CLASS – 11

WORKSHEET- GRAVITATION

(1 mark questions)

1. Kepler's second law is a consequence of
   (a) conservation of energy (b) conservation of linear momentum
   (c) conservation of angular momentum (d) conservation of mass

2. When will the Kepler's law be applicable on the planets?

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   _____

3. What would be the weight of the body inside the earth if it were a hollow sphere?

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   _____

4. Is it possible to shield a body from gravitational effects?

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   _____

5. Why does the weight of a body become zero at the centre of the earth?

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   _____

6. The orbit of satellite is
   (a) circular (b) elliptic (c) helical (d) both (a) and (b)

7. A satellite of small mass burns during its descent and not during ascent. Why?

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8. Why are space rockets usually launched from west to east in the equatorial plane?

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9. Two satellites are at different heights. Which would have greater velocity?

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10. What is parking orbit?

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11. The height of a geostationary satellite is
(a) 1000 km (b) 32000 km (c) 36000 km (d) 850 km

12. Weightlessness in satellite is due to
(a) zero gravitational acceleration (b) zero acceleration
(c) zero mass (d) none of these

13. The mass and diameter of the planet are twice those of the earth. What will be the time period of the pendulum on this planet, which is a second's pendulum on the earth?
[Ans.$2\sqrt{2}$s]

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14. Why do different planets have different escape velocities?

15. The artificial satellite does not have any fuel, but even it remains in its orbit around the earth. Why?

16. What are the dimensions of gravitational constant?

17. A satellite revolves close to the surface of a planet. How is its orbital velocity related with velocity of escape from that planet?

18. What is (i) period of revolution and (ii) sense of rotation of a geostationary satellite?

19. If the change in the value of 'g' at a height 'h' above the surface of the earth is same as that at a depth 'x' below it (both x and h being much smaller than the radius of earth), then how are x and h related to each other?

20. If the radius of the earth shrinks by 1%, its mass remaining the same by what percentage will the acceleration due to gravity on its surface change?

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21. What is weightlessness?

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22. What are the time period and height of a geostationary satellite above the surface of the earth?

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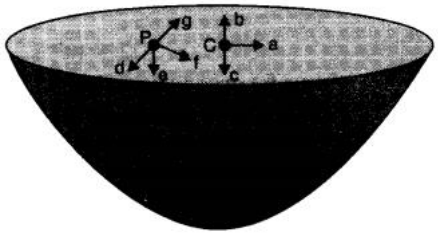
23. Choose the correct alternative:
(a) If the zero of potential energy is at infinity, the total energy of an orbiting satellite is negative of its kinetic/potential energy.
(b) The energy required to launch an orbiting satellite out of Earth's gravitational influence is more/less than the energy required to project a stationary object at the same height (as the satellite) out of Earth's influence.

24. The escape speed of a body from the Earth depend on
(a) the mass of the body, (b) the location from where it is projected,
(c) the direction of projection,
(d) the height of the location from where the body is launched?

25. Which of the following symptoms is likely to afflict an astronaut in space
(a) swollen feet (b) swollen face (c) headache (d) orientational problem.

26. In the following exercise, choose the correct answer from among the given ones: The gravitational intensity at the centre of a hemispherical shell of uniform mass density has the direction indicated by the arrow (see Fig.)
(i) a (ii) b (iii) c (iv) 0.



27. For the above problem, the direction of the gravitational intensity at an arbitrary point P is indicated by the arrow
(i) d (ii) e (iii) f (iv) g.

(2 marks Qs)

28. What is the direction of a real velocity of the earth around the sun?

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29. Two bodies of masses 4kg and 9kg are separated by a distance of 60cm. A 1kg mass is placed in between these two masses. What is its distance from 4kg mass, if the net force on 1kg is zero?

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30. The escape speed of a projectile on the earth's surface is 11.2 km/s. 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.

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

32. A person sitting in a satellite of Earth feels weightlessness but a person standing on Moon has weight though Moon is also a satellite of Earth. Why?

33. Calculate the force of attraction between two balls each of mass 1kg, when their centres are 10cm apart. Given $G = 6.67\times10^{-11}\ Nm^2\ kg^{-2}$. [Ans. 6.67×10^{-9} N]

34. The acceleration due to gravity at the moon's surface is 1.67 ms^{-2}. If the radius of the moon is 1.74×10^{6}m, calculate the mass of the moon. Use the known value of G.
[Ans. 7.58×10^{22} kg]

35. Determine the escape velocity of a body from the moon. Take the moon to be uniform sphere of radius 1.76×10^{6}m, and mass 7.36×10^{22}kg. Given $G = 6.67\times10^{-11}\ Nm^2\ kg^{-2}$. [Ans. 2.375 km s^{-1}]

36. Prove that acceleration due to gravity on the surface of the earth is given by $g = 4/3\ \pi \rho GR$, where G is gravitational constant, ρ is mean density and R is the radius of the earth.

37. Why is the weight of the body at the poles more than the weight at the equator? Explain.

38. A geo-stationary satellite orbits around the earth in a circular orbit of radius 36,000km. Then what will be the time period of a spy satellite orbiting a few hundred km above the earth's surface (R_{earth} = 6,400km)? [Ans. 2h]

39. State Newton's law of gravitation. Hence define universal gravitational constant. Give the value and dimensions of G.

40. Define acceleration due to gravity. Show that the value of 'g' decreases with altitude or height.

41. Suppose there existed a planet that went around the Sun twice as fast as the Earth. What would be its orbital size as compared to that of the Earth? [Ans. 0.63 AU]

42. I_o, one of the satellites of Jupiter, has an orbital period of 1.769 days and the radius of the orbit is 4.22×10^8 m. Show that the mass of Jupiter is about one-thousandth that of the Sun.

43. A comet orbits the Sun in a highly elliptical orbit. Does the comet have a constant (a) linear speed (b) angular speed (c) angular momentum (d) kinetic energy (e) potential energy (f) total energy throughout its orbit? Neglect any mass loss of the comet when it comes very close to the Sun.

44. A Saturn year is 29.5 times the Earth year. How far is the Saturn from the Sun if the Earth is 1.50×10^8 km away from the Sun? [Ans. 14.32×10^8 km]

45. 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]

46. 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]

(3 marks Qs)

47. State and explain the Kepler's laws of planetary motion.

48. A rocket is fired from the earth towards the sun. At what distance from the earth's centre is the gravitational force on the rocket zero? Mass of the sun = 2×10^{30} kg, mass of the earth = 6×10^{24} kg. Neglect the effect of other planets etc. (orbital radius = 1.5×10^{11} m).

49. How much above the earth surface does the acceleration due to gravity reduces by 36% if its value on the earth surface? Take the value of radius of earth 6400km.

50. Two identical heavy spheres are separated by a distance 10 times their radii. Determine the potential at the midpoint. Is an object placed at that point in stable or unstable equilibrium?

51. Define escape velocity. Derive and expression for the escape velocity of a body from the surface of the earth. Write any two significant features of this velocity.

52. Two mean orbital radius of the earth around the sun is 1.5×10^{8} km. Calculate the mass of the sun if $G = 6.67\times10^{-11}\ Nm^2\ kg^{-2}$. [Ans. 2.01×10^{30}kg]

53. If the earth were made of lead of relative density 11.3, what then would be the value of acceleration due to gravity on the surface of the earth? Radius of the earth = 6.4×10^{6}m and G = 6.67×10^{-11} Nm^2 kg^{-2}. [Ans. 22.21 m/s^2]

54. If the radius of the earth shrinks by 2.0%, mass remaining constant, then how would the value of acceleration due to gravity change?

55. A body weighs 90kg f on the surface of the earth. How much will it weight on the surface of Mars whose mass is 1/9 and the radius is ½ of that of the earth? [Ans. 40 kg f]

56. Determine the speed with which the earth would have to rotate on its axis so that a person on the equator would weigh $3/5^{th}$ as much as a t present. Take the equatorial radius as 6400 km. [Ans. 7.8×10^{-4} rad s^{-1}]

57. Two bodies of mass 10kg and 1000kg are at a distance 1m apart. At which point on the line joining them will the gravitational field intensity be zero? [Ans. 1/11m]

58. Two masses, 800kg and 600kg are at a distance 0.25m apart. Compute the magnitude of the intensity of the gravitational field at a point distant 0.20m from the 800kg mass and 0.15m from the 600kg mass. [Ans. 2.22×10^{-6}N]

59. Find the potential energy of a system of four particles, each of mass m, placed at the vertices of a square of side 1. Also obtain the potential at the centre of the square.

60. An earth's satellite makes a circle around the earth in 90 minutes. Calculate the height of the satellite above the earth's surface. Given radius of the earth is 6400 km and g = 980 cms^{-2}. [Ans. 268km]

61. Define the term orbital speed, Establish a relation for orbital speed of a satellite orbiting very close to the surface of the earth. Find the ratio of this orbital speed and escape speed.

62. State and explain Kepler's laws of planetary motion. Name the physical quantities which remain constant during the planetary motion.

63. (a) According to Kepler's second law, the radius vector to a planet from the sun sweeps out equal areas in equal interval and time. The law is consequence of which conservation law.
(b) State Kepler's third law.

64. Let us assume that our galaxy consists of 2.5 x 10^{11} stars each of one solar mass. How long will a star at a distance of 50,000 ly from the galactic centre take to complete one revolution? Take the diameter of the Milky way to be 10^5 ly. [Ans. 3.54×10^8 years]

65. A rocket is fired from the earth towards the sun. At what distance from the earth's centre is the gravitational force on the rocket zero? Mass of the sun = 2×10^{30} kg, mass of the earth = 6×10^{24} kg. Neglect the effect of other planets etc. (orbital radius = 1.5×10^{11} m).
[Ans. 2.59×10^{8} m]

66. How will you 'weigh the sun', that is, estimate its mass? The mean orbital radius of the earth around the sun is 1.5×10^{8} km. [Ans. 2.0×10^{30} kg]

67. A rocket is fired vertically with a speed of 5 km s^{-1} from the earth's surface. How far from the earth does the rocket go before returning to the earth? Mass of the earth = 6.0×10^{24} kg; mean radius of the earth = 6.4×10^{6} m; G = 6.67×10^{-11} N m^2 kg^{-2}.
[Ans. 1.6×10^{6} m]

68. 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. 31.7 km s^{-1}]

69. A satellite orbits the earth at a height of 400 km above the surface. How much energy must be expended to rocket the satellite out of the earth's gravitational influence? Mass of the satellite = 200 kg; mass of the earth = 6.0 x 10^{24} kg; radius of the earth = 6.4 × 10^{6} m; G = 6.67 × 10^{-11} N m^2 kg^{-2}. [Ans. 5.9×10^{9}J]

70. Two stars each of one solar mass (=2 x 10^{30} kg) are approaching each other for a head on collision. When they are at a distance 10^{9} km, their speeds are negligible. What is the speed with which they collide? The radius of each star is 10^{4} km. Assume the stars to remain undistorted until they collide. (Use the known value of G). [Ans. 2.6 × 10^{6} ms^{-1}]

71. Two heavy spheres each of mass 100 kg and radius 0.10 mare placed 1.0 m apart on a horizontal table. What is the gravitational field and potential at the mid point of the line joining the centres of the spheres? Is an object placed at that point in equilibrium? If so, is the equilibrium stable or unstable? [Ans. 2.668×10^{-8}J kg^{-1}]

72. As you have learnt in the text, a geostationary satellite orbits the Earth at a height of nearly 36,000 km from the surface of the Earth. What is the potential due to Earth's gravity at the site of this satellite? (Take the potential energy at infinity to be zero). Mass of the Earth = 6.0×10^{24} kg, radius = 6400 km.) [Ans. 9.44×10^6 J kg^{-1}]

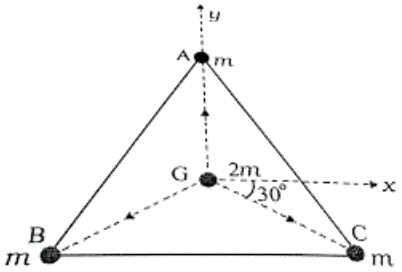
73. A star 2.5 times the mass of the sun and collapsed to a size of 12 km rotates with a speed of 1.2 rev. per second. (Extremely compact stars of this kind are known as neutron stars. Certain stellar objects called pulsars belong to this category). Will an object placed on its equator remain stuck to its surface due to gravity? (mass of the sun = 2×10^{30} kg).
[Ans. $1.065 \times 10^6 ms^{-2}$]

74. A spaceship is stationed on Mars. How much energy must be expended on the spaceship to rocket it out of the solar system? Mass of the spaceship = 1000 kg, Mass of the Sun = 2×10^{30} kg. Mass of the Mars = 6.4×10^{23} kg, Radius of Mars = 3395 km. Radius of the orbit of Mars = 2.28×10^{11} m, G = 6.67×10^{-11} N m^2 kg^{-2}. [Ans. 2.9×10^{11} J]

75. A rocket is fired 'vertically' from the surface of Mars with a speed of 2 km s-1. If 20% of its initial energy is lost due to Martian atmospheric resistance, how far will the rocket go from the surface of mars before returning to it? Mass of Mars = 6.4 x 10^{23} kg; radius of Mars = 3395 km; G = 6.67 x 10^{-11} N m^2 kg^{-2}. [Ans. 1655 km]

(5 marks Qs)

76. Three equal mass of m kg each are fixed at the vertices of an equilateral triangle ABC as shown in figure.

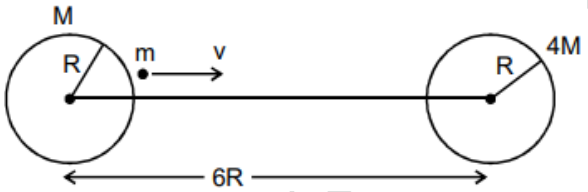


(a) What is the force acting on a mass 2m placed at the centroid G of the triangle?
(b) What is the force if the mass at the vertex A is doubled?
Take AG = BG = CG = 1cm.

77. (a) Derive an expression showing variation of acceleration due to gravity with height.
(b) (i) A body weighs 6.3N on the surface of the earth. What is the geometrical force on it due to the earth at a height equal to half the radius of the earth?
(ii) 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 250N on the surface?

78. Calculate the speed v with which a projectile should be launched from the surface of Earth so as to reach a height equal to one fourth of Earth's radius, R.

79. Two uniform solid spheres of equal radii R , but mass M and 4M have a centre to centre separation 6R, as shown in the figure. 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.



80. (a) Define Orbital Velocity and establish an expression for it.
(b) Calculate the value of orbital velocity for an artificial satellite of earth orbiting at a height of 1000 km.

Given: Mass of earth = 6×10^{24} kg, Radius of earth = 6400 km

81. Answer the following:
(a) You can shield a charge from electrical forces by putting it inside a hollow conductor. Can you shield a body from the gravitational influence of nearby matter by putting it inside a hollow sphere or by some other means?
(b) 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?
(c) If you compare the gravitational force on the Earth due to the Sun to that due to the Moon, you would find that the Sun's pull is greater than the Moon's pull. (You can check this yourself using the data available in the succeeding exercises). However, the tidal effect of the Moon's pull is greater than the tidal effect of Sun. Why?