Exercise-1

ONLY ONE OPTION CORRECT TYPE

SECTION (A) : UNIVERSAL LAW OF GRAVITATION

1. Weight of an object is :
(1) Normal reaction between ground and the object
(2) Gravitational force exerted by earth on the object.
(3) dependent on frame of reference.
(4) net force on the object

2. The weight of a body at the centre of the earth is -
(1) Zero (2) Infinite
(3) Same as on the surface of earth (4) None of the above

3. If the distance between two masses is doubled, the gravitational attraction between them.
(1) Is doubled (2) Becomes four times
(3) Is reduced to half (4) Is reduced to a quarter

4. The gravitational force between two stones of mass 1 kg each separated by a distance of 1 metre in vacuum is -
(1) Zero (2) 6.675×10^{-5} newton
(3) 6.675×10^{-11} newton (4) 6.675×10^{-8} newton

5. 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 -
(1) $v = \frac{1}{2R}\sqrt{\frac{1}{Gm}}$ (2) $v = \sqrt{\frac{Gm}{2R}}$ (3) $v = \frac{1}{2}\sqrt{\frac{Gm}{R}}$ (4) $v = \sqrt{\frac{4Gm}{R}}$

6. Reason of weightlessness in a satellite is -
(1) Zero gravity (2) Centre of mass
(3) Zero reaction force by satellite surface (4) None

7. The gravitational force F_g between two objects does not depend on -
(1) Sum of the masses (2) Product of the masses
(3) Gravitational constant (4) Distance between the masses

8. A mass M splits into two parts m and (M – m), which are then separated by a certain distance. What ratio (m/M) maximies the gravitational force between the parts ?
(1) $\frac{2}{3}$ (2) $\frac{3}{4}$ (3) $\frac{1}{2}$ (4) $\frac{1}{3}$

9. On a planet (whose size is the same as that of earth and mass 4 times to the earth) the energy needed to lift a 2kg mass vertically upwards through 2m distance on the planet is ($g = 10 m/sec^2$ on surface of earth)
(1) 16 J (2) 32 J (3) 160 J (4) 320 J

10. The dimensions of universal gravitational constant are :
(1) $[M^{-1}L^3T^{-2}]$ (2) $[ML^2T^{-1}]$ (3) $[M^{-2}L^3T^{-2}]$ (4) $[M^{-2}L^2T^{-1}]$

SECTION (B) : GRAVITATIONAL FIELD AND POTENTIAL

1. 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) -
(1) x = h (2) x = 2h (3) $x = \frac{h}{2}$ (4) $x = h^2$

2. The moon's radius is 1/4 that of the earth and its mass is 1/80 time 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
(1) g/4 (2) g/5 (3) g/6 (4) g/8

3. Assuming the earth to be a homogeneous sphere of radius R, its density in terms of G (constant of gravitation) and g (acceleration due to gravity on the surface of the earth) is
(1) 3g/(4πRG) (2) 4πg/(3RG) (3) 4πRg/(3G) (4) 4πRG/(3g)

4. An object is placed at a distance of R/2 from the centre of earth. Knowing mass is distributed uniformly, acceleration of that object due to gravity at that point is: (g = acceleration due to gravity on the surface of earth and R is the radius of earth)
(1) g (2) 2 g (3) g/2 (4) none of these

5. Altitude at which acceleration due to gravity decreases by 0.1% approximately : (Radius of earth = 6400 km)
(1) 3.2 km (2) 6.4 km (3) 2.4 km (4) 1.6 km

6. 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 -
(1) Unequal (2) Exactly equal (3) Roughly equal (4) Zero

7. The correct answer to above question is based on -
(1) Acceleration due to gravity in vacuum is same irrespective of size and mass of the body
(2) Acceleration due to gravity in vacuum depends on the mass of the body
(3) There is no acceleration due to gravity in vacuum
(4) In vacuum there is resistance offered to the motion of the body and this resistance depends on the mass of the body

8. When a body is taken from the equator to the poles, its appearent weight -
(1) Remains constant (2) Increases
(3) Decreases (4) Increases at N-pole and decreases at S-pole

9. A body of mass m is taken to the bottom of a deep mine. Then -
(1) Its mass increases (2) Its mass decreases
(3) Its weight increases (4) Its weight decreases

10. As we go from the equator to the poles, the value of g
(1) Remains the same (2) Decreases
(3) Increases (4) Decreases upto a latitude of 45º

11. Force of gravity is least at
(1) The equator (2) The poles
(3) A point in between equator and any pole (4) None of these

12. Spot the wrong statement :
The acceleration due to gravity 'g' decreases if -
(1) We go down from the surface of the earth towards its centre
(2)' We go up from the surface of the earth
(3) We go from the equator towards the poles on the surface of the earth
(4) The rotational velocity of the earth is increased

13. Choose the correct statement from the following :
Weightlessness of an astronaut moving in a satellite is a situation of -
(1) Zero g (2) No gravity (3) Zero mass (4) Free fall

14. If the earth suddenly shrinks (without changing mass) to half of its present radius, the acceleration due to gravity will be -
(1) g/2 (2) 4g (3) g/4 (4) 2g

15. 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 -
(1) g/4 (2) g/5 (3) g/6 (4) g/8

16. Radius of earth is around 6000 km. The weight of body at height of 6000 km from earth surface becomes -
(1) Half (2) One-fourth (3) One third (4) No change

17. At what height from the ground will the value of 'g' be the same as that in 10km deep mine below the surface of earth -
(1) 20 km (2) 10 km (3) 15 km (4) 5 km

18. At what distance from the centre of the earth, the value of acceleration due to gravity g will be half that on the surface (R = Radius of earth)
(1) 2R (2) R (3) 1.414 R (4) 0.414 R

19. What will be the acceleration due to gravity at height h if h >> R. Where R is radius of earth and g is acceleration due to gravity on the surface of earth.
(1) $\frac{g}{\left(1+\frac{h}{R}\right)^2}$ (2) $g\left(1-\frac{2h}{R}\right)$ (3) $\frac{g}{\left(1-\frac{h}{R}\right)^2}$ (4) $g\left(1-\frac{h}{R}\right)$

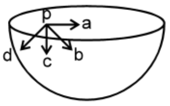
20. If the density of the earth is doubled keeping its radius constant then acceleration due to gravity will be ($g = 9.8$ m/s^2)
(1) 19.6 m/s^2 (2) 9.8 m/s^2 (3) 4.9 m/s^2 (4) 2.45 m/s^2

21. The acceleration due to gravity at pole and equator can be related as -
(1) $g_p < g_e$ (2) $g_p = g_e = g$ (3) $g_p = g_e < g$ (4) $g_p > g_e$

22. The depth at which the effective value of acceleration due to gravity is $\frac{g}{4}$ is -
(1) R (2) $\frac{3R}{4}$ (3) $\frac{R}{2}$ (4) $\frac{R}{4}$

23. Two bodies of mass 100 kg and 10^4 kg are lying one meter apart. At what distance from 100 kg body will the intensity of gravitational field be zero
(1) $\frac{1}{9}\ m$ (2) $\frac{1}{10}\ m$ (3) $\frac{1}{11}\ m$ (4) $\frac{10}{11}\ m$

24. Figure show a hemispherical shell having uniform mass density. The direction of gravitational field intensity at point P will be along:



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

25. Two bodies of mass 10^2 kg and 10^3 kg are lying 1m apart. The gravitational potential at the mid-point of the line joining them is
(1) 0 (2) –1.47 Joule/kg (3) 1.47 Joule/kg (4) -147×10^{-9} joule/kg

26. 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:
(1) 1 (2) $\sqrt{2}$ (3) 4 (4) 2

27. Near earth's time period of a satellite is 4 h. Find its time period at distance 4R from the centre of earth :

(1) 32 h (2) $\left(\frac{1}{8\ ^{3}\sqrt{2}}\right)$ h (3) $8\ ^{3}\sqrt{2}\ \ h$ (4) 16 h

28. The radius of the orbit of a planet is two times that of the earth. The time period of planet is :
(1) 4.2 T (2) 2.8 T (3) 5.6 T (4) 8.4 T

29. In case of earth :
(1) field is zero, both at centre and infinity
(2) potential is zero, both at centre and infinity
(3) potential is same, both at centre and infinity but not zero
(4) potential is maximum at the centre

30. What would be the angular speed of earth, so that bodies lying on equator may appear weightless ? ($g = 10 m/s^2$ and radius of earth = 6400 km)
(1) 1.25×10^{-3} rad/sec (2) 1.25×10^{-2} rad/sec
(3) 1.25×10^{-4} rad/sec (4) 1.25×10^{-1} rad/sec

31. The speed with which the earth have to rotate on its axis so that a person on the equator would weight (3/5)th as much as present will be (Take the equatorial radius as 6400 km.)
(1) 3.28×10^{-4} rad/sec (2) 7.826×10^{-4} rad/sec
(3) 3.28×10^{-3} rad/sec (4) 7.28×10^{-3} rad/sec

SECTION (C) : GRAVITATIONAL POTENTIAL ENERGY AND SELF ENERGY

1. A body of mass m is lifted up from the surface of earth to a height three times the radius of the earth. The change in potential energy of the body is (g = gravity field at the surface of the earth)
(1) mgR (2) $\frac{3}{4}$ mgR (3) $\frac{1}{3}$ mgR (4) $\frac{2}{3}$ mgR

2. The change in potential energy when a body of mass m is raised to a height n R from the earth surface is (R = Radius of earth)
(1) mgR (2) nmgR (3) mgR $\frac{n^2}{n^2+1}$ (4) mgR $\frac{n}{n+1}$

3. If mass of earth is M, radius is R and gravitational constant is G, then work done to take 1 kg mass from earth surface to infinity will be -
(1) $\sqrt{\frac{GM}{2R}}$ (2) $\frac{GM}{R}$ (3) $\sqrt{\frac{2GM}{R}}$ (4) $\frac{GM}{2R}$

4. A rocket is launched with velocity 10 km/s. If radius of earth is R, then maximum height attained by it will be-
(1) 2R (2) 3R (3) 4R (4) 5R

5. What is intensity of gravitational field at the centre of a spherical shell -
(1) Gm/r^2 (2) g (3) Zero (4) None of these

6. 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 -
(1) – 5000 J (2) – 1000 J (3) – 2400 J (4) 5000 J

7. The kinetic energy needed to project a body of mass m from the earth surface (radius R) to infinity is -
(1) mgR/2 (2) 2 mgR (3) mgR (4) mgR/4

8. The escape velocity of a sphere of mass m from earth having mass M and radius R is given by -

(1) $\sqrt{\frac{2GM}{R}}$ (2) $2\sqrt{\frac{GM}{R}}$ (3) $\sqrt{\frac{2GMm}{R}}$ (4) $\sqrt{\frac{GM}{R}}$

9. 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 -

(1) gr (2) $\sqrt{2gr}$ (3) g / r (4) r / g

10. For the moon to cease to remain the earth's satellite, its orbital velocity has to increase by a factor of -

(1) 2 (2) $\sqrt{2}$ (3) 1/ $\sqrt{2}$ (4) $\sqrt{3}$

11. Escape velocity on a planet is v_e. If radius of the planet remains same and mass becomes 4 times, the escape velocity becomes -

(1) $4v_e$ (2) $2v_e$ (3) v_e (4) v_e

12. How many times is escape velocity (V_e), of orbital velocity (V_0) for a satellite revolving near earth -

(1) $\sqrt{2}$ times (2) 2 times (3) 3 times (4) 4 times

13. If the radius of a planet is R and its density is , the escape velocity from its surface will be -

(1) $v_e \propto R$ (2) $v_e \propto R\sqrt{p}$ (3) $v_e \propto \frac{\sqrt{\rho}}{R}$ (4) $v_e \propto \frac{1}{\sqrt{\rho R}}$

14. If V, R and g denote respectively the escape velocity from the surface of the earth radius of the earth,and acceleration due to gravity, then the correct equation is -

(1) V = $\sqrt{gR}$ (2) V = $\sqrt{\frac{4}{3}gR^3}$ (3) V = $R\sqrt{g}$ (4) V = $\sqrt{2gR}$

15. If the radius of a planet is four times that of earth and the value of g is same for both, the escape velocity on the planet will be -

(1) 11.2 km/s (2) 5.6 km/s (3) 22.4 km/s (4) None

16. If the radius and acceleration due to gravity both are doubled, escape velocity of earth will become.

(1) 11.2 km/s (2) 22.4 km/s (3) 5.6 km/s (4) 44.8 km/s

17. If g is the acceleration due to gravity on the earth's surface, the gain in P.E. of an object of mass m raised from the surface of the earth to a height of the radius R of the earth is

(1) mgR (2) 2mgR (3) $\frac{1}{2}$ mgR (4) $\frac{1}{4}$ mgR

18. A missile is launched with a velocity less than the escape velocity. The sum of kinetic energy and potential energy will be

(1) positive (2) negative
(3) negative or positive, uncertain (4) zero

19. If v_e is escape velocity and v_0 is orbital velocity of a satellite for orbit close to the earth's surface, then these are related by :

(1) $v_0 = \sqrt{2}v_e$ (2) $v_0 = v_e$ (3) $v_e = \sqrt{2v_0}$ (4) $v_e = \sqrt{2}v_0$

20. An artificial satellite moving in a circular orbit around the earth has a total (kinetic + potential) energy E_0. Its potential energy is :

(1) $-E^o$ (2) $1.5\ E^o$ (3) $2\ E^o$ (4) E^o

21. The mass and radius of earth and moon are M_1, R_1 and M_2, R_2 respectively. Their centres are d distance apart. With what velocity should a particle of mass m be projected from the mid point of their centres so that it may escape out to infinity.

(1) $\sqrt{\frac{G(M_1+M_2)}{d}}$ (2) $\sqrt{\frac{2G(M_1+M_2)}{d}}$ (3) $\sqrt{\frac{4G(M_1+M_2)}{d}}$ (4) $\sqrt{\frac{GM_1M_2}{d}}$

22. A satellite has to revolve round the earth in a circular orbit of radius 8×10^3 km. The velocity of projection of the satellite in this orbit will be

(1) 16 km/sec (2) 8 km/sec (3) 3 km/sec (4) 7.08 km/sec

23. The radio of the radius of the earth to that of the moon is 10. The ratio of g an earth to the moon is 6. The ratio of the escape velocity from the earth's surface to that from the moon is approximately

(1) 10 (2) 8 (3) 4 (4) 2

24. Acceleration due to gravity on a planet is 10 times the value on the earth. Escape velocity for the planet and the earth are V_p and V_e respectively Assuming that the radii of the planet and the earth are the same, then

(1) $V_P = 10\ V_e$ (2) $V_P = \sqrt{10}\ V_e$ (3) $V_P = \frac{V_e}{\sqrt{10}}$ (4) $V_P = \frac{V_e}{10}$

25. A space shuttle is launched in a circular orbit near the earth's surface. The additional velocity be given to the space-shuttle to get free from the influence of gravitational force, will be

(1) 1.52 km/s (2) 2.75 km/s (3) 3.28 km/s (4) 5.18 km/s

26. A body of mass m is situated at a distance $4R_e$ above the earth's surface, where R_e is the radius of earth. How much minimum energy be given to the body so that it may escape

(1) mgR_e (2) $2mgR_e$ (3) $\frac{mgR_e}{5}$ (4) $\frac{mgR_e}{16}$

27. The potential energy of a body of mass 3kg on the surface of a planet is 54 joule. The escape velocity will be

(1) 18m/s (2) 162 m/s (3) 36 m/s (4) 6 m/s

28. The escape velocity from a planet is v_0. The escape velocity from a planet having twice the radius but same density will be

(1) 0.5 v_0 (2) v_0 (3) $2v_0$ (4) $4v_0$

29. If the kinetic energy of a satellite orbiting around the ear:th is doubled then

(1) the satellite will escape into the space. (2) the satellite will fall down on the earth
(3) radius of its orbit will be doubled (4) radius of its orbit will become half

30. The escape velocity from the earth does not depend upon

(1) mass of earth (2) mass of the body (3) radius of earth (4) acceleration due to gravity

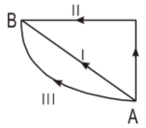
31. There is no atmosphere on moon because

(1) it is near the earth
(2) it is orbiting around the earth
(3) there was no gas at all
(4) the escape velocity of gas molecules is less than their root-mean square velocity

32. The escape velocity is

(1) 2gR (2) gR (3) $\sqrt{gR}$ (4) $\sqrt{2gR}$

33. A particle of mass m is taken through the gravitational field produced by a source S, from A to B, along the three paths as shown in figure. If the work done along the paths I, II and III is W_I, W_{II} and W_{III} respectively, then



(1) $W_I = W_{II} = W_{III}$ (2) $W_{II} > W_{III} = W_{II}$ (3) $W_{III} = W_{II} > W_I$ (4) $W_I > W_{II} > W_{III}$

34. The escape velocity of a particle of mass m varies as :
(1) m^2 (2) m (3) m^0 (4) m^{-1}

35. Acceleration due to gravity at earth's surface is g ms^{-2}. Find the effective value of gravity at a height of 32 km from sea level : (R_e = 6400 km)
(R_e = 6400 km)
(1) 0.5 g ms^{-2} (2) 0.99 g ms^{-2} (3) 1.01 g ms^{-2} (4) 0.90 g ms^{-2}

36. Radius of orbit of satellite of earth is R. Its kinetic energy is proportional to :
(1) $\frac{1}{R}$ (2) $\frac{1}{\sqrt{R}}$ (3) R (4) $\frac{1}{R^{3/2}}$

37. A cosmonaut is orbiting earth in a spacecraft at an altitude h = 630 km with a speed of 8 km/s. If the radius of the earth is 6400 km, the acceleration of the cosmonaut is
(1) 9.10 m/s^2 (2) 9.80 m/s^2 (3) 10.0 m/s^2 (4) 9.88 m/s^2

38. A very very large number of particles of same mass m are kept at horizontal distances of 1m, 2m, 4m, 8m and so on from (0,0) point. The total gravitational potential at this point is (addition of G.P. of infinite terms = $\frac{a}{1-r}$ where a = first term, r = common ratio) :
(1) – 8G m (2) – 3G m (3) – 4G m (4) – 2G m

39. A body starts from rest at a point, distance R_0 from the centre of the earth of mass M, radius R. The velocity acquired by the body when it reaches the surface of the earth will be
(1) GM$\left(\frac{1}{R}-\frac{1}{R_0}\right)$ (2) 2 GM$\left(\frac{1}{R}-\frac{1}{R_0}\right)$ (3) $\sqrt{2\ GM\ \left(\frac{1}{R}-\frac{1}{R_0}\right)}$ (4) 2GM$\sqrt{\left(\frac{1}{R}-\frac{1}{R_0}\right)}$

40. The relation between the escape velocity from the earth and the velocity of a satellite orbiting near the earth's surface is
(1) $v_e = 3v$ (2) $v_e = v$ (3) $v_e = 2v$ (4) $v_e = v/2$

SECTION (D) : KEPLER'S LAW FOR SATELLITES, ORBITAL SPEED AND ESCAPE SPEED

1. A body attains a height equal to the radius of the earth. The velocity of the body with which it was projected is :
(1) $\sqrt{\frac{GM}{R}}$ (2) $\sqrt{\frac{2GM}{R}}$ (3) $\sqrt{\frac{5}{4}\frac{GM}{R}}$ (4) $\sqrt{\frac{3GM}{R}}$

2. 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
(1) $m\sqrt{GMR_0}$ (2) $M\sqrt{GmR_0}$ (3) $m\sqrt{\frac{GM}{R_0}}$ (4) $M\sqrt{\frac{GM}{R_0}}$

3. Which of the following quantity is conserved for a satellite revolving around the earth in particular orbit ?
(1) Angular velocity (2) Force (3) angular momentum (4) Velocity

4. 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 -

(1) $\sqrt{10}$ (2) 100 (3) $10\sqrt{10}$ (4) $1/\sqrt{10}$

5. 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 -

(1) 4T (2) T/4 (3) 8T (4) T/8

6. 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 -

(1) $T \propto r$ (2) $T \propto r^2$ (3) $T^2 \propto r^3$ (4) $T \propto r^4$

7. The escape velocity of a sphere of mass m from earth having mass M and radius R is given by -

(1) $\sqrt{\frac{2GM}{R}}$ (2) $2\sqrt{\frac{GM}{R}}$ (3) $\sqrt{\frac{2GMm}{R}}$ (4) $\sqrt{\frac{GM}{R}}$

8. 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 -

(1) 22km/sec (2) 11 km/sec (3) 5.5 km/sec (4) 15.5 km/sec

9. 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 -

(1) 4.8 hours (2) $48\sqrt{2}$ hours (3) 24 hrs (4) Infinite

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

(1) 12 V (2) 6 V (3) 4/3 V (4) 3/2 V

11. 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-

(1) 11.2 (2) 5.6 (3) 22.4 (4) 53.6

12. A satellie revolves around the earth in an elliptical orbit. Its speed

(1) Is the same at all point in the orbit
(2) Is greatest when it is closest to the earth
(3) Is greatest when it is farthest from the earth
(4) Goes on increasing or decreasing continuously depending upon the mass of the satellite

13. Time period of revolution of a satellite around a planet of radius R is T. Period of revolution around another planet, whose radius is 3R but having same density is -

(1) $\frac{T}{3\sqrt{3}}$ (2) 3T (3) 9T (4) $3\sqrt{3}$ T

14. 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 -

(1) $V_e = V_o$ (2) $\sqrt{2}V_0 = V_e$ (3) $V_e = \frac{1}{\sqrt{2}}V_o$ (4) none of these

15. A spherical planet far out in space has a mass M_0 and diameter D_0. A particle will experience an acceleration due to gravity which is equal to

(1) GM_0/D_0^2 (2) $2mGM_0/D_0^2$ (3) $4GM_0/D_0^2$ (4) GmM_0/D_0^2

16. A satellite can be in a geostationary orbit around a planet at a distance r from the centre of the planet. If the angular velocity of the planet about its axis doubles, a satellite can now be in a geostationary orbit around the planet if its distance from the centre of the planet is

(1) $\frac{r}{2}$ (2) $\frac{r}{2\sqrt{2}}$ (3) $\frac{r}{(4)^{1/3}}$ (4) $\frac{r}{(2)^{1/3}}$

17. Consider a satellite going round the earth in an orbit. Which of the following statements is wrong -
(1) It is a freely falling body (2) It suffers no acceleration
(3) It is moving with a constant speed (4) Its angular momentum remains constant

18. The period of a satellite in a circular orbit around a planet is indepent of -
(1) The mass of the planet (2) The radius of the planet
(3) The mass of the satellite (4) All the three parameters (1), (2) and (3)

19. A small satellite is revolving near earth's surface. Its orbital velocity will be nearly.
(1) 8 km/sec (2) 11.2 km/sec (3) 4 km/sec (4) 6 km/sec

20. A satellite revolves around the earth in an elliptical orbit. Its speed.
(1) Is the same at all points in the orbit
(2) Is greatest when it is closest to the earth
(3) Is greatest when it is farthest from the earth
(4) Goes on increasing or decreasing continuously depending upon the mass of the satellite

21. 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 -
(1) gR (2) gR/2 (3) $\sqrt{g/R}$ (4) $\sqrt{gR}$

22. Orbital velocity of an artificial satellite does not depend upon -
(1) Mass of the earth (2) Mass of the satellite
(3) Radius of the earth (4) Acceleration due to gravity

23. The time period of a geostationary satellite is -
(1) 24 hours (2) 12 hours (3) 365 days (4) One month

24. Which one of the following statements regarding artificial satellite of the earth is incorrect -
(1) The orbital velocity depends on the mass of the satellite
(2) A minimum velocity of 8 km/sec is required by a satellite to orbit quite close to the earth
(3) The period of revolution is large if the radius of its orbit is large
(4) The height of a geostationary satellite is about 36000 km from earth

25. Two identical satellites are at R and 7R away from earth surface, the wrong statement is (R = Radius of earth)
(1) Ratio of total energy will be 4
(2) Ratio of kinetic energies will be 4
(3) Ratio of potential energies will be 4
(4) Ratio of total energy will be 4 but ratio of potential and kinetic energies will be 2

26. For a satellite escape velocity is 11 km/s. If the satellite is launched at an angle of 60º with the vertical, then escape velocity will be -
(1) 11 km/s (2) $11\sqrt{3}$ km/s (3) $\frac{11}{\sqrt{3}}$ km/s (4) 33 km/s

27. The distance of a geo-stationary satellite from the centre of the earth (Radius R = 6400 km) is nearest to -
(1) 5 R (2) 7 R (3) 10 R (4) 18 R

28. Periodic time of a satellite revolving above Earth's surface at a height equal to R, radius of Earth, is [g is acceleration due to gravity at Earth's surface]

(1) $2\pi\sqrt{\frac{2R}{g}}$ (2) $4\sqrt{2}\pi\sqrt{\frac{R}{g}}$ (3) $2\pi\sqrt{\frac{R}{g}}$ (4) $8\pi\sqrt{\frac{R}{g}}$

29. 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]
(1) +R (2) – R (3) – R (4) None

30. Distance of geostationary satellite from the surface of earth radius (R_e = 6400 km) in terms of R_e is -
(1) 13.76 R_e (2) 10.76 R_e (3) 5.56 R_e (4) 2.56 R_e

31. The orbital velocity of a planet revolving close to earth's surface is -
(1) $\sqrt{2gR}$ (2) $\sqrt{gR}$ (3) $\sqrt{\frac{2g}{R}}$ (4) $\sqrt{\frac{g}{R}}$

32. 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 -
(1) $-\frac{1}{2}Mv^2$ (2) $\frac{1}{2}Mv^2$ (3) $\frac{3}{2}Mv^2$ (4) Mv^2

33. If satellite is shifted towards the earth. Then time period of satellite will be -
(1) Increase (2) Decrease (3) Unchanged (4) Nothing can be said

34. Two satellites A and B go round a planet in circular orbits having radii 4R and R, respectively. If the speed of satellite A is 3v, then speed of satellite B is -
(1) $\frac{3v}{2}$ (2) $\frac{4v}{2}$ (3) 6v (4) 12v

35. If gravity field due to a point mass follows g ∝ $\frac{1}{r^3}$ insted of $\frac{1}{r^2}$, then the relation between time period of a satellite near earth's surface and radius of its orbit r will be -

(1) $T^2 \propto r^3$ (2) $T \propto r^2$ (3) $T^2 \propto r$ (4) $T \propto r$

36. A satellite appears to be at rest when seen from the equator. Its height from the earth's surface is nearly
(1) 35800km (2) 358000 km
(3) 6400km (4) such a satellite cannot exist

37. A body is dropped by a satellite in its geo-stationary orbit
(1) it will burn on entering into the atmosphere
(2) it will remain in the same place with respect to the earth
(3) it will reach the earth in 24 hours
(4) it will perform uncertain motion

38. A satellite of earth can move only in those orbits whose plane coincides with
(1) the plane of great circle of earth (2) the plane passing through the poles of earth
(3) the plane of a circle at any latitude of earth (4) none of these

39. A satellite launching station should be
(1) near the equatorial region (2) near the polar region
(3) on the polar axis (4) all locations are equally good

40. The minimum number of satelites needed to be placed at the surface of earth for world-wide communication between any two locations is -
(1) 6 (2) 4 (3) 3 (4) 5

41. A geostationary satellite orbits around the earth in a circular orbit of radius 36000 km. Then, the time period of a spy satellite orbiting a few hundred kilometers above the earth's surface (R_{Earth} = 6400 km) will approximately be :
(1) 1/2 hr (2) 1 hr (3) 2 hr (4) 4 hr

42. A satellite is moving with a constant speed 'V' in a circular orbit about the earth. An object of mass *'m'* is ejected from the satellite such that it just escapes from the gravitational pull of the earth. At the time of its ejection, the kinetic energy of the object is
(1) $\frac{1}{2}mV^2$ (2) mV^2 (3) $\frac{3}{2}mV^2$ (4) $2mV^2$

43. Two satellite of earth, S_1 and S_2 are moving in the same orbit. The mass of S_1 is four times the mass of S_2 . Which one of the following statements is true :
(1) The time period of S_1 is four times that of S_2
(2) The potential energies of earth and satellite in the two cases are equal
(3) S_1 and S_2 are moving with the same speed
(4) The kinetic energies of the two satellites are equal

44. The orbital speed of a satellite revolving nearby the earth is :
(1) $\sqrt{2gR}$ (2) $\sqrt{gR}$ (3) $\sqrt{g/R}$ (4) $\sqrt{2g/R}$

45. If the radius of earth is decreased by 1% and mass remain constant, then the acceleration due to gravity
(1) decrease by 2% (2) decrease by 1% (3) increase by 1% (4) increase by 2%

46. Escape velocity for a rocket is 11.2 km/s. If it is taken to a planet where the radius and acceleration due to gravity is double than earth, then escape velocity will be :
(1) 5.6 m/s (2) 11.2 m/s (3) 22.4 km/s (4) 44.2 m/s

47. Suppose radius of the moon's orbit around the earth is doubled. Its period around the earth will become:
(1) 1/2 times (2) $\sqrt{2}$ times (3) $2^{2/3}$ times (4) $2^{3/2}$ times

48. In case of an orbiting satellite if the radius of orbit is decreased :
(1) its Kinetic Energy decreases (2) its Potential Energy increase
(3) its Mechanical Energy decreases (4) its speed decreases

49. A satellite of the earth is revolving in a circular orbit with a uniform speed v. If the gravitational force suddenly disappears, the statellite will
(1) Continue to move with velocity v along the original orbit
(2) Move with a velocity v, tangentially to the original orbit
(3) Fall down with increasing velocity
(4) Ultimately come to rest somewhere on the original orbit

50. The time period of a satellite of earth is 5 hours. If the separation between the earth and the satellite is increased to 4 times the previous value, the new time period becomes
(1) 10 hour (2) 80 hour (3) 40 hour (4) 20 hour

51. 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 45º with the vertical, the escape velocity will be :
(1) $11\sqrt{2}$ km/s (2) 22 km/s (3) 11 km/s (4) $11/\sqrt{2}$ m/s

52. A satellite of mass m revolves around earth of radius R at a height x from its surface. If g is the acceleration due to gravity on the surface of the earth, the orbital speed of the satellite is :
(1) gx (2) $\frac{gR}{R-x}$ (3) $\frac{gR^2}{R+x}$ (4) $\left(\frac{gR^2}{R+x}\right)^{1/2}$

53. The time period of an earth satellite in circular orbit is independent of :
(1) the mass of the satellite

(2) radius of its orbit
(3) both the mass and radius of the orbit
(4) neither the mass of the satellite nor the radius of its orbit

54. If g is the acceleration due to gravity on the earth's surface, the gain in the potential energy of an object of mass m raised from the surface of the earth to a height equal to the radius R of the earth, is :

(1) 2mgR (2) $\frac{1}{2}mgR$ (3) $\frac{1}{4}mgR$ (4) mgR

55. The change in the value of 'g' at a height 'h' above the surface of the earth is the same as at a depth 'd' below the surface of earth. When both 'd' and 'h' are much smaller than the radius of earth, then, which one of the following is correct ?

(1) d = $\frac{h}{2}$ (2) d = $\frac{3h}{2}$ (3) d = 2h (4) d = h

56. A particle of mass 10 kg 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 = 6.67×10^{-11} Nm^2/kg^2);

(1) 13.34×10^{-10} J (2) 3.33×10^{-10} J (3) 6.67×10^{-9} J (4) 6.67×10^{-7} J

57. If g_E and g_m are the accelerations due to gravity on the surfaces of the earth and the moon respectively and if Millikan's oil drop expriment could be performed on the two surfaces, one will find the ratio $\frac{\text{Electronic charge on the moon}}{\text{electronic charge on the earth}}$ to be

(1) 1 (2) 0 (3) g_E/g_M (4) g_M/g_E

58. A planet in a distant solar system is 10 times more massive than the earth and its radius is 10 times smaller. Given that the escape velocity from the earth is 11 km s^{-1}, the escape velocity from the surface of the planet would be

(1) 11 km s^{-1} (2) 110 km s^{-1} (3) 0.11 km s^{-1} (4) 1.1 km s^{-1}

SECTION (E) : THE EARTH AND OTHER PLANETS GRAVITY

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 -

(1) $\sqrt{10}$ (2) 100 (3) 10 (4) 1/10

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

(1) 4T (2) T/4 (3) 8T (4) T/8

3. 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 -

(1) $(r_1 / r_2)^{1/2}$ (2) r_1 / r_2 (3) $(r_1 / r_2)^2$ (4) $(r_1 / r_2)^{3/2}$

4. The rotation period of an earth satellite close to the surface of the earth is 83 minutes. The time period of another earth satellite in an orbit at a distance of three earth radii from its surface will be -

(1) 83 minute (2) 83 × $\sqrt{8}$ minutes (3) 664 minutes (4) 249 minutes

5. 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 -

(1) m $\sqrt{GMR_0}$ (2) M $\sqrt{GMR_0}$ (3) m $\sqrt{\frac{GM}{R_0}}$ (4) M $\sqrt{\frac{GM}{R_0}}$

6. A planet revolves around sun whose mean distance is 1.588 times the mean distance between earth and sun. The revolution time of planet will be -

(1) 1.25 years (2) 1.59 years (3) 0.89 years (4) 2 years

7. If mass of a satellite is doubled and time period remain constant the ratio of orbit in the two cases will be -

(1) 1 : 2 (2) 1 : 1 (3) 1 : 3 (4) None of these

8. The earth revolves round the sun in one year. If the distance between them becomes double, the new period of revolution will be -

(1) 1/2 years (2) 2 $\sqrt{2}$ years (3) 4 years (4) 8 years

9. A body revolved around the sun 27 times faster then the earth what is the ratio of their radii

(1) 1/3 (2) 1/9 (3) 1/27 (4) 1/4

10. 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 -

(1) 16 L (2) 64 L (3) $\frac{L}{4}$ (4) 4 L

11. The ratio of the distance of two planets from the sun is 1.38. The ratio of their period of revolution around the sun is -

(1) 1.38 (2) $1.38^{3/2}$ (3) $1.38^{1/2}$ (4) 1.38^{3}

12. Kepler's second law (law of areas) is nothing but a statement of -

(1) Work energy theorem (2) Conservation of linear momentum
(3) Conservation of angular momentum (4) Conservation of energy

13. In an elliptical orbit under gravitational force, in general.

(1) Tangential velocity is constant (2) Angular velocity is constant
(3) Radial velocity is constant (4) Areal velocity is constant

14. What does not change in the field of central force.

(1) Potential energy (2) Kinetic energy (3) Linear momentum (4) Angular momentum

15. A planet is moving in an elliptic orbit. If T, V, E, L stand respectivley for its kinetic energy, gravitational potential energy, total energy and magnitude of angular momentum about the centre of force, which of the following statements is correct

(1) T is conserved
(2) V is always positive
(3) E is always negative
(4) L is conserved but the direction of vector changes continuously

Exercise-2

1. Three identical stars of mass M are located at the vertices of an equilateral triangle with side L. The speed at which they will move if they all revolve under the influence of one another's gravitational force in a circular orbit circumscribing the triangle while still preserving the equilateral triangle :

(1) $\sqrt{\frac{2\ GM}{L}}$ (2) $\sqrt{\frac{GM}{L}}$ (3) $2\sqrt{\frac{GM}{L}}$ (4) not possible at all

2. Periodic-time of a satellite revolving very near to the surface of the earth is - (ρ is density of earth)

(1) Proportional to $\frac{1}{\rho}$ (2) Proportional to $\frac{1}{\sqrt{\rho}}$ (3) Proportional ρ (4) does not depend on ρ.

3. A satellite is moving round the earth. In order to make it move to infinity, its velocity must be increased by

(1) 20% (2) it is impossible to do so
(3) 82.8% (4) 41.4%

4. If the radius of earth is to decrease by 4% and its density remains same, then its escape velocity will
(1) remain same (2) increase by 4% (3) decrease by 4% (4) increase by 2%

5. An earth satellite is moved from one stable circular orbit to another higher stable circular orbit. Which one of the following quantities increases for the satellite as a result of this change
(1) gravitational force (2) gravitational potential energy
(3) centripetal acceleration (4) Linear orbital speed

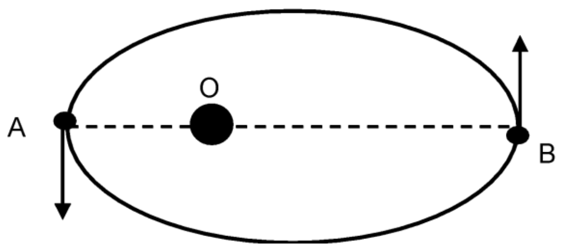
6. The relay satellite transmits the television programme continuously from one part of the world to another because its
(1) period is greater than the period of rotation of the earth
(2) period is less than the period of rotation of the earth about its axis
(3) period has no relation with the period of the earth about its axis
(4) period is equal to the period of rotation of the earth about its axis

7. If the universal constant of gravitation were decreasing uniformly with time, then a satellite in orbit would still maintain its
(1) radius (2) tangential speed (3) angular momentum (4) period of revolution

8. 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 the earth :
(1) The acceleration of S is always directed towards the centre of the earth
(2) The angular momentum of S about the centre of the earth changes in direction, but its magnitude remains constant
(3) The total mechanical energy of S varies periodically with time
(4) The linear momentum of S remains constant in magnitude.

9. The moon revolves round the earth 13 times in one year. If the ratio of sun-earth distance to earth-moon distance is 392, then the ratio of masses of sun and earth will be
(1) $3.56 \times 10_5$ (2) $3.56 \times 10_6$ (3) $3.56 \times 10_7$ (4) $3.56 \times 10_8$

10. The earth is revolving round the sun in an elliptical orbit. If $\frac{OA}{OB} = x,$ the ratio of speeds of earth at B and A will be



(1) x (2) $\sqrt{x}$ (3) x_2 (4) $x\sqrt{x}$

11. The time period of a satellite of earth is 5 h. If the separation between the earth and the satellite is increased to 4 times the previous value, the new time period will become
(1) 10 h (2) 80 h (3) 40 h (4) 20 h

12. If two spheres of same masses and radius are brought in contact, then the force of attraction between them will be proportional to (for a given density ρ) :
(1) r^2 (2) r^3 (3) r^6 (4) r^4

13. Assume the earth to be a sphere of radius R. If g is the acceleration due to gravity at any point on the earth's surface, the mass of the earth is :

(1) $\frac{gR}{G}$ (2) $\frac{g^2R^2}{G}$ (3) $\frac{gR^2}{G}$ (4) $\frac{g^2R}{G}$

14. Energy required to transfer a 400 kg satellite in a circular orbit of radius 2 R to a circular orbit of radius 4 R, where R is the radius of the earth. [Given g = 9.8 ms^{-2}, R = 6.4 × 10^6 m]

(1) 1.65 × 10^9 J (2) 3.13 × 10^9 J (3) 6.26 × 10^9 H (4) 4.80 × 10^9 J

15. Suppose the gravitational force varies inversely as the 4^{th} power of the distance. If a satel lite describes a circular orbit of radius R under the influence of this force, then the time period T of the orbit is proportional to

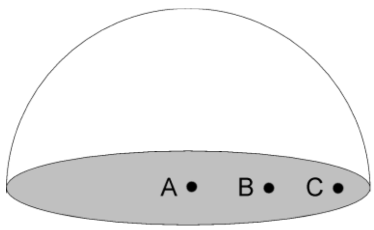
(1) $R^{3/2}$ (2) $R^{5/2}$ (3) R^2 (4) $R^{7/2}$

16. A double star system consists of two stars A and B which have time period T_A and T_B. Radius R_A and R_B and mass M_A and M_B. Choose the correct option.

(1) If $T_A > T_B$ then $R_A > R_B$ (2) If $T_A > T_B$ then $M_A > M_B$

(3) $\left(\frac{T_A}{T_B}\right)^2 = \left(\frac{R_A}{R_B}\right)^3$ (4) $T_A = T_B$

17. Mass M is uniformly distributed only on curved surface of a thin hemispherical shell. *A*, *B* and *C* are three points on the circular base of hemisphere, such that *A* is the centre. Let the gravitational potential at points A, B and C be V_A, V_B, V_C respectively. Then

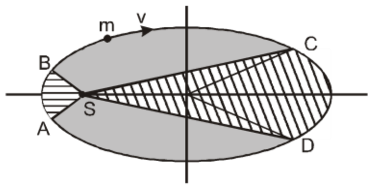


(1) $V_A > V_B > V_C$ (2) $V_C > V_B > V_A$ (3) $V_B > V_A$ and $V_B > V_C$ (4) $V_A = V_B = V_C$

Exercise-3

PART - I : NEET / AIPMT QUESTION (PREVIOUS YEARS)

1. The figure shows elliptical orbit of a planet m about the sun S. The shaded area SCD is twice the shaded area SAB. If t1 is the time for the planet to move from C to D and t2 is the time to move from A to B, then: **[AIPMT 2009]**



(1) t1 > t2 (2) t1 = 4t2 (3) t1 = 2t2 (4) t1 = t2

2. A particle of mass M is situated at the center of a spherical shell of same mass and radius a. The gravitational potential at a point situated at $\frac{a}{2}$ distance from the centre, will be **[AIPMT 2010]**

(1) $-\frac{3GM}{a}$ (2) $-\frac{2GM}{a}$ (3) $-\frac{GM}{a}$ (4) $-\frac{4GM}{a}$

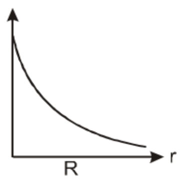
3. The additional kinetic energy to be provided to a satellite of mass m revolving around a planet of mass M, to transfer it from a circular orbit of radius R1 to another of radius R2 (R2 > R1) is **[AIPMT 2010]**

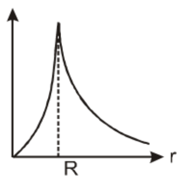
(1) $GmM\left(\frac{1}{R_1^2}-\frac{1}{R_2^2}\right)$ (2) $GmM\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$ (3) $2GmM\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$ (4) $\frac{1}{2}GmM\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

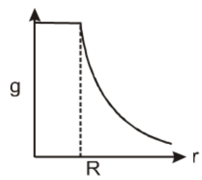
4. The radii of circular orbits of two satellites A and B of the earth, are 4R and R, respectively. If the speed of satellite A is 3V, then the speed of satellite B will be **[AIPMT 2010, Screening]**

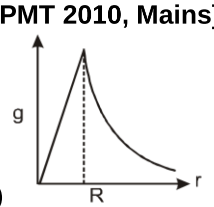
(1) $\frac{3V}{4}$ (2) 6V (3) 12 V (4) $\frac{3V}{2}$

5. The dependence of acceleration due to gravity g on the distance r from the centre of the earth, assumed to be a sphere of radius R of uniform density is as shown in figures below. The correct figure is. **[AIPMT 2010, Mains]**

(1)


(2)


(3)


(4)


6. A planet moving along an elliptical orbit is closest to the sun at a distance r1 and farthest away at a distance of r2. If v1 and v2 are the linear velocities at these points respectively, then the ratio $\frac{v_1}{v_2}$ is : **[AIPMT (Scr) 2010]**

(1) (r1/r2)2 (2) r2/r1 (3) (r2/r1)2 (4) r1/r2

7. A body projected vertically from the earth reaches a height equal to earth's radius before returning to the earth. The power exerted by the gravitational force is greatest : **[AIPMT (Scr) 2010]**

(1) at the highest position of the body

(2) at the instant just before the body hits the earth

(3) it remains constant all through

(4) at the instant just after the body is projected

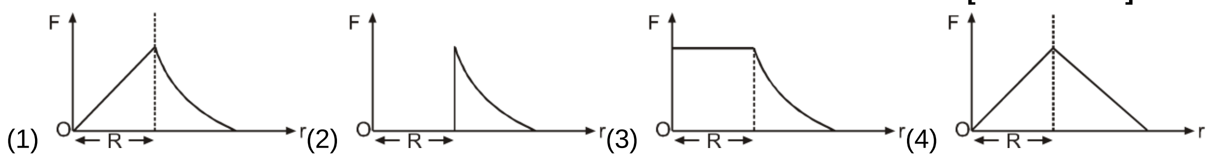
8. A particle of mass m is thrown upwards from the surface of the earth, with a velocity u. The mass and the radius of the earth are , respectively, M and R. G is gravitational constant and g is acceleration due to gravity on the surface of the earth. The minimum value of u so that the particle does not return back to earth, is : **[AIPMT (Mains) 2011]**

(1) $\sqrt{\frac{2GM}{R}}$ (2) $\sqrt{\frac{2GM}{R^2}}$ (3) $\sqrt{2gR^2}$ (4) $\sqrt{\frac{2GM}{R^2}}$

9. A particle of mass M is situated at the centre of spherical shell of mass and radius a. The magnitude of the gravitational potential at a point situated at a/2 distance from the centre will be: **[AIPMT(Mains)2011]**

(1) $\frac{2GM}{a}$ (2) $\frac{3GM}{a}$ (3) $\frac{4GM}{a}$ (4) $\frac{GM}{a}$

10. Which one of the following plots represents the variation of gravitational field on a particle with distance r due to a thin spherical shell of radius R ? (r is measured from the centre of the spherical shell) **[AIPMT 2012]**



11. The height at which the weight of a body becomes 1/16th, its weight on the surface of earth (radius R), is : **[AIPMT 2012]**

(1) 5R (2) 15R (3) 3R (4) 4R

12. A spherical planet has a mass MP and diameter DP. A particle of mass m falling freely near the surface of this planet will experience an acceleration due to gravity, equal to : **[AIPMT 2012]**

(1) 4GMP/DP2 (2) GMPm/DP2 (3) GMP/DP2 (4) 4GMPm/DP2

13. A geostationary satellite is orbiting the earth at a height of 5R above that surface of the earth, R being the radius of the earth. The time period of another satellite in hours at a height of 2R from the surface of the earth is : **[AIPMT 2012]**

(1) 5 (2) 10 (3) $6\sqrt{2}$ (4) $\frac{6}{\sqrt{2}}$

14. A body of mass 'm' is taken from the earth's surface to the height equal to twice the radius (R) of the earth. The change in potential energy of body will be : **[NEET-2013; 3/180, –1]**

(1) $\frac{2}{3}mgR$ (2) 3mgR (3) $\frac{1}{3}mgR$ (4) mg2R

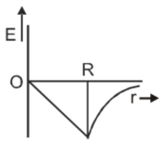
15. Infinite number of bodies, each of mass 2 kg are situated on x-axis at distances 1m, 2m, 4m, 8m, ... respectively, from the origin. The resulting gravitational potential due to this system at the origin will be : **[NEET-2013; 3/180, –1]**

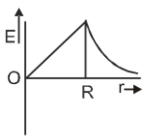
(1) $-\frac{8}{3}G$ (2) $-\frac{4}{3}G$ (3) –4G (4) – G

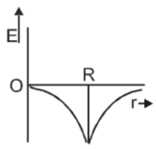
16. A block hole is an object whose gravitational field is so strong that even light cannot escape from it. To what approximate radius would earth (mass = 5.98×1024 kg) have to be compressed to be a black hole? **[AIPMT-2014]**

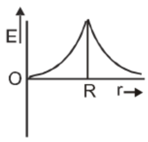
(1) 10–9 m (2) 10–6 m (3) 10–2 m (4) 100 m

17. Dependence of intensity of gravitational field (E) of earth with distance (r) from centre of earth is correctly represented by : **[AIPMT-2014]**

(1) 

(2) 

(3) 

(4) 

18. Kepler's third law states that square of period of revolution (T) of a planet around the sun, is proportional to third power of average distance r between sun and planet i.e. T2 = Kr3 here K is constant. If the masses of sun and planet are M and m respectively then as per Newton's law of gravitation force of attraction between them is **[AIPMT-2015]**

F = $\frac{GMm}{r^2}$, here G is gravitational constant. The relation between G and K is described as:

(1) GMK = 4π2 (2) K = G (3) K = $\frac{1}{G}$ (4) GK = 4π2

19. A remote - sensing satellite of earth revolves in a circular orbit at a height of 0.25 × 106 m above the surface of earth. If earth's radius is 6.38 × 106 m and g = 9.8 ms–2, then the orbital speed of the satellite is : **[AIPMT-2015]**

(1) 8.56 km s–1 (2) 9.13 km s–1 (3) 6.67 km s–1 (4) 7.76 km s–1

20. At what height from the surface of earth the gravitational potential and the value of g are -5.4×10^7 J kg^{-2} and 6.0 ms^{-2} respectively ? Take the radius of earth as 6400 km. **[AIPMT_2016]**

(1) 2000 km (2) 2600 km (3) 1600 km (4) 1400 km

21. 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 the earth. Then, **[AIPMT_2016]**

(1) the total mechanical energy of S varies periodically with time.

(2) the linear momentum of S remains constant in magnitude.

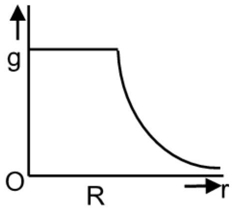
(3) the acceleration of S is always directed towards the centre of the earth.

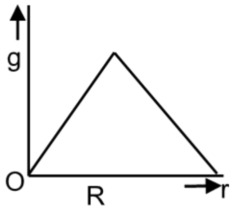
(4) the angular momentum of S about the centre of the earth changes in direction, but its magnitude remains constant.

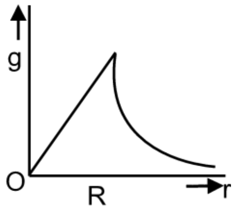
22. The ratio of escape velocity at earth (v_e) to the escape velocity at a planet (v_p) whose radius and mean density are twice as that of earth is : **[AIPMT-2016]**

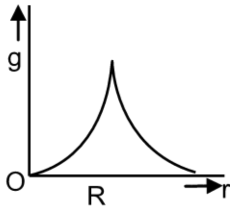
(1) 1 : $\sqrt{2}$ (2) 1 : 2 (3) 1 : $2\sqrt{2}$ (4) 1 : 4

23. Starting from the centre of the earth having radius r, the variation of g (acceleration due to gravity) is shown by **[NEET 2016-17]**

(1) 

(2) 

(3) 

(4) 

24. A satellite of mass m is orbiting the earth (of radius R) at a height h from its surface. The total energy of the satellite in terms of g_0, the value of acceleration due to gravity at the earth's surface, is **[NEET 2017]**

(1) $-\frac{2mg_0R^2}{R+h}$ (2) $\frac{mg_0R^2}{2(R+h)}$ (3) $-\frac{mg_0R^2}{2(R+h)}$ (4) $\frac{Rmg_0R^2}{R+h}$

25. A physical quantity of the dimensions of length that can be formed out of c, G and $\frac{e^2}{4\pi\epsilon_0}$ is [c is velocity of light, G is universal constant of gravitation and e is charge] : **[NEET 2017]**

(1) $\frac{1}{c^2}\left[G\frac{e^2}{4\pi\epsilon_0}\right]^{1/2}$ (2) $c^2\left[G\frac{e^2}{4\pi\epsilon_0}\right]^{1/2}$ (3) $\frac{1}{c^2}\left[\frac{e^2}{G4\pi\epsilon_0}\right]^{1/2}$ (4) $\frac{1}{c}G\frac{e^2}{4\pi\epsilon_0}$

26. Suppose the charge of a proton and an electron differ slightly. One of them is – e, the other is (e + Δe). If the net of electrostatic force and gravitational force between two hydrogen atoms placed at a distance d (much greater than atomic size) apart is zero, then Δe is of the order of [Given mass of hydrogen $m_h = 1.67 \times 10^{-27}$ kg] **[NEET-2017]**

(1) 10^{-20} C (2) 10^{-23} C (3) 10^{-37} C (4) 10^{-47} C

27. Two astronauts are floating in gravitational free space after having lost contact with their spaceship. The two will : **[NEET-2017]**

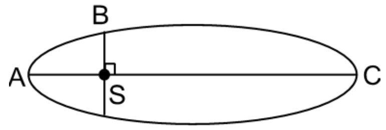
(1) keep floating at the same distance between them

(2) move towards each other

(3) move away from each other

(4) will become stationary

28. The kinetic energies of a planet in an elliptical orbit about the Sun, at positions A, B and C are K_A, K_B and K_C, respectively. AC is the major axis and SB is perpendicular to AB at the position of the Sun S as shown in the figure. Then **[NEET 2018]**



(1) $K_A < K_B < K_C$ (2) $K_B > K_A > K_C$ (3) $K_B < K_A < K_C$ (4) $K_A > K_B > K_C$

29. If the mass of the Sun were ten times smaller and the universal gravitational constant were ten times larger in magnitude, which of the following is not correct? **[NEET 2018]**
(1) Raindrops will fall faster.
(2) 'g' on the Earth will not change
(3) Time period of a simple pendulum on the Earth would decrease.
(4) Walking on the ground would become more difficult.

30. The work done to raise a mass m from the surface of the earth to a height h, which is equal to the radius of the earth, is : **[NEET-2019-I]**

(1) $\frac{3}{2}mgR$ (2) mgR (3) 2 mgR (4) $\frac{1}{2}mgR$

31. The time period of a geostationary satellite is 24 h, at a height $6R_E$ (R_E is radius of earth) from surface of earth. The time period of another satellite whose height is 2.5 R_E from surface will be : **[NEET_2019-II]**

(1) $6\sqrt{2}h$ (2) $12\sqrt{2}h$ (3) $\frac{24}{2.5}h$ (4) $\frac{12}{2.5}h$

32. Assuming that the gravitational potential energy of an object at infinity is zero, the change in potential energy (final – initial) of an object of mass m, when taken to a height h from the surface of earth (of radius R), is given by : **[NEET_2019 - II]**

(1) $-\frac{GMm}{R+h}$ (2) $\frac{GMmh}{R(R+h)}$ (3) mgh (4) $\frac{GMm}{R+h}$

PART - II : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

1. The height at which the acceleration due to gravity becomes $\frac{g}{9}$ (where g = the acceleration due to gravity on the surface of the earth) in terms of R, the radius of the earth, is **[AIEEE-2009, 4/144]**

(1) $\frac{R}{\sqrt{2}}$ (2) $\frac{R}{2}$ (3) $\sqrt{2}\ R$ (4) 2R

2. Two bodies of masses m and 4 m are placed at a distance r. The gravitational potential at a point on the line joining them where the gravitational field is zero is : **[AIEEE - 2011, 4/120, –1]**

(1) zero (2) $-\frac{4Gm}{r}$ (3) $-\frac{6Gm}{r}$ (4) $-\frac{9Gm}{r}$

3. Two particles of equal mass 'm' go around a circle of radius R under the action of their mutual gravitational attraction. The speed of each particle with respect to their centre of mass is:

[AIEEE 2011, 11 May; 4, –1]

(1) $\sqrt{\frac{Gm}{4R}}$ (2) $\sqrt{\frac{Gm}{3R}}$ (3) $\sqrt{\frac{Gm}{2R}}$ (4) $\sqrt{\frac{Gm}{R}}$

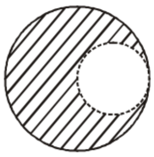
4. What is the minimum energy required to launch a satellite of mass m from the surface of a planet of mass M and radius R in a circular orbit at an altitude of 2R? **[JEE-Main 2013 ; 4/120, –1]**

(1) $\frac{5GmM}{6R}$ (2) $\frac{2GmM}{3R}$ (3) $\frac{GmM}{2R}$ (4) $\frac{GmM}{3R}$

5. Four particles, each of mass M and equidistant from each other, move along a circle of radius R under the action of their mutual gravitational attration. the speed of each particle is:**[JEE-Main 2014;4/120,–1]**

(1) $\sqrt{\frac{GM}{R}}$ (2) $\sqrt{2\sqrt{2}\frac{GM}{R}}$ (3) $\sqrt{\frac{GM}{R}\left(1+2\sqrt{2}\right)}$ (4) $\frac{1}{2}\sqrt{\frac{GM}{R}\left(1+2\sqrt{2}\right)}$

6. From a solid sphere of mass M and radius R, a spherical portion of radius R/2 is removed, as shown in the figure. Taking gravitational potential V = 0 at r = ∞, the potential at the centre of the cavity thus formed is :(G = gravitational constant) **[JEE(Main)-2015; 4/120, –1]**



(1) $\frac{-GM}{2R}$ (2) $\frac{-GM}{R}$ (3) $\frac{-2GM}{3R}$ (4) $\frac{-2GM}{R}$

7. If the angular momentum of a planet of mass m, moving around the sun in a circular orbit is L, about the center of the Sun, its areal velocity is : **[JEE(Main)-2019]**

(1) $\frac{2L}{m}$ (2) $\frac{4L}{m}$ (3) $\frac{L}{2m}$ (4) $\frac{L}{m}$

8. The energy required to take a satellite to a height 'h' above Earth surface (radius or Earth = 6.4×10^3 km) is E_1 and kinetic energy required for the satellite to be in a circular orbit at this height is E_2. The value of h for which E_1 and E_2 are equal is : **[JEE(Main)-2019]**

(1) 1.28×10^4 km (2) 6.4×10^3 km (3) 3.2×10^3 km (4) 1.6×10^3 km

9. A satellite i1s moving with a constant speed v in circular orbit around the earth. An object of mass 'm' is ejected from the satellite such that it just escapes from the gravitational pull of the earth. At the time of ejection, the kinetic energy of the object is : **[JEE(Main)-2019]**

(1) $\frac{3}{2}mv^2$ (2) $\frac{1}{2}mv^2$ (3) $2mv^2$ (4) mv^2

10. Two stars of masses 3×10^{31} kg each, and at distance 2×10^{11} m rotate in a plane about their common centre of mass O. A meteorite passes through O moving perpendicular to the star's rotation plane. In order to escape from the gravitational field of this double star, the minimum speed that meteorite should have at O is (Take Gravitational constant $G = 6.67 \times 10^{-11}$ Nm^2 kg^{-2})
What is the order of energy of the gas due to its thermal motion ? **[JEE(Main)-2019]**

(1) 3.8×10^4 m/s (2) 1.4×10^5 m/s (3) 2.8×10^5 m/s (4) 2.4×10^4 m/s

11. A satellite is revolving in a circular orbit at a height h from the earth surface, such that h<<R where R is the radius of the earth. Assuming that the effect of earth's atmosphere can be neglected. The minimum increase in the speed required so that the satellite could escape from the gravitational field of earth is : **[JEE(Main)-2019]**

(1) $\sqrt{gR}\left(\sqrt{2}-1\right)$ (2) $\sqrt{\frac{gR}{2}}$ (3) $\sqrt{2gR}$ (4) $\sqrt{gR}$

12. The mass and the diameter of a planet are three times the respective values for the Earth. The period of oscillation of a simple pendulum on the Earth is 2 s. The period of oscillation of the same pendulum on the planet would be: **[JEE(Main)-2019]**

(1) $\frac{3}{2}$s (2) $\frac{2}{\sqrt{3}}$s (3) $\frac{\sqrt{3}}{2}$s (4) $2\sqrt{3}$ s

13. A straight rod of length L extends from x = a to x = L + a. The gravitational force it exerts on a point mass 'm' at x = 0, if the mass per unit length of the rod is $A + Bx^2$, is given by **[JEE(Main)-2019]**

(1) $Gm\left[A\left(\frac{1}{a+L}-\frac{1}{a}\right)-BL\right]$ (2) $Gm\left[A\left(\frac{1}{a+L}-\frac{1}{a}\right)+BL\right]$

(3) $Gm\left[A\left(\frac{1}{a}-\frac{1}{a+L}\right)+BL\right]$ (4) $Gm\left[A\left(\frac{1}{a}-\frac{1}{a+L}\right)-BL\right]$

14. A satellite of mass M is in a circular orbit of radius R about the centre of the earth. A meteorite of the same mass, falling towards the earth, collides with the satellite completely inelastically. The speeds of the satellite and the meteorite are the same, just before the collision. the subsequent motion of the combined body will be : **[JEE(Main)-2019]**

(1) In the same circular orbit of radius R (2) such that it escapes to infinity
(3) in an elliptical orbit (4) in a circular orbit of a different radius

15. Two satellites, A and B, have masses m and 2m respectively. A is in a circular orbit of radius R, and B is in a circular orbit of radius 2R around the earth. The ratio of their kinetic energies, $\frac{T_A}{T_B}$, is : **[JEE(Main)-2019]**

(1) 1 (2) $\sqrt{\frac{1}{2}}$ (3) 2 (4) $\frac{1}{2}$

Answers

EXERCISE - 1

SECTION (A) :

1.	(2)	**2.**	(1)	**3.**	(4)	**4.**	(3)	**5.**	(3)	**6.**	(3)	**7.**	(1)
8.	(3)	**9.**	(3)	**10.**	(1)								

SECTION (B) :

1.	(2)	**2.**	(2)	**3.**	(1)	**4.**	(3)	**5.**	(1)	**6.**	(2)	**7.**	(1)
8.	(2)	**9.**	(4)	**10.**	(3)	**11.**	(1)	**12.**	(3)	**13.**	(4)	**14.**	(2)
15.	(2)	**16.**	(2)	**17.**	(4)	**18.**	(3)	**19.**	(1)	**20.**	(1)	**21.**	(4)
22.	(2)	**23.**	(3)	**24.**	(3)	**25.**	(4)	**26.**	(4)	**27.**	(1)	**28.**	(2)
29.	(1)	**30.**	(1)	**31.**	(2)								

SECTION (C) :

1.	(2)	**2.**	(4)	**3.**	(2)	**4.**	(3)	**5.**	(3)	**6.**	(1)	**7.**	(3)
8.	(1)	**9.**	(2)	**10.**	(2)	**11.**	(2)	**12.**	(1)	**13.**	(2)	**14.**	(4)
15.	(3)	**16.**	(2)	**17.**	(3)	**18.**	(2)	**19.**	(4)	**20.**	(3)	**21.**	(3)
22.	(4)	**23.**	(2)	**24.**	(2)	**25.**	(3)	**26.**	(3)	**27.**	(4)	**28.**	(3)
29.	(1)	**30.**	(2)	**31.**	(4)	**32.**	(4)	**33.**	(1)	**34.**	(3)	**35.**	(2)
36.	(1)	**37.**	(1)	**38.**	(4)	**39.**	(3)	**40.**	(2)				

SECTION (D) :

1.	(1)	**2.**	(1)	**3.**	(3)	**4.**	(3)	**5.**	(3)	**6.**	(3)	**7.**	(1)
8.	(1)	**9.**	(2)	**10.**	(2)	**11.**	(3)	**12.**	(2)	**13.**	(1)	**14.**	(2)
15.	(3)	**16.**	(3)	**17.**	(2)	**18.**	(3)	**19.**	(1)	**20.**	(2)	**21.**	(4)
22.	(2)	**23.**	(1)	**24.**	(1)	**25.**	(4)	**26.**	(1)	**27.**	(2)	**28.**	(2)
29.	(3)	**30.**	(3)	**31.**	(2)	**32.**	(1)	**33.**	(2)	**34.**	(3)	**35.**	(2)
36.	(1)	**37.**	(2)	**38.**	(1)	**39.**	(1)	**40.**	(3)	**41.**	(3)	**42.**	(2)
43.	(3)	**44.**	(2)	**45.**	(4)	**46.**	(3)	**47.**	(4)	**48.**	(3)	**49.**	(2)
50.	(3)	**51.**	(3)	**52.**	(4)	**53.**	(1)	**54.**	(2)	**55.**	(3)	**56.**	(4)
57.	(1)	**58.**	(2)										

SECTION (E) :

1.	(3)	**2.**	(3)	**3.**	(4)	**4.**	(3)	**5.**	(1)	**6.**	(4)	**7.**	(2)
8.	(2)	**9.**	(2)	**10.**	(4)	**11.**	(2)	**12.**	(3)	**13.**	(4)	**14.**	(4)
15.	(3)												

EXERCISE - 2

1.	(2)	**2.**	(2)	**3.**	(4)	**4.**	(3)	**5.**	(2)	**6.**	(4)	**7.**	(3)
8.	(1)	**9.**	(1)	**10.**	(1)	**11.**	(3)	**12.**	(4)	**13.**	(3)	**14.**	(2)
15.	(2)	**16.**	(4)	**17.**	(4)								

EXERCISE - 3

PART – I

1.	(3)	**2.**	(1)	**3.**	(4)	**4.**	(2)	**5.**	(4)	**6.**	(2)	**7.**	(2)
8.	(1)	**9.**	(2)	**10.**	(2)	**11.**	(3)	**12.**	(1)	**13.**	(3)	**14.**	(1)
15.	(3)	**16.**	(3)	**17.**	(1)	**18.**	(1)	**19.**	(4)	**20.**	(2)	**21.**	(3)
22.	(3)	**23.**	(3)	**24.**	(3)	**25.**	(1)	**26.**	(3)	**27.**	(2)	**28.**	(4)
29.	(2)	**30.**	(4)	**31.**	(1)	**32.**	(2)						

PART – II

1.	(4)	**2.**	(4)	**3.**	(1)	**4.**	(1)	**5.**	(4)	**6.**	(2)	**7.**	(3)
8.	(3)	**9.**	(4)	**10.**	(3)	**11.**	(1)	**12.**	(4)	**13.**	(3)	**14.**	(3)
15.	(1)												