

CH: 6 GRAVITATION

1. Two objects of equal masses placed at certain distance from each other attracts each other with a force of F . If one-third mass of one object is transferred to the other object, then the new force will be:
(a) $2/9 F$ (b) $16/9 F$ (c) $8/9 F$ (d) F
2. 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 $2m$ placed at the centroid G of the triangle?
(b) What is the force if the mass at the vertex A is doubled? Take $AG=BG=CG=1m$.
3. Obtain an expression for the acceleration due to gravity on the surface of the earth in terms of mass of the earth and its radius.
4. Derive the expression for the variation of 'g' with height from the surface of the earth.
5. Derive the expression for the variation of 'g' at a depth d from the surface of the earth.
6. Draw a graph showing the variation of acceleration due to gravity g with distance r from the centre of the earth.
7. What is the relation between height h and depth d for the same change in g , near the earth surface?
8. Derive the expression for the variation of 'g' on the surface of the earth due to axial rotation of the earth.
9. The height at which the acceleration due to gravity becomes $g/9$ is
(a) $2R$ (b) $R/\sqrt{2}$ (c) $R/2$ (d) $\sqrt{2} R$
10. At what height the acceleration due to gravity will be reduced by 36 % its value 'g' the surface of the earth? Radius of the earth =6400 km.
ANS= 1600km
11. Assuming the earth to be a sphere of uniform mass density, how much would a body weigh half way down to the centre of the earth if it weighed 250 N on the surface?
ANS= 125N
12. A body weighs 63 N on the surface of the earth. What is the gravitational force on it due to the earth at a height equal to half the radius of the earth?
ANS= 28N
13. A planet has twice the mass of earth and of identical size. What will be the height above the surface of the planet where its acceleration due to gravity reduces by 36% of its value on its surface?
ANS= 1600km
14. At what height, the value of 'g' is half that on the surface of the earth of radius R ?
ANS= 0.414R
15. Find the percentage decrease in the weight of the body when taken to a height of 16 km above the surface of Earth. Radius of the Earth is 6400 km.
ANS= 0.5%
16. A body hanging from a spring stretches it by 1 cm at the earth's surface. How much will the same body stretch the spring at a place 16400km above the earth's surface.? (Radius of the earth =6400km)
ANS= 0.64 cm
17. At what height above the surface of the earth will the acceleration due to gravity be 25% of its on the surface of the earth? Radius of the earth =6400 km.

18. Find the acceleration due to gravity at a height of 400 km above the surface of the earth. Given radius of earth=6400 km and acceleration due to gravity at the surface of the earth is 10 m/s^2 .
19. How far away from the surface of earth does the value of g is reduced to 4% of its value on the surface of the earth Given radius of earth = 6400 km.
ANS= 25,600 km
20. Find the percentage decrease in the weight of the body when taken to a depth of 32 km below the surface of earth. Radius of the earth is 6400km.
ANS= 0.5%
21. How much below the earth's surface of the earth does the acceleration due to gravity become 1% of its value at the earth's surface?
ANS= 6336 km
22. At what height above the earth's surface the value of g is same as in a mine 80km deep?
ANS= 40 km
23. How much below the surface of the earth does the acceleration due to gravity become 70% of its value at the surface of earth? (Take $R=6400\text{km}$)
ANS= 1920 km
24. How much below the surface of the earth does the acceleration due to gravity. (i) Reduces to 36% (ii) Reduce by 36% of its value on the surface of earth? (Take $R_e=6400\text{km}$)
ANS= (i) 4096 km (ii) 2304 km
25. Derive an expression for the gravitational potential energy of a body of m located at distance r from the centre of the earth.
26. Define the term gravitational potential. Give the units and dimension of gravitational potential.
27. Two bodies of mass 10 kg and 1000 kg are separated by a distance of 1 m. At what distance a mass of 1 kg should be placed between two masses so that it experiences no net gravitational attraction?
ANS= 1/11 m.
28. Three mass points each of mass m are placed at the vertices of an equilateral triangle of side l . What is the gravitational field and potential at the centroid of the triangle.
29. Find the gravitational potential energy of a system of four particles, each having mass m , placed at the vertices of a square of side l at the centre of the square. Also obtain the potential at the centre of the square.
30. Two bodies of masses m and $4m$ are placed at a distance r . Find the gravitational potential at a point on the line joining them where the gravitational field is zero.
31. Define escape velocity. Obtain an expression for the escape velocity of a body from the surface of the earth.
32. If the earth has a mass nine times and radius twice that of the planet Mars, calculate the maximum speed required by a rocket to pull out of the gravitational force of Mars. Given escape speed on the surface of Earth is 11.2 kms
ANS= 5.28 km/s
33. The escape speed of a projectile on the earth's surface is 11.2 km s^{-1} . A body is projected out with thrice this speed. What is the speed of the body far away from the earth? Ignore the presence of the sun and other planets.
ANS= 31.68 km/s
34. Define orbital velocity of a satellite. Derive expressions for the orbital velocity of a satellite. Show that the escape velocity of a body from the earth's surface is $\sqrt{2}$ times its velocity in a circular orbit just above the earth's surface.
35. Derive expressions for time period, height and angular momentum of satellite.
36. What are geostationary satellites? Necessary conditions for a geostationary satellite.

- 37.** What are polar satellites? Give some of their uses.
- 38.** Derive an expression for the total energy of a satellite orbiting the earth. What is the significance of negative total energy?
- 39.** State and explain the Kepler's laws of planetary motion.
- 40.** A geostationary satellite is orbiting the earth at a height $6R$ above the earth's surface, where R is radius of earth. Find the time period of another satellite at a height $2.5R$ from earth's surface.
- 41.** The time period of a satellite of earth is 5 hours. If the separation between the earth and the satellite is increased to 4 times the previous value, find the new time period of satellite.