CBSE

GRAVITATION WS 4

Class 11 - Physics

Section A

1. A planet has twice the density of earth but the acceleration due to gravity on its surface is exactly the same as on the surface of earth. Its radius in terms of radius of earth R will be **[1]**

   a) $\frac{R}{2}$ b) $\frac{R}{4}$

   c) $\frac{R}{8}$ d) $\frac{R}{3}$

2. The acceleration due to gravity at a depth d in terms of g(acceleration due to gravity) at radius of the earth R_E is **[1]**

   a) $g(d) = g(1 - \frac{2d}{R_E})$ b) $g(d) = g(1 - \frac{d}{R_E})$

   c) $g(d) = g(1 + \frac{d}{R_E})$ d) $g(d) = g(1 + \frac{d}{2R_E})$

3. Two spheres of same size, one of mass 2 kg and another of mass 4 kg are dropped simultaneously from the top of Qutab Minar (height = 72 km). When they are 1 m above the ground, the two spheres have the same: **[1]**

   a) potential energy b) momentum

   c) kinetic energy d) acceleration

4. If the mass of the earth is doubled and its radius halved, then new acceleration due to the gravity g' is **[1]**

   a) g'= 16g b) g '= 4 g

   c) g' = g d) g' = 8g

5. The radius of earth is about 6400 km and that of mars is 3200 km. The mass of the earth is about 10 times mass of mars. An object weighs 200 N on the surface of earth. Its weight on the surface of mars will be: **[1]**

   a) 40 N b) 80 N

   c) 8 N d) 20 N

6. The reading of a spring balance corresponds to 100 N while situated at the north pole and a body is kept on it. The weight recorded on the same scale if it is shifted to the equator (take, g = 10m/s^2 and radius of the earth, R = 6.4 $\times$ 10^{3}m) is: **[1]**

   a) 106 N b) 97.66 N

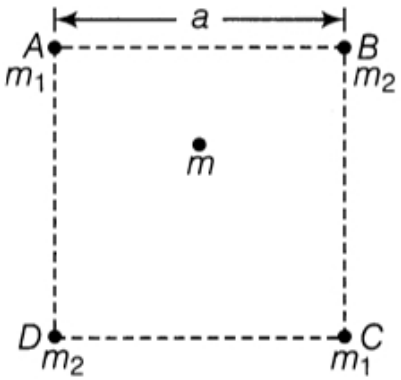
   c) 110 N d) 99.66 N

7. If g is the acceleration due to gravity at the surface of the earth. The force acting on the particle of mass m placed at the surface is **[1]**

   a) Both mg and $\frac{GmM_e}{R_e^2}$ b) Data insufficient

   c) $\frac{GmM_e}{R_e^2}$ d) mg

8. A point mass m is placed at the centre of the square ABCD of side a units as shown below. **[1]**



The resultant gravitational force on mass m due to masses m_1 and m_2 placed on the vertices of square is

a) $\frac{Gm(m_1+m_2)}{(a\sqrt{2})^2}$

b) $\frac{2Gm(m_1+m_2)}{a^2}$

c) $\frac{Gm_1m_2}{(a\sqrt{2})^2}$

d) zero

9. There are two bodies of masses 1 kg and 100 kg separated by a distance 1 m. At what distance from the smaller body, the intensity of gravitational field will be zero? **[1]**

a) $\frac{10}{11}m$

b) $\frac{1}{9}m$

c) $\frac{1}{11}m$

d) $\frac{1}{10}m$

10. If the earth loses its gravity, then for a body: **[1]**

a) neither mass nor weight is zero

b) mass becomes zero but not weight

c) both mass and weight are zero

d) weight becomes zero, but not the mass

11. **Assertion (A):** If the earth suddenly stops rotating about its axis, then the value of acceleration due to gravity will become the same at all the places. **[1]**

Reason (R): The value of acceleration due to gravity is independent of the rotation of the earth.

a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

12. **Assertion:** Earth is continuously pulling moon towards its centre but moon does not fall to earth. **[1]**

Reason: Attraction of sun on moon is greater than that of earth on moon.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

13. **Assertion:** A person feels weightlessness in an artificial satellite of the earth. However a person on the moon (natural satellite) feels his weight. **[1]**

Reason: Satellite (natural or artificial) of a planet is a freely falling body.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is

d) Assertion is wrong statement but reason is

wrong statement. correct statement.

14. **Assertion:** The acceleration due to gravity near the: earth surface differs slightly from the $\frac{GM}{r^2}$ where M = mass of earth and R = radius of earth. **[1]**

Reason: The earth is not a uniform sphere and earth rotates about its axis.

a) Assertion and reason both are correct statements and reason is correct explanation for assertion.

b) Assertion and reason both are correct statements but reason is not correct explanation for assertion.

c) Assertion is correct statement but reason is wrong statement.

d) Assertion is wrong statement but reason is correct statement.

15. **Assertion (A):** The difference in the value of acceleration due to gravity at pole and equator is proportional to square of angular velocity of earth. **[1]**

Reason (R): The value of acceleration due to gravity is minimum at the equator and maximum at the pole.

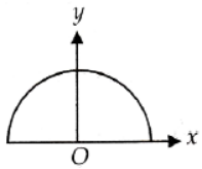
a) Both A and R are true and R is the correct explanation of A.

b) Both A and R are true but R is not the correct explanation of A.

c) A is true but R is false.

d) A is false but R is true.

16. A wire of length l and mass m is bent in the form of a semicircle. The gravitational field intensity at the centre of semicircle is: **[1]**



a) $\frac{2\pi Gm}{l^2}$ along x-axis

b) $\frac{Gm}{\pi l}$ along x-axis

c) $\frac{2\pi Gm}{l^2}$ along y-axis

d) $\frac{Gm}{\pi l}$ along y-axis

17. Why does one feel giddy while moving on a merry round? **[1]**

18. When dropped from the same height a body reaches the ground quicker at poles than at the equator. Why? **[1]**

19. Does the acceleration with which a body falls towards the centre of the earth depend on mass of the body? **[1]**

20. Moon-travellers tie heavyweight at their back before landing on the moon. Why? **[1]**

21. If a man goes from the surface of the earth to a height equal to the radius of the earth, then what will be his weight relative to that on the earth? What if he goes equally below the surface of the earth? **[1]**

22. Why a body weighs more at the poles than at the equator? **[1]**

23. If the radii of two planets be R_1 and R_2 and their mean densities be ρ_1 and ρ_2, then prove that the ratio of accelerations due to gravity on the planets will be $R_1\rho_1 : R_2\rho_2$. **[1]**

24. Which is more fundamental-mass or weight of a body? **[1]**

25. On what factors does the value of g depend? **[1]**

26. What are the values of g and G at the centre of the earth? **[1]**

Section B

27. Two bodies of masses 100 kg and 1000 kg are at a distance 1.00 metre apart. Calculate the gravitational field intensity and the potential at the middle-point of the line joining them. Take G = 6.67×10^{-11} Nm^2 kg^{-2}. **[2]**

28. Why does the earth impart the same acceleration to all bodies? **[2]**

29. An apple of mass 0.25 kg falls from a tree. What is the acceleration of the apple towards the earth? Also, **[2]**

calculate the acceleration of the earth towards the apple. Mass of the earth = 5.983×10^{24} kg, Radius of the earth = 6.378×10^{6} m and G = 6.67×10^{-11} Nm^2 kg^{-2}.

30. Calculate that imaginary angular velocity of the earth for which effective acceleration due to gravity at the equator becomes zero. In this condition what will be the length (in hours) of the day? Given radius of the earth = 6400 km and g = 10 ms^{-2}. **[2]**

31. If the radius of earth shrinks by 2.0%, mass remaining constant. How would the value of acceleration due to gravity change? **[2]**

32. A man can jump 1.5 m high on earth. Calculate the height he may be able to jump on a planet whose density is one fourth that of the earth and Whose radius is one-third of the earth. **[2]**

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

34. Which planet of the solar system has the greatest gravitational field strength? What is the gravitational field strength of a planet where the weight of a 60 kg astronaut is 300 N. **[2]**

35. How will the value of g be affected if **[2]**

    i. the rotation of the earth stops

    ii. the rotational speed of the earth is doubled

    iii. the rotational speed of the earth is increased to seventeen times its present value?

36. The mass of Jupiter is 314 times that of earth and the diameter of Jupiter is 11.35 times that of earth. If **g** has a value of 9.8 ms^{-2} on the earth, what is its value on Jupiter? **[2]**

37. Assuming earth to be a uniform sphere find an expression for density of earth in terms of g and G? **[2]**

38. Two planets of radii r_1, and r_2 are made from the same material. Calculate the ratio of the acceleration due to gravity on the surface of the planets. **[2]**

39. The acceleration due to gravity at the moon's surface is 1.67 ms^{-2}. If the radius of the moon is 1.74 x 10^6 m, then calculate the mass of the moon. **[2]**

40. The radii of two planets are R and 2 R respectively and their densities ρ and $\frac{\rho}{2}$ respectively. What is the ratio of acceleration due to gravity at their surfaces? **[2]**

41. Assuming the earth to be a uniform sphere of radius 6400 km and density 5.5 gcm^{-3}, find the value of g on its surface. Given G = 6.66×10^{-11} Nm^2kg^{-2}. **[2]**

42. The weight of a person on the earth is 80 kg. What will be his weight on the moon? Mass of the moon = 7.34×10^{22} kg, radius = 1.75×10^{6} m and gravitational constant = 6.67×10^{-11} Nm^2 kg^{-2}. What will be the mass of the person s t the moon and acceleration due to gravity there? If this person can jump 2 m high on the earth, how much high can he jump at the moon? **[2]**

43. 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 mass of earth = 6.4×10^{24} kg, radius of earth = 6.4×10^{6} m, mass of moon = 7.4×10^{22} kg, radius of moon = 1.76×10^{6} m. **[2]**

44. At what height above the surface of the earth will the acceleration due to gravity be 25 % of its value on the surface of the earth? Assume that the radius of the earth is 6400 km. **[2]**

45. Are we living at the bottom of a gravitational well? Give reason. **[2]**

46. Two bodies of masses M and m (M > m) are allowed to fall freely from the same height. If air resistance for each body is same, which one will reach the ground first. **[2]**

47. The gravitational force on the earth due to the sun is greater than moon. However tidal effect due to the moon's pull is greater than the tidal effect due to sun. Why? **[2]**

48. A body weighs 90 kg of the surface of the earth. How much will it weigh on the surface of Mars whose mass is $\frac{1}{9}$ and the radius is $\frac{1}{2}$ of that of the earth? **[2]**

49. Which of the following symptoms is likely to affect an astronaut in space **[2]**

a. swollen feet

b. swollen face

c. headache

d. Orientational problem

50. Why is the weight of a body at the poles more than the weight at the equator? Explain. **[2]**

51. A body hanging from a spring stretches it by 1 cm at the earth's surface. How much will the same body stretch at a place 1600 klm above the earth's surface? Radius of earth 6400 km. **[2]**

Section C

52. **State True or False:** **[3]**

(a) Body weighs more at poles and less at equator. **[1]**

(b) Condition of weightlessness can be experienced only when the mass of satellite is negligible so that it does not produce its own gravity. **[1]**

(c) Acceleration due to gravity is independent of the mass of the body. **[1]**

53. If the earth were a perfect sphere of radius 6.37×10^6 m, rotating about its axis with a period of 1 day (= 8.64×10^4 s), how much would the acceleration due to gravity (g) differ from the poles to the equator? **[3]**

54. Compare the gravitational acceleration of the earth due to attraction of the sun with that due to attraction of the moon. Given that mass of sun, $M_s = 1.99 \times 10^{30}$ kg, mass of moon, $M_m = 7.35 \times 10^{22}$ kg, distance of sun from earth, $r_{es} = 1.49 \times 10^{11}$ m and distance of moon from earth $V_{em} = 3.84 \times 10^8$ m. **[3]**

55. Define the term gravitational field. Show that acceleration due to gravity is equal to the intensity of gravitational field at any point. **[3]**

56. i. What is meant by gravitational field strength? **[3]**

ii. Which of the planets of the solar system has the greatest gravitational field strength?

iii. What is the gravitational field strength of a planet where the weight of a 60 kg astronaut is 300 N?

57. A star 2.5 times the mass of the sun and collapsed to a size of 12 km rotates with a speed of 1.5 rev/s. Will an object placed on its equator remain stuck to its surface due to gravity? Mass of the sun = 2×10^{30} kg. **[3]**

58. Discuss the variation of **g** **[3]**

i. with altitude

ii. with depth

iii. with latitude: Rotation of earth

59. Explain how mass and density of the Earth can be obtained from the knowledge of G and g. **[3]**

60. Define acceleration due to gravity. Derive expression for the variation of **g** with height from the surface of the earth. **[3]**

Section D

Question No. 61 to 65 are based on the given text. Read the text carefully and answer the questions: **[5]**

Journey through the centre of earth:

Suppose you could dig a tunnel from one surface to the opposite through the centre of the Earth. How will be journey

through the tunnel? Let us assume that the Earth to be of uniform density, there is no air friction and temperature is normal.

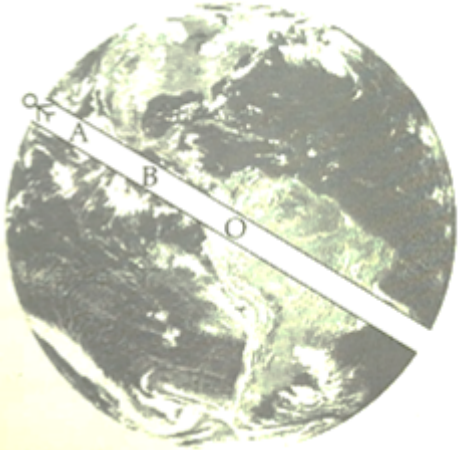
At the starting point the initial acceleration will be g = 9.8 m/s^2

The acceleration gradually reduces as one approaches the center

$g_{eff} = g \times \frac{r_{eff}}{R_{errth}}$

The gravity at any radius r_{eff} is less than R_{Earth} and is linearly proportional to the distance from the center.

So, the weight will go on reducing as the centre is approached. It will again goes on increasing as one moves from away from the centre.



The traveller will pop up on the opposite side of the Earth within 42 minutes approximately. But unless the traveller grabs something to hold on, he or she will fall back for a return journey and continue to oscillate with a round-trip time.

The time period will be $2\pi\sqrt{\frac{R_{earth}}{g}}$

61. Compare the weight of the traveller at point A and B inside the tunnel.

a) Weight at B > Weight at A
b) Weight at A > weight at B
c) Weight at A= Weight at B
d) Weight at A = Weight at B = 0

62. The approximate time required for the journey from A to D and back to A through the tunnel is:

a) 84 minutes
b) 42 hours
c) 42 minutes
d) 84 hours

63. How the acceleration due to gravity varies inside the tunnel?

i. Acceleration due to gravity remains constant throughout.
ii. Acceleration due to gravity increases as one approaches the centre. It is maximum at the centre. It again starts reducing as one moves away from the centre.
iii. Acceleration due to gravity decreases as one approaches the centre. It is zero at the centre. It again starts increasing as one moves away from the centre.
iv. Acceleration due to gravity is unpredictable.

a) iv
b) ii
c) i
d) iii

64. What may happen if the traveller reaching point D does not grab something to hold on?

a) The traveller will oscillate inside the tunnel with a time period $2\pi\sqrt{\frac{g}{R_{earth}}}$
b) The traveler will return to the centre of the earth and will remain there.

c) The traveler will remain at point D.

d) The traveller will oscillate inside the tunnel with a time period $2\pi\sqrt{\frac{R_{\text{earth}}}{g}}$

65. Which parameter of the traveller will be non-zero at the centre of the earth during this journey?

a) Acceleration

b) Weight

c) Potential energy

d) Mass

66. **Fill in the blanks:** **[5]**

(a) The law of gravitation is strictly true for _____. **[1]**

(b) If the diameter of the earth becomes half its present value but its average density remains unchanged, then the weight of the object on the surface of the earth will be _____. **[1]**

(c) If the radius of the earth shrinks by 1%, its mass remaining the same, then the acceleration due to gravity on its surface would _____ by _____ %. **[1]**

(d) The acceleration due to gravity at a height h above the surface of the earth has the same value as that at depth d = _____ below the earth surface. **[1]**

(e) The acceleration due to gravity is _____ at the surface of the earth and _____ at the centre of the earth. **[1]**

67. What is meant by acceleration due to gravity? Obtain an expression for it in terms of mass of the earth and gravitational constant. Explain how the mass and the density of the earth can be obtained from the knowledge of G. **[5]**

68. What do you mean by acceleration due to gravity? Discuss the variation of g on the surface of the earth due to axial rotation of the earth. Derive the necessary relation. **[5]**

69. 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. Discuss the variation of acceleration due to gravity with altitude and depth. If a body is taken to a height $\frac{R}{4}$ from the surface of the earth, find percentage decrease in the weight of the body? Here R is the radius of the earth. **[5]**