Gravitation

Very Short Answer Type Questions

1. Molecules in air in the atmosphere are attracted by gravitational force of the earth. Explain why all of them do not fall into the earth just like an apple falling from a tree.
2. Give one example each of central force and non-central force.
3. Draw areal velocity versus time graph for mars.
4. What is the direction of areal velocity of the earth around the sun?
5. How is the gravitational force between two point masses affected when they are dipped in water keeping the separation between them the same?
6. Is it possibe for a body to have inertia but no weight?
7. We can shield a charge from electric fields by putting it inside a hollow conductor. Can we shield a body from the gravitational influence of nearby matter by putting it inside a hollow sphere or by some other means?
8. An astronaut inside a small spaceship orbiting around the earth cannot detect gravity. If the space station orbiting around the earth has a large size, can he hope to detect gravity?
9. The gravitational force between a hollow spherical shell (of radius R and uniform density) and a point mass is F. Show the nature of F vs r graph where r is the distance of the point from the centre of the hollow spherical shell of uniform density.
10. Out of aphelion and perihelion, where is the speed of the earth more and why ?
11. What is the angle between the equatorial plane and the orbital plane of
    (a) Polar satellite?
    (b) Geostationary satellite?

Short Answer Type Questions

1. Mean solar day is the time interval between two successive noon when sun passes through zenith point (meridian).
2. Sidereal day is the time interval between two successive transit of a distant star through the zenith point (meridian).

3. By drawing appropriate diagram showing earth's spin and orbital motion, show that mean solar day is four minutes longer than the sidereal day. In other words, distant stars would rise 4 minutes early every successive day.
   (Hint: you may assume circular orbit for the earth).
4. Two identical heavy spheres are separated by a distance 10 times their radius. Will an object placed at the mid point of the line joining their centres be in stable equilibrium or unstable equilibrium? Give reason for your answer.
5. Show the nature of the following graph for a satellite orbiting the earth.
   - (a) KE vs orbital radius R
   - (b) PE vs orbital radius R
   - (c) TE vs orbital radius R.

6. Shown are several curves (Fig. 8.2). Explain with reason, which ones amongst them can be possible trajectories traced by a projectile (neglect air friction).

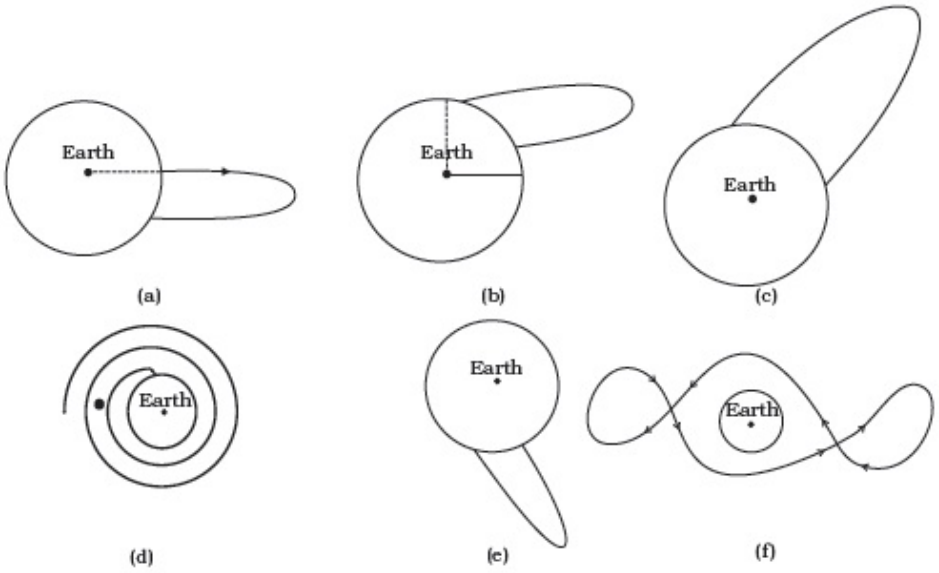

Fig. 8.2

7. An object of mass m is raised from the surface of the earth to a height equal to the radius of the earth, that is, taken from a distance R to 2R from the centre of the earth. What is

the gain in its potential energy?

8. A mass m is placed at P a distance h along the normal through the centre O of a thin circular ring of mass M and radius r (Fig. 8.3).

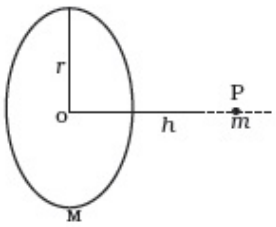

Fig. 8.3

9. If the mass is removed further away such that OP becomes 2h, by what factor the force of gravitation will decrease, if h = r ?

Long Answer Type Questions

1. A star like the sun has several bodies moving around it at different distances. Consider that all of them are moving in circular orbits. Let r be the distance of the body from the centre of the star and let its linear velocity be v, angular velocity ω, kinetic energy K, gravitational potential energy U, total energy E and angular momentum l. As the radius r of the orbit increases, determine which of the above quantities increase and which ones decrease.
2. Six point masses of mass m each are at the vertices of a regular hexagon of side l. Calculate the force on any of the masses.
3. A satellite is to be placed in equatorial geostationary orbit around earth for communication.
   - (a) Calculate height of such a satellite.
   - (b) Find out the minimum number of satellites that are needed to cover entire earth so that at least one satellites is visible from any point on the equator.
     [M = 6×10^{24} kg, R = 6400 km, T = 24h, G = 6.67×10^{-11} SI units]

4. Earth's orbit is an ellipse with eccentricity 0.0167. Thus, earth's distance from the sun and speed as it moves around the sun varies from day to day. This means that the length of the solar day is not constant through the year. Assume that earth's spin axis is normal to its orbital plane and find out the length of the shortest and the longest day. A day should be taken from noon to noon. Does this explain variation of length of the day during the year?
5. A satellite is in an elliptic orbit around the earth with aphelion of 6R and perihelion of 2 R where R= 6400 km is the radius of the earth. Find eccentricity of the orbit. Find the velocity of the satellite at apogee and perigee. What should be done if this satellite has to be transferred to a circular orbit of radius 6R ?
   [G = 6.67×10^{-11} SI units and M = 6×10^{24} kg]