Gravitation

Newton's Law of Gravitation

1. A satellite of the earth is revolving in a circular orbit with a uniform speed *v*. If the gravitational force suddenly disappears, the satellite will **[AIIMS 1982; AIEEE 2002]**

(a) Continue to move with velocity *v* along the original orbit

(b) Move with a velocity *v*, tangentially to the original orbit

(c) Fall down with increasing velocity

(d) Ultimately come to rest somewhere on the original orbit

2. The atmosphere is held to the earth by **[IIT 1986]**

(a) Winds (b) Gravity

(c) Clouds (d) None of the above

3. The weight of a body at the centre of the earth is **[AFMC 1988]**

(a) Zero

(b) Infinite

(c) Same as on the surface of earth

(d) None of the above

4. If the distance between two masses is doubled, the gravitational attraction between them **[CPMT 1973; AMU (Med.) 2000]**

(a) Is doubled (b) Becomes four times

(c) Is reduced to half (d) Is reduced to a quarter

5. Which of the following is the evidence to show that there must be a force acting on earth and directed towards the sun **[AIIMS 1980]**

(a) Deviation of the falling bodies towards east

(b) Revolution of the earth round the sun

(c) Phenomenon of day and night

(d) Apparent motion of sun round the earth

6. Two particles of equal mass go round a circle of radius *R* under the action of their mutual gravitational attraction. The speed of each particle is **[CBSE PMT 1995; RPMT 2003]**

(a) $v=\frac{1}{2R}\sqrt{\frac{1}{Gm}}$ (b) $v=\sqrt{\frac{Gm}{2R}}$

(c) $v=\frac{1}{2}\sqrt{\frac{Gm}{R}}$ (d) $v=\sqrt{\frac{4Gm}{R}}$

7. The earth (mass $=6\times10^{24}\,kg$)) revolves round the sun with angular velocity $2\times10^{-7}\,rad/s$ in a circular orbit of radius $1.5\times10^{8}\,km$. The force exerted by the sun on the earth in *newtons*, is **[CBSE PMT 1995; AFMC 1999; Pb. PMT 2003]**

(a) 18×10^{25} (b) Zero

(c) 27×10^{39} (d) 36×10^{21}

8. Gravitational mass is proportional to gravitational **[AIIMS 1998]**

(a) Field (b) Force

(c) Intensity (d) All of these

9. The gravitational force between two point masses m_1 and m_2 at separation *r* is given by $F=k\frac{m_1m_2}{r^2}$

The constant *k* **[CPMT 1993]**

(a) Depends on system of units only

(b) Depends on medium between masses only

(c) Depends on both (a) and (b)

(d) Is independent of both (a) and (b)

10. The distance of the centres of moon and earth is *D*. The mass of earth is 81 times the mass of the moon. At what distance from the centre of the earth, the gravitational force will be zero **[RPET 1996]**

(a) $\frac{D}{2}$ (b) $\frac{2D}{3}$

(c) $\frac{4D}{3}$ (d) $\frac{9D}{10}$

11. The centripetal force acting on a satellite orbiting round the earth and the gravitational force of earth acting on the satellite both equal *F*. The net force on the satellite is **[AMU 1999]**

(a) Zero (b) F

(c) $F\sqrt{2}$ (d) $2F$

12. Mass *M* is divided into two parts *x M* and $(1-x)M$. For a given separation, the value of *x* for which the gravitational attraction between the two pieces becomes maximum is **[EAMCET 2001]**

(a) $\frac{1}{2}$ (b) $\frac{3}{5}$

(c) 1 (d) 2

13. The force of gravitation is **[AIIMS 2002]**

(a) Repulsive (b) Electrostatic

(c) Conservative (d) Non-conservative

14. Two sphere of mass *m* and *M* are situated in air and the gravitational force between them is *F*. The space around the masses is now filled with a liquid of specific gravity 3. The gravitational force will now be **[CBSE PMT 2003]**

(a) F (b) $\frac{F}{3}$

(c) $\frac{F}{9}$ (d) $3F$

15. Which of the following statements about the gravitational constant is true **[Kerala PET 2005]**

(a) It is a force

(b) It has no unit

(c) It has same value in all systems of units

(d) It depends on the value of the masses

(e) It does not depend on the nature of the medium in which the bodies are kept.

16. Two identical solid copper spheres of radius R placed in contact with each other. The gravitational attracton between them is proportional to **[Kerala PET 2005]**

(a) R^2 (b) R^{-2}

(c) R^4 (d) R^{-4}

Acceleration Due to Gravity

1. Weightlessness experienced while orbiting the earth in space-ship, is the result of **[NCERT 1978; DPMT 1982]**

(a) Inertia (b) Acceleration

(c) Zero gravity (d) Free fall towards earth

2. If the change in the value of 'g' at a height h above the surface of the earth is the same as at a depth x below it, then (both x and h being much smaller than the radius of the earth) **[NCERT 1983; BHU 2002]**

(a) $x = h$ (b) $x = 2h$

(c) $x = \frac{h}{2}$ (d) $x = h^2$

3. The time period of a simple pendulum on a freely moving artificial satellite is **[CPMT 1984; AFMC 2002]**

(a) Zero (b) 2 sec

(c) 3 sec (d) Infinite

4. Two planets have the same average density but their radii are R_1 and R_2. If acceleration due to gravity on these planets be g_1 and g_2 respectively, then **[AIIMS 1985]**

(a) $\frac{g_1}{g_2} = \frac{R_1}{R_2}$ (b) $\frac{g_1}{g_2} = \frac{R_2}{R_1}$

(c) $\frac{g_1}{g_2} = \frac{R_1^2}{R_2^2}$ (d) $\frac{g_1}{g_2} = \frac{R_1^3}{R_2^3}$

5. An iron ball and a wooden ball of the same radius are released from a height 'h' in vacuum. The time taken by both of them to reach the ground is **[NCERT 1975; AFMC 1998]**

(a) Unequal (b) Exactly equal

(c) Roughly equal (d) Zero

6. The correct answer to above question is based on **[NCERT 1975]**

(a) Acceleration due to gravity in vacuum is same irrespective of size and mass of the body

(b) Acceleration due to gravity in vacuum depends on the mass of the body

(c) There is no acceleration due to gravity in vacuum

(d) In vacuum there is resistance offered to the motion of the body and this resistance depends on the mass of the body

7. When a body is taken from the equator to the poles, its weight **[EAMCET 1978]**

(a) Remains constant

(b) Increases

(c) Decreases

(d) Increases at N-pole and decreases at S-pole

8. A body of mass m is taken to the bottom of a deep mine. Then **[NCERT 1982]**

(a) Its mass increases (b) Its mass decreases

(c) Its weight increases (d) Its weight decreases

9. A spherical planet far out in space has a mass M_0 and diameter D_0. A particle of mass m falling freely near the surface of this planet will experience an acceleration due to gravity which is equal to **[MP PMT 1987; DPMT 2002]**

(a) GM_0 / D_0^2 (b) $4mGM_0 / D_0^2$

(c) $4GM_0 / D_0^2$ (d) GmM_0 / D_0^2

10. If the earth stops rotating, the value of 'g' at the equator will **[CPMT 1986]**

(a) Increase (b) Remain same

(c) Decrease (d) None of the above

11. The mass and diameter of a planet have twice the value of the corresponding parameters of earth. Acceleration due to gravity on the surface of the planet is **[NCERT 1971; Pb. PMT 2000]**

(a) $9.8\, m/\sec^2$ (b) $4.9\, m/\sec^2$

(c) $980\, m/\sec^2$ (d) $19.6\, m/\sec^2$

12. As we go from the equator to the poles, the value of g **[CPMT 1975; AFMC 1995; AFMC 2004]**

(a) Remains the same

(b) Decreases

(c) Increases

(d) Decreases upto a latitude of 45°

13. Force of gravity is least at **[CPMT 1992]**

(a) The equator

(b) The poles

(c) A point in between equator and any pole

(d) None of these

14. The radius of the earth is 6400 km and $g = 10 m/\sec^2$. In order that a body of 5 kg weighs zero at the equator, the angular speed of the earth is **[MP PMT 1985]**

(a) 1/80 *radian/sec* (b) 1/400 *radian/sec*

(c) 1/800 *radian/sec* (d) 1/1600 *radian/sec*

15. 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) $19.6\,m/\sec^2$

16. 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

MH CET (Med.) 1999; CBSE PMT 1995]

(a) $4\pi G/3gR$ (b) $3\pi R/4gG$

(c) $3g/4\pi RG$ (d) $\pi RG/12G$

17. The weight of an object in the coal mine, sea level, at the top of the mountain are W_1, W_2 and W_3 respectively, then

[EAMCET 1990]

(a) $W_1 < W_2 > W_3$ (b) $W_1 = W_2 = W_3$

(c) $W_1 < W_2 < W_3$ (d) $W_1 > W_2 > W_3$

18. The radii of two planets are respectively R_1 and R_2 and their densities are respectively ρ_1 and ρ_2. The ratio of the accelerations due to gravity at their surfaces is

[MP PET 1994]

(a) $g_1 : g_2 = \frac{\rho_1}{R_1^2} : \frac{\rho_2}{R_2^2}$ (b) $g_1 : g_2 = R_1R_2 : \rho_1\rho_2$

(c) $g_1 : g_2 = R_1\rho_2 : R_2\rho_1$ (d) $g_1 : g_2 = R_1\rho_1 : R_2\rho_2$

19. The mass of the earth is 81 times that of the moon and the radius of the earth is 3.5 times that of the moon. The ratio of the acceleration due to gravity at the surface of the moon to that at the surface of the earth is **[MP PMT 1994]**

(a) 0.15 (b) 0.04

(c) 1 (d) 6

20. Spot the *wrong* statement :

The acceleration due to gravity 'g' decreases if

[MP PMT 1994]

(a) We go down from the surface of the earth towards its centre

(b) We go up from the surface of the earth

(c) We go from the equator towards the poles on the surface of the earth

(d) The rotational velocity of the earth is increased

21. Which of the following statements is true

[Manipal MEE 1995]

(a) g is less at the earth's surface than at a height above it or a depth below it

(b) g is same at all places on the surface of the earth

(c) g has its maximum value at the equator

(d) g is greater at the poles than at the equator

22. Choose the correct statement from the following :

Weightlessness of an astronaut moving in a satellite is a situation of **[MP PMT 1995]**

(a) Zero g (b) No gravity

(c) Zero mass (d) Free fall

23. If the earth rotates faster than its present speed, the weight of an object will **[Haryana CEE 1996]**

(a) Increase at the equator but remain unchanged at the poles

(b) Decrease at the equator but remain unchanged at the poles

[CPMT 1999; BHU 1998; Kerala PMT 2002;

(c) Remain unchanged at the equator but decrease at the poles

(d) Remain unchanged at the equator but increase at the poles

24. If the earth suddenly shrinks (without changing mass) to half of its present radius, the acceleration due to gravity will be **[MNR 1998]**

(a) $g/2$ (b) $4g$

(c) $g/4$ (d) $2g$

25. The moon's radius is 1/4 that of the earth and its mass is 1/80 times that of the earth. If g represents the acceleration due to gravity on the surface of the earth, that on the surface of the moon is

MP PET 2000, 01; RPET 2000; Pb. PET 2001]

(a) $g/4$ (b) $g/5$

(c) $g/6$ (d) $g/8$

26. R is the radius of the earth and ω is its angular velocity and g_p is the value of g at the poles. The effective value of g at the latitude $\lambda = 60°$ will be equal to

(a) $g_p - \frac{1}{4}R\omega^2$ (b) $g_p - \frac{3}{4}R\omega^2$

(c) $g_p - R\omega^2$ (d) $g_p + \frac{1}{4}R\omega^2$

27. The depth d at which the value of acceleration due to gravity becomes $\frac{1}{n}$ times the value at the surface, is [R = radius of the earth] **[MP PMT 1999; Kerala PMT 2005]**

(a) $\frac{R}{n}$ (b) $R\left(\frac{n-1}{n}\right)$

(c) $\frac{R}{n^2}$ (d) $R\left(\frac{n}{n+1}\right)$

28. At what height over the earth's pole, the free fall acceleration decreases by one percent (assume the radius of earth to be 6400 km) **[KCET 1994]**

(a) 32 km (b) 80 km

(c) 1.253 km (d) 64 km

29. 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

30. At what altitude in metre will the acceleration due to gravity be 25% of that at the earth's surface (Radius of earth = R *metre*) **[ISM Dhanbad 1994]**

(a) $\frac{1}{4}R$ (b) R

(c) $\frac{3}{8}R$ (d) $\frac{R}{2}$

31. If the angular speed of the earth is doubled, the value of acceleration due to gravity (g) at the north pole **[EAMCET (Med.) 1995]**

(a) Doubles (b) Becomes half
(c) Remains same (d) Becomes zero

32. At the surface of a certain planet, acceleration due to gravity is one-quarter of that on earth. If a brass ball is transported to this planet, then which one of the following statements is not correct **[SCRA 1994]**

(a) The mass of the brass ball on this planet is a quarter of its mass as measured on earth
(b) The weight of the brass ball on this planet is a quarter of the weight as measured on earth
(c) The brass ball has the same mass on the other planet as on earth
(d) The brass ball has the same volume on the other planet as on earth

33. Weight of 1 *kg* becomes 1/6 on moon. If radius of moon is $1.768 \times 10^6\ m$, then the mass of moon will be **[RPET 1997]**

(a) $1.99 \times 10^{30}\ kg$ (b) $7.56 \times 10^{22}\ kg$
(c) $5.98 \times 10^{24}\ kg$ (d) $7.65 \times 10^{22}\ kg$

34. Radius of earth is around 6000 *km*. The weight of body at height of 6000 *km* from earth surface becomes **[RPMT 1997]**

(a) Half (b) One-fourth
(c) One third (d) No change

35. 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 increases by 4%
(d) g decreases by 4% and K increases by 4%

36. If the radius of the earth shrinks by 1.5% (mass remaining same), then the value of acceleration due to gravity changes by **[BHU 1997]**

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

37. If mass of a body is M on the earth surface, then the mass of the same body on the moon surface is **[AIIMS 1997; RPMT 1997; JIPMER 2000]**

(a) $M/6$ (b) Zero
(c) M (d) None of these

38. Mass of moon is $7.34 \times 10^{22}\ kg$. If the acceleration due to gravity on the moon is $1.4\ m/s^2$, the radius of the moon is
$(G = 6.667 \times 10^{-11}\ Nm^2/kg^2)$ **[AFMC 1998]**

(a) $0.56 \times 10^4\ m$ (b) $1.87 \times 10^6\ m$
(c) $1.92 \times 10^6\ m$ (d) $1.01 \times 10^8\ m$

39. What should be the velocity of earth due to rotation about its own axis so that the weight at equator become 3/5 of initial value. Radius of earth on equator is 6400 *km* **[AMU 1999]**

(a) $7.4 \times 10^{-4}\ rad/\sec$ (b) $6.7 \times 10^{-4}\ rad/\sec$
(c) $7.8 \times 10^{-4}\ rad/\sec$ (d) $8.7 \times 10^{-4}\ rad/\sec$

40. At what height from the ground will the value of 'g' be the same as that in 10 *km* deep mine below the surface of earth **[RPET 1999]**

(a) 20 *km* (b) 10 *km*
(c) 15 *km* (d) 5 *km*

41. An object weights 72 N on earth. Its weight at a height of $R/2$ from earth is **[AIIMS 2000]**

(a) 32 N (b) 56 N
(c) 72 N (d) Zero

42. The angular velocity of the earth with which it has to rotate so that acceleration due to gravity on 60° latitude becomes zero is (Radius of earth = 6400 *km*. At the poles $g = 10\,ms^{-2}$) **[EAMCET 2000]**

(a) $2.5 \times 10^{-3}\ rad/s$ (b) $5.0 \times 10^{-1}\ rad/s$
(c) $10 \times 10^{1}\ rad/s$ (d) $7.8 \times 10^{-2}\ rad/s$

43. Assuming earth to be a sphere of a uniform density, what is the value of gravitational acceleration in a mine 100 *km* below the earth's surface (Given R = 6400 *km*) **[AFMC 2000; Pb. PMT 2000]**

(a) $9.66\ m/s^2$ (b) $7.64\ m/s^2$
(c) $5.06\ m/s^2$ (d) $3.10\ m/s^2$

44. If radius of earth is R then the height 'h' at which value of 'g' becomes one-fourth is **[BHU 2000]**

(a) $\frac{R}{4}$ (b) $\frac{3R}{4}$
(c) R (d) $\frac{R}{8}$

45. R and r are the radii of the earth and moon respectively. ρ_e and ρ_m are the densities of earth and moon respectively. The ratio of the accelerations due to gravity on the surfaces of earth and moon is **[EAMCET 2000]**

(a) $\frac{R}{r}\frac{\rho_e}{\rho_m}$ (b) $\frac{r}{R}\frac{\rho_e}{\rho_m}$
(c) $\frac{r}{R}\frac{\rho_m}{\rho_e}$ (d) $\frac{R}{r}\frac{\rho_e}{\rho_m}$

46. If the mass of earth is 80 times of that of a planet and diameter is double that of planet and 'g' on earth is $9.8\ m/s^2$, then the value of 'g' on that planet is **[Pb. PMT 1999; CPMT 2000]**

(a) $4.9\ m/s^2$ (b) $0.98\ m/s^2$
(c) $0.49\ m/s^2$ (d) $49\ m/s^2$

47. A man can jump to a height of 1.5 m on a planet A. What is the height he may be able to jump on another planet whose density and radius are, respectively, one-quarter and one-third that of planet A **[AMU (Med.) 2001]**

(a) 1.5 m (b) 15 m

(c) 18 m (d) 28 m

48. The acceleration due to gravity near the surface of a planet of radius R and density d is proportional to **[MP PET 2002; AIEEE 2004]**

(a) $\frac{d}{R^2}$ (b) dR^2

(c) dR (d) $\frac{d}{R}$

49. The acceleration due to gravity is g at a point distant r from the centre of earth of radius R. If $r < R$, then **[CPMT 2002]**

(a) $g \propto r$ (b) $g \propto r^2$

(c) $g \propto r^{-1}$ (d) $g \propto r^{-2}$

50. 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) $\frac{8W}{27}$

51. Acceleration due to gravity on moon is 1/6 of the acceleration due to gravity on earth. If the ratio of densities of earth (ρ_e) and moon (ρ_m) is $\left(\frac{\rho_e}{\rho_m}\right) = \frac{5}{3}$ then radius of moon R_m in terms of R_e will be **[MP PMT 2003]**

(a) $\frac{5}{18}R_e$ (b) $\frac{1}{6}R_e$

(c) $\frac{3}{18}R_e$ (d) $\frac{1}{2\sqrt{3}}R_e$

52. The acceleration of a body due to the attraction of the earth (radius R) at a distance 2 R from the surface of the earth is (g = acceleration due to gravity at the surface of the earth) **[MP PET 2003]**

(a) $\frac{g}{9}$ (b) $\frac{g}{3}$

(c) $\frac{g}{4}$ (d) g

53. Weight of a body of mass m decreases by 1% when it is raised to height h above the earth's surface. If the body is taken to a depth h in a mine, change in its weight is **[KCET 2003; MP PMT 2003]**

(a) 2% decrease (b) 0.5% decrease

(c) 1% increase (d) 0.5% increase

54. Two planets of radii in the ratio 2 : 3 are made from the material of density in the ratio 3 : 2. Then the ratio of acceleration due to gravity g_1/g_2 at the surface of the two planets will be **[J & K CET 2004]**

(a) 1 (b) 2.25

(c) 4/9 (d) 0.12

55. A body weight 500 N on the surface of the earth. How much would it weigh half way below the surface of the earth **[Pb. PET 2001; BHU 2004]**

(a) 125 N (b) 250 N

(c) 500 N (d) 1000 N

56. Acceleration due to gravity 'g' for a body of mass 'm' on earth's surface is proportional to (Radius of earth=R, mass of earth=M) **[DCE 2004]**

(a) GM/R^2 (b) m^0

(c) mM (d) $1/R^{3/2}$

57. The masses of two planets are in the ratio 1 : 2. Their radii are in the ratio 1 : 2. The acceleration due to gravity on the planets are in the ratio **[MH CET 2004]**

(a) 1 : 2 (b) 2 : 1

(c) 3 : 5 (d) 5 : 3

Gravitation Potential, Energy and Escape Velocity

1. A body of mass m rises to height $h = R/5$ from the earth's surface, where R is earth's radius. If g is acceleration due to gravity at earth's surface, the increase in potential energy is **[CPMT 1989; SCRA 1996; DPMT 2001]**

(a) mgh (b) $\frac{4}{5}mgh$

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

2. In a gravitational field, at a point where the gravitational potential is zero **[CPMT 1990]**

(a) The gravitational field is necessarily zero

(b) The gravitational field is not necessarily zero

(c) Nothing can be said definitely about the gravitational field

(d) None of these

3. The gravitational field due to a mass distribution is $E = K/x^3$ in the x-direction. (K is a constant). Taking the gravitational potential to be zero at infinity, its value at a distance x is **[MP PET 1994]**

(a) K/x (b) $K/2x$

(c) K/x^2 (d) $K/2x^2$

4. The change in potential energy, when a body of mass m is raised to a height nR from the earth's surface is (R = Radius of earth) **[MP PMT 1996]**

(a) $mgR\frac{n}{n-1}$ (b) $nmgR$

(c) $mgR\frac{n^2}{n^2+1}$ (d) $mgR\frac{n}{n+1}$

5. 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 escapes 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) $2\sqrt{\frac{Gm(M_1+M_2)}{d(R_1+R_2)}}$

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

[RPET 1997]

(a) $2R$ (b) $3R$

(c) $4R$ (d) $5R$

7. 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) $\frac{10}{11}m$

8. What is the intensity of gravitational field of the centre of a spherical shell **[RPET 2000]**

(a) Gm/r^2 (b) g

(c) Zero (d) None of these

9. The gravitational potential energy of a body of mass 'm' at the earth's surface $-mgR_e$. Its gravitational potential energy at a height R_e from the earth's surface will be (Here R_e is the radius of the earth)

[AIIMS 2000; MP PET 2000; Pb. PMT 2004]

(a) $-2mgR_e$ (b) $2mgR_e$

(c) $\frac{1}{2}mgR_e$ (d) $-\frac{1}{2}mgR_e$

10. 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

11. A body of mass m is placed on the earth's surface. It is taken from the earth's surface to a height $h = 3R$. The change in gravitational potential energy of the body is

[CBSE PMT 2002]

(a) $\frac{2}{3}mgR$ (b) $\frac{3}{4}mgR$

(c) $\frac{mgR}{2}$ (d) $\frac{mgR}{4}$

12. A body of mass m kg. starts falling from a point $2R$ above the Earth's surface. Its kinetic energy when it has fallen to a point 'R' above the Earth's surface [R-Radius of Earth, M-Mass of Earth, G-Gravitational Constant]**[MP PMT 2002]**

(a) $\frac{1}{2}\frac{GMm}{R}$ (b) $\frac{1}{6}\frac{GMm}{R}$

(c) $\frac{2}{3}\frac{GMm}{R}$ (d) $\frac{1}{3}\frac{GMm}{R}$

13. A body is projected vertically upwards from the surface of a planet of radius R with a velocity equal to half the escape velocity for that planet. The maximum height attained by the body is **[KCET (Engg./Med.) 2002]**

(a) $R/3$ (b) $R/2$

(c) $R/4$ (d) $R/5$

14. Energy required to move a body of mass m from an orbit of radius $2R$ to $3R$ is **[AIEEE 2002]**

(a) $GMm/12R^2$ (b) $GMm/3R^2$

(c) $GMm/8R$ (d) $GMm/6R$

15. The kinetic energy needed to project a body of mass m from the earth surface (radius R) to infinity is

[AIEEE 2002]

(a) $mgR/2$ (b) $2\,mgR$

(c) mgR (d) $mgR/4$

16. Radius of orbit of satellite of earth is R. Its kinetic energy is proportional to **[BHU 2003; CPMT 2004]**

(a) $\frac{1}{R}$ (b) $\frac{1}{\sqrt{R}}$

(c) R (d) $\frac{1}{R^{3/2}}$

17. In some region, the gravitational field is zero. The gravitational potential in this region **[BVP 2003]**

(a) Must be variable (b) Must be constant

(c) Cannot be zero (d) Must be zero

18. A particle falls towards earth from infinity. It's velocity on reaching the earth would be **[Orissa JEE 2003]**

(a) Infinity (b) $\sqrt{2gR}$

(c) $2\sqrt{gR}$ (d) Zero

19. Gas escapes from the surface of a planet because it acquires an escape velocity. The escape velocity will depend on which of the following factors :

I. Mass of the planet

II. Mass of the particle escaping

III. Temperature of the planet

IV. Radius of the planet

Select the correct answer from the codes given below : **[SCRA 1994]**

(a) I and II (b) II and IV

(c) I and IV (d) I, III and IV

20. 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) $v_e = v_p / 4$

21. The escape velocity of a sphere of mass *m* from earth having mass *M* and radius *R* is given by **[NCERT 1981, 84; CBSE PMT 1999]**

(a) $\sqrt{\frac{2GM}{R}}$ (b) $2\sqrt{\frac{GM}{R}}$

(c) $\sqrt{\frac{2GMm}{R}}$ (d) $\sqrt{\frac{GM}{R}}$

22. The escape velocity for a rocket from earth is 11.2 *km/sec*. Its value on a planet where acceleration due to gravity is double that on the earth and diameter of the planet is twice that of earth will be in *km/sec* **[NCERT 1983; CPMT 1990; MP PMT 2000; UPSEAT 1999]**

(a) 11.2 (b) 5.6

(c) 22.4 (d) 53.6

23. The escape velocity from the earth is about 11 *km/second*. The escape velocity from a planet having twice the radius and the same mean density as the earth, is **[NCERT 1980; MP PMT 1987; MP PET 2001, 2003; AIIMS 2001; UPSEAT 1999]**

(a) 22 *km/sec* (b) 11 *km/sec*

(c) 5.5 *km/sec* (d) 15.5 *km/sec*

24. A missile is launched with a velocity less than the escape velocity. The sum of its kinetic and potential energy is **[MNR 1986; MP PET 1995]**

(a) Positive

(b) Negative

(c) Zero

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

25. If *g* is the acceleration due to gravity at the earth's surface and *r* is the radius of the earth, the escape velocity for the body to escape out of earth's gravitational field is **[NCERT 1975; RPET 2003]**

(a) gr (b) $\sqrt{2gr}$

(c) g / r (d) r / g

26. 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}

27. 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) $\sqrt{3}$

28. The escape velocity of an object from the earth depends upon the mass of the earth (*M*), its mean density (ρ), its radius (*R*) and the gravitational constant (*G*). Thus the formula for escape velocity is **[MP PMT 1995]**

(a) $v = R\sqrt{\frac{8\pi}{3}G\rho}$ (b) $v = M\sqrt{\frac{8\pi}{3}GR}$

(c) $v = \sqrt{2GMR}$ (d) $v = \sqrt{\frac{2GM}{R^2}}$

29. Escape velocity on a planet is v_e. If radius of the planet remains same and mass becomes 4 times, the escape velocity becomes **[MP PMT 1996; DPMT 1999]**

(a) $4v_e$ (b) $2v_e$

(c) v_e (d) $\frac{1}{2}v_e$

30. The mass of the earth is 81 times that of the moon and the radius of the earth is 3.5 times that of the moon. The ratio of the escape velocity on the surface of earth to that on the surface of moon will be **[MP PMT/PET 1998; JIPMER 2000]**

(a) 0.2 (b) 2.57

(c) 4.81 (d) 0.39

31. The escape velocity from the surface of earth is V_e. The escape velocity from the surface of a planet whose mass and radius are 3 times those of the earth will be **[MP PMT/PET 1998; JIPMER 2001, 02; Pb. PMT 2004]**

(a) V_e (b) $3V_e$

(c) $9V_e$ (d) $27V_e$

32. 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 $27.4 \times 10^{12}\ J$

33. The escape velocity for the earth is 11.2 *km/sec*. The mass of another planet is 100 times that of the earth and its radius is 4 times that of the earth. The escape velocity for this planet will be **[MP PMT 1999; Pb. PMT 2002]**

(a) 112.0 *km/s* (b) 5.6 *km/s*

(c) 280.0 *km/s* (d) 56.0 *km/s*

34. The escape velocity of a planet having mass 6 times and radius 2 times as that of earth is **[CPMT 1999; MP PET 2003; Pb. PET 2002]**

(a) $\sqrt{3}\ V_e$ (b) $3\ V_e$

(c) $\sqrt{2}\ V_e$ (d) $2\ V_e$

35. The escape velocity on earth is 11.2 km/s. On another planet having twice radius and 8 times mass of the earth, the escape velocity will be **[Bihar CMEET 1995]**

(a) 3.7 km/s (b) 11.2 km/s

(c) 22.4 km/s (d) 43.2 km/s

36. 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

37. Given mass of the moon is 1/81 of the mass of the earth and corresponding radius is 1/4 of the earth. If escape velocity on the earth surface is 11.2 km/s, the value of same on the surface of the moon is

[CPMT 1997; AIIMS 2000; Pb. PMT 2001]

(a) 0.14 km/s (b) 0.5 km/s

(c) 2.5 km/s (d) 5 km/s

38. The angular velocity of rotation of star (of mass M and radius R) at which the matter start to escape from its equator will be **[MH CET 1999]**

(a) $\sqrt{\frac{2GM^2}{R}}$ (b) $\sqrt{\frac{2GM}{g}}$

(c) $\sqrt{\frac{2GM}{R^3}}$ (d) $\sqrt{\frac{2GR}{M}}$

39. The least velocity required to throw a body away from the surface of a planet so that it may not return is (radius of the planet is $6.4\times10^6 m,\ g=9.8\ m/sec^2$) **[AMU (Engg.) 1999**

(a) $9.8\times10^{-3} m/sec$ (b) $12.8\times10^3 m/sec$

(c) $9.8\times10^3 m/sec$ (d) $11.2\times10^3 m/sec$

40. Escape velocity on earth is 11.2 km/s. What would be the escape velocity on a planet whose mass is 1000 times and radius is 10 times that of earth **[DCE 2001; DPMT 2004]**

(a) 112 km/s (b) 11.2 km/s

(c) 1.12 km/s (d) 3.7 km/s

41. If the radius of a planet is R and its density is ρ, the escape velocity from its surface will be **[MP PMT 2001]**

(a) $v_e \propto \rho R$ (b) $v_e \propto \sqrt{\rho}R$

(c) $v_e \propto \frac{\sqrt{\rho}}{R}$ (d) $v_e \propto \frac{1}{\sqrt{\rho}R}$

42. Escape velocity on the earth **[BHU 2001]**

(a) Is less than that on the moon

(b) Depends upon the mass of the body

(c) Depends upon the direction of projection

(d) Depends upon the height from which it is projected

43. If acceleration due to gravity on the surface of a planet is two times that on surface of earth and its radius is double that of earth. Then escape velocity from the surface of that planet in comparison to earth will be **[RPET 2001]**

(a) $2\ v_e$ (b) $3\ v_e$

(c) $4\ v_e$ (d) None of these

44. The ratio of the radii of planets A and B is k_1 and ratio of acceleration due to gravity on them is k_2. The ratio of escape velocities from them will be **[BHU 2002]**

(a) k_1k_2 (b) $\sqrt{k_1k_2}$

(c) $\sqrt{\frac{k_1}{k_2}}$ (d) $\sqrt{\frac{k_2}{k_1}}$

45. A mass of $6\times10^{24} kg$ is to be compressed in a sphere in such a way that the escape velocity from the sphere is $3\times10^8 m/s$. Radius of the sphere should be $(G=6.67\times10^{-11} N-m^2/kg^2)$ **[UPSEAT 2002]**

(a) 9 km (b) 9 m

(c) 9 cm (d) 9 mm

46. The escape velocity of a body on an imaginary planet which is thrice the radius of the earth and double the mass of the earth is (v_e is the escape velocity of earth)

[Kerala (Med.) 2002]

(a) $\sqrt{2/3}\,v_e$ (b) $\sqrt{3/2}\,v_e$

(c) $\sqrt{2}/3v_e$ (d) $2/\sqrt{3}\,v_e$

47. The velocity with which a projectile must be fired so that it escapes earth's gravitation does not depend on

[AIIMS 2003]

(a) Mass of the earth

(b) Mass of the projectile

(c) Radius of the projectile's orbit

(d) Gravitational constant

48. The radius of a planet is $\frac{1}{4}$ of earth's radius and its acceleration due to gravity is double that of earth's acceleration due to gravity. How many times will the escape velocity at the planet's surface be as compared to its value on earth's surface **[BCECE 2003; MH CET 2000]**

(a) $\frac{1}{\sqrt{2}}$ (b) $\sqrt{2}$

(c) $2\sqrt{2}$ (d) 2

49. The escape velocity for the earth is v_e. The escape velocity for a planet whose radius is four times and density is nine times that of the earth, is **[MP PET 2003]**

(a) $36v_e$ (b) $12v_e$

(c) $6v_e$ (d) $20v_e$

50. The escape velocity for a body projected vertically upwards from the surface of earth is 11 km/s. If the body is projected at an angle of 45^o with the vertical, the escape velocity will be **[AIEEE 2003]**

(a) $\frac{11}{\sqrt{2}} km/s$ (b) $11\sqrt{2}\ km/s$

(c) 22 km/s (d) 11 km/s

51. The acceleration due to gravity on a planet is same as that on earth and its radius is four times that of earth. What will be the value of escape velocity on that planet if it is v_e on earth **[RPET 2002]**

(a) v_e (b) $2v_e$

(c) $4v_e$ (d) $\frac{v_e}{2}$

52. A particle of mass 10 g is kept on the surface of a uniform sphere of mass 100 kg and radius 10 cm. Find the work to be done against the gravitational force between them to take the particle far away from the sphere (you may take $G = 6.67 \times 10^{-11}\ Nm^2/kg^2$) **[AIEEE 2005]**

(a) $6.67 \times 10^{-9}\ J$ (b) $6.67 \times 10^{-10}\ J$

(c) $13.34 \times 10^{-10}\ J$ (d) $3.33 \times 10^{-10}\ J$

53. For a satellite moving in an orbit around the earth, the ratio of kinetic energy to potential energy is

[CBSE PMT 2005]

(a) 2 (b) $\frac{1}{2}$

(c) $\frac{1}{\sqrt{2}}$ (d) $\sqrt{2}$

54. 3 particles each of mass m are kept at vertices of an equilateral triangle of side L. The gravitational field at centre due to these particles is **[DCE 2005]**

(a) Zero (b) $\frac{3GM}{L^2}$

(c) $\frac{9GM}{L^2}$ (d) $\frac{12}{\sqrt{3}}\frac{GM}{L^2}$

55. Four particles each of mass M, are located at the vertices of a square with side L. The gravitational potential due to this at the centre of the square is **[Kerala PET 2005]**

(a) $-\sqrt{32}\frac{GM}{L}$ (b) $-\sqrt{64}\frac{GM}{L^2}$

(c) Zero (d) $\sqrt{32}\frac{GM}{L}$

56. There are two planets. The ratio of radius of the two planets is K but ratio of acceleration due to gravity of both planets is g. What will be the ratio of their escape velocity **[BHU 2005]**

(a) $(Kg)^{1/2}$ (b) $(Kg)^{-1/2}$

(c) $(Kg)^2$ (d) $(Kg)^{-2}$

Motion of Satellite

1. If v_e and v_o represent the escape velocity and orbital velocity of a satellite corresponding to a circular orbit of radius R, then **[CPMT 1982; MP PMT 1997; KCET (Engg./Med.) 1999; AIIMS 2002]**

(a) $v_e = v_o$

(b) $\sqrt{2}v_o = v_e$

(c) $v_e = v_0/\sqrt{2}$

(d) v_e and v_o are not related

2. If r represents the radius of the orbit of a satellite of mass m moving around a planet of mass M, the velocity of the satellite is given by

[CPMT 1974; MP PMT 1987; RPMT 1999]

(a) $v^2 = g\frac{M}{r}$ (b) $v^2 = \frac{GMm}{r}$

(c) $v = \frac{GM}{r}$ (d) $v^2 = \frac{GM}{r}$

3. Select the correct statement from the following

[MP PMT 1993]

(a) The orbital velocity of a satellite increases with the radius of the orbit

(b) Escape velocity of a particle from the surface of the earth depends on the speed with which it is fired

(c) The time period of a satellite does not depend on the radius of the orbit

(d) The orbital velocity is inversely proportional to the square root of the radius of the orbit

4. An earth satellite of mass m revolves in a circular orbit at a height h from the surface of the earth. R is the radius of the earth and g is acceleration due to gravity at the surface of the earth. The velocity of the satellite in the orbit is given by

[NCERT 1983; AIEEE 2004]

(a) $\frac{gR^2}{R+h}$ (b) gR

(c) $\frac{gR}{R+h}$ (d) $\sqrt{\frac{gR^2}{R+h}}$

5. Consider a satellite going round the earth in an orbit. Which of the following statements is wrong **[NCERT 1966]**

(a) It is a freely falling body

(b) It suffers no acceleration

(c) It is moving with a constant speed

(d) Its angular momentum remains constant

6. Two satellites of masses m_1 and $m_2 (m_1 > m_2)$ are revolving round the earth in circular orbits of radius r_1 and $r_2 (r_1 > r_2)$ respectively. Which of the following statements is true regarding their speeds v_1 and v_2 ?

[NCERT 1984; MNR 1995; BHU 1998]

(a) $v_1 = v_2$ (b) $v_1 < v_2$

(c) $v_1 > v_2$ (d) $\frac{v_1}{r_1} = \frac{v_2}{r_2}$

7. A satellite which is geostationary in a particular orbit is taken to another orbit. Its distance from the centre of earth in new orbit is 2 times that of the earlier orbit. The time period in the second orbit is **[NCERT 1984; MP PET 1997]**

(a) 4.8 *hours* (b) $48\sqrt{2}$ *hours*

(c) 24 *hours* (d) $24\sqrt{2}$ *hours*

8. The ratio of the K.E. required to be given to the satellite to escape earth's gravitational field to the K.E. required to be given so that the satellite moves in a circular orbit just above earth atmosphere is **[NCERT 1975]**

(a) One (b) Two

(c) Half (d) Infinity

9. An astronaut orbiting the earth in a circular orbit 120 *km* above the surface of earth, gently drops a spoon out of space-ship. The spoon will **[NCERT 1971]**

(a) Fall vertically down to the earth

(b) Move towards the moon

(c) Will move along with space-ship

(d) Will move in an irregular way then fall down to earth

10. The period of a satellite in a circular orbit around a planet is independent of **[NCERT 1974; AIEEE 2004]**

(a) The mass of the planet

(b) The radius of the planet

(c) The mass of the satellite

(d) All the three parameters (a), (b) and (c)

11. If a satellite is orbiting the earth very close to its surface, then the orbital velocity mainly depends on **[NCERT 1982]**

(a) The mass of the satellite only

(b) The radius of the earth only

(c) The orbital radius only

(d) The mass of the earth only

12. Two satellites A and B go round a planet P in circular orbits having radii $4R$ and R respectively. If the speed of the satellite A is $3V$, the speed of the satellite B will be.

[MNR 1991; AIIMS 1995; UPSEAT 2000]

(a) 12 V (b) 6 V

(c) $\frac{4}{3}V$ (d) $\frac{3}{2}V$

13. A small satellite is revolving near earth's surface. Its orbital velocity will be nearly

[CPMT 1987; Orissa JEE 2002; JIPMER 2001, 02]

(a) 8 *km/sec* (b) 11.2 *km/sec*

(c) 4 *km/sec* (d) 6 *km/sec*

14. A satellite revolves around the earth in an elliptical orbit. Its speed **[NCERT 1981; MP PET 2001]**

(a) Is the same at all points in the orbit

(b) Is greatest when it is closest to the earth

(c) Is greatest when it is farthest from the earth

(d) Goes on increasing or decreasing continuously depending upon the mass of the satellite

15. 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

[MNR 1994]

(a) $\frac{3}{2}v$ (b) $\sqrt{\frac{3}{2}}v$

(c) $\sqrt{\frac{2}{3}}v$ (d) $\frac{2}{3}v$

16. In a satellite if the time of revolution is T, then K.E. is proportional to **[BHU 1995]**

(a) $\frac{1}{T}$ (b) $\frac{1}{T^2}$

(c) $\frac{1}{T^3}$ (d) $T^{-2/3}$

17. If the height of a satellite from the earth is negligible in comparison to the radius of the earth R, the orbital velocity of the satellite is **[MP PET 1995; RPET 2001]**

(a) gR (b) $gR/2$

(c) $\sqrt{g/R}$ (d) $\sqrt{gR}$

18. Choose the correct statement from the following : The radius of the orbit of a geostationary satellite depends upon

[MP PMT 1995]

(a) Mass of the satellite, its time period and the gravitational constant

(b) Mass of the satellite, mass of the earth and the gravitational constant

(c) Mass of the earth, mass of the satellite, time period of the satellite and the gravitational constant

(d) Mass of the earth, time period of the satellite and the gravitational constant

19. Out of the following, the only incorrect statement about satellites is **[Haryana CEE 1996]**

(a) A satellite cannot move in a stable orbit in a plane passing through the earth's centre

(b) Geostationary satellites are launched in the equatorial plane

(c) We can use just one geostationary satellite for global communication around the globe

(d) The speed of a satellite increases with an increase in the radius of its orbit

20. A satellite is moving around the earth with speed v in a circular orbit of radius r. If the orbit radius is decreased by 1%, its speed will **[MP PET 1996, 99, 2002]**

(a) Increase by 1% (b) Increase by 0.5%

(c) Decrease by 1% (d) Decrease by 0.5%

21. Orbital velocity of an artificial satellite does not depend upon **[MP PMT 1996]**

(a) Mass of the earth

(b) Mass of the satellite

(c) Radius of the earth

(d) Acceleration due to gravity

22. The time period of a geostationary satellite is **[EAMCET 1994; MP PMT 1999]**

(a) 24 hours (b) 12 hours

(c) 365 days (d) One month

23. Two identical satellites are at R and $7R$ away from earth surface, the wrong statement is (R = Radius of earth) **[RPMT 1997]**

(a) Ratio of total energy will be 4

(b) Ratio of kinetic energies will be 4

(c) Ratio of potential energies will be 4

(d) Ratio of total energy will be 4 but ratio of potential and kinetic energies will be 2

24. For a satellite escape velocity is 11 km/s. If the satellite is launched at an angle of 60° with the vertical, then escape velocity will be **[CBSE PMT 1993; RPMT 1997]**

(a) 11 km/s (b) $11\sqrt{3}\ km/s$

(c) $\frac{11}{\sqrt{3}}\ km/s$ (d) 33 km/s

25. A ball is dropped from a spacecraft revolving around the earth at a height of 120 km. What will happen to the ball **[CBSE PMT 1996; CPMT 2001; BHU 1999]**

(a) It will continue to move with velocity v along the original orbit of spacecraft

(b) It will move with the same speed tangentially to the spacecraft

(c) It will fall down to the earth gradually

(d) It will go very far in the space

26. An artificial satellite is placed into a circular orbit around earth at such a height that it always remains above a definite place on the surface of earth. Its height from the surface of earth is **[AMU 1999]**

(a) 6400 km (b) 4800 km

(c) 32000 km (d) 36000 km

27. The weight of an astronaut, in an artificial satellite revolving around the earth, is **[BHU 1999]**

(a) Zero

(b) Equal to that on the earth

(c) More than that on the earth

(d) Less than that on the earth

28. In the following four periods **[AMU 2000]**

(i) Time of revolution of a satellite just above the earth's surface (T_{st})

(ii) Period of oscillation of mass inside the tunnel bored along the diameter of the earth (T_{ma})

(iii) Period of simple pendulum having a length equal to the earth's radius in a uniform field of 9.8 N/kg (T_{sp})

(iv) Period of an infinite length simple pendulum in the earth's real gravitational field (T_{is})

(a) $T_{st} > T_{ma}$ (b) $T_{ma} > T_{st}$

(c) $T_{sp} < T_{is}$ (d) $T_{st} = T_{ma} = T_{sp} = T_{is}$

29. Which of the following statements is correct in respect of a geostationary satellite **[MP PET 2001]**

(a) It moves in a plane containing the Greenwich meridian

(b) It moves in a plane perpendicular to the celestial equatorial plane

(c) Its height above the earth's surface is about the same as the radius of the earth

(d) Its height above the earth's surface is about six times the radius of the earth

30. 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

31. If Gravitational constant is decreasing in time, what will remain unchanged in case of a satellite orbiting around earth **[DCE 1999, 2001]**

(a) Time period (b) Orbiting radius

(c) Tangential velocity (d) Angular velocity

32. Given radius of Earth 'R' and length of a day 'T' the height of a geostationary satellite is [G–Gravitational Constant, M–Mass of Earth] **[MP PMT 2002]**

(a) $\left(\frac{4\pi^2 GM}{T^2}\right)^{1/3}$ (b) $\left(\frac{4\pi GM}{R^2}\right)^{1/3} - R$

(c) $\left(\frac{GMT^2}{4\pi^2}\right)^{1/3} - R$ (d) $\left(\frac{GMT^2}{4\pi^2}\right)^{1/3} + R$

33. 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.) 2002; Pb. PET 2003]**

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

(c) 6 hr (d) $6\sqrt{2}\ hr$

34. The distance between centre of the earth and moon is 384000 km. If the mass of the earth is $6\times10^{24}\,kg$ and

$G = 6.66 \times 10^{-11}\, Nm^2/kg^2$. The speed of the moon is nearly **[MH CET 2002]**

(a) 1 km/sec (b) 4 km/sec

(c) 8 km/sec (d) 11.2 km/sec

35. A satellite is launched into a circular orbit of radius 'R' around earth while a second satellite is launched into an orbit of radius 1.02 R. The percentage difference in the time periods of the two satellites is **[EAMCET 2003]**

(a) 0.7 (b) 1.0

(c) 1.5 (d) 3

36. Distance of geostationary satellite from the surface of earth $radius(R_e = 6400\ km)$ in terms of R_e is

[Pb. PET 2000]

(a) 13.76 R_e (b) 10.76 R_e

(c) 6.56 R_e (d) 2.56 R_e

37. Two satellite A and B, ratio of masses 3 : 1 are in circular orbits of radii r and $4r$. Then ratio of total mechanical energy of A to B is **[DCE 2002]**

(a) 1 : 3 (b) 3 : 1

(c) 3 : 4 (d) 12 : 1

38. The orbital velocity of a planet revolving close to earth's surface is **[RPMT 2002, 03]**

(a) $\sqrt{2gR}$ (b) $\sqrt{gR}$

(c) $\sqrt{\frac{2g}{R}}$ (d) $\sqrt{\frac{g}{R}}$

39. If the gravitational force between two objects were proportional to $1/R$ (and not as $1/R^2$) where R is separation between them, then a particle in circular orbit under such a force would have its orbital speed v proportional to **[CBSE PMT 1994; JIPMER 2001, 02]**

(a) $1/R^2$ (b) R^0

(c) R^1 (d) $1/R$

40. A satellite moves around the earth in a circular orbit of radius r with speed v. If the mass of the satellite is M, its total energy is **[MP PMT 2001]**

(a) $-\frac{1}{2}Mv^2$ (b) $\frac{1}{2}Mv^2$

(c) $\frac{3}{2}Mv^2$ (d) Mv^2

41. A satellite with kinetic energy E_k is revolving round the earth in a circular orbit. How much more kinetic energy should be given to it so that it may just escape into outer space **[KCET (Engg./Med.) 2001]**

(a) E_k (b) $2\,E_k$

(c) $\frac{1}{2}E_k$ (d) $3\,E_k$

42. Potential energy of a satellite having mass 'm' and rotating at a height of $6.4 \times 10^6\, m$ from the earth surface is

[AIIMS 2000; CBSE PMT 2001; BHU 2001]

(a) $-0.5\, mgR_e$ (b) $-mgR_e$

(c) $-2\, mgR_e$ (d) $4\, mgR_e$

43. When a satellite going round the earth in a circular orbit of radius r and speed v loses some of its energy, then r and v change as **[JIPMER 2002; EAMCET 2000]**

(a) r and v both with increase

(b) r and v both will decrease

(c) r will decrease and v will increase

(d) r will decrease and v will decrease

44. An earth satellite S has an orbit radius which is 4 times that of a communication satellite C. The period of revolution of S is **[MP PMT 1994; DCE 1999]**

(a) 4 days (b) 8 days

(c) 16 days (d) 32 days

45. Which is constant for a satellite in orbit

[Bihar CMEET 1995]

(a) Velocity (b) Angular momentum

(c) Potential energy (d) Acceleration

(e) Kinetic energy

46. If satellite is shifted towards the earth. Then time period of satellite will be **[RPMT 2000]**

(a) Increase (b) Decrease

(c) Unchanged (d) Nothing can be said

47. The time period of a satellite of earth is 5 $hours$. If the separation between the earth and the satellite is increased to four times the previous value, the new time period will become **[AIIMS 1995; AIEEE 2003]**

(a) 20 $hours$ (b) 10 $hours$

(c) 80 $hours$ (d) 40 $hours$

48. A satellite moves round the earth in a circular orbit of radius R making one revolution per day. A second satellite moving in a circular orbit, moves round the earth once in 8 days. The radius of the orbit of the second satellite is

[UPSEAT 2004]

(a) 8 R (b) 4R

(c) 2R (d) R

49. A person sitting in a chair in a satellite feels weightless because **[UPSEAT 2004]**

(a) The earth does not attract the objects in a satellite

(b) The normal force by the chair on the person balances the earth's attraction

(c) The normal force is zero

(d) The person in satellite is not accelerated

50. If $g \propto \frac{1}{R^3}$ (instead of $\frac{1}{R^2}$), then the relation between time period of a satellite near earth's surface and radius R will be **[RPMT 2002]**

(a) $T^2 \propto R^3$ (b) $T \propto R^2$

(c) $T^2 \propto R$ (d) $T \propto R$

51. To an astronaut in a spaceship, the sky appears

[KCET 1994]

(a) Black (b) White

(c) Green (d) Blue

52. A geostationary satellite is revolving around the earth. To make it escape from gravitational field of earth, is velocity must be increased **[J&K CET 2005]**

(a) 100% (b) 41.4%

(c) 50% (d) 59.6%

53. A satellite of mass m is placed at a distance r from the centre of earth (mass M). The mechanical energy of the satellite is

[J&K CET 2005]

(a) $-\frac{GMm}{r}$ (b) $\frac{GMm}{r}$

(c) $\frac{GMm}{2r}$ (d) $-\frac{GMm}{2r}$

Kepler's Laws of Planetary Motion

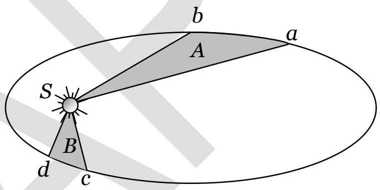
1. The distance of neptune and saturn from sun are nearly 10^{13} and 10^{12} meters respectively. Assuming that they move in circular orbits, their periodic times will be in the ratio **[NCERT 1975; CBSE PMT 1994; MP PET 2001]**

(a) $\sqrt{10}$ (b) 100

(c) $10\sqrt{10}$ (d) $1/\sqrt{10}$

2. The figure shows the motion of a planet around the sun in an elliptical orbit with sun at the focus. The shaded areas A and B are also shown in the figure which can be assumed to be equal. If t_1 and t_2 represent the time for the planet to move from a to b and d to c respectively, then

[CPMT 1986, 88]



(a) $t_1 < t_2$

(b) $t_1 > t_2$

(c) $t_1 = t_2$

(d) $t_1 \le t_2$

3. 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 PMT 2002]**

(a) $4T$ (b) $T/4$

(c) $8T$ (d) $T/8$

4. Orbit of a planet around a star is **[CPMT 1982]**

(a) A circle (b) An ellipse

(c) A parabola (d) A straight line

5. If a body describes a circular motion under inverse square field, the time taken to complete one revolution T is related to the radius of the circular orbit as

[NCERT 1975; RPMT 2000]

(a) $T \propto r$ (b) $T \propto r^2$

(c) $T^2 \propto r^3$ (d) $T \propto r^4$

6. If the earth is at one-fourth of its present distance from the sun, the duration of the year will be **[EAMCET 1987]**

(a) Half the present year

(b) One-eighth the present year

(c) One-fourth the present year

(d) One-sixth the present year

7. The earth revolves about the sun in an elliptical orbit with mean radius $9.3 \times 10^7\ m$ in a period of 1 year. Assuming that there are no outside influences

(a) The earth's kinetic energy remains constant

(b) The earth's angular momentum remains constant

(c) The earth's potential energy remains constant

(d) All are correct

8. Venus looks brighter than other planets because

[MNR 1985]

(a) It is heavier than other planets

(b) It has higher density than other planets

(c) It is closer to the earth than other planets

(d) It has no atmosphere

9. A planet moves around the sun. At a given point P, it is closest from the sun at a distance d_1 and has a speed v_1. At another point Q, when it is farthest from the sun at a distance d_2, its speed will be **[MP PMT 1987; DCE 2002]**

(a) $\frac{d_1^2 v_1}{d_2^2}$ (b) $\frac{d_2 v_1}{d_1}$

(c) $\frac{d_1 v_1}{d_2}$ (d) $\frac{d_2^2 v_1}{d_1^2}$

10. The orbital speed of Jupiter is **[MNR 1986; UPSEAT 2000]**

(a) Greater than the orbital speed of earth

(b) Less than the orbital speed of earth

(c) Equal to the orbital speed of earth

(d) Zero

11. Two planets move around the sun. The periodic times and the mean radii of the orbits are T_1, T_2 and r_1, r_2 respectively. The ratio T_1 / T_2 is equal to **[CPMT 1978]**

(a) $(r_1/r_2)^{1/2}$ (b) r_1/r_2

(c) $(r_1/r_2)^2$ (d) $(r_1/r_2)^{3/2}$

12. Kepler's second law regarding constancy of aerial velocity of a planet is a consequence of the law of conservation of

[CPMT 1990; AIIMS 2002]

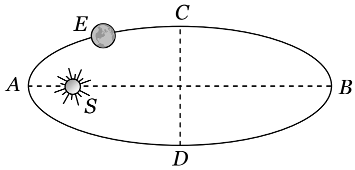
(a) Energy (b) Angular momentum

(c) Linear momentum (d) None of these

13. 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) $M\sqrt{\frac{GM}{R_0}}$

14. The earth E moves in an elliptical orbit with the sun S at one of the foci as shown in figure. Its speed of motion will be maximum at the point **[BHU 1994; CPMT 1997]**



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

15. The period of revolution of planet A around the sun is 8 times that of B. The distance of A from the sun is how many times greater than that of B from the sun **[CBSE PMT 1997; BHU 2001]**

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

16. If the radius of earth's orbit is made 1/4, the duration of an year will become **[BHU 1998; JIPMER 2001, 2002]**

(a) 8 times
(b) 4 times
(c) 1/8 times
(d) 1/4 times

17. Planetary system in the solar system describes **[DCE 1999]**

(a) Conservation of energy
(b) Conservation of linear momentum
(c) Conservation of angular momentum
(d) None of these

18. Kepler discovered **[DCE 2000]**

(a) Laws of motion
(b) Laws of rotational motion
(c) Laws of planetory motion
(d) Laws of curvilinear motion

19. In the solar system, which is conserved **[DCE 2001]**

(a) Total Energy
(b) K.E.
(c) Angular Velocity
(d) Linear Momentum

20. The maximum and minimum distances of a comet from the sun are $8\times10^{12}\,m$ and $1.6\times10^{12}\,m$. If its velocity when nearest to the sun is 60 m/s, what will be its velocity in m/s when it is farthest **[Orissa 2001]**

(a) 12
(b) 60
(c) 112
(d) 6

21. 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 (Med.) 2002]**

(a) $n_1^2d_1^2 = n_2d_2^2$
(b) $n_2^2d_2^3 = n_1^2d_1^3$
(c) $n_1d_1^2 = n_2d_2^2$
(d) $n_1^2d_1 = n_2^2d_2$

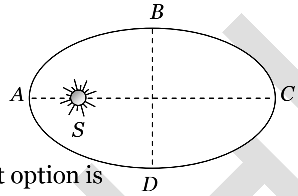
22. Which of the following astronomer first proposed that sun is static and earth rounds sun **[AFMC 2002]**

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

23. The distance of a planet from the sun is 5 times the distance between the earth and the sun. The time period of the planet is **[UPSEAT 2003]**

(a) $5^{3/2}$ *years*
(b) $5^{2/3}$ *years*
(c) $5^{1/3}$ *years*
(d) $5^{1/2}$ *years*

24. A planet is revolving around the sun as shown in elliptical path **[UPSEAT 2003]**



The correct option is

(a) The time taken in travelling DAB is less than that for BCD
(b) The time taken in travelling DAB is greater than that for BCD
(c) The time taken in travelling CDA is less than that for ABC
(d) The time taken in travelling CDA is greater than that for ABC

25. In the previous question the orbital velocity of the planet will be minimum at **[UPSEAT 2003; RPET 2002]**

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

26. The radius of orbit of a planet is two times that of the earth. The time period of planet is **[BHU 2003; CPMT 2004]**

(a) 4.2 *years*
(b) 2.8 *years*
(c) 5.6 *years*
(d) 8.4 *years*

27. The orbital angular momentum of a satellite revolving at a distance r from the centre is L. If the distance is increased to $16r$, then the new angular momentum will be **[MP PET 2003]**

(a) $16\,L$
(b) $64\,L$
(c) $\frac{L}{4}$
(d) $4\,L$

28. According to Kepler's law the time period of a satellite varies with its radius as **[Orissa JEE 2003]**

(a) $T^2 \propto R^3$
(b) $T^3 \propto R^2$
(c) $T^2 \propto (1/R^3)$
(d) $T^3 \propto (1/R^2)$

29. In planetary motion the areal velocity of position vector of a planet depends on angular velocity (ω) and the distance of the planet from sun (r). If so the correct relation for areal velocity is **[EAMCET 2003]**

(a) $\frac{dA}{dt} \propto \omega r$
(b) $\frac{dA}{dt} \propto \omega^2 r$
(c) $\frac{dA}{dt} \propto \omega r^2$
(d) $\frac{dA}{dt} \propto \sqrt{\omega r}$

30. Kepler's second law (law of areas) is nothing but a statement of **[UPSEAT 2004]**

(a) Work energy theorem
(b) Conservation of linear momentum

(c) Conservation of angular momentum

(d) Conservation of energy

31. If a new planet is discovered rotating around Sun with the orbital radius double that of earth, then what will be its time period (in earth's days) **[DCE 2004]**

(a) 1032 (b) 1023

(c) 1024 (d) 1043

32. Suppose the law of gravitational attraction suddenly changes and becomes an inverse cube law i.e. $F \propto 1/r^3$, but still remaining a central force. Then **[UPSEAT 2002]**

(a) Keplers law of areas still holds

(b) Keplers law of period still holds

(c) Keplers law of areas and period still hold

(d) Neither the law of areas, nor the law of period still holds

33. What does not change in the field of central force **[MP PMT 2004]**

(a) Potential energy (b) Kinetic energy

(c) Linear momentum (d) Angular momentum

34. The eccentricity of earth's orbit is 0.0167. The ratio of its maximum speed in its orbit to its minimum speed is **[NCERT 1973]**

(a) 2.507 (b) 1.033

(c) 8.324 (d) 1.000

35. The mass of a planet that has a moon whose time period and orbital radius are T and R respectively can be written as **[AMU 1995]**

(a) $4\pi^2R^3G^{-1}T^{-2}$ (b) $8\pi^2R^3G^{-1}T^{-2}$

(c) $12\pi^2R^3G^{-1}T^{-2}$ (d) $16\pi^2R^3G^{-1}T^{-2}$

36. If orbital velocity of planet is given by $v = G^aM^bR^c$, then **[EAMCET 1994]**

(a) $a = 1/3, b = 1/3, c = -1/3$

(b) $a = 1/2, b = 1/2, c = -1/2$

(c) $a = 1/2, b = -1/2, c = 1/2$

(d) $a = 1/2, b = -1/2, c = -1/2$

37. Hubble's law states that the velocity with which milky way is moving away from the earth is proportional to **[Kerala PMT 2004]**

(a) Square of the distance of the milky way from the earth

(b) Distance of milky way from the earth

(c) Mass of the milky way

(d) Product of the mass of the milky way and its distance from the earth

(e) Mass of the earth

38. The condition for a uniform spherical mass m of radius r to be a black hole is [G= gravitational constant and g= acceleration due to gravity] **[AIIMS 2005]**

(a) $(2Gm/r)^{1/2} \le c$ (b) $(2Gm/r)^{1/2} = c$

(c) $(2Gm/r)^{1/2} \ge c$ (d) $(gm/r)^{1/2} \ge c$

39. Earth is revolving around the sun if the distance of the Earth from the Sun is reduced to 1/4th of the present distance then the present day length reduced by **[BHU 2005]**

(a) $\frac{1}{4}$ (b) $\frac{1}{2}$

(c) $\frac{1}{8}$ (d) $\frac{1}{6}$

Smart Thinking

1. 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 $R^{-\frac{5}{2}}$, then T^2 is proportional to **[IIT 1989; RPMT 1997]**

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

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

2. The magnitudes of the gravitational force at distances r_1 and r_2 from the centre of a uniform sphere of radius R and mass M are F_1 and F_2 respectively. Then **[IIT 1994]**

(a) $\frac{F_1}{F_2} = \frac{r_1}{r_2}$ if $r_1 < R$ and $r_2 < R$

(b) $\frac{F_1}{F_2} = \frac{r_1^2}{r_2^2}$ if $r_1 > R$ and $r_2 > R$

(c) $\frac{F_1}{F_2} = \frac{r_1}{r_2}$ if $r_1 > R$ and $r_2 > R$

(d) $\frac{F_1}{F_2} = \frac{r_2^2}{r_1^2}$ if $r_1 < R$ and $r_2 < R$

3. A satellite S is moving in an elliptical orbit around the earth. The mass of the satellite is very small compared to the mass of earth **[IIT 1998]**

(a) The acceleration of S is always directed towards the centre of the earth

(b) The angular momentum of S about the centre of the earth changes in direction but its magnitude remains constant

(c) The total mechanical energy of S varies periodically with time

(d) The linear momentum of S remains constant in magnitude

4. 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 **[AMU 2000]**

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

5. Suppose the gravitational force varies inversely as the n^{th} power of distance. Then the time period of a planet in circular orbit of radius R around the sun will be proportional to

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

(c) R^n (d) $R^{\left(\frac{n-2}{2}\right)}$

6. If the radius of the earth were to shrink by 1% its mass remaining the same, the acceleration due to gravity on the earth's surface would **[IIT 1981; CPMT 1981; MP PMT 1996, 97; Roorkee 1992; MP PET 1999; Kerala PMT 2004]**

(a) Decrease by 2% (b) Remain unchanged
(c) Increase by 2% (d) Increase by 1%

7. The radius and mass of earth are increased by 0.5%. Which of the following statements are true 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

8. In order to make the effective acceleration due to gravity equal to zero at the equator, the angular velocity of rotation of the earth about its axis should be $(g = 10\,ms^{-2}$ and radius of earth is 6400 kms) **[Roorkee 2000]**

(a) $0\ rad\sec^{-1}$ (b) $\frac{1}{800} rad\sec^{-1}$

(c) $\frac{1}{80} rad\sec^{-1}$ (d) $\frac{1}{8} rad\sec^{-1}$

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

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

10. A body of mass m is taken from earth surface to the height h equal to radius of earth, the increase in potential energy will be **CBSE PMT 1991; Kurukshetra CEE 1996; CMEET Bihar 1995; MNR 1998; AIEEE 2004]**

(a) mgR (b) $\frac{1}{2} mgR$

(c) $2\ mgR$ (d) $\frac{1}{4} mgR$

11. An artificial satellite moving in a circular orbit around the earth has a total (kinetic + potential) energy E_0. Its potential energy is **[IIT 1997 Cancelled; MH CET 2002; MP PMT 2000]**

(a) $-E_0$ (b) $1.5\ E_0$
(c) $2\ E_0$ (d) E_0

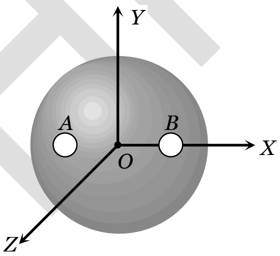
12. A rocket of mass M is launched vertically from the surface of the earth with an initial speed V. Assuming the radius of the earth to be R and negligible air resistance, the maximum height attained by the rocket above the surface of the earth is**[AMU 1995]**

[AIEEE 2004]

(a) $R / \left(\frac{gR}{2V^2} - 1\right)$ (b) $R\left(\frac{gR}{2V^2} - 1\right)$

(c) $R / \left(\frac{2gR}{V^2} - 1\right)$ (d) $R\left(\frac{2gR}{V^2} - 1\right)$

13. 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



(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 $y^2 + z^2 = 4$

14. Two bodies of masses m_1 and m_2 are initially at rest at infinite distance apart. They are then allowed to move towards each other under mutual gravitational attraction. Their relative velocity of approach at a separation distance r between them is **[BHU 1994; RPET 1999]**

(a) $\left[2G\frac{(m_1 - m_2)}{r}\right]^{1/2}$ (b) $\left[\frac{2G}{r}(m_1 + m_2)\right]^{1/2}$

(c) $\left[\frac{r}{2G(m_1 m_2)}\right]^{1/2}$ (d) $\left[\frac{2G}{r} m_1 m_2\right]^{1/2}$

15. A projectile is projected with velocity kv_e in vertically upward direction from the ground into the space. (v_e is escape velocity and $k < 1$). If air resistance is considered to be negligible then the maximum height from the centre of earth to which it can go, will be : (R = radius of earth) **[NCERT 1971; CPMT 1971, 97; IIT 1983]** **[Roorkee 1999; RPET 1999]**

(a) $\frac{R}{k^2 + 1}$ (b) $\frac{R}{k^2 - 1}$

(c) $\frac{R}{1 - k^2}$ (d) $\frac{R}{k + 1}$

16. 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 1995]**

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

17. 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 1996; RPET 1996]**

(a) 64.5 (b) 129

(c) 182.5 (d) 730

18. 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 ($R_{\text{Earth}} = 6400\,km$) will approximately be

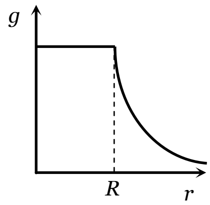
[IIT-JEE (Screening) 2002]

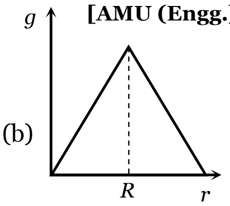
(a) $1/2\,h$ (b) $1\,h$

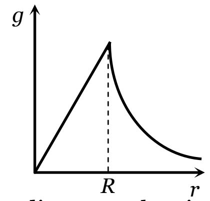
(c) $2\,h$ (d) $4\,h$

Graphical

1. Assuming the earth to have a constant density, point out which of the following curves show the variation of acceleration due to gravity from the centre of earth to the points far away from the surface of earth **[AMU (Engg.) 2000]**

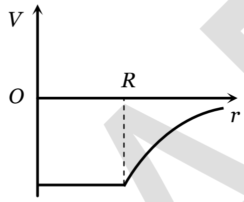
(a) 

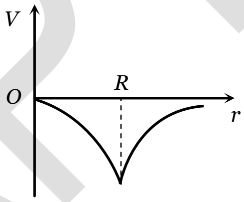
(b) 

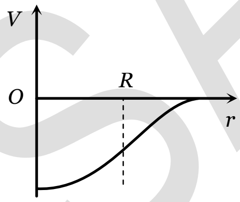
(c) 

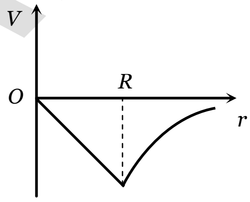
(d) None of these

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

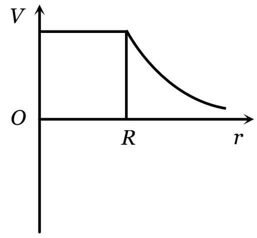
(a) 

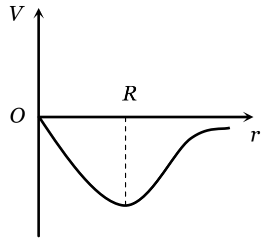
(b) 

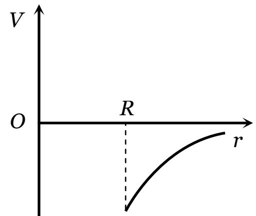
(c) 

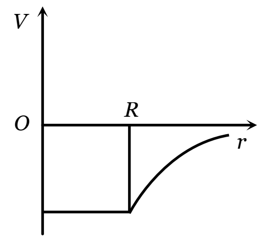
(d) 

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

(a) 

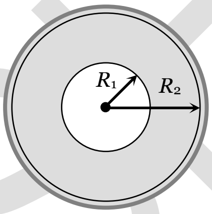
(b) 

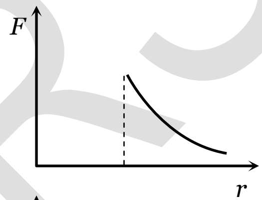


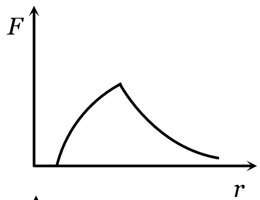
(c) 

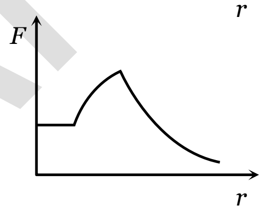
(d)

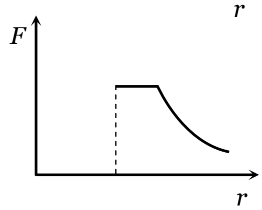
4. A sphere of mass M and radius R_2 has a concentric cavity of radius R_1 as shown in figure. The force F exerted by the sphere on a particle of mass m located at a distance r from the centre of sphere varies as $(0 \le r \le \infty)$



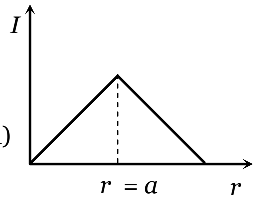
(a) 

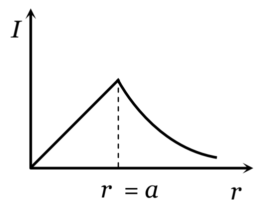
(b) 

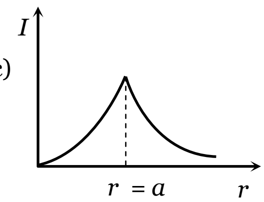
(c) 

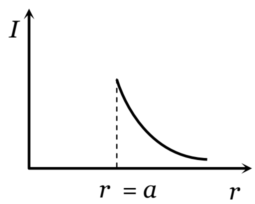
(d) 

5. 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) 

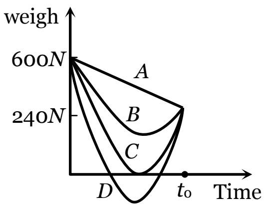
(b) 

(c) 

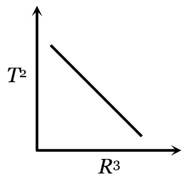
(d) 

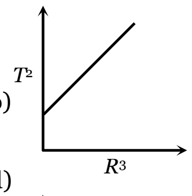
6. Suppose, the acceleration due to gravity at the earth's surface is 10 m/s^2 and at the surface of Mars it is 4.0 m/s^2. A 60 *kg* passenger goes from the earth to the Mars in a spaceship moving with a constant velocity. Neglect all other objects in the sky. Which part of figure best represents the weight (net gravitational force)of the passenger as a function of time.

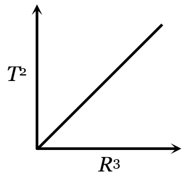
(a) A
(b) B
(c) C
(d) D

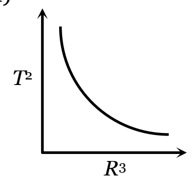


7. Which of the following graphs represents the motion of a planet moving about the sun **[NCERT 1983]**

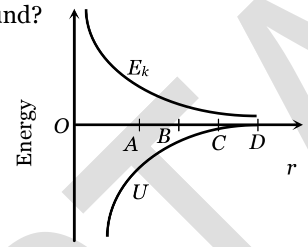
(a)


(b)


(c)


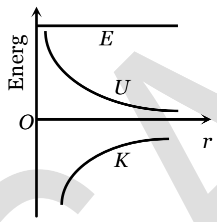
(d)


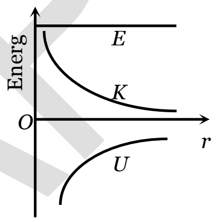
8. The curves for potential energy (U) and kinetic energy (E_k) of a two particle system are shown in figure. At what points the system will be bound?

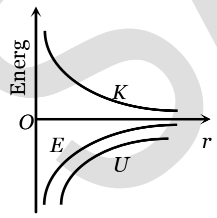


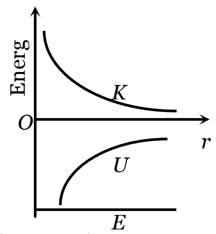
(a) Only at point D
(b) Only at point A
(c) At point D and A
(d) At points A, B and C

9. The correct graph representing the variation of total energy (E_t) kinetic energy (E_k) and potential energy (U) of a satellite with its distance from the centre of earth is

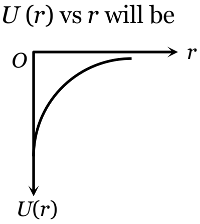
(a)


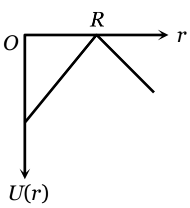
(b)


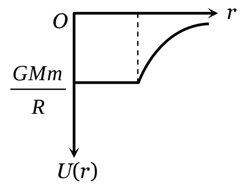
(c)


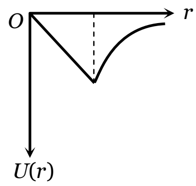
(d)


10. A shell of mass M and radius R has a point mass m placed at a distance r from its centre. The gravitational potential energy $U(r)$ vs r will be

(a)


(b)


(c)


(d)


Assertion and Reasoning

Read the assertion and reason carefully to mark the correct option out of the options given below:

(a) If both assertion and reason are true and the reason is the correct explanation of the assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of the assertion.
(c) If assertion is true but reason is false.
(d) If the assertion and reason both are false.
(e) If assertion is false but reason is true.

1. Assertion : Smaller the orbit of the planet around the sun, shorter is the time it takes to complete one revolution.
Reason : According to Kepler's third law of planetary motion, square of time period is proportional to cube of mean distance from sun.

2. Assertion : Gravitational force between two particles is negligibly small compared to the electrical force.
Reason : The electrical force is experienced by charged particles only.

3. Assertion : The universal gravitational constant is same as acceleration due to gravity.
Reason : Gravitational constant and acceleration due to gravity have same dimensional formula.

4. Assertion : The value of acceleration due to gravity does not depend upon mass of the body on which force is applied.
Reason : Acceleration due to gravity is a constant quantity.

5. Assertion : If a pendulum is suspended in a lift and lift is falling freely, then its time period becomes infinite.
Reason : Free falling body has acceleration equal to acceleration due to gravity.

6. Assertion : If earth suddenly stops rotating about its axis, then the value of acceleration due to gravity will become same at all the places.
Reason : The value of acceleration due to gravity is independent of rotation of earth.

7. Assertion : The difference in the value of acceleration due to gravity at pole and equator is proportional to square of angular velocity of earth.

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

8. Assertion : There is no effect of rotation of earth on acceleration due to gravity at poles.

Reason : Rotation of earth is about polar axis.

9. Assertion : A force act upon the earth revolving in a circular orbit about the sun. Hence work should be done on the earth.

Reason : The necessary centripetal force for circular motion of earth comes from the gravitational force between earth and sun.

10. Assertion : The ratio of inertial mass to gravitational mass is equal to one.

Reason : The inertial mass and gravitational mass of a body are equivalent.

11. Assertion : Gravitational potential of earth at every place on it is negative.

Reason : Every body on earth is bound by the attraction of earth.

12. Assertion : Even when orbit of a satellite is elliptical, its plane of rotation passes through the centre of earth.

Reason : According to law of conservation of angular momentum plane of rotation of satellite always remain same.

13. Assertion : A planet moves faster, when it is closer to the sun in its orbit and vice versa.

Reason : Orbital velocity in orbital of planet is constant.

14. Assertion : Orbital velocity of a satellite is greater than its escape velocity.

Reason : Orbit of a satellite is within the gravitational field of earth whereas escaping is beyond the gravitational field of earth.

15. Assertion : If an earth satellite moves to a lower orbit, there is some dissipation of energy but the satellite speed increases.

Reason : The speed of satellite is a constant quantity.

16. Assertion : Earth has an atmosphere but the moon does not.

Reason : Moon is very small in comparison to earth.

17. Assertion : The time period of geostationary satellite is 24 hours.

Reason : Geostationary satellite must have the same time period as the time taken by the earth to complete one revolution about its axis.

18. Assertion : The principle of superposition is not valid for gravitational force.

Reason : Gravitational force is a conservative force.

19. Assertion : Two different planets have same escape velocity.

Reason : Value of escape velocity is a universal constant.

20. Assertion : The time period of revolution of a satellite close to surface of earth is smaller than that revolving away from surface of earth.

Reason : The square of time period of revolution of a satellite is directly proportional to cube of its orbital radius.

21. Assertion : When distance between two bodies is doubled and also mass of each body is also doubled, gravitational force between them remains the same.

Reason : According to Newton's law of gravitation, force is directly proportional to mass of bodies and inversely proportional to square of distance between them.

22. Assertion : Generally the path of a projectile from the earth is parabolic but it is elliptical for projectiles going to a very large height.

Reason : The path of a projectile is independent of the gravitational force of earth.

23. Assertion : A body becomes weightless at the centre of earth.

Reason : As the distance from centre of earth decreases, acceleration due to gravity increases.

24. Assertion : Space rockets are usually launched in the equatorial line from west to east.

Reason : The acceleration due to gravity is minimum at the equator.

25. Assertion : The binding energy of a satellite does not depend upon the mass of the satellite.

Reason : Binding energy is the negative value of total energy of satellite.

26. Assertion : We can not move even a finger without disturbing all the stars.

Reason : Every body in this universe attracts every other body with a force which is inversely proportional to the square of distance between them.

27. Assertion : If earth were a hollow sphere, gravitational field intensity at any point inside the earth would be zero.

Reason : Net force on a body inside the sphere is zero.

28. Assertion : For a satellite revolving very near to earth's surface the time period of revolution is given by 1 hour 24 minutes.

Reason : The period of revolution of a satellite depends only upon its height above the earth's surface.

29. Assertion : A person sitting in an artificial satellite revolving around the earth feels weightless.

Reason : There is no gravitational force on the satellite.

30. Assertion : The speed of satellite always remains constant in an orbit.

Reason : The speed of a satellite depends on its path.

31. Assertion : The speed of revolution of an artificial satellite revolving very near the earth is $8\,kms^{-1}$.

Reason : Orbital velocity of a satellite, become independent of height of near satellite.

32. Assertion : Gravitational field is zero both at centre and infinity.

Reason : The dimensions of gravitational field is $[LT^{-2}]$.

33. Assertion : For the planets orbiting around the sun, angular speed, linear speed, *K.E.* changes with time, but angular momentum remains constant.

Reason : No torque is acting on the rotating planet. So its angular momentum is constant.

Answers For Gravitation MCQ's

Newton's Law of Gravitation

1	2	3	4	5	6	7	8	9	10
B	B	A	D	B	C	D	D	A	D
11	12	13	14	15	16				
B	A	C	A	E	C				

Acceleration Due to Gravity

1	2	3	4	5	6	7	8	9	10
D	B	D	A	B	A	B	D	C	A
11	12	13	14	15	16	17	18	19	20
B	C	A	C	C	C	A	D	A	C
21	22	23	24	25	26	27	28	29	30
D	D	B	B	B	A	B	A	C	B
31	32	33	34	35	36	37	38	39	40
C	A	D	B	C	C	C	B	C	A
41	42	43	44	45	46	47	48	49	50
A	A	A	C	A	C	C	C	A	C
51	52	53	54	55	56	57			

A	A	B	A	B	A	B

Gravitation Potential, Energy and Escape Velocity

1	2	3	4	5	6	7	8	9	10
C	A	D	D	A	C	C	C	D	A
11	12	13	14	15	16	17	18	19	20
B	B	A	D	C	A	B	B	C	B
21	22	23	24	25	26	27	28	29	30
A	C	A	B	B	C	B	A	B	C
31	32	33	34	35	36	37	38	39	40
A	C	D	A	C	C	C	C	D	A
41	42	43	44	45	46	47	48	49	50
B	D	A	B	D	A	B	A	B	D
51	52	53	54	55	56				
B	B	B	A	A	A				

Motion Of Satellite

1	2	3	4	5	6	7	8	9	10
B	D	D	D	B	B	B	B	C	C
11	12	13	14	15	16	17	18	19	20
B	B	A	B	C	D	D	D	D	B
21	22	23	24	25	26	27	28	29	30
B	A	D	A	A	D	A	C	D	B
31	32	33	34	35	36	37	38	39	40
C	C	D	A	D	C	D	B	B	A
41	42	43	44	45	46	47	48	49	50
A	A	C	B	B	B	D	B	C	B
51	52	53							
A	B	D							

Kepler's Laws of Planetary Motion

1	2	3	4	5	6	7	8	9	10
C	C	C	A	C	B	B	C	C	B
11	12	13	14	15	16	17	18	19	20
D	B	A	B	C	C	C	C	A	A
21	22	23	24	25	26	27	28	29	30
B	A	A	A	C	B	D	A	C	C
31	32	33	34	35	36	37	38	39	
A	D	D	B	A	B	B	C	C	

Smart Thinking

1	2	3	4	5	6	7	8	9	10
B	AB	A	B	A	C	BCD	B	D	B
11	12	13	14	15	16	17	18		
C	C	ACD	B	C	C	B	C		

Graphical

1	2	3	4	5	6	7	8	9	10
C	C	C	B	D	C	C	D	C	C

Assertion and Reasoning

1	2	3	4	5	6	7	8	9	10
A	B	D	C	A	C	B	A	E	A
11	12	13	14	15	16	17	18	19	20
A	A	C	E	C	B	B	E	D	A
21	22	23	24	25	26	27	28	29	30
A	C	C	B	E	A	A	A	C	E
31	32	33							
A	B	A							