Practice Problems

Problems based on Newton's law of gravitation

▶ Basic level

1. The force of gravitation is

(a) Repulsive (b) Electrostatic (c) Conservative (d) Non - conservative

2. If the distance between two masses is doubled, the gravitational attraction between them

(a) Is doubled (b) Becomes four times (c) Is reduced to half (d) Is reduced to a quarter

3. A mass M is split into two parts, m and $M - m$, which are then separated by a certain distance. What ratio of m/M maximizes the gravitational force between the two parts

(a) 1/3 (b) 1/2 (c) 1/4 (d) 1/5

4. Three particles each of mass m are placed at the three corners of an equilateral triangle. The centre of the triangle is at a distance x from either corner. If a mass M be placed at the centre, what will be the net gravitational force on it

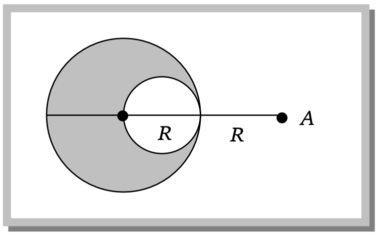
(a) Zero (b) $3GMm/x^2$ (c) $2GMm/x^2$ (d) GMm/x^2

5. Two identical spheres are placed in contact with each other. The force of gravitation between the spheres will be proportional to (R = radius of each sphere)

(a) R (b) R^2 (c) R^4 (d) None of these

▶▶ Advance level

6. A solid sphere of uniform density and radius R applies a gravitational force of attraction equal to F_1 on a particle placed at A, distance $2R$ from the centre of the sphere. A spherical cavity of radius $R/2$ is now made in the sphere as shown in the figure. The sphere with cavity now applies a gravitational force F_2 on the same particle placed at A. The ratio F_2/F_1 will be **[CBSE PMT 1993]**



(a) 1/2

(b) 3

(c) 7

(d) 7/9

7. Three uniform spheres of mass M and radius R each are kept in such a way that each touches the other two. The magnitude of the gravitational force on any of the spheres due to the other two is

(a) $\frac{\sqrt{3}}{4}\frac{GM^2}{R^2}$ (b) $\frac{3}{2}\frac{GM^2}{R^2}$ (c) $\frac{\sqrt{3}GM^2}{R^2}$ (d) $\frac{\sqrt{3}}{2}\frac{GM^2}{R^2}$

8. A mass of 10*kg* is balanced on a sensitive physical balance. A 1000 *kg* mass is placed below 10 *kg* mass at a distance of 1*m*. How much additional mass will be required for balancing the physical balance

(a) $66 \times 10^{-15} kg$ (b) $6.7 \times 10^{-8} kg$ (c) $66 \times 10^{-12} kg$ (d) $6.7 \times 10^{-6} kg$

Problems based on acceleration due to gravity

▶ *Basic level*

9. If R is the radius of the earth and g the acceleration due to gravity on the earth's surface, the mean density of the earth is

[CPMT 1990; CBSE 1995; BHU 1998; MH CET (Med.) 1999; Kerala PMT 2002]

(a) $4\pi G / 3gR$ (b) $3\pi R / 4gG$ (c) $3g / 4\pi RG$ (d) $\pi Rg / 12G$

10. A mass 'm' is taken to a planet whose mass is equal to half that of earth and radius is four times that of earth. The mass of the body on this planet will be **[RPMT 1989, 97]**

(a) $m / 2$ (b) $m / 8$ (c) $m / 4$ (d) m

11. The diameters of two planets are in the ratio 4 : 1 and their mean densities in the ratio 1: 2. The acceleration due to gravity on the planets will be in ratio **[ISM Dhanbad 1994]**

(a) 1 : 2 (b) 2 : 3 (c) 2 : 1 (d) 4 : 1

12. The acceleration due to gravity on the moon is only one sixth that of earth. If the earth and moon are assumed to have the same density, the ratio of the radii of moon and earth will be

(a) $\frac{1}{6}$ (b) $\frac{1}{(6)^{1/3}}$ (c) $\frac{1}{36}$ (d) $\frac{1}{(6)^{2/3}}$

▶▶ *Advance level*

13. Let g be the acceleration due to gravity at earth's surface and K be the rotational kinetic energy of the earth. Suppose the earth's radius decreases by 2% keeping all other quantities same, then **[BHU 1994; JIPMER 2000]**

(a) g decreases by 2% and K decreases by 4% (b) g decreases by 4% and K increases by 2%

(c) g increases by 4% and K decreases by 4% (d) g decreases by 4% and K increase by 4%

14. Clock A based on spring oscillations and a clock B based on oscillations of simple pendulum are synchronised on earth. Both are taken to mars whose mass is 0.1 times the mass of earth and radius is half that of earth. Which of the following statement is correct

(a) Both will show same time

(b) Time measured in clock A will be greater than that in clock B

(c) Time measured in clock B will be greater than that in clock A

(d) Clock A will stop and clock B will show time as it shows on earth

Problems based on variation in g with height

▶ *Basic level*

15. A body weight W *Newton* at the surface of the earth. Its weight at a height equal to half the radius of the earth will be

[UPSEAT 2002]

(a) $\frac{W}{2}$ (b) $\frac{2W}{3}$ (c) $\frac{4W}{9}$ (d) $\frac{8W}{27}$

16. The value of g on the earth's surface is 980 cm/sec^2. Its value at a height of 64 km from the earth's surface is

(Radius of the earth R = 6400 *Kilometers*) **[MP PMT 1995]**

(a) $960.40 cm/sec^2$ (b) $984.90 cm/sec^2$ (c) $982.45 cm/sec^2$ (d) $977.55 cm/sec^2$

17. The decrease in the value of g at height h from earth's surface is

(a) $\frac{2h}{R}$ (b) $\frac{2h}{R}g$ (c) $\frac{h}{R}g$ (d) $\frac{R}{2hg}$

Advance level

18. A simple pendulum has a time period T_1 when on earth's surface and T_2 when taken to a height R above the earth's surface, where R is the radius of earth. The value of T_2/T_1 is **[IIT-JEE (Screening) 2001]**

(a) 1 (b) $\sqrt{2}$ (c) 4 (d) 2

19. A pendulum clock is set to give correct time at the sea level. This clock is moved to hill station at an altitude of 2500*m* above the sea level. In order to keep correct time of the hill station, the length of the pendulum **[SCRA 1994]**

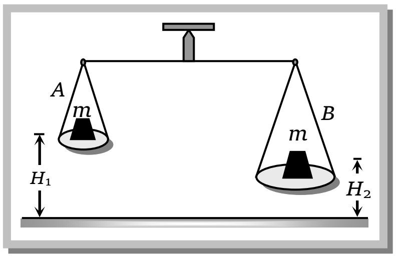
(a) Has to be reduced (b) Has to be increased

(c) Needs no adjustment (d) Needs no adjustment but its mass has to be increased

20. Which of the following correctly indicates the approximate effective values of g on various parts of a journey to the moon (values are in *metres/sec*^{2})

	Before take off from earth	One minute after lift – off	In earth orbit	on the moon
(a)	9.80	9.80	0	1.6
(b)	9.80	0.98	0	1.6
(c)	9.80	0.00	0	9.8×6
(d)	9.80	7.00	0	1.6

21. Two blocks of masses m each are hung from a balance. The scale pan A is at height H_1 whereas scale pan B is at height H_2. The error in weighing when $H_1 > H_2$ and R being the radius of earth is



(a) $mg\left(\frac{1-2H_1}{R}\right)$

(b) $2mg\left(\frac{H_1}{R}-\frac{H_2}{R}\right)$

(c) $2mg\left(\frac{H_2}{R}-\frac{H_1}{R}\right)$

(d) $2mg\frac{H_2 H_1}{H_1+H_2}$

Problems based on variation in g with depth

Basic level

22. If the value of 'g' acceleration due to gravity, at earth surface is $10 m/s^2$, its value in m/s^2 at the centre of the earth, which is assumed to be a sphere of radius 'R' *metre* and uniform mass density is **[AIIMS 2002]**

(a) 5 (b) 10/R (c) 10/2R (d) Zero

23. The loss in weight of a body taken from earth's surface to a height h is 1%. The change in weight taken into a mine of depth h will be

(a) 1% loss (b) 1% gain (c) 0.5% gain (d) 0.5% loss

24. The weight of body at earth's surface is W. At a depth half way to the centre of the earth, it will be (assuming uniform density in earth)

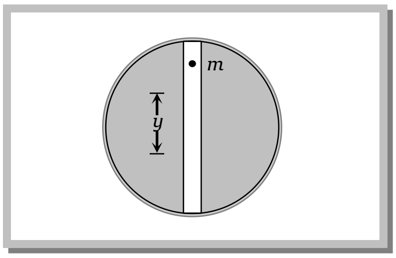
(a) W (b) $W/2$ (c) $W/4$ (d) $W/8$

▶▶ *Advance level*

25. A particle would take a time t to move down a straight tunnel from the surface of earth (supposed to be a homogeneous sphere) to its centre. If gravity were to remain constant this time would be t'. The ratio of $\frac{t}{t'}$ will be

(a) $\frac{\pi}{2\sqrt{2}}$ (b) $\frac{\pi}{2}$ (c) $\frac{2\pi}{3}$ (d) $\frac{\pi}{\sqrt{3}}$

26. Suppose a vertical tunnel is dug along the diameter of earth assumed to be a sphere of uniform mass having density ρ. If a body of mass m is thrown in this tunnel, its acceleration at a distance y from the centre is given by



(a) $\frac{4\pi}{3} G\rho ym$

(b) $\frac{3}{4} \pi G\rho y$

(c) $\frac{4}{3} \pi\rho y$

(d) $\frac{4}{3} \pi G\rho y$

27. A tunnel is dug along the diameter of the earth. If a particle of mass m is situated in the tunnel at a distance x from the centre of earth then gravitational force acting on it, will be

(a) $\frac{GM_e m}{R_e^3} x$ (b) $\frac{GM_e m}{R_e^2}$ (c) $\frac{GM_e m}{x^2}$ (d) $\frac{GM_e m}{(R_e + x)^2}$

Problems based on variation in g due to shape of the earth

▶ *Basic level*

28. The acceleration due to gravity at pole and equator can be related as **[DPMT 2002]**

(a) $g_p < g_e$ (b) $g_p = g_e = g$ (c) $g_p = g_e < g$ (d) $g_p > g_e$

29. Weight of a body is maximum at **[AFMC 2001]**

(a) Moon (b) Poles of earth (c) Equator of earth (d) Centre of earth

30. The value of 'g' at a particular point is $9.8 m/s^2$. Suppose the earth suddenly shrinks uniformly to half its present size without losing any mass. The value of 'g' at the same point (assuming that the distance of the point from the centre of earth does not shrink) will now be

[NCERT 1984; DPMT 1999]

(a) $4.9 m/\sec^2$ (b) $3.1 m/\sec^2$ (c) $9.8 m/\sec^2$ (d) $19.6 m/\sec^2$

▶▶ *Advance level*

31. The acceleration due to gravity increases by 0.5% when we go from the equator to the poles. What will be the time period of the pendulum at the equator which beats seconds at the poles

(a) 1.950 *s* (b) 1.995 *s* (c) 2.050 *s* (d) 2.005 *s*

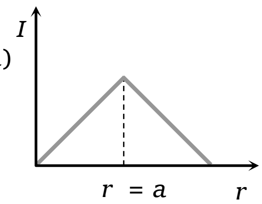
Problems based on gravitational field

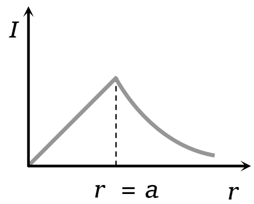
▶ *Basic level*

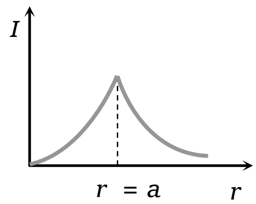
32. There are two bodies of masses 100 *kg* and 10000 *kg* separated by a distance 1*m*. At what distance from the smaller body, the intensity of gravitational field will be zero **[BHU 1997]**

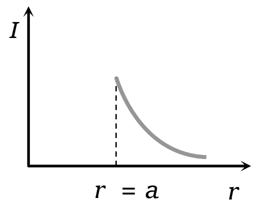
(a) $\frac{1}{9}m$ (b) $\frac{1}{10}m$ (c) $\frac{1}{11}m$ (d) $\frac{10}{11}m$

33. Which one of the following graphs represents correctly the variation of the gravitational field (F) with the distance (r) from the centre of a spherical shell of mass M and radius a

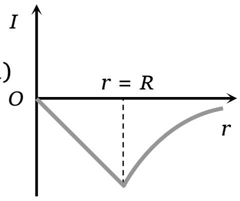
(a) 

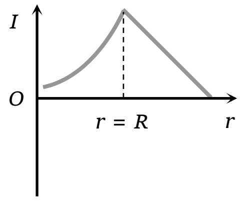
(b) 

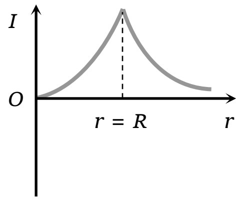
(c) 

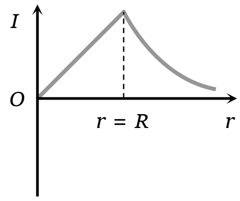
(d) 

34. The curve depicting the dependence of intensity of gravitational field on the distance r from the centre of the earth is

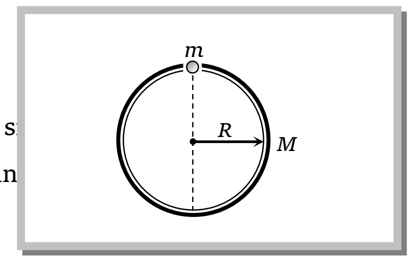
(a) 

(b) 

(c) 

(d) 

35. A thin spherical shell of mass M and radius R has a small hole. A particle of mass m is released at the mouth of the hole. Then



(a) The particle will execute simple harmonic motion inside the shell

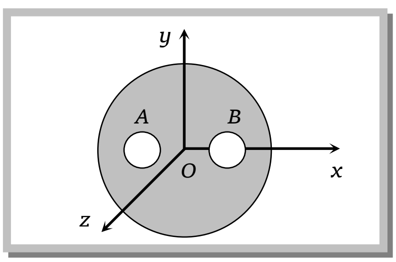
(b) The particle will oscillate inside the small, but the oscillations are not s

(c) The particle will not oscillate, but the speed of the particle will go on in

(d) None of these

▶▶ *Advance level*

36. A solid sphere of uniform density and radius 4 units is located with its centre at the origin O of coordinates. Two spheres of equal radii 1 unit with their centres at $A(-2, 0, 0)$ and $B(2, 0, 0)$ respectively are taken out of the solid leaving behind spherical cavities as shown in figure **[IIT-JEE 1993]**



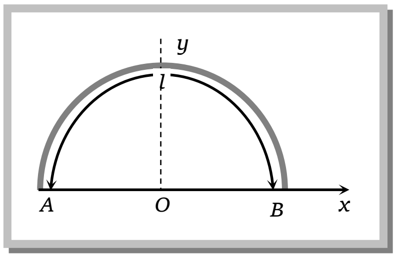
(a) The gravitational force due to this object at the origin is zero

(b) The gravitational force at the point $B(2,0,0)$ is zero

(c) The gravitational potential is the same at all points of the circle $y^2+z^2=36$

(d) The gravitational potential is the same at all points on the circle $y^2+z^2=4$

37. Gravitational field at the centre of a semicircle formed by a thin wire *AB* of mass *m* and length *l* is



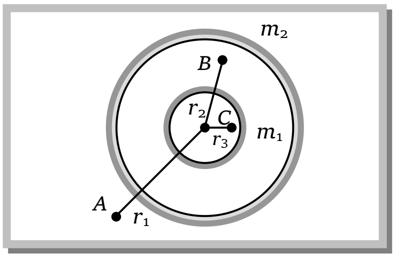
(a) $\frac{Gm}{l}$ along *x* axis

(b) $\frac{Gm}{\pi l}$ along *y* axis

(c) $\frac{2\pi Gm}{l^2}$ along *x* axis

(d) $\frac{2\pi Gm}{l^2}$ along *y* axis

38. Two concentric shells of different masses m_1 and m_2 are having a sliding particle of mass *m*. The forces on the particle at position *A*, *B* and *C* are



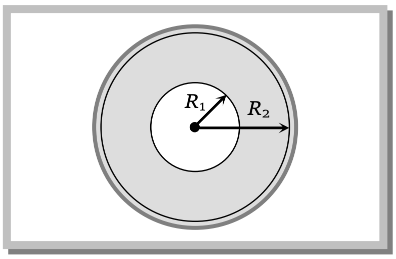
(a) $0, \frac{Gm_1}{r_2^2}, \frac{G(m_1+m_2)m}{r_1^2}$

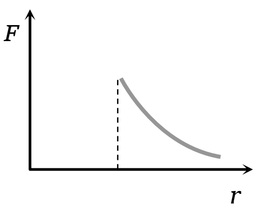
(b) $\frac{Gm_2}{r_2^2}, 0, \frac{Gm_1}{r_1^2}$

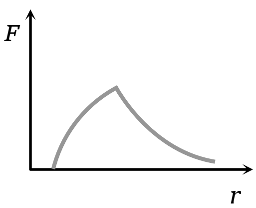
(c) $\frac{G(m_1+m_2)m}{r_1^2}, \frac{Gm_2}{r_2^2}, 0$

(d) $\frac{G(m_1+m_2)m}{r_1^2}, \frac{Gm_1}{r_2^2}, 0$

39. A sphere of mass *M* and radius R_2 has a concentric cavity of radius R_1 as shown in figure. The force *F* exerted by the sphere on a particle of mass m located at a distance r from the centre of sphere varies as $(0 \le r \le \infty)$



(a)


(b)


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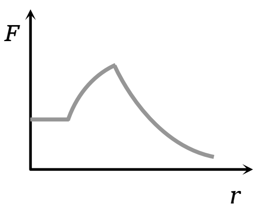
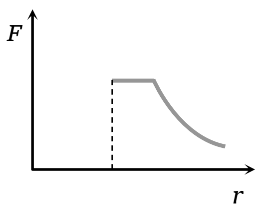
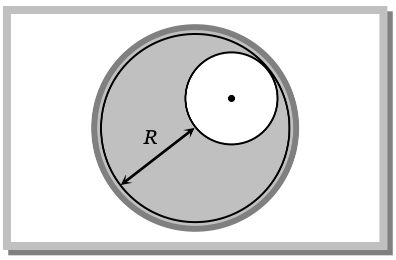


(d)


40. A spherical hole is made in a solid sphere of radius *R*. The mass of the sphere before hollowing was *M*. The gravitational field at the centre of the hole due to the remaining mass is



(a) Zero

(b) $\frac{GM}{8R^2}$

(c) $\frac{GM}{2R^2}$

(d) $\frac{GM}{R^2}$

41. A point P lies on the axis of a ring of mass M and radius a, at a distance a from its centre C. A small particle starts from P and reaches C under gravitational attraction only. Its speed at C will be

(a) $\sqrt{\frac{2GM}{a}}$ (b) $\sqrt{\frac{2GM}{a}\left(1-\frac{1}{\sqrt{2}}\right)}$ (c) $\sqrt{\frac{2GM}{a}(\sqrt{2}-1)}$ (d) Zero

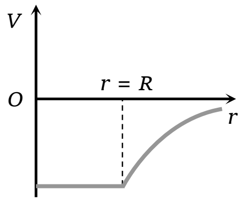
Problems based on gravitational potential

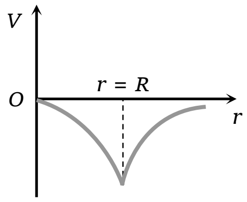
▶ Basic level

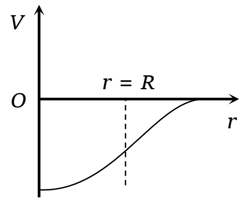
42. If V is the gravitational potential on the surface of the earth, then what is its value at the centre of the earth

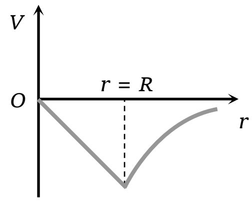
(a) $2V$ (b) $3V$ (c) $\frac{3}{2}V$ (d) $\frac{2}{3}V$

43. The diagram showing the variation of gravitational potential of earth with distance from the centre of earth is

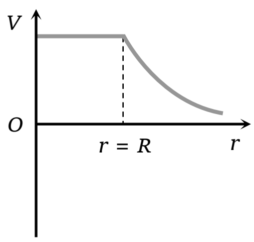
(a) 

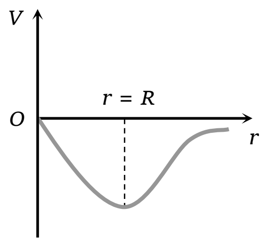
(b) 

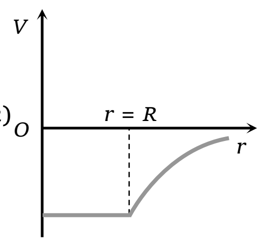
(c) 

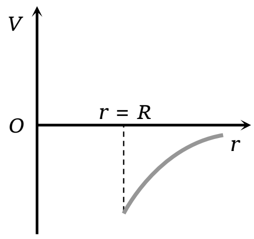
(d) 

44. By which curve will the variation of gravitational potential of a hollow sphere of radius R with distance be depicted

(a) 

(b) 

(c) 

(d) 

45. Two concentric shells have mass M and m and their radii are R and r respectively, where $R > r$. What is the gravitational potential at their common centre

(a) $-\frac{GM}{R}$ (b) $-\frac{Gm}{r}$ (c) $-G\left[\frac{M}{R}-\frac{m}{r}\right]$ (d) $-G\left[\frac{M}{R}+\frac{m}{r}\right]$

▶▶ Advance level

46. A person brings a mass of 1 *kg* from infinity to a point A. Initially the mass was at rest but it moves with a speed of 2 *m/s* as it reaches A. The work done by the person on the mass is – 3 *J*. The potential of A is

(a) – 3 *J/kg* (b) – 2 *J/kg* (c) – 5 *J/kg* (d) – 7 *J/kg*

47. A thin rod of length L is bent to form a semicircle. The mass of the rod is M. What will be the gravitational potential at the centre of the circle

(a) $-\frac{GM}{L}$ (b) $-\frac{GM}{2\pi L}$ (c) $-\frac{\pi GM}{2L}$ (d) $-\frac{\pi GM}{L}$

Problems based on escape velocity

Basic level

48. The escape velocity of a planet having mass 6 times and radius 2 times as that of earth is **[CPMT 1999; MP PET 2003]**

(a) $\sqrt{3}V_e$ (b) $3V_e$ (c) $\sqrt{2}V_e$ (d) $2V_e$

49. The escape velocity of a particle of mass *m* varies as **[CPMT 1978; RPMT 1999; AIEEE 2002]**

(a) m^2 (b) *m* (c) m^0 (d) m^{-1}

50. How many times is escape velocity (v_e), of orbital velocity (v_0) for a satellite revolving near earth **[RPMT 2000]**

(a) $\sqrt{2}$ *times* (b) 2 *times* (c) 3 *times* (d) 4 *times*

51. The orbital velocity of a satellite at a height *h* above the surface of earth is *v*. The value of escape velocity from the same location is given by **[J&K CET 2000]**

(a) $\sqrt{2}v$ (b) v (c) $\frac{v}{\sqrt{2}}$ (d) $\frac{v}{2}$

52. How much energy will be necessary for making a body of 500 *kg* escape from the earth $[g = 9.8\, m/s^2$, radius of earth $= 6.4 \times 10^6\, m]$

[MP PET 1999]

(a) About $9.8 \times 10^6\, J$ (b) About $6.4 \times 10^8\, J$ (c) About $3.1 \times 10^{10}\, J$ (d) About $27.4 \times 10^{12}\, J$

53. The escape velocity of a body on the surface of the earth is $11.2\, km/s$. If the earth's mass increases to twice its present value and the radius of the earth becomes half, the escape velocity would become **[CBSE PMT 1997]**

(a) $5.6\, km/s$ (b) $11.2\, km/s$ (remain unchanged)

(c) $22.4\, km/s$ (d) $44.8\, km/s$

54. A rocket is launched with velocity 10 *km/s*. If radius of earth is *R*, then maximum height attained by it will be **[RPET 1**

(a) 2*R* (b) 3*R* (c) 4*R* (d) 5*R*

55. A missile is launched with a velocity less then the escape velocity. The sum of its kinetic and potential energy is **[MP PET 1995]**

(a) Positive

(b) Negative

(c) Zero

(d) May be positive or negative depending upon its initial velocity

56. v_e and v_p denotes the escape velocity from the earth and another planet having twice the radius and the same mean density as the earth. Then **[NCERT 1974; MP PMT 1994]**

(a) $v_e = v_p$ (b) $v_e = v_p/2$ (c) $v_e = 2v_p$ (d) $v_e = v_p/4$

57. The magnitude of the potential energy per unit mass of the object at the surface of earth is *E*. Then the escape velocity of the object is

(a) $\sqrt{2E}$ (b) $4E^2$ (c) $\sqrt{E}$ (d) $\sqrt{E/2}$

Advance level

58. A ball of mass m is fired vertically upwards from the surface of the earth with velocity nv_e, where v_e is the escape velocity and $n < 1$. Neglecting air resistance, to what height will the ball rise? (Take radius of the earth as R)

(a) R/n^2 (b) $R/(1-n^2)$ (c) $Rn^2/(1-n^2)$ (d) Rn^2

59. The masses and radii of the earth and moon are M_1, R_1 and M_2, R_2 respectively. Their centres are distance d apart. The minimum velocity with which a particle of mass m should be projected from a point midway between their centres so that it escape to infinity is

[MP PET 1997]

(a) $2\sqrt{\frac{G}{d}(M_1+M_2)}$ (b) $2\sqrt{\frac{2G}{d}(M_1+M_2)}$ (c) $2\sqrt{\frac{Gm}{d}(M_1+M_2)}$ (d) $2\sqrt{\frac{Gm(M_1+M_2)}{d(R_1+R_2)}}$

60. A body is projected with a velocity $2v_e$, where v_e is the escape velocity. Its velocity when it escapes the gravitational field of the earth is

(a) $\sqrt{7}v_e$ (b) $\sqrt{5}v_e$ (c) $\sqrt{3}v_e$ (d) v_e

Problems based on energy

▶ *Basic level*

61. Escape velocity of a body of 1 *kg* mass on a planet is 100 *m/sec*. Gravitational potential energy of the body at the planet is

[MP PMT 2002]

(a) – 5000 J (b) – 1000 J (c) – 2400 J (d) 5000 J

62. A body of mass m rises to a height $h = \frac{R}{5}$ from the earth's surface where R is earth's radius. If g is acceleration due to gravity at the earth's surface, the increase in potential energy is **[CPMT 1989]**

(a) mgh (b) $\frac{4}{5}mgh$ (c) $\frac{5}{6}mgh$ (d) $\frac{6}{7}mgh$

63. The work done is bringing three particles each of mass 10 g from large distances to the vertices of an equilateral triangle of side 10 *cm*.

(a) 1×10^{-13} J (b) 2×10^{-13} J (c) 4×10^{-11} J (d) 1×10^{-11} J

64. The potential energy due to gravitational field of earth will be maximum at

(a) Infinite distance (b) The poles of earth (c) The centre of earth (d) The equator of earth

▶▶ *Advance level*

65. The radius and mass of earth are increased by 0.5%. Which of the following statement is false at the surface of the earth

[Roorkee 2000]

(a) g will increase (b) g will decrease

(c) Escape velocity will remain unchanged (d) Potential energy will remain unchanged

66. Two identical thin rings each of radius R are coaxially placed at a distance R. If the rings have a uniform mass distribution and each has mass m_1 and m_2 respectively, then the work done in moving a mass m from centre of one ring to that of the other is

(a) Zero (b) $\frac{Gm(m_1-m_2)(\sqrt{2}-1)}{\sqrt{2}R}$ (c) $\frac{Gm\sqrt{2}(m_1-m_2)}{R}$ (d) $\frac{Gm_1m_2(\sqrt{2}+1)}{m_2R}$

Problems based on orbital velocity of satellite

▶ *Basic level*

67. The orbital velocity of an artificial satellite in a circular orbit just above the earth's surface is *v*. For a satellite orbiting at an altitude of half of the earth's radius, the orbital velocity is **[Kerala (Engg.) 2001]**

(a) $\frac{3}{2}V$ (b) $\sqrt{\frac{3}{2}}V$ (c) $\sqrt{\frac{2}{3}}V$ (d) $\frac{2}{3}V$

68. The speed of a satellite is *v* while revolving in an elliptical orbit and is at nearest distance '*a*' from earth. The speed of satellite at farthest distance '*b*' will be **[RPMT 1995]**

(a) $(b/a)v$ (b) $(a/b)v$ (c) $(\sqrt{a/b})v$ (d) $(\sqrt{b/a})v$

69. For the moon to cease to remain the earth's satellite its orbital velocity has to increase by a factor of **[MP PET 1994]**

(a) 2 (b) $\sqrt{2}$ (c) $1/\sqrt{2}$ (d) $\sqrt{3}$

70. Two artificial satellites *A* and *B* are at a distances r_A and r_B above the earth's surface. If the radius of earth is *R*, then the ratio of their speeds will be

(a) $\left(\frac{r_B+R}{r_A+R}\right)^{1/2}$ (b) $\left(\frac{r_B+R}{r_A+R}\right)^{2}$ (c) $\left(\frac{r_B}{r_A}\right)^{2}$ (d) $\left(\frac{r_B}{r_A}\right)^{1/2}$

▶▶ *Advance level*

71. When a satellite going round earth in a circular orbit of radius *r* and speed *v*, losses some of its energy. Then *r* and *v* change as

[EAMCET (Med.) 2000]

(a) *r* and *v* both will increase (b) *r* and *v* both will decrease

(c) *r* will decrease and *v* will increase (d) *r* will increase and *v* will decrease

72. A satellite is revolving around a planet of mass *M* in an elliptical orbit of semi-major axis *a*. The orbital velocity of the satellite at a distance *r* from the focus will be

(a) $\left[GM\left(\frac{2}{r}-\frac{1}{a}\right)\right]^{1/2}$ (b) $\left[GM\left(\frac{1}{r}-\frac{2}{a}\right)\right]^{1/2}$ (c) $\left[GM\left(\frac{2}{r^2}-\frac{1}{a^2}\right)\right]^{1/2}$ (d) $\left[GM\left(\frac{1}{r^2}-\frac{2}{a^2}\right)\right]^{1/2}$

Problems based on time period of satellite

▶ *Basic level*

73. A geo-stationary satellite is orbiting the earth at a height of 6 *R* above the surface of earth, *R* being the radius of earth. The time period of another satellite at a height of 2.5 *R* from the surface of earth is **[UPSEAT 2002; AMU (Med**

(a) $10\ hr$ (b) $(6/\sqrt{2})hr$ (c) $6\ hr$ (d) $6\sqrt{2}\ hr$

74. Time period of revolution of a satellite around a planet of radius *R* is *T*. Period of revolution around another planet. Whose radius is 3*R* but having same density is **[CPMT 1981]**

(a) *T* (b) 3*T* (c) 9*T* (d) $3\sqrt{3}\,T$

75. A satellite is orbiting around the earth with a period *T*. If the earth suddenly shrinks to half its radius without change in mass, the period of revolution of the satellite will be

(a) $T/\sqrt{2}$ (b) $T/2$ (c) *T* (d) 2*T*

76. A satellite is orbiting around the earth in the equitorial plane rotating from west to east as the earth does. If ω_e be the angular speed of the earth and ω_s be that of satellite, then the satellite will repeatedly appear at the some location after a time *t* =

(a) $\frac{2\pi}{\omega_s - \omega_c}$ (b) $\frac{2\pi}{\omega_s + \omega_c}$ (c) $\frac{\pi}{\omega_s - \omega_c}$ (d) $\frac{\pi}{\omega_s + \omega_c}$

77. Suppose the gravitational force varies inversely as the *nth* power of distance. Then, the time period of a planet in circular orbit of radius *R* around the sun will be proportional to

(a) R^n (b) $R^{\frac{n+1}{2}}$ (c) $R^{\frac{n+1}{2}}$ (d) R^{-n}

▶▶ *Advance level*

78. A geostationary satellite orbits around the earth in a circular orbit of radius 36000 *km*. Then, the time period of a satellite orbiting a few hundred *kilometres* above the earth's surface $(R_{Earth} = 6400\ km)$ will approximately be**[IIT-JE**

(a) 1/2 *h* (b) 1 *h* (c) 2 *h* (d) 4 *h*

79. If the distance between the earth and the sun becomes half its present value, the number of days in a year would have been

[IIT-JEE 1996; RPET 1996]

(a) 64.5 (b) 129 (c) 182.5 (d) 730

80. A satellite is launched into a circular orbit of radius *R* around the earth. A second satellite is launched into an orbit of radius (1.01) *R*. The period of the second satellite is larger than that of the first one by approximately **[IIT-JE**

(a) 0.5% (b) 1.0% (c) 1.5% (d) 3.0%

81. A satellite moves eastwards very near the surface of the earth in the equatorial plane of the earth with speed v_0. Another satellite moves at the same height with the same speed in the equatorial plane but westwards. If *R* = radius of the earth about its own axis, then the difference in the two time period as observed on the earth will be approximately equal to

(a) $\frac{4\pi R v_0}{R^2\omega^4 - v_0^2}$ (b) $\frac{4\pi R v_0}{R^2\omega^2 - v_0^2}$ (c) $\frac{4\pi R v_0}{R^2\omega^2 + v_0^2}$ (d) $\frac{2\pi R v_0}{R^2\omega^2 + v_0^2}$

82. A "*double star*" is a composite system of two stars rotating about their centre of mass under their mutual gravitational attraction. Let us consider such a "*double star*" which has two stars of masses *m* and 2*m* at separation *l*. If *T* is the time period of rotation about their centre of mass then,

(a) $T = 2\pi\sqrt{\frac{l^3}{mG}}$ (b) $T = 2\pi\sqrt{\frac{l^3}{2mG}}$ (c) $T = 2\pi\sqrt{\frac{l^3}{3mG}}$ (d) $T = 2\pi\sqrt{\frac{l^3}{4mG}}$

83. A space probe projected from the earth moves round the moon in a circular orbit at a distance equal to its radius $R_{moon} = \frac{R}{4}$ where *R* = radius of the earth. Its rocket launcher moves in circular orbit around the earth at a distance equal to *R* from its surface. The ratio of the times taken for one revolution by the probe and the rocket launcher is $\left(M_{moon} = \frac{M}{80}, \text{where } M = \text{mass of the earth}\right)$

(a) $\sqrt{3} : 2$ (b) $\sqrt{5} : 2$ (c) 1 : 1 (d) $2 : \sqrt{3}$

Problems based on height of satellite

▶ *Basic level*

84. The distance of a geo-stationary satellite from the centre of the earth (Radius *R* = 6400 *km*) is nearest to**[AFMC 2001]**

(a) 5 *R* (b) 7 *R* (c) 10 *R* (d) 18 *R*

85. An artificial satellite is moving in a circular orbit around the earth with a speed equal to half the escape speed from the earth. If *R* is the radius of the earth then the height of the satellite above the surface of the earth is

(a) $\frac{R}{2}$ (b) $\frac{2R}{3}$ (c) R (d) $2R$

▶▶ *Advance level*

86. If the angular velocity of a planet about its own axis is halved, the distance of geostationary satellite of this planet from the centre of the planet will become

(a) $(2)^{1/3}$ times (b) $(2)^{3/2}$ times (c) $(2)^{2/3}$ times (d) 4 times

Problems based on energy of satellite

▶ *Basic level*

87. A satellite moves around the earth in a circular orbit with speed v. If m is the mass of the satellite, its total energy is **[CBSE PMT 1991]**

(a) $-\frac{1}{2}mv^2$ (b) $\frac{1}{2}mv^2$ (c) $\frac{3}{2}mv^2$ (d) $\frac{1}{4}mv^2$

88. The minimum energy required to launch a satellite of mass m from the surface of earth of radius R in a circular orbit at an altitude 2 R is (mass of earth is M)

(a) $\frac{5GmM}{6R}$ (b) $\frac{2GmM}{3R}$ (c) $\frac{GmM}{2R}$ (d) $\frac{GmM}{3R}$

89. The masses of moon and earth are $7.36 \times 10^{22}\ kg$ and $5.98 \times 10^{24}\ kg$ respectively and their mean separation is $3.82 \times 10^5\ km$. The energy required to break the earth-moon system is

(a) $12.4 \times 10^{32}\ J$ (b) $3.84 \times 10^{28}\ J$ (c) $5.36 \times 10^{24}\ J$ (d) $2.96 \times 10^{20}\ J$

90. A body placed at a distance R_o form the centre of earth, starts moving from rest. The velocity of the body on reaching at the earth's surface will be (R_e = radius of earth and M_e = mass of earth)

(a) $GM_e\left(\frac{1}{R_e} - \frac{1}{R_0}\right)$ (b) $2GM_e\left(\frac{1}{R_e} - \frac{1}{R_0}\right)$ (c) $GM_e\sqrt{\frac{1}{R_e} - \frac{1}{R_0}}$ (d) $\sqrt{2GM_e\left(\frac{1}{R_e} - \frac{1}{R_0}\right)}$

91. If total energy of an earth satellite is zero, it means that

(a) The satellite is bound to earth

(b) The satellite may no longer be bound to earth's field

(c) The satellite moves away from the orbit along a parabolic path

(d) The satellite escapes in a hyperbolic path

▶▶ *Advance level*

92. By what percent the energy of a satellite has to be increased to shift it from an orbit of radius r to $\frac{3}{2}r$

(a) 66.7% (b) 33.3% (c) 15% (d) 20.3%

93. A mass m is raised from the surface of the earth to a point distant $\beta R (\beta > 1)$ from the centre of the earth and then put into a circular orbit to make it an artificial satellite. The total work done to complete this job is

(a) $mgR(2\beta - 1)$ (b) $mgR(2\beta + 1)$ (c) $mgR(\beta + 1)$ (d) $mgR\,\frac{2\beta - 1}{2\beta}$

Problems based on angular momentum of satellite

▶ *Basic level*

94. A satellite of mass m is circulating around the earth with constant angular velocity. If radius of the orbit is R_0 and mass of the earth M, the angular momentum about the centre of the earth is **[MP PMT 1996; RPMT 2000]**

(a) $m\sqrt{GMR_0}$ (b) $M\sqrt{GmR_0}$ (c) $m\sqrt{\frac{GM}{R_0}}$ (d) $M\sqrt{\frac{GM}{R_0}}$

95. A planet of mass m is moving in an elliptical path about the sun. Its maximum and minimum distances from the sun are r_1 and r_2 respectively. If M_s is the mass of sun then the angular momentum of this planet about the center of sun will be

(a) $\sqrt{\frac{2GM_s}{(r_1 + r_2)}}$ (b) $2GM_s m\sqrt{\frac{r_1 r_2}{(r_1 + r_2)}}$ (c) $m\sqrt{\frac{2GM_s r_1 r_2}{(r_1 + r_2)}}$ (d) $m\sqrt{\frac{2GM_s m(r_1 + r_2)}{r_1 r_2}}$

Problems based on weightlessness in satellite

▶ *Basic level*

96. Reaction of weightlessness in a satellite is **[RPMT 2000]**

(a) Zero gravity (b) Centre of mass

(c) Zero reaction force by satellite surface (d) None of these

97. A body suspended from a spring balance is placed in a satellite. Reading in balance is W_1 when the satellite moves in an orbit of radius R. Reading in balance is W_2 when the satellite moves in an orbit of radius $2R$. Then

(a) $W_1 = W_2$ (b) $W_1 > W_2$ (c) $W_1 < W_2$ (d) $W_1 = 2W_2$

98. An astronaut feels weightlessness because

(a) Gravity is zero there

(b) Atmosphere is not there

(c) Energy is zero in the chamber of a rocket

(d) The fictitious force in rotating frame of reference cancels the effect or weight

99. Inside a satellite orbiting very close to the earth's surface, water does not fall out of a glass when it is inverted. Which of the following is the best explanation for this

(a) The earth does not exert any force on the water

(b) The earth's force of a attraction on the water is exactly balanced by the force created by the satellites motion

(c) The water and the glass have the same acceleration, equal to g, towards the centre of the earth, and hence there is no relative motion between them

(d) The gravitational attraction between the glass and the water balances the earth's attraction on the water

100. To overcome the effect of weightlessness in an artificial satellite

(a) The satellite is rotated its axis with compartment of astronaut at the centre of the satellite

(b) The satellite is shaped like a wheel

(c) The satellite is rotated around and around till weightlessness disappears

(d) The compartment of astronaut is kept on the periphery of rotating wheel like satellite

Problems based on Kepler's laws

▶ *Basic level*

101. Which of the following astronomer first proposed that sun is static and earth rounds sun **[AFMC 2002]**

(a) Copernicus (b) Kepler (c) Galilio (d) None

102. The period of a satellite in a circular orbit of radius R is T, the period of another satellite in a circular orbit of radius $4R$ is

[CPMT 1982; MP PET/PMT 1998; AIIMS 2000; CBSE 2002]

(a) $4T$ (b) $T/4$ (c) $8T$ (d) $T/8$

103. Kepler's second law is based on **[AIIMS 2002]**

(a) Newton's first law (b) Newton's second law

(c) Special theory of relativity (d) Conservation of angular momentum

104. Two planets at mean distance d_1 and d_2 from the sun and their frequencies are n_1 and n_2 respectively then **[Kerala (M**

(a) $n_1^2 d_1^2 = n_2 d_2^2$ (b) $n_2^2 d_2^3 = n_1^2 d_1^3$ (c) $n_1 d_1^2 = n_2 d_2^2$ (d) $n_1^2 d_1 = n_2^2 d_2$

105. Earth needs one year to complete one revolution round the sun. If the distance between sun and earth is doubled then the period of revolution of earth will become **[PM PMT 1997]**

(a) $2\sqrt{2}$ yrs (b) 8 yrs (c) $\frac{1}{2}$ yrs (d) 1 yrs

106. The eccentricity of earth's orbit is 0.0167. The ratio of its maximum speed in its orbit to its minimum speed is **[NCER**

(a) 2.507 (b) 1.033 (c) 8.324 (d) 1.000

107. For a planet around the sun in an elliptical orbit of semi – major and semi – minor axes *a* and *b,* respectively, and period *T*

(A) The torque acting on the planet about the sun is non – zero

(B) The angular momentum of the planet about the sun is constant

(C) The areal velocity is $\pi ab / T$

(D) The planet moves with a constant speed around the sun

(a) A, B (b) B, C (c) C, D (d) D, A

108. A planet moves in an elliptical orbit around one of the foci. The ratio of maximum velocity $v_{\max}$ and minimum velocity $v_{\min}$ in terms of eccentricity *e* of the ellipse is given by

(a) $\frac{1-e}{1+e}$ (b) $\frac{e-1}{e+1}$ (c) $\frac{1+e}{1-e}$ (d) $\frac{e}{e-1}$

109. The satellites S_1 and S_2 describe circular orbits of radii *r* and 2*r* respectively around a planet. If the orbital angular velocity of S_1 is ω, that of S_2 is

(a) $\frac{\omega}{2\sqrt{2}}$ (b) $\omega\sqrt{2}$ (c) $\frac{\omega}{\sqrt{2}}$ (d) $\frac{\omega\sqrt{2}}{3}$

▶▶ *Advance level*

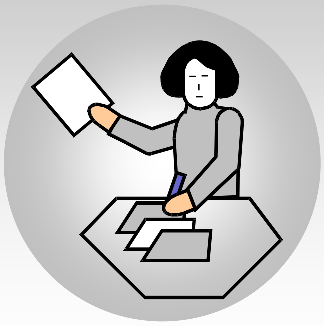
110. Imagine a light planet revolving around a very massive star in a circular orbit of radius *R* with a period of revolution *T*. If the gravitational force of attraction between planet and star is proportional to $R^{-5/2}$, then T^2 is proportional to

[IIT-JEE 1989; RPMT 1997]

(a) R^3 (b) $R^{7/2}$ (c) $R^{5/2}$ (d) $R^{3/2}$

111. A binary star has stars of masses *m* and *nm* (where *n* is a numerical factor) having separation of their centres as *r*. If these stars revolve because of gravitational force of each other, the period of revolution is given by

(a) $\frac{2\pi r^{3/2}}{\left(\frac{Gnm^2}{(n+1)m}\right)^{\frac{1}{2}}}$ (b) $\frac{2\pi r^{1/2}}{\left(\frac{G(n+1)m}{nm}\right)^{\frac{1}{2}}}$ (c) $\frac{2\pi r^3}{\frac{2}{3}GMn}$ (d) $\frac{2\pi r^{3/2}}{\left(\frac{2}{3}GMn\right)^{2/3}}$



Answer Sheet (Practice problems)

1.	**2.**	**3.**	**4.**	**5.**	**6.**	**7.**	**8.**	**9.**	**10.**
c	d	b	a	c	d	a	b	c	d
11.	**12.**	**13.**	**14.**	**15.**	**16.**	**17.**	**18.**	**19.**	**20.**
c	a	c	b	c	a	b	d	a	d
21.	**22.**	**23.**	**24.**	**25.**	**26.**	**27.**	**28.**	**29.**	**30.**
b	d	d	b	a	d	a	d	b	c
31.	**32.**	**33.**	**34.**	**35.**	**36.**	**37.**	**38.**	**39.**	**40.**
d	c	d	b	d	a, c, d	d	d	b	c
41.	**42.**	**43.**	**44.**	**45.**	**46.**	**47.**	**48.**	**49.**	**50.**
b	c	c	c	d	c	d	a	c	a
51.	**52.**	**53.**	**54.**	**55.**	**56.**	**57.**	**58.**	**59.**	**60.**
b	c	c	c	b	b	a	c	a	c
61.	**62.**	**63.**	**64.**	**65.**	**66.**	**67.**	**68.**	**69.**	**70.**
a	c	b	a	a	b	c	b	b	a
71.	**72.**	**73.**	**74.**	**75.**	**76.**	**77.**	**78.**	**79.**	**80.**
c	a	d	a	c	a	b	c	b	c
81.	**82.**	**83.**	**84.**	**85.**	**86.**	**87.**	**88.**	**89.**	**90.**
b	c	b	b	c	c	a	a	b	d
91.	**92.**	**93.**	**94.**	**95.**	**96.**	**97.**	**98.**	**99.**	**100.**
c	b	d	a	c	c	a	d	c	d
101.	**102.**	**103.**	**104.**	**105.**	**106.**	**107.**	**108.**	**109.**	**110.**
a	c	d	b	a	b	b	c	a	b
111.									
a									