Chapter- 8

Gravitation

01. Why do planets move slower along their orbits when they are farthest from the sun (at apogee) and faster when nearest (at perigee) from the sun?

02. According to Kepler's second law, the radius vector to a planet from the sun sweeps out equal areas in equal intervals of time. This law is a consequence of which conservation law?

03. If the earth is at one half its present distances from the sun, how many days will be there in a year?

04. If the density of the planet is doubled without any change in its radius, how does 'g' change on the planet?

05. On earth, value of G = 6.67 x 10^{-11} Nm^2 kg^{-2}. What is its value on the moon, where g is nearly one-sixth than that of the earth?

06. Draw the graph showing the variation of acceleration due to gravity 'g' with distance from the centre of the earth.

07. Why does a body weigh more at poles than at equator?

08. why does earth impart the same acceleration to all the bodies?

09. Define Gravitational field intensity. Is it scalar or vector?

10. Prove that gravitational force obeys Newton's 3rd law of motion.

11. Show that Kepler's second law follows from the law of conservation of angular momentum.

12. At what depth below the surface of the earth does the acceleration due to gravity become 1% of its value at the surface of the earth? Earth considered as the sphere of radius $6.4\times10^{6}m$.

13. What is meant by the acceleration due to gravity? Derive an expression for it in terms of the mass of the earth and the gravitational constant.

14. Show that the value of acceleration due to gravity decreases with the altitude.

15. Define acceleration due to gravity. Show that gravity decreases with depth.

16. If the change in the value of g at the height h above the surface of the earth is the same as at a depth d below it, both d and h being much smaller than the radius of the earth, find the relation between d and h.

17. A satellite is orbiting the earth with speed v_0. To make the satellite escape, what should be the minimum percentage increase in velocity?

18. Derive the expression for orbital velocity. Find its value for the satellite which is orbiting close to the earth surface.

19. Derive the expression for the time of revolution for satellite. Find out the time of revolution of the satellite which is revolving close to the surface of the earth.

20. Derive the expression for the total energy of satellite while revolving around the planet. What is the importance of -ve potential energy? Draw the graph showing the variation of the kinetic, potential and total energy of a satellite with distance from the centre of the planet.

21.Derive the expressions for

(i) escape speed (ii) find out the escape speed (a) earth (b) on the moon

(iii) why the earth has an atmosphere whereas the moon has no atmosphere?

22. What do you mean by a satellite? What is a geostationary satellite? What are the three conditions which must be met by a satellite to be a geostationary satellite?

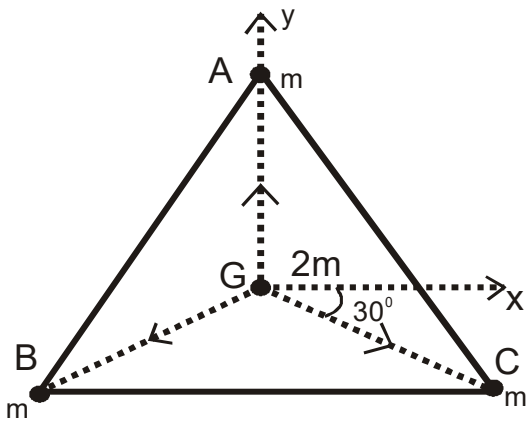
23. (a) Suppose the gravitational force varies inversely as the n^{th} power of distance. Then, find the expression for the period of a planet in a circular orbit of radius 'r' around the sun.

(b)Find the potential energy of the system of four particles each of mass's' placed at vertices of a square of side 'l'. Also, find the potential at the centre of the square.

24. (i) Three equal masses of m kg each are fixed at the vertices of an equilateral triangle ABC.

(a) What is the force acting on a mass 2 m placed at the centroid G of the triangle?

(b) What is the force if the mass at the vertex A is doubled?



25. Define gravitational potential energy. Derive an expression for it. Hence find the relation between gravitational potential and potential energy.

26. Calculate the period of revolution of Neptune around the sun, given that diameter of its orbit, is 30 times the diameter of earth's orbit around the sun, both orbits being assumed to be circular.

27. The planet Mars has two moons, Phobos and Deimos.

(i) Phobos has a period of 7 hours, 39 minutes and an orbital radius of 9.4×10^{3}km . Calculate the mass of Mars.

(ii) Assume that earth and Mars move in circular orbits around the Sun, with the Martian orbit being 1.52 times the orbital radius of the Earth. What is the length of the Martian year in days?

28. The distances of two planets from the sun are 10^{13} m and 10^{12} m respectively. Find the ratio of periods and speeds of the two planets.

29. The planet Neptune travels around the sun with a period of 165 years. Show that the radius of its orbit is approximately 30 times that of earth's orbit, both being considered as circular.

30. A geostationary satellite is orbiting the earth at a height 6R above the surface of the earth, where R is the radius of the earth. Find the period of another satellite at a height of 2.5 R from the surface of the earth in hours.

31. A mass M is broken into two parts of masses m_1 and m_2. How are m_1 and m_2 related so that force of gravitational attraction between the two parts is maximum?

32. The mean orbital radius of the earth around the sun is 1.5×10^{8} km. Calculate the mass of the sun if $G=6.67\times10^{-11}Nm^{2}kg^{-2}$.

33. Aspherical mass of 20 kg lying on the surface of the earth is attracted by another spherical mass of 150 kg with a force equal to the weight of 0.25 mg. The centres of the two masses are 30 cm apart. Calculate the mass of the earth. The radius of the earth = 6×10^{6}m

34. Assuming the earth to be a uniform sphere of radius 6400 km and density 5.5 g cm^{-3}, find the value of g on its surface. Given $G=6.66\times10^{-11}Nm^{2}kg^{-2}$

35. The value of g on the surface of the earth is 9.81 ms^{-2}. Find its value on the surface of the moon. Given the mass of earth = 6.4×10^{24}kg, a radius of the earth $=6.4\times10^{6}$m, a mass of moon = $=6.4\times10^{22}$kg, a radius of moon = 1.76×10^{6}m.

36. At what height above the earth's surface, the value of g is the same as in a mine 80 km deep?

37. At what height above the earth's surface, the value of g is half of its value on the earth's surface? Given its radius is 6400 km.

38. Find the value of g at a depth of 640 km from the surface of the earth. Given the radius of the earth. R = 6400 km and the value of g on the surface of the earth is 9.8 ms^{-2}.

39. Calculate the depth below the surface of the earth where the acceleration due to gravity becomes half of its value at the surface of the earth. The radius of the earth = 6400 km.

40. How much below the surface of the earth does the acceleration due to gravity become 70% of its value at the surface of the earth? The radius of the earth is 6400km.

41. The radius of the earth is 6000 km. What will be the weight of a 120 kg body if it is taken to a height of 2000 km above the surface of the earth.

42. Two bodies of masses 10 kg and 1000 kg are at a distance 1 m apart. At which point on the line joining them will the gravitational field intensity be zero?

.43. Find the potential energy of a system of four particles placed at the vertices of a square of side L. Find the potential at the Centre of the square.

44. The gravitational field intensity at a point 10,000 km from the centre of the earth is $4.8 Nkg^{-1}$. Calculate the gravitational potential at that point.

45. Find the work done to bring 4 particles each of mass 100 gram from large distances to the vertices of a square of side 20 cm.

46. Calculate the escape velocity for an atmospheric particle 1600 km above the earth's surface, given that the radius of the earth is 6400 km and acceleration due to gravity on the surface of the earth is $9.8 ms^{-2}$.

47. Find the velocity of escape at the moon. Given that its radius is $1.7 \times 10^{6} m$ and the value of g is $1.63 ms^{-2}$.

48. The mass of Jupiter is $1.90 \times 10^{36} kg$ and its diameter is $13.1 \times 10^{7} m$. Calculate the escape velocity on the surface of Jupiter.

49. If the earth has a mass 9 times and radius twice that of a planet mars, calculate the minimum velocity required by a rocket to pull out of gravitational force of Mars. Take the escape velocity on the surface of the earth to be $11.2 kms^{-1}$.

50. Find the velocity of escape from the sun, if its mass is $1.89 \times 10^{30} kg$ and its distance from the earth is $1.58 \times 10^{8} km$. Take $G = 6.67 \times 10^{-11} Nm^{2} kg^{-2}$.

51. A 200 kg satellite is in a circular orbit of radius R_E about the earth. How much energy is required to transfer it to a circular orbit of radius $4R_E$? What are the changes in the kinetic and potential energies?

52. A rocket is launched vertically from the surface of the earth with an initial velocity of $10 kms^{-1}$. How far above the surface of the earth would it go? The radius of the earth = 6400 km and $g = 9.8 ms^{-2}$.

53. A satellite of mass 250 kg is orbiting the earth at a height of 500 km above the surface of the earth. How much energy must be expended to rocket the satellite out of the gravitational influence of the earth? Given the mass of the earth = $6.0 \times 10^{24} kg$, $G = 6.67 \times 10^{-11} Nm^{2} kg^{-2}$.

54. A satellite orbits the earth at a height of 400 km from its surface. Compute its (i) kinetic energy, (ii) potential energy, and (iii) total energy. Mass of the satellite = 500 kg. Mass of the earth = 6.0×10^{24} kg , a radius of the earth = 6.4×10^{6} m, $G=6.67\times10^{-11}Nm^2kg^{-2}$.

MODEL QUESTIONS

Very Short Answer Type Questions (each question 1 mark)

01. Write the Dimensional formula for universal gravitational constant.

02. What is the relation between orbital and escape velocities?

Short Answer Type Questions (each question 2 marks)

03. For a satellite, escape velocity is 11 km s^{-1}. If the satellite is launched at an angle of 60^0 with the vertical, what will be the escape velocity?

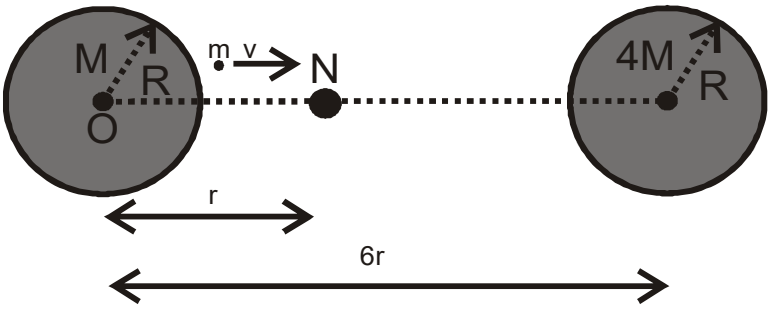
04. Why does hydrogen escape faster from earth's atmosphere than oxygen?

05. What do you understand by a geostationary satellite? Derive an expression for its height above the surface of the earth.

06. What are the necessary conditions for a satellite to appear stationary?

Long Answer Type Questions ***(each question 5 marks)***

07. Two uniform solid spheres of equal radii R, but mass M and 4M have a centre to centre separation 6R, as shown. The two spheres are held fixed. A projectile of mass m is projected from the surface of the sphere of mass M directly towards the centre of the second sphere. Obtain an expression for the minimum speed v of the projectile so that it reaches the surface of the second sphere.



08. Given: g = 9.81 ms^{-2}, R_E = 6.37 x 10^6 m, the distance to the moon R = 3.84 x 10^8 m and the time period of the moon's revolution is 27.3 days. Obtain the mass of the Earth M_E in two different ways.
