic energy of the system relative to the centre of mass. 2
8. a) Reduce two body problem to one body problem and obtain equation of motion for equivalent one body problem for two masses. 3
b) A couple of 10 N-m is applied to a fly wheel of mass 10 kg and radius of gyration 0.5m. What is the resultant angular acceleration? 2

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| 9. | a) | State and prove the theorem of perpendicular axes for moment of inertia. | 3 |
| | b) | Determine the moment of inertia of a solid cylinder about the axis of cylindrical symmetry. | 2 |
| 10. | | Define gravitational self-energy. Calculate the gravitational self-energy of a sphere of mass 'M' and radius 'r'. | 1+4 |

Group – B

Answer **any four** questions; each carrying 5 marks: [4 × 5]

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| 11. | a) | What are the coherent sources of light? | |
| | b) | Calculate the necessary formula to find the wavelength of a monochromatic light using Newton's ring experiment. | 1+4 |
| 12. | a) | What is Fresnel's half period zone and how is it formed? | 1+2 |
| | b) | Write down two differences between Fresnel and Fraunhofer class diffraction. | 2 |
| 13. | | In a Fraunhofer diffraction at a single slit, find out the condition for principle maxima, secondary maxima and minima. | 5 |
| 14. | a) | What is the resolving power of an instrument? | 2 |
| | b) | What is Brewster's law? Also prove it. | 1+2 |
| 15. | a) | Define plane polarised and circularly polarised light. | 2 |
| | b) | What is double refraction? | 1 |
| | c) | Define positive crystal and negative crystal. | 1+1 |
| 16. | a) | How is quarter and half wave plate made? | 1½+1½ |
| | b) | Calculate the thickness of a quartz half wave plate for the line 6563Å for which the extraordinary and ordinary refractive index are $\mu_e = 1.55085$ and $\mu_o = 1.54184$. | 2 |

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