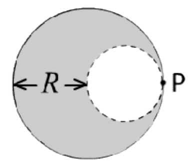
Only one option correct

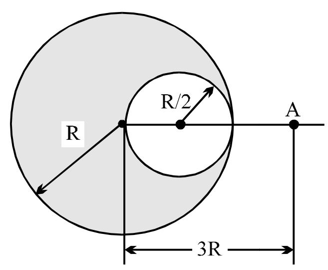
1. A large spherical planet of radius R, made of a material of density ρ, has a spherical cavity of radius $R/2$, with center of cavity a distance $R/2$ from the centre of the planet. Gravitational force on a small mass m at the center of the cavity is
1. $2\pi RGm\rho/3$ 2. $\pi RGm\rho/3$ 3. $2\pi RGm\rho$ 4. $4\pi RGm\rho/3$

2. A spherical hole of radius $R/2$ is excavated from the asteroid of mass M as shown in figure below. Acceleration due to gravity at a point on the surface of the asteroid just above the excavation (at point P) is



1. $\frac{GM}{R^2}$ 2. $\frac{GM}{2R^2}$ 3. $\frac{GM}{8R^2}$ 4. $\frac{7GM}{8R^2}$

3. A solid sphere of uniform density and radius R applies a gravitational force of attraction equal to F_1 on a particle placed at a distance $3R$ from the centre of the sphere. A spherical cavity of radius $R/2$ is now made in the sphere as shown in the figure. The sphere, with the cavity, now applies a gravitational force F_2 on the same particle. Ratio F_2/F_1 is



1. 9/50 2. 41/50 3. 3/25 4. 22/25

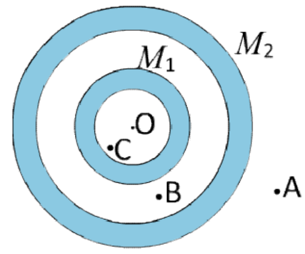
4. An infinite number of masses, each of one kg are placed on the positive x-axis at locations 1m, 2m, 4m… from the origin. Magnitude of gravitational field at the origin due to this distribution of masses is
1. $2G$ 2. $4G/3$ 3. $3G/4$ 4. infinite

5. Assuming that gravitational force varies inversely as the n^{th} power of distance, the time period of a planet in circular orbit of radius R around the sun will be proportional to
1. $R^{\frac{n+1}{2}}$ 2. $R^{\frac{n-1}{2}}$ 3. R^n 4. $R^{\frac{n-2}{2}}$

6. A body is projected horizontally from the surface of the Earth of radius R with a velocity equal to n times the escape velocity. Neglect rotational effects of the earth. If the maximum height attained by the body from the Earth's surface is $R/2$ then, n is equal to
1. $\sqrt{0.6}$ 2. $\sqrt{3/2}$ 3. $\sqrt{0.4}$ 4. $1/\sqrt{2}$

7. A body of mass m starts falling towards a body of mass M and radius R. The distribution of mass is such that outer spherical shell, of negligible thickness, has mass $M/3$ and a point mass of $2M/3$ at located at the centre. As the object passes through a small hole in the outer shell, change in the force of gravity experienced by it is
1. $\frac{2GmM}{3R^2}$ 2. $\frac{GmM}{3R^2}$ 3. $\frac{2GmM}{R^2}$ 4. zero

8. Two concentric shells of uniform density of mass M_1 and M_2 are situated as shown in the figure below. Forces experienced by a particle of mass m when placed at positions A, B and C respectively are (given OA = p, OB = q and OC = r)



1. zero, $\frac{GmM_1}{q^2}$, $\frac{Gm(M_1+M_2)}{p^2}$
2. $\frac{Gm(M_1+M_2)}{p^2}$, $\frac{Gm(M_1+M_2)}{q^2}$, $\frac{GmM_1}{r^2}$
3. $\frac{GmM_1}{q^2}$, $\frac{Gm(M_1+M_2)}{p^2}$, zero
4. $\frac{Gm(M_1+M_2)}{p^2}$, $\frac{GmM_1}{q^2}$, zero

9. A newly discovered planet has a density eight times the density of the earth and a radius twice the radius of the earth. The time taken by 2 kg mass to fall freely through a distance S near the surface of the earth is 1

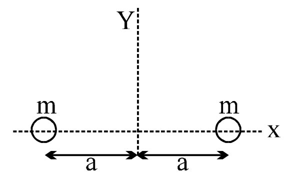
second. Time taken for a 4 kg mass to fall freely through the same distance S near the surface of the new planet is

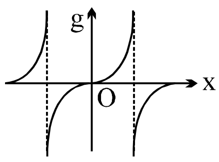
1. 0.25 s 2. 0.5 s 3. 1 s 4. 4 s

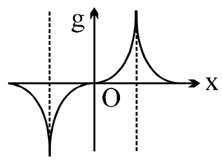
10. Mass and diameter of a planet are twice those of earth. What will be the period of oscillation of a pendulum on this planet if it is a seconds pendulum on the earth?

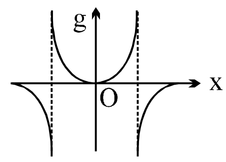
1. $\sqrt{2}$ seconds 2. $2\sqrt{2}$ seconds 3. $1/\sqrt{2}$ seconds 4. $1/(2\sqrt{2})$ seconds

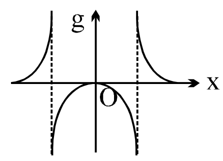
11. Two identical spheres, each of mass m, are placed as shown in figure. Plot of net gravitational field along the x-axis is given by



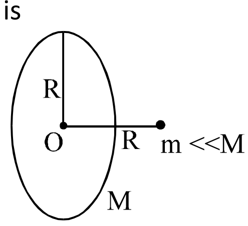
1. 

2. 

3. 

4. 

12. A particle starts from rest at a distance R from the centre and along the axis of a fixed ring of radius R and mass M. Its velocity at the centre of the ring is



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

13. A spherical uniform planet is rotating about its axis. Velocity of a point on its equator is v. Due to rotation of the planet about its axis, acceleration due to gravity at equator is half the value at poles. Escape velocity (v_e) of a particle on the planet in terms of v is

1. $v_e = 2v$ 2. $v_e = v$ 3. $v_e = v/2$ 4. $\sqrt{3}v$

14. Magnitude of the potential energy per unit mass of the object at the surface of earth is E. Then the escape velocity of the object is

1. $\sqrt{2E}$ 2. $\sqrt{E}$ 3. $\sqrt{\frac{2E}{3}}$ 4. $\sqrt{3E}$

15. A small body of super-dense material, whose mass is twice the mass of the earth but whose size is very small compared to the size of the earth. If it starts from rest at a height $H << R$ above the earth's surface then the time taken by it to reach the earth is (assume that acceleration due to gravity remains constant)

1. $\sqrt{\frac{2H}{g}}$ 2. $\sqrt{\frac{H}{g}}$ 3. $\frac{2H}{3g}$ 4. $\sqrt{\frac{4H}{3g}}$

16. A rocket is launched straight up from the surface of the earth. When its altitude is one fourth the radius of the earth, its fuel runs out and therefore it coasts. The minimum velocity which the rocket must have when it starts to coast if it is to escape from the gravitational pull of the earth is (escape velocity on surface of earth is 11.2 km s^{-1})

1. 1 km s^{-1} 2. 1 km s^{-1} 3. 10 km s^{-1} 4. 1 km s^{-1}

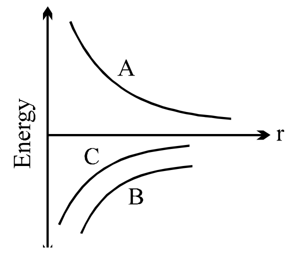
17. Gravitational potential difference between a point on the surface of a planet and another point 10 m above it is 4 J kg^{-1}. Considering gravitational field to be uniform, how much work is done in moving a mass of 2.0 kg from the surface to a point 5.0m above the surface?

1. 0.4 J 2. 2.5 J 3. 4.0 J 4. 8.0 J

18. A particle is projected with a velocity $\sqrt{\frac{4gR}{3}}$ vertically upward from the surface of the earth, R being the radius of the earth and g being the acceleration due to gravity on the surface of the earth. Velocity of the particle when it is at half the maximum height reached by it is

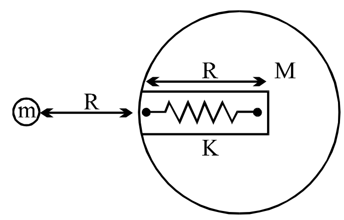
1. $\sqrt{\frac{gR}{2}}$ 2. $\frac{gR}{3}$ 3. $\sqrt{gR}$ 4. $\sqrt{\frac{2gR}{3}}$

19. The figure shows the variation of energy with the orbit radius of a body in circular planetary motion. Find the correct statement about the curves A, B and C



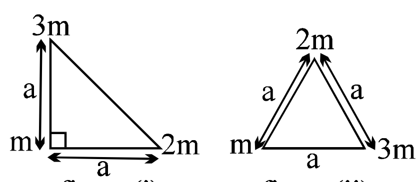
1. A shows the kinetic energy, B the total energy and C the potential energy of the system.
2. C shows the total energy, B the kinetic energy and A the potential energy of the system
3. C and A are kinetic and potential energies respectively and B is the total energy of the system.
4. A and B are kinetic and potential energies and C is the total energy of the system

20. Consider the following hypothetical situation. A small ball of mass m is released from a height R above the earth's surface, as shown in the figure below. The ball passes through a groove containing a spring of natural length R and spring constant K. If the maximum depth to which it goes is $R/2$ inside the earth then the value of spring constant is



1. $\frac{3GmM}{R^3}$ 2. $\frac{6GmM}{R^3}$ 3. $\frac{9GmM}{R^3}$ 4. $\frac{7GmM}{R^3}$

21. Consider two configurations of a system of three particles of masses m, 2m and 3m. The work done by external agent in changing the configuration of the system from figure (i) to figure (ii) is



1. $-\frac{6Gm^2}{a}\left(2+\frac{1}{\sqrt{2}}\right)$ 2. $-\frac{6Gm^2}{a}\left(1+\frac{1}{\sqrt{2}}\right)$ 3. $-\frac{6Gm^2}{a}\left(1-\frac{1}{\sqrt{2}}\right)$ 4. $-\frac{6Gm^2}{a}\left(2-\frac{1}{\sqrt{2}}\right)$

22. Acceleration due to gravity is g on a uniform spherical planet of radius R. Consider two points P and Q located inside and outside the planet respectively such that acceleration due to gravity at these points is $g/4$. Maximum possible separation between P and Q is
1. $7R/4$ 2. $3R/2$ 3. $9R/4$ 4. $R/4$

23. 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. $\frac{r}{2^{1/3}}$

24. Two planets with radii R_1, R_2 have densities ρ_1, ρ_2 respectively. Their atmospheric pressures are P_1, P_2 respectively. Ratio of masses of their atmospheres, neglecting variation of g within the limits of atmosphere, is

1. $\frac{P_1R_2\rho_1}{P_2R_1\rho_2}$ 2. $\frac{P_1R_2\rho_2}{P_2R_1\rho_1}$ 3. $\frac{P_1R_1\rho_1}{P_2R_2\rho_2}$ 4. $\frac{P_1R_1\rho_2}{P_2R_2\rho_1}$

25. A satellite is seen after every 6 hours over the equator. It is known that it rotates opposite to that of earth's direction. Then the angular velocity of the satellite about the centre of earth will be
1. $\pi/2$ rad hr^{-1} 2. $\pi/3$ rad hr^{-1} 3. $\pi/4$ rad hr^{-1} 4. $\pi/8$ rad hr^{-1}

26. A particle is dropped on Earth from height equal to the earth's radius (R). If it bounces back to a height $R/2$, then the coefficient of restitution for collision is (ignore air resistance and rotation of Earth) is
1. 2/3 2. $\sqrt{(2/3)}$ 3. $\sqrt{(1/3)}$ 4. $\sqrt{(1/2)}$

27. A satellite is in a circular orbit very close to the surface of a planet. At some point it is given an impulse along its direction of motion, causing its velocity to increase n times. It now goes into an elliptical orbit. The maximum possible value of n for this to occur is
1. 2 2. $\sqrt{2}$ 3. $\sqrt{2} + 1$ 4. $1 / (\sqrt{2} - 1)$

28. A planet of mass m is in an elliptical orbit about the sun ($m << M_{sun}$) with an orbital period T. If A be the area of orbit, then its angular momentum would be
1. $\frac{2mA}{T}$ 2. mAT 3. $\frac{mA}{2T}$ 4. $2mAT$

More than one option correct

29. Consider the motion of a planet (assumed to be circular) around the sun and choose the correct option(s)
1. Torque acting on the planet is zero though the force acting on it is not zero
2. Angular momentum of the planet is zero
3. Work done on the planet by the gravitational force of the sun is zero
4. Net force acting on the planet is zero, but the torque is not zero

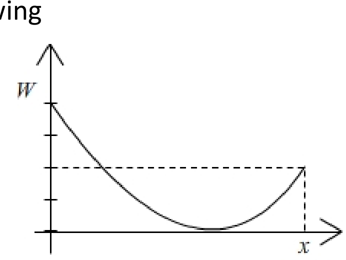
30. Consider a geostationary satellite orbiting the earth. Let kinetic energy, gravitational potential energy and total energy of planet be KE, PE and TE respectively. Choose the correct statements from the following.
1. $KE = PE$ 2. $KE + PE = 0$ 3. $KE + PE < 0$ 4. $KE < PE$

31. An earth satellite is moved from one stable orbit to another stable orbit. Choose the correct statements from the following
1. Gravitational potential energy increases
2. Orbital velocity of the satellite decreases
3. Time period of revolution increases
4. Kinetic energy of the satellite increases

32. Two identical satellites A and B, each of mass m, revolve around the same planet. The time period of A is 32 days and that of B is 256 days. Radius of orbit of A is x.
1. Radius of orbit of satellite B is $8x$
2. Radius of orbit of satellite B is $4x$
3. Angular momentum of B is greater than that of A
4. Kinetic energy of second satellite is less than that of the first satellite

33. Two particles of mass m and M ($M > m$) are separated by a distance D. They rotate with same angular velocity under the influence of gravitational force. Choose the correct options from the following
1. The angular velocity of the particles is $\sqrt{\frac{(M+m)G}{D^3}}$
2. The linear velocity of the larger particle is $\sqrt{\frac{GM^2}{(M+m)D}}$
3. Radius of the circular orbit of larger particle is smaller than the radius of orbit of smaller particle
4. Force acting on larger particle is more than the force acting on the smaller particle

34. Variation of magnitude of weight of a body as it moves from earth to a planet P is given in the graph. Choose the correct statement(s) from the following



1. Mass of earth is more than the mass of planet P
2. A body projected from earth with a velocity less that the escape velocity may reach the planet P
3. As the body moves from earth to planet P its gravitational potential energy decreases
4. At some point on its path, the force acting on the body becomes zero.

35. As a planet orbits the earth(assuming circular orbits)
1. Work done by gravitational force is zero
2. Gravitational force is zero
3. Momentum of the planet remains constant
4. Angular momentum remains constant because torque acting on the planet is zero

36. Two bodies A and B each of mass M and radius R are placed at a distance of D from each other. Another point object of mass m is placed at the midpoint of the line joining A and B. It is slightly displaced from this position towards the body B. Choose the correct statements from the following.
1. The body undergoes oscillatory motion and finally comes to rest at the initial position
2. The velocity with which the body reaches B is $\sqrt{(GM/R)}$
3. The body moves towards B and finally reaches B
4. The total potential energy of the system decreases as the body reaches B

Key

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

31. 1, 2, 3
32. 2, 3, 4
33. 1, 2, 3
34. 1, 2, 3, 4
35. 1, 4
36. 3, 4