PHYSICS

BOOKS - CENGAGE PHYSICS (ENGLISH)

GRAVITATION

Illustration

1. The time period of Jupiter is 11.6 year, how far is Jupiter from the sun. Distance of earth from the sun is $1.5 \times 10^{11} m$.

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2. The mean distance of Mars from the sun in 1.524 times that of the Earth from the sun. Find the number of years requires for Mars make one revolution about the Sun.

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3. Let the speed of the planet at the perhelion Pin Fig. 8.1 (a) be v_p and the sun-planat distance SP be r_p. Relate $(r_p{'}v_p)$ to the corresponding quantities at the aphelion $(r_A . v_A)$ will the planat take equal times to traverse BAC and CPB?

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4. A sphere of mass $40kg$ is attracted by a second sphere of mass $15kg$, when their centres are $20cm$ apart, with a force of 0.1 miligram weight. Caculate the value of gravitational constant.

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5. The mass of planet Jupiter is $1.9 \times 10^7 kg$ and that of the Sun is $1.99 \times 10^{30} kg$. The mean distance of Jupiter from the Sun is 7.8×10^{11}m. Calculate the gravitational force which Sun exerts on Jupiter. Assuming that Jupiter moves in circular orbit around the Sun, also calculate the speed of Jupiter $G = 6.67 \times 10^{-11} Nm^2 kg^{-2}$.

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6. Gravitational force between two point masses m and M separated by a distance r is F. Now if a point mass $3m$ is placed next to m, what will be the (a) force on M due to m, (b) total force on M?

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7. Two particles of mass m and M are initialljy at rest at infinite distance. Find their relative velocity of approach due to gravitational attraction when d is their separation at any instant

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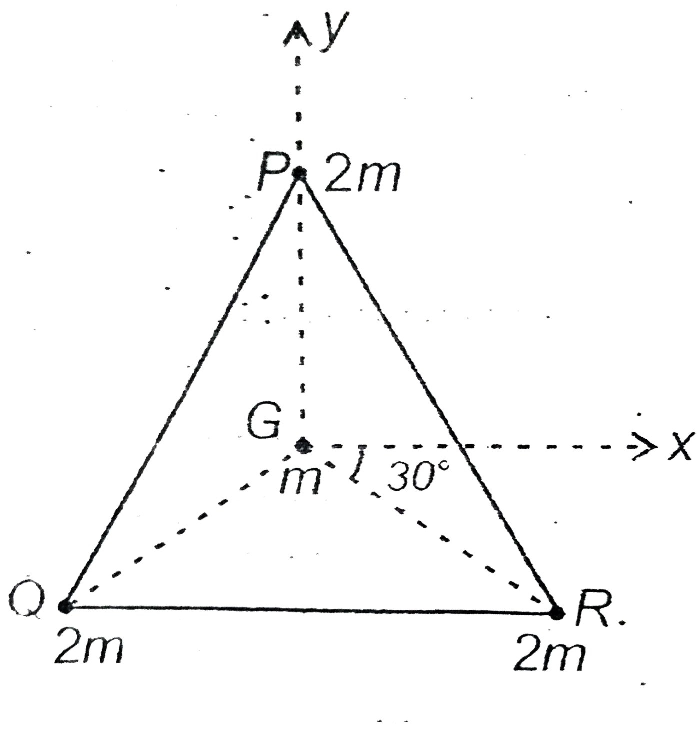
8. Three equal masses 2m each are placed at the vertices an equilateral triangle PQR

(i) What is the force acting on a mass m placed at the centroid G of the triangle ?

(ii) What is the force on mass m if the mass at the vertex P is quadrupled ?

Take PG = QG = RG = 1m



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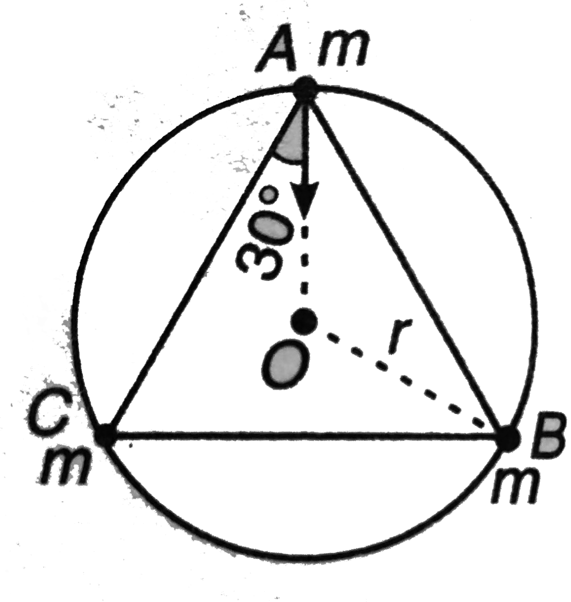
9. Three particles each of mass m, are located

at the vertices of an equilateral triangle of side

a. At what speed must they move if they all revolve under the influence of their gravitational force of attraction in a circular orbit circumscribing the triangle while still preserving the equilateral triangle ?



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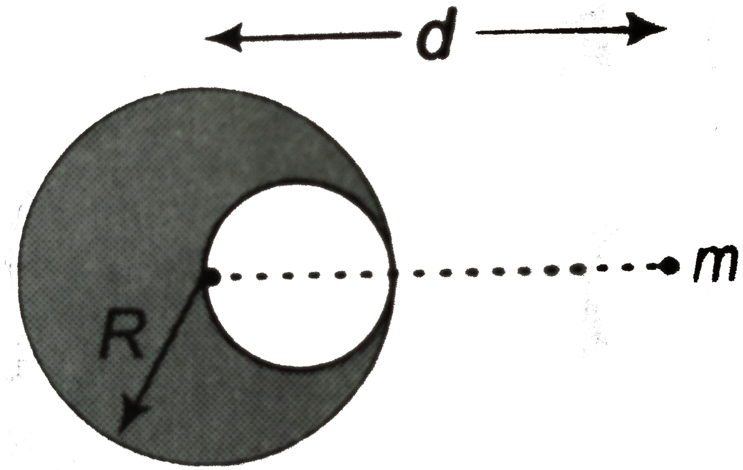
10. Figure shows a spherical cavity inside a lead sphere. The surface of the cavity passes through the centre of the sphere and touches the right side of the sphere. The mass of the sphere before hollowing was M. With what gravitational force does the hollowed out lead sphere attract a particle of mass m that lies at a distance d from the centre of the lead sphere on the straight line connecting the centres of the spheres and of the cavity.



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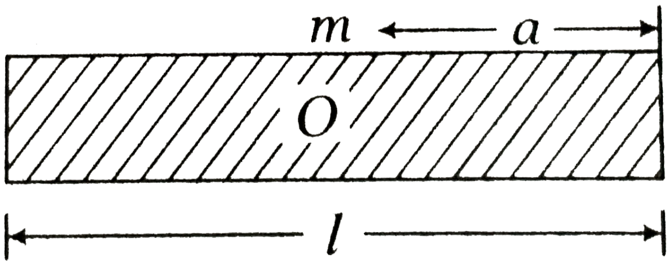
11. A mass m is at a distance a from centre of a uniform rod of length l and M. The gravitational force on the mass due to the rod

is



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12. In a double star, two stars one of mass m_1 and another of mass m_2, with a separation d, rotate about their common centre of mass. Find

(a) an expression for their time period of revolution.

(b) the ratio of their kinetic energies.

(c) the ratio of their angular momenta about the centre of mass.

(d) the total angular momentum of the system.

(e) the kinetic energy of the system.

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13. Find the relation between the gravitational field on the surface of two planets A and B of masses m_A, m_B and radii R_A and R_B, respectively if

a. they have equal mass.

b. they have equal (uniform)density.

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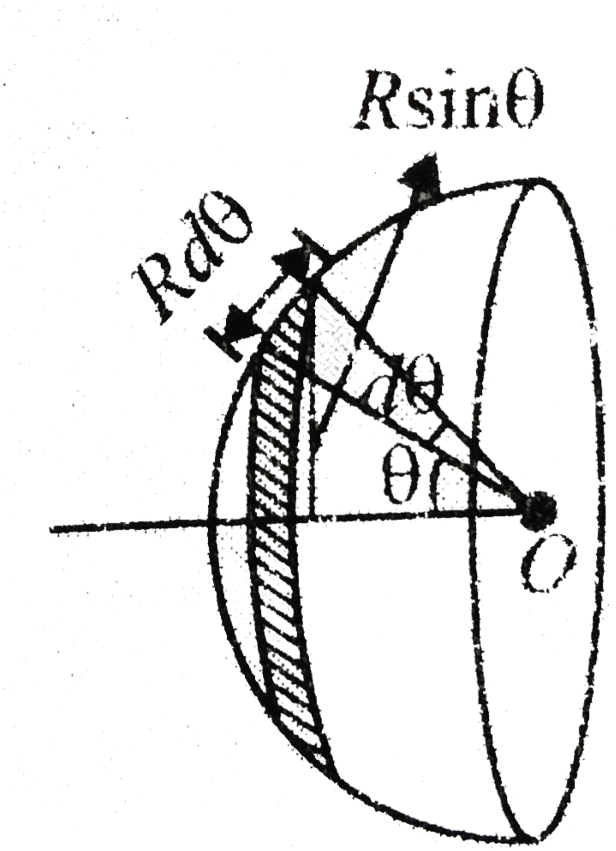
14. Calculate the gravitational field intensity at the centre of the base of a hollow hemisphere of mass M and radius R. (Assume the base of hemisphere to be open)



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15. Two masses $90kg$ and $160kg$ are at a distance $5m$ apart. Compute the magnitude of intensity of the gravitational field at a point distance $3m$ from the $90kg$ and $4m$ from the $160kg$ mass. $G = 6.67 \times 10^{-11}kg^{-2}$

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16. Two bodies of masses $100kg$ and $10,000kg$ are at a distance $1m$ part. At which point on the line joining them will the resultant gravitational field intensity be zero?

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17. Assuming the earth of to be a uniform sphere of radius $6400km$ and density $5.5g/c.c.$, find the value of g on its surface $G = 6.66 \times 10^{-11} Nm^2 kg^{-2}$

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18. At what height from the surface of earth will the value of g be reduced by 36% from the

value on the surface? Take radius of earth $R = 6400 km.$

A. 3.2×10^6 m

B. 1.6×10^6 m

C. 2.5×10^6 m

D. 4.6×10^6 m

Answer: B

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19. Calculate the percentage decrease in the weight of a body when taken 32 km below the surface of the earth. Radius of the earth is 6400 km and g $= 9.8 ms^{-2}$

A. 0.6%

B. 0.2%

C. 0.5%

D. 0.7%

Answer: C

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20. What is the fractional decrease in the value of free-fall acceleration g for a particle when it is lifted from the surface to an elevation h? $(h < < R)$

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21. a. Find the height from the earth's surface where g will be 25% of its value on the surface of earth $(R = 6400 km)$. b. Find the percentage increase in the value of g at a depth h from the surface of earth.

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22. What would be the time period of rotation of earth so that the bodies at the equator would weight 40% of their actual weight?

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23. On a planet whose size is the same and mass four times as that of our earth, find the amount of work done to lift $3kg$ mass vertically upwards through $3m$ distance on the planet. The value of g on the surface of earth is $10ms^{-2}$

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24. The gravitational field in a region is given by $\overrightarrow{E} = -\left(20Nkg^{-1}\right)\left(\hat{i} + \hat{j}\right)$. Find the gravitational potential at the origin $(0, 0)$ in Jkg^{-1}

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25. Calculate the gravitational field intensity and potential at the centre of the base of a solid hemisphere of mass m, radius R

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26. A particle of mass 'm' is raised to a height $h = R$ from the surface of earth. Find increase in potential energy. $R =$ radius of earth. $g =$ acceleration due to gravity on the surface of earth.

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27. The gravitational potential difference between the surface of a planet and a point $20m$ above it is $16J/kg$. Calculate the work done in moving a $4kg$ body by $8m$ on a slope of 60° from the horizontal.

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28. A projectile is fired vertically from the earth's surface with an initial speed of $10km/s$. Neglecting air drag, how high above the surface of earth will it go?

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29. A satellite of mass $1000 kg$ is rotating around the earth in a circular orbit of radius $3R$. What extra energy should be given to this satellite if it is to be lifted into an orbit of radius $4R$?

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30. Two particles of mass m and M are initialljy at rest at infinite distance. Find their relative velocity of approach due to gravitational attraction when d is their separation at any instant

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31. A body is released at a distance far away from the surface of the earth. Calculate its speed when it is near the surface of earth. Given $g = 9.8ms^{-2}$, radius of earth $R = 6.37 \times 10^6 m$

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32. Calculate the velocity with which a body must be thrown vertically upward from the surface of the earth so that it may reach a height of $10R$, where R is the radius of the earth and is equal to $6.4 \times 10^6 m$. (Given: Mass of the earth $= 6 \times 10^{24} kg$, gravitational constant $G = 6.7 \times 10^{-11} Nm^2 kg^{-2}$)

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33. Distance between the centres of two stars is $10a$. The masses of these stars are M and $16M$

and their radit a and $2a$ respectively. A body of mass m is fired straight from the surface of the larger star towards the smaller star. What should be its minimum inital speed to each the surface of the smaller star? Obtain the expression in terms of G, M and a.

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34. Estimate whether it takes more energy to get a satellite upto $1600 km$ above the earth than to put in orbit there. Earth's radius is

$6400km$. Does your answer remain same for height $3200km$ or for height $4800km$?

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35. Calculate the self-gravitational potential energy of matter forming a. a thin uniform shell of mass M and radius R, b. a uniform sphere of mass m and radius R.

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36. Calculate the escape speed on the surface of a planet of mass $7.5 \times 10^{25} g$, and radius $1.6 \times 10^{8} cm$. $G = 6.67 \times 10^{-8} \text{dyne} cm^{2} g^{-2}$.

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37. The escape speed from earth's surface is $11 kms^{-1}$. A certain planet has a radius twice that of earth but its mean density is the same as that of the earth. Find the value of the escape speed from the planet.

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38. A spaceship is launched into a circular orbit close to the earth's surface . What additional velocity has now to be imparted to the spaceship in the orbit to overcome the gravitational pull. Radius of earth $= 6400 km$, $g = 9.8 m / s^2$.

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39. A rocket starts vertically upward with speed v_0. Show that its speed v at height h is given by

$$v_0^2 - v^2 = \frac{2hg}{1 + \frac{h}{R}}$$

where R is the radius of the earth and g is acceleration due to gravity at earth's suface. Deduce an expression for maximum height reachhed by a rocket fired with speed 0.9 times the escape velocity.

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40. For a particle projected in a transverse direction from a height h above earth's surface, find te minimum initial velocity so that it just grazes the surface of earth such that path of this particle would be an ellipse with centre of earth as the farther focus, point of projection as the apogee and a diametrically opposite point on earth's surface as perigee.

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41. Two masses m_1 and m_2 at an infinite distance from each other are initially at rest, start interacting gravitationally. Find their velocity of approach when they are at a distance r apart.

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42. A satellite revolves around the earth at a height of 1000 km. The radius of the earth is 6.38×10^3km. Mass of the earth is $6 \times 10^{24} kg$ and $G = 6.67 \times 10^{-14}$N-m$^2 kg^{-2}$.

Determine its orbital velocity and period of revolution.

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43. A satellite orbits the earth at a height of $3.6 \times 10^6 m$ from its surface. Compute it's a kinetic energy, b. potential energy, c. total energy. Mass of the satellite $= 500 kg$ mass of the earth $= 6 \times 10^{24}$kg, radius of the earth $= 6.4 \times 10^6, G = 6.67 \times 10^{-11} Nm^2 kg^{-2}$.

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44. You are given the following data $: g = 9.81 ms^{-2}$, radius of earth $= 6.37 \times 10^6 m$ the distance of the Moon from the earth $= 3.84 \times 10^8 m$ and the time period of the Moon's revolution $= 27.3 days$. Obtain the mass of the earth in two different ways. $G = 6.67 \times 10^{-11} Nm^2 kg^{-2}$.

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45. Assume the radius of the earth to be $6.4 \times 10^6 m$

a. Calculate the time period T of a satellite on equational orbit at $1.4 \times 10^e m$ above the surface of the earth.

b. What is the speed of the satellite in this orbit?

c. If the satellite is travelling in the same direction as the rotation of the earth i.e. west to east, what is the interval between two successie times at which it will appear vertically overhead to an observed at a fixed point on the equator?

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46. Two satellites A and B of equal mass move in the equatorial plane of the earth, close to earth's surface. Satellite A moves in the same direction as the of the rotation of the earth while satellite B moves in the opposite direction. Calclate the ratio of the kinetic energy of B of that of A in the reference frame fixed to the earth $(g = 9.8 ms^{-2}$ and radius of the earth $= 6.37 \times 10^6 m)$

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47. A satellite is revolving in the circular equatorial orbit of radius $R = 2 \times 10^4 km$ from east to west. Calculate the interval after which it will appear at the same equatorial town. Given that the radius of the earth $= 6400 km$ and g (acceleration due to gravity) $= 10 ms^{-2}$

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48. A satellite ils launched into a circular orbit $1600km$ above the surface of the earth. Find the period of revolution if the radius of the earth is $R = 6400km$ and the acceleration due to gravity is $9.8ms^{-2}$. At what height from the ground should it be launched so that it may appear stationary over a point on the earth's equator?

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Exercise 6.1

1. Gravitational force is a weak force but still it is considered the most important force. Why ?

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2. The earth is continuously pulling the Moon towards its centre. Why the moon does not fall on to the earth?

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3. Which has longer period of revolution, a satellite revolving close or away from the surface of earth?

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4. What would happen if gravity suddenly disappears?

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5. Two identical copper spheres of radius R are in contact with each other. If the gravitational attraction between them is F, find the relation between F and R.

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6. A mass M is broken into two parts of masses m_1 and m_2. How are m_1 and m_2 related so that force of gravitational attraction between the two parts is maximum?

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7. A small planet is revolving around a very massive star in a circular orbit of Radius R with a period of revolution T. If the gravitational force between the planet and the star were proportional to $R^{-5/2}$, then T would be proportional to

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8. A planet of mass m moves around the sun of mass M in an elliptical orbit. The maximum and minimum distance of the planet from the sun are r_1 and r_2 respectively. The time period of the planet is proportional to

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9. 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

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10. The distance of the planet Jupiter from the Sun is 5.2 times that of the Earth. Find the period of Jupiter's revolution around the Sun.

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11. The distance of the two planets from the Sun are $10^{13} m$ and $10^{12} m$, respectively. Find the ratio of time periods of the two planets.

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12. Given that $T^2 = kR^3$, express the constant k of the above relation in days and kilometres. Given, $k = 10^{-13} s^2 m^3$. The Moon is at a distance of $3.84 \times 10^5 km$ from the earth. Obtain its time period of revolution in days.

13. Two heavy particles of masses 40 kg and 60 kg attracts each other with a fore of

$4 \times 10^{-5} N$. If G is $6 \times 10^{-11} N - m^2 kg^{-2}$, calculate the distance between them.

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Exercise 6.2

1. 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 (g_1 / g_2) at their surfaces is

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2. Draw g' versus d and g versus h graph. Here, d is depth below the surface of earth and h is the height from the surface of earth.

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3. The mass and diameter of a planet are twice those of earth. What will be the period of oscillation of a pendulum on this plenet. If it is a 2 second's pendulum on earth?

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4. Will $1kg$ sugar be more at poles or at the equator?

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5. The magnitude of gravitational field at distances r_1 and r_2 from the centre of a uniform sphere of radius R and mass M, respectively. Find the ratio of $(I_1)/(I_2))$ if $r_1 > R$ and $r_2 > R$.

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6. Assertion : On satellites we feel weightlessness. Moon is also a satellite of earth. But we do not feel weightlessness on moon.

Reason : Mass of moon is considerable.

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7. Why does a body lose weight at the centre of the earth?

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8. Does the concentration of the earth's mass near its centre change the variation of g (acceleration due to gravity) with height from its surface?

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9. The Sun's tide-raising power is only half as great as that of the Moon. The direct pull of the Sun on the earth, however, is about 175 times that of the Moon. Why is it then that the Moon causes larger tides?

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10. If a planet of given density were made larger, its force of attraction for an object on its surface would increase because of the greater distance from the object to the centre of the planet. Which effect predominates?

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11. A stone is dropped along the centre of a deep vertical mine shaft. Assume no air resistance but consider the earth's rotation. Will the stone continue along the centre of the shaft? If not, describe the motion.

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12. Show that if the earth were not rotating about its axis the value of g at the equator would exceed its present value by $3.36cm / s^{-2}$. Given the radius of earth $= 6.371 \times 10^6 m$.

and angular speed of earth $= 7.27 \times 10^{-5} rad / s^{-1}$

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13. How far away from the earth does the acceleration due to gravity become 10% of its value on earth's surface? Radius of earth $= 6.37 \times 10^6 m.$

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14. (a) Assuming the earth to be a sphere of uniform density, calculate the value of acceleration due to gravity at a point (i) $1600km$ above the earth, (ii) $1600km$ below the earth, (b) Also find the rate of variation of acceleration due to gravity above and below the earth's surface. Radius of earth $= 6400km, g9.8m/s^2$.

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15. How much faster than its present speed should the. earth (radius $6.37 \times 10^6 m$) rotate so that the bodies lying on the equator may fly off into space? (At equator, $g = 9.78 m / s^{-2}$)

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Exercise 6.3

1. Why do different planets have different escape speeds?

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2. What are the two factors which determine why some bodies in solar system have atmosphere and others do not?

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3. Why does Moon have no atmosphere'?

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4. What is binding energy of a satellite?

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5. If a body is projected with speed v greater than escape speed v_e from the surface of earth, find its speed in intersteller space.

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6. The radius of a planet is double that of earth but their average are the same. If the escape velocities at the planet and the earth are v_p and v_e respectively , then prove that $v_p = 2v_e$.

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7. A particle is projected vertically upwards from the surface of earth (radius R) with a kinetic energy equal to half of the minimum value needed for it to escape. The height to which it rises above the surface of earth is

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8. The magnitude of the potential energy per unit mass of the object on the surface of earth is E. Then the escape velocity of the object is

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9. Would you expect the total energy of the solar system to be constant? What about the total angular momentum? Explain

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10. The total energy of the earth $+$ Sun system is negative. How do you interpret the negative energy of a system?

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11. An artificial satellite in the presence of frictional forces will move into an orbit closer to the earth and may have increased kinetic energy. Explain this.

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12. The value of escape speed from the surface of earth is

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13. A body is released at a distance far away from the surface of the earth. Calculate its speed when it is near the surface of earth. Given $g = 9.8 ms^{-2}$ radius of earth $R = 6.37 \times 10^6 m$

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14. A projectile is fired vertically from the earth's surface with an initial speed of $10km/s$. Neglecting air drag, how high above the surface of earth will it go?

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15. Two earth satellites A and B, each of mass m are to be launched into circular orbits about earth's centre at altitudes $6400km$ and

$19200km$, respectively. The radius of earth is $6400km$. Find (i) the ratio of potential energy of B to that of A, (ii) ratio of kinetic energy of B to that of A and (iii) which one has greater total energy?

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16. Calculate te radus of an isolated sphere of density $3.0gcm^{-3}$ from the surface of which the escape velocity be $40ms^{-1}$

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Exercise 6.4

1. What are the conditions under which a rocket, fired from the earth, launches an artificial satellite of the earth?

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2. Two artificial satellites one close to the surface and the other away, are revolving around the earth. Which one has larger speed?

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3. Should the speed of two artificial satellites of the earth having the different masses but the same orbital radius be the same?

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4. Can a pendulum vibrate in an artificial satellite.

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5. Air friction increases the velocity of the sastellite. Explain.

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6. Why is it that we can learn more about the shape of the earth by studying the motion of an artificial satellite than by studying the motion of the Moon?

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7. Objects at rest on the earth's surface move in circular paths with a period of $24h$. Are they in 'orbit' in the sense that an earth satellite is in orbit? Explain.

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8. Can a satellite move in a stable orbit in a plane not passing through the earth's centre? Explain,

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9. A scientist is making a precise measurement of g at a certain point in the indian ocean (on the equator) by timing the swings of a pendulum of accurately known construction. To provide stable base, the measurements are conducted in a submerged submarine. It is observed that slightly different results, for g is obtained when the submarine is moving eastward through the point than when the submarine is moving westward, the speed in each case being 10 mile/h. Account for this difference and calculate the effect, in parts per million that it has on the value of g.

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10. Two satellites move along a circular orbit in the same direction at a small distance from each other. A container has to be thrown from the first satellite on the second a one. When will the container reach the second satellite earlier, if it is thrown in the direction of motion of the first satellite or in the opposite direction? The velocity of the container is small in comparison to that of the satellite.

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11. Explain the reason of weightlessness inside a satellite.

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12. A satellite moves in a circular orbit around the earth at height $(R_e)/2$ from earth's surface where R_e is the radius of the earth. Calculate its period of revolution. Given $R = 6.38 \times 10^6 m$.

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13. A small satellite revolves around a planet in an orbit just above planet's surface. Taking the mean density of the planet $8000 kgm^{-3}$ and $G = 6.67 \times 10^{-11} N / kg^{-2}$, find the time period of the satellite.

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14. Consider two satellites A and B of equal mass, moving in the same circular orbit of radius r around the earth but in the opposite sense and therefore a collision occurs.

(a) Find the total mechanical energy $E_A + E_B$ of the two satellite-plus-earth system before collision.

(b) If the collision is completely inelastic, find the total mechanical energy immediately after collision. Describe the subsequent motion of the combined satellite.

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15. Mars and earth have masses in the ratio $1:11$ and radii in the ratio $42:79$. Compare

a. their densities, assuming them to be spheres of uniform density,

b. gravitational field strengths at their surfaces:

c. escape velocities from their surfaces,

d. periods of their satellites near their surfaces.

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16. If a satellite is revolving around a planet of mass M in an elliptical orbit of semi-major axis a. Show that the orbital speed of the satellite when it is a distance r from the focus will be given by

$$v^2 = GM\left[\frac{2}{r} - \frac{1}{a}\right]$$

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Subjective

1. Calculate the velocity with which a body must be thrown vertically upward from the surface of the earth so that it may reach a height of $10R$, where R is the radius of the earth and is equal to $6.4 \times 10^6 m$. (Given: Mass of the earth $= 6 \times 10^{24} kg$, gravitational constant $G = 6.7 \times 10^{-11} Nm^2 kg^{-2}$)

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2. A sky lab of mass $2 \times 10^3 kg$ is first launched from the surface of earth in a circular orbit of radius $2R$ and them it is shifted from this circular orbit to another circular orbit of radius $3R$. Calculate the energy required

(a) to place the lab in the first orbit,

(b) to shift the lab from first orbit to the second orbit. $(R = 6400km, g = 10m/s^2)$

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3. Estimate whether it takes more energy to get a satellite upto $1600km$ above the earth than to put in orbit there. Earth's radius is $6400km$.

Does your answer remain same for height $3200km$ or for height $4800km$?

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4. The gravitational field in a region is given by $\overrightarrow{E} = \left(3\hat{i} - 4\hat{j}\right)Nkg^{-1}$. Find out the work done (in joule) in displacing a particle by $1m$ along the line $4y = 3x + 9$.

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5. A body suspended on a spring balance in a ship weighs W_0 when the ship is at rest. When the ship begins to move along the equator with a speed v, show that the scale reading is very close to $W_0(1 \pm 2\omega V / g)$, where ω is the angular speed of the earth.

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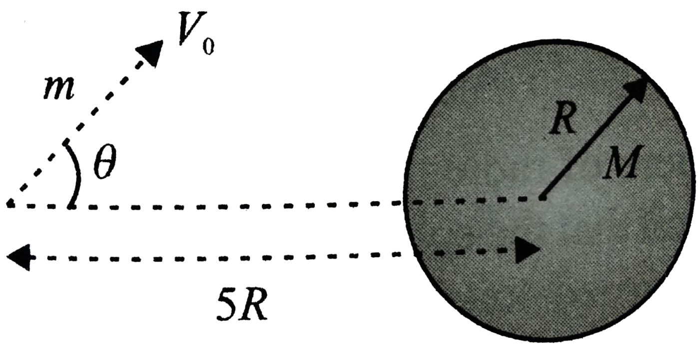
6. A spaceship is sent to investigate a planet of mass M and radius R. While hanging motionless in space at a distance $5R$ from the

centre of the planet, the spaceship fires an instrument package of mass m, which is much smaller than the mass of the spaceship. For what angle θ will the package just graze the surface of the planet?



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7. Ravi can throw a ball at a speed on the earth which can cross a river of width $10m$. Ravi reaches on an imaginary planet whose mean density is twice that of the earth. Find out the maximum possible radius of the planet so that if Ravi throws the ball at the same speed it may escape from the planet. Given radius of the earth $= 6.4 \times 10^6 m$.

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8. A spaceship approaches the Moon (mass $= M$ and radius $= R$ along a parabolic path which is almost tangential to its surface. At the moment of the maximum approach, the brake rocket is fired to convert the spaceship into a satellite of the Moon. Find the change in speed.

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9. Taking the earth to be a uniform sphere of radius $6400 km$ and the value of g at the surface to be $10 ms^{-2}$, calculate the energy needed to raise a satellite of mass $2000kg$ to a height of $800km$ a above the earth's surface and to set it into circular orbit at that altitude.

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10. A satellite is to be put into an orbit $600km$ above the surface of the earth. If its vertical velocity after launching is $2400m/s$ at this height, calculate the magnitude and direction in the impulse required to put the satellite directly increase. The mass of the satellite is

$60kg$ and the radius of the earth is $6400km$.

Take $g = 10ms^{-2}$

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11. A pair of stars rotates about a common centre of mass. One of the stars has a mass M and the other has mass m such that =2m. The distance between the centres of the stars is d (d being large compare to the size of eithe star). The period of rotation of the stars about their common centre of mass (in terms of d,m,G) is

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12. The small dense stars rotate about their common centre of mass as a binary system, each with a period of 1 year. One star has mass double than that of the other, while mass of the lighter star is one-third the mass of the Sun. The distance between the two stars is r and the distance of the earth from the Sun is R, find the relation between r and R.

13. A satellite revolving in a circular equatorial orbit of radius $R = 2.0 \times 10^4$ km from west to east appears over a certain point at the equator every $11.6h$. From these data, calculate the mass of the earth. $(G = 6.67 \times 10^{-11} Nm^2)$

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14. An artificial satellite (mass m) of a planet (mass M) revolves in a circular orbit whose radius is n times the radius R of the planet in the process of motion the satellite experiences a slight resistance due to cosmic dust. Assuming the force of resistance on satellite to depend on velocity as $F = av^2$ where 'a' is a constant caculate how long the satellite will stay in the space before it falls on to the planet's surface.

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15. A satellite of mass m is orbiting the earth in a circular orbit of radius r. It starts losing energy due to small air resistance at the rate of

CJ/s. Then the time teken for the satellite to reach the earth is...........

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Single Correct

1. The escape velocity from the earth is $11.2km/s$. If a body is to be projected in a direcion making an angle 45° to the vertical, then the escape velocity is

A. $\frac{11.2}{\sqrt{2}}kms^{-1}$

B. $11.2 \times \sqrt{2} kms^{-1}$

C. $11.2 \times 2 kms^{-1}$

D. $11.2 kms^{-1}$

Answer: D

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2. A projectile is fired from the surface of earth of radius R with a velocity kv_e (where v_e is the escape velocity from surface of earth and

$k < 1)$. Neglecting air resistance, the maximum height of rise from centre of earth is

A. $\dfrac{I - k^2}{R}$

B. $\dfrac{R}{1 - k^2}$

C. $R(1 - k)^2$

D. $\dfrac{R}{1 + k^2}$

Answer: B

Watch Video Solution

3. The radius of a planet is R. A satellite revolves around it in a circle of radius r with angular velocity ω_0. The acceleration due to the gravity on planet's surface is

A. $\dfrac{r^3\omega_0}{R}$

B. $\dfrac{r^3\omega_0^2}{R^2}$

C. $\dfrac{r^3\omega_0^2}{R}$

D. $\dfrac{r^3\omega_0^2}{R^2}$

Answer: D

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4. A space vehicle approaching a planet has a speed v when it is very far from the planet At that moment tangent of its trajectory would miss the centre of the planet by distance R if the planet has mass M and radius r what is the smallest value of R in order that the resulting orbit of the space vehicle will just miss the surface of the planet?

A. a) $\frac{r}{v}\left[v^2 + \frac{2GM}{r}\right]^{\frac{1}{2}}$

B. b) $vr\left[1 + \frac{2GM}{r}\right]$

C. c) $\frac{r}{v}\left[v^2 + \frac{2GM}{r}\right]$

D. d) $\frac{2GMv}{r}$

Answer: A

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5. The planets with radii R_1 and R_2 have densities p_1, p_2 respectively. Their atmospheric pressues are p_1 and p_2 respectively.Therefore, the ratio of masses of their atmospheres, neglecting variation of g within the limits of atmoshpere is

A. $\frac{p_1 R_2 \rho_1}{p_2 R_1 \rho_2}$

B. $\frac{p_1 R_2 \rho_2}{p_2 R_1 \rho_1}$

C. $\frac{p_1 R_1 \rho_1}{p_2 R_2 \rho_2}$

D. $\frac{p_1 R_1 \rho_2}{p_2 R_2 \rho_1}$

Answer: D

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6. A particle of mass 'm' is raised to a height $h = R$ from the surface of earth. Find increase in potential energy. $R =$ radius of earth. $g =$ acceleration due to gravity on the surface of earth.

A. $\frac{mgR}{2}$

B. $2mgR$

C. mgR

D. $-mgR$

Answer: A

Watch Video Solution

7. A space station is set up in space at a distance equal to the earth's radius from the surface of the earth. Suppose a satellite can be launched from the space station. Let v_1 and v_2 be the escape velocities of the satellite on the earth's surface and space station, respectively. Then

A. $v_2 = v_1$

B. $v_2 < v_1$

C. $v_2 > v_1$

D. a,b and c are valid depending on the mass of satellite

Answer: B

Watch Video Solution

8. The orbital velocity of an artificial in a circular orbit just above the earth's surface v. For a satellite orbiting at an altitude of half the earth's radius the orbital velocity is

A. $\left(\frac{3}{2}\right)v$

B. $\sqrt{\left(\frac{3}{2}\right)}v$

C. $\sqrt{\left(\frac{2}{3}\right)}v$

D. $\left(\frac{2}{3}\right)v$

Answer: C

Watch Video Solution

9. The radius of earth is about $6400Km$ and that of mars is about $3200km$ The mass of the earth is about 10times the mass of mars. An object weight $200N$ on earth 's surface, then its weight on the surface of mars will be:

A. $6N$

B. $20N$

C. $40N$

D. $80N$

Answer: D

Watch Video Solution

10. The distance of the two planets from the Sun are $10^{13}m$ and $10^{12}m$, respectively. Find the ratio of time periods of the two planets.

A. $\frac{1}{\sqrt{10}}$

B. 100

C. $\frac{10}{\sqrt{10}}$

D. $\sqrt{10}$

Answer: C

Watch Video Solution

11. If the gravitational force between two objects were proportional to $\frac{1}{R}$ (and not as $\frac{1}{R^2}$, where R is separation between them, then a particle in circular orbit under such a force would have its orbital speed v proportional to

A. $\frac{1}{R^2}$

B. R^0

C. R^1

D. $\frac{1}{R}$

Answer: B

Watch Video Solution

12. Two particles of equal mass go around a circle of radius R under the action of their mutual gravitational attraction. Find the speed of each particle.

A. $v = \frac{1}{2R}\sqrt{\left(\frac{1}{Gm}\right)}$

B. $v = \sqrt{\left(\frac{Gm}{2R}\right)}$

C. $v = \frac{1}{2}\sqrt{\left(\frac{Gm}{R}\right)}$

D. $v = \sqrt{\left(\frac{4Gm}{R}\right)}$

Answer: C

Watch Video Solution

13. The gravitational potential energy of 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)

A. mgR

B. $0.67mgR$

C. $-\frac{mgR}{2}$

D. $0.33mgR$

Answer: C

Watch Video Solution

14. If g is same at a height h and at a depth d, then

A. $R = 2d$

B. $d = 2h$

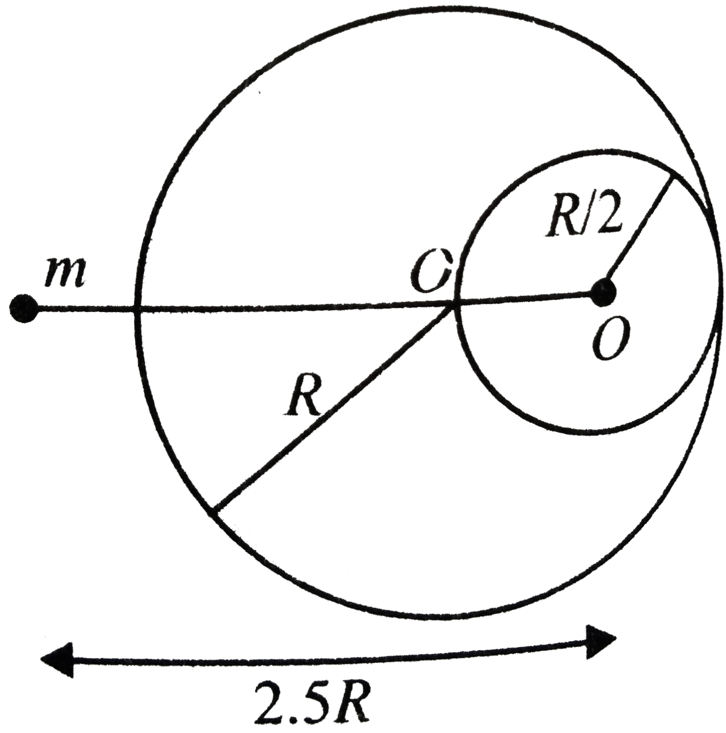
C. $h = d$

D. none

Answer: B

Watch Video Solution

15. A solid sphere of radius $R/2$ is cut out of a solid sphere of radius R such that the spherical cavity so formed touches the surface on one side and the centre of the sphere on the other side, as shown. The initial mass of the solid sphere was M. If a particle of mass m is placed at a distance $2.5R$ from the centre of the cavity, then what is the gravitational attraction on the mass m?



A. (a) $\frac{GMm}{R^2}$

B. (b) $\frac{GMm}{2R^2}$

C. (c) $\frac{GMm}{8R^2}$

D. (d) $\frac{23}{100}\frac{GMm}{R^2}$

Answer: D

Watch Video Solution

16. A geo-stationary 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

A. $\frac{1}{2}h$

B. $1h$

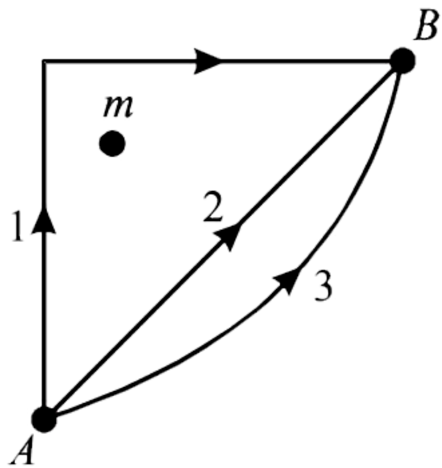
C. $2h$

D. h

Answer: C

Watch Video Solution

17. If $W_1 W_2$ and W_3 represent the work done in moving a particle from A to B along three different paths 1.2 and3 respectively (asshown) in the gravitational fieled of a point mass m, find the correct relation between W_(1) W_(2) and W_(3)`



A. $W_1 > W_2 > W_3$

B. $W_1 = W_2 = W_3$

C. $W_1 < W_2 > W_3$

D. $W_2 > W_1 > W_3$

Answer: B

Watch Video Solution

18. 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

A. $\frac{4\pi G}{3gR}$

B. $\frac{3\pi R}{4gG}$

C. $\frac{3g}{4\pi RG}$

D. $\frac{\pi R}{12G}$

Answer: C

Watch Video Solution

19. The satellite of mass m is orbitating around the earth in a circular orbit with a velocity v. what will be its total energy ?

A. $-\frac{1}{2}mv^2$

B. $\frac{1}{2}mv^2$

C. $\frac{3}{2}mv^2$

D. $\frac{1}{4}mv^2$

Answer: A

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20. The value of g (acceleration due to gravity) at earth's surface is $10ms^{-2}$. Its value in ms^{-2} at the centre of the earth which is assumed to be a sphere of radius R metre and uniform mass density is

A. 5

B. $\frac{10}{R}$

C. $\frac{10}{2R}$

D. zero

Answer: D

Watch Video Solution

21. Two satellites A and B of masses m_1 and $m_2 (m_1 = 2m_2)$ are moving in circular orbits of radii r_1 and $r_2 (r_1 = 4r_2)$, respectively, around the earth. If their periods are T_A and T_B, then the ratio T_A / T_B is

A. 4

B. 16

C. 2

D. 8

Answer: D

Watch Video Solution

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

A. $\frac{GM^2}{4r^2}$

B. $\frac{2GM^2}{r^2}$

C. $\frac{2GM^2}{4r^2}$

D. $\frac{\sqrt{3}GM^2}{4r^2}$

Watch Video Solution

23. If the radius of the earth decreases by 10%, the mass remaining unchanged, what will happen to the acceleration due to gravity?

A. Decreases by 19%

B. Increases by 19%

C. Decreases by more than 19%

D. Increases by more than 19%

Answer: D

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24. The maximum vertical distance through which a fully dressed astronaut can jump on the earth is $0.5m$. If mean density of the Moon is two-third that of the earth and radius is one quarter that of the earth, the maximum vertical distance through which he can jump on the Moon and the ratio of the time of duration of the jump on the Moon to hold on the earth are

A. $3m, 6:1$

B. $6m, 3:1$

C. $3m, 1:6$

D. $6m, 1:6$

Answer: A

Watch Video Solution

25. Two equal masses each in are hung from a balance whose scale pans differ in vertical height by h. The error in weighing in terms of density of the earth ρ is

A. $\pi G\rho mh$

B. $\frac{1}{2}\pi G\rho mh$

C. $\frac{8}{3}\pi G\rho mh$

D. $\frac{4}{3}\pi G\rho mh$

Answer: C

Watch Video Solution

26. The distances from the centre of the earth, where the weight of a body is zero and one-fourth that of the weight of the body on the surface of the earth are (assume R is the radius of the earth)

A. $0, \frac{R}{4}$

B. $0, \frac{3R}{4}$

C. $\frac{R}{4}, 0$

D. $\frac{3R}{4}, 0$

Answer: A

Watch Video Solution

27. If a man at the equator would weight (3/5)th of his weight, the angular speed of the earth is:

A. $\sqrt{\frac{2}{5}\frac{g}{R}}$

B. $\sqrt{\frac{g}{R}}$

C. $\sqrt{\frac{R}{g}}$

D. $\sqrt{\frac{2}{5}\frac{R}{g}}$

Answer: A

Watch Video Solution

28. The distance of the centres of moon the 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 on a particle will be zero.

A. $\frac{D}{2}$

B. $\frac{2D}{3}$

C. $\frac{4D}{3}$

D. $\frac{9D}{10}$

Answer: D

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29. Two bodies with masses M_1 and M_2 are initially at rest and a distance R apart. Then they move directly towards one another under the influence of their mutual gravitational attraction. What is the ratio of the distances travelled by M_1 to the distance travelled by M_2 ?

A. $\frac{M_1}{M_2}$

B. $\frac{M_2}{M_1}$

C. 1

D. $\frac{1}{2}$

Answer: B

Watch Video Solution

30. If g be the acceleration due to gravity of the earth's surface, the gain is 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

A. $\frac{1}{2}mgR$

B. $2mgR$

C. mgR

D. $\frac{1}{4}mgR$

Answer: A

Watch Video Solution

31. A small planet is revolving around a very massive star in a circular orbit of Radius R with a period of revolution T. If the gravitational force between the planet and the star were proportional to $R^{-5/2}$, then T would be proportional to

A. r^3

B. r^2

C. $r^{2.5}$

D. $r^{3.5}$

Answer: D

Watch Video Solution

32. The masses and radii of the Earth and the Moon are M_1, R_1 and M_2, R_2 respectively. Their centres are at a distance d apart. The minimum speed with which a particle of mass m should be projected from a point midway between the two centres so as to escape to infinity is ....

A. $\sqrt{\frac{2G(M_1 + M_2)}{d}}$

B. $\sqrt{\frac{4G(M_1 + M_2)}{d}}$

C. $\sqrt{\frac{4GM_1M_2}{d}}$

D. $\sqrt{\frac{G(M_1 + M_2)}{d}}$

Answer: B

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33. A spaceship is launched into a circular orbit close to the earth's surface . What additional velocity has now to be imparted to the spaceship in the orbit to overcome the gravitational pull. Radius of earth $= 6400 km$, $g = 9.8 m / s^2$.

A. $11.2 kms^{-1}$

B. $8 kms^{-1}$

C. $3.2 kms^{-1}$

D. $1.414 \times 8 kms^{-1}$

Answer: C

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34. A sky lab of mass $2 \times 10^3 kg$ is first launched from the surface of earth in a circular orbit of radius $2R$ and them it is shifted from this circular orbit to another circular orbit of radius $3R$. Calculate the energy required

(a) to place the lab in the first orbit,

(b) to shift the lab from first orbit to the second orbit. $\left(R = 6400 km, g = 10 m / s^2\right)$

A. $\frac{3}{4} mgR, \frac{mgR}{6}$

B. $\frac{3}{4} mgR, \frac{mgR}{12}$

C. mgR, mgR

D. $2mgR, mgR$

Answer: B

Watch Video Solution

35. Consider two satellites A and B of equal mass, moving in the same circular orbit of radius r around the earth but in the opposite sense and therefore a collision occurs.

(a) Find the total mechanical energy $E_A + E_B$ of the two satellite-plus-earth system before collision.

(b) If the collision is completely inelastic, find the total mechanical energy immediately after collision. Describe the subsequent motion of the combined satellite.

A. $-\frac{2GMm}{r}$

B. $-\frac{GMm}{r}$

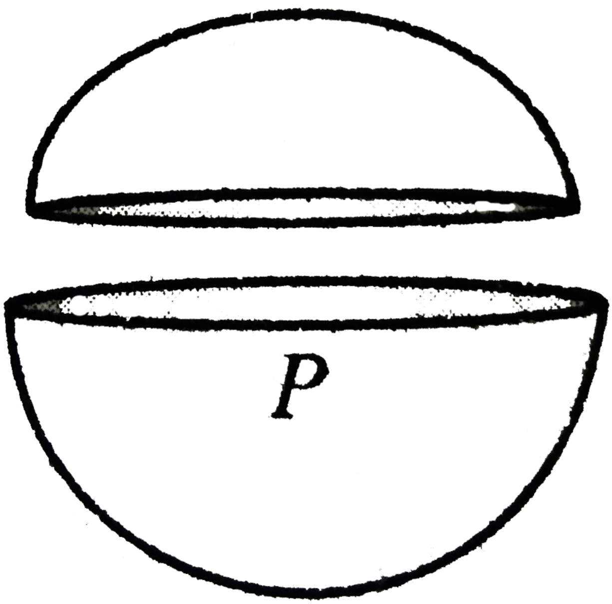
C. $\frac{GMm}{2r}$

D. $\frac{GMm}{4r}$

Answer: A

Watch Video Solution

36. A spherical shell is cut into two pieces along a chord as shown in the figure. P is a point on the plane of the chord. The gravitational field at P due to the upper part is I_1, and that due to the lower part is I_2. What is the relation between them?



A. $I_1 > I_2$

B. $I_1 < I_2$

C. $I_1 = I_2$

D. no definite relation

Answer: C

Watch Video Solution

37. Two particles of equal mass go around a circle of radius R under the action of their mutual gravitational attraction. Find the speed of each particle.

A. $v = \frac{1}{2R}\sqrt{\left(\frac{1}{Gm}\right)}$

B. $v = \sqrt{\left(\frac{GM}{2R}\right)}$

C. $v = \frac{1}{2}\sqrt{\left(\frac{Gm}{R}\right)}$

D. $v = \sqrt{\left(\frac{4Gm}{R}\right)}$

Answer: C

Watch Video Solution

38. A rocket is fired vertically from the surface of the earth with a speed v. How far from the earth does the rocket go before returning to the earth ? (where R_E is the radius of the earth and g is acceleration due to gravity)

A. $R\left(\frac{2gR}{v^2}-1\right)^{-1/2}$

B. $R\left(\frac{2gR}{v^2}-1\right)$

C. $R\left(\frac{2gR}{v^2}-1\right)^{-1}$

D. $R\left(\frac{2gR}{v^2}-1\right)^{2}$

Answer: C

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39. The gravitational potential due to earth at infinite distance from it is zero. Let the gravitational potential at a point P be $-5Jkg^{-1}$. Suppose, we arbitrarily assume the gravitational potential at infinity to be $+10Jkg^{-1}$, then the gravitational potential at P will be

A. $-5Jkg^{-1}$

B. $+5Jkg^{-1}$

C. $-15 J kg^{-1}$

D. $+15 J kg^{-1}$

Answer: B

Watch Video Solution

40. A projectile is fired from the surface of earth of radius R with a velocity kv_e (where v_e is the escape velocity from surface of earth and $k < 1$). Neglecting air resistance, the maximum height of rise from centre of earth is

A. $\dfrac{R}{n^2}$

B. $\dfrac{R}{(1-n^2)}$

C. $\dfrac{Rn^2}{(1-n^2)}$

D. Rn^2

Answer: C

Watch Video Solution

41. How many hours would make a day if the earth were rotating at such a high speed that the weight of a body on the equator were zero

A. 6.24

B. $1.4h$

C. $28h$

D. $5.6h$

Answer: B

Watch Video Solution

42. Two particles of masses m and Mm are placed a distance d apart. The gravitational potential at the position where the gravitational field due to them is zero is V. then

A. $-G\frac{\sqrt{M_1}}{R}$

B. $-G\frac{\sqrt{M_2}}{R}$

C. $-\left(\sqrt{M_1}+\sqrt{M_2}\right)^2\frac{G}{R}$

D. $-\left(\sqrt{M_1}-\sqrt{M_2}\right)^2\frac{G}{R}$

Answer: C

Watch Video Solution

43. In the solar system, the Sun is in the focus of the system for Sun-earth binding system. Then the binding energy for the system will be [given that radius of the earth's orbit round the Sun is $1.5 \times 10^{11} m$ and mass of the earth $= 6 \times 10^{24} kg$]

A. $2.7 \times 10^{33} J$

B. $5.4 \times 10^{33} J$

C. $2.7 \times 10^{30} J$

D. $5.4 \times 10^{30} J$

Answer: A

Watch Video Solution

44. A body is released from a point of distance R' from the centre of earth. Its velocity at the time of striking the earth will be $(R' > R_e)$

A. $\sqrt{2gR_e}$

B. $\sqrt{R_e g}$

C. $\sqrt{2g(R' - R_e)}$

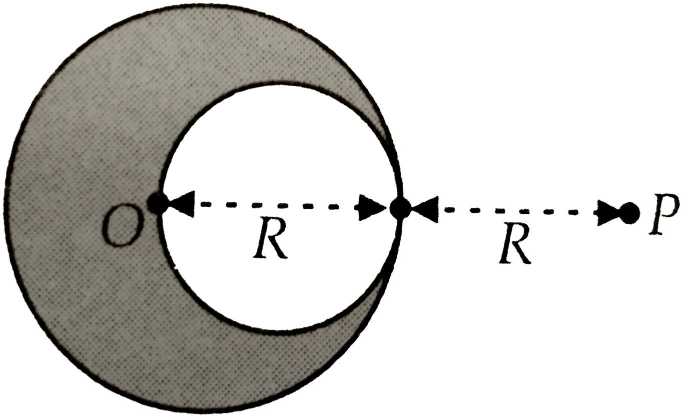
D. $\sqrt{2gR_e\left(1 - \frac{R_e}{R^r}\right)}$

Answer: D

Watch Video Solution

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

will be



A. $\frac{1}{2}$

B. $\frac{3}{4}$

C. $\frac{7}{8}$

D. $\frac{9}{7}$

Answer: D

Watch Video Solution

46. The value of g at a particular point is $10ms^{-2}$. Suppose the earth shrinks uniformly to half of 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 the earth does not change) will now be

A. $5ms^{-2}$

B. $10ms^{-2}$

C. $3ms^{-2}$

D. $20ms^{-2}$

Answer: B

Watch Video Solution

47. Two satellites of masses of 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?

A. $v_1 = v_2$

B. $v_1 > v_2$

C. $v_1 < v_2$

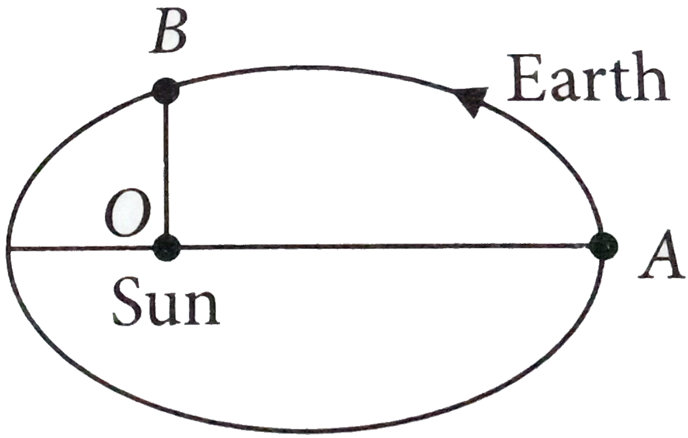
D. $\frac{v_1}{r_1} = \frac{v_2}{v_2}$

Answer: C

Watch Video Solution

48. The earth moves around the Sun in an elliptical orbit as shown figure. The ratio OA/OB=x. The ratio of the speed of the earth at

B to that at A is nearly



A. $\sqrt{x}$

B. x

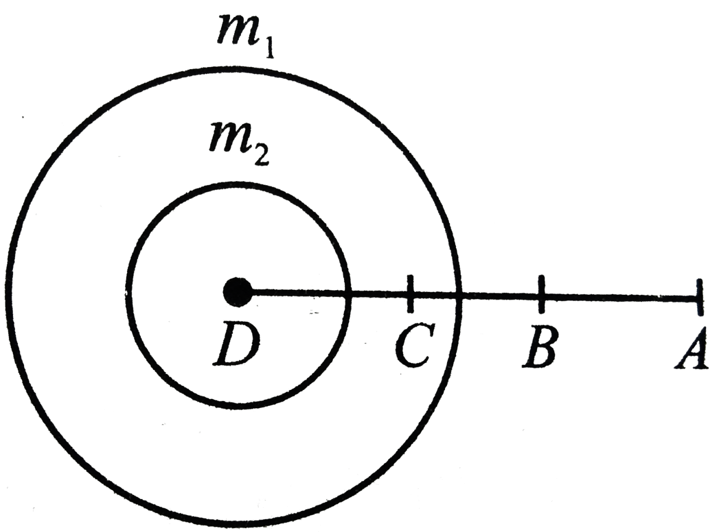
C. $x\sqrt{x}$

D. x^2

Answer: B

Watch Video Solution

49. Figure shows two shells of masses m_1 and m_2. The shells are concentric. At which point, a particle of mass m shall experience zero force?



A. A

B. B

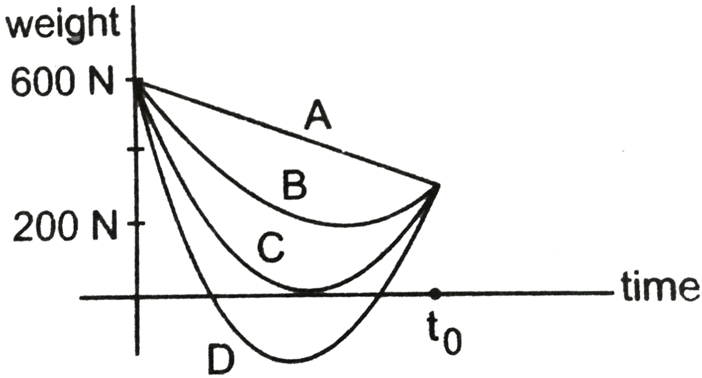
C. C

D. D

Answer: D

Watch Video Solution

50. Suppose the acceleration due to gravity at earth's surface is $10ms^{-2}$ and at the surface of Mars it is $4.0ms^{-2}$. A passenger goes from the earth to the mars in a spaceship with a constant velocity. Neglect all other object in sky. Which part of figure best represent the weight (net gravitational force) of the passenger as a function of time?



A. A

B. B

C. C

D. D

Answer: C

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51. Two satellites A and B of the same mass are revolving around the earth in the concentric circular orbits such that the distance of satellite B from the centre of the earth is thrice as compared to the distance of the satellite A from the centre of the earth. The ratio of the centripetal force acting on B as compared to that on A is

A. $\frac{1}{3}$

B. 3

C. $\frac{1}{9}$

D. $\frac{1}{\sqrt{3}}$

Answer: C

Watch Video Solution

52. 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?

A. $\frac{5}{3}mgR$

B. $\frac{4}{3}mgR$

C. $\frac{5}{6}mgR$

D. $\frac{5}{4}mgR$

Answer: C

Watch Video Solution

53. What is the mass of the planet that has a satellite whose time period is T and orbital radius is r?

A. $\frac{4\pi^3 r^3}{GT^2}$

B. $\frac{4\pi^2 r^3}{GT^2}$

C. $\frac{4\pi^2 r^3}{GT^3}$

D. $\frac{4\pi^2 T}{GT^2}$

Answer: B

Watch Video Solution

54. If the mass of a planet is 10% less than that of the earth and the radius is 20% greater than that of the earth, the acceleration due to gravity on the planet will be

A. $\frac{5}{8}$ times that on the surface of the earth

B. $\frac{3}{4}$ times that on the surface of the earth

C. $\frac{1}{2}$ times that on the surface of the earth

D. $\frac{9}{10}$ times that on the surface of the earth

Answer: A

Watch Video Solution

55. If a man at the equator would weigh $(3/5)$ th of his weight, the angular speed of the earth is

A. $\sqrt{\frac{v}{3R}}$

B. $\sqrt{\frac{2g}{3R}}$

C. $\sqrt{\frac{2g}{5R}}$

D. $\sqrt{\frac{2g}{7R}}$

Answer: C

Watch Video Solution

56. In order to shift a body of mass m from a circular orbit of radius $3R$ to a higher orbit of radius $5R$ around the earth, the work done is

A. $\frac{3GMm}{5R}$

B. $\frac{GMm}{2R}$

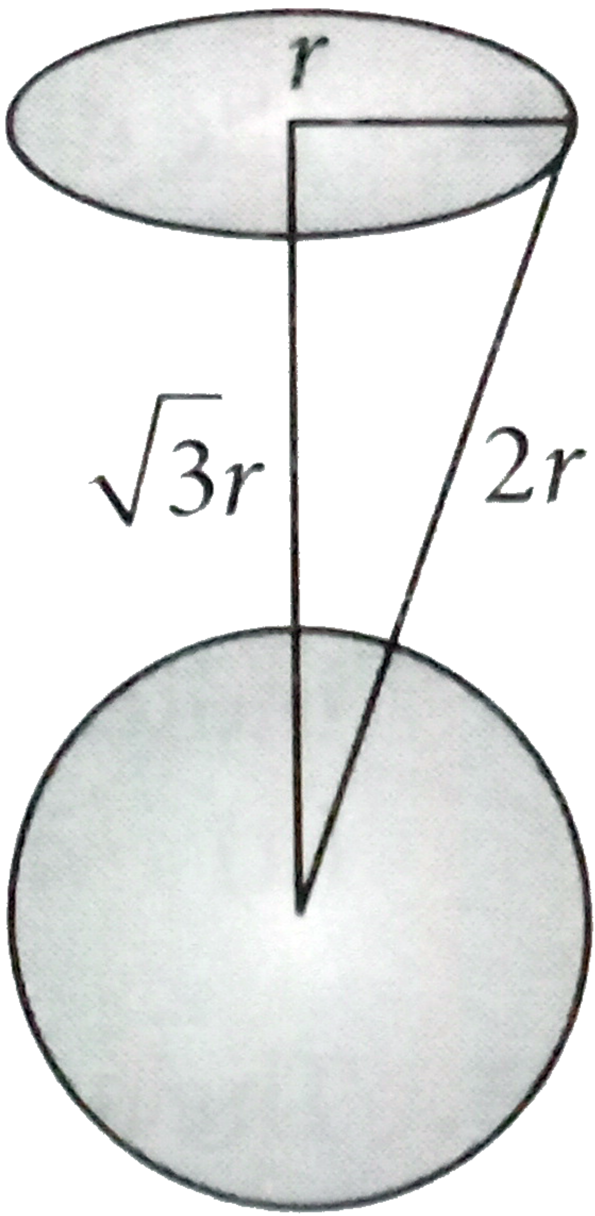
C. $\frac{2}{15}\frac{GMm}{R}$

D. $\frac{GMm}{5R}$

Answer: C

Watch Video Solution

57. A uniform ring of mass m and radius r is placed directly above a uniform sphere of mass M and of equal radius. The centre of the ring is directly above the centre of the sphere at a distance $r\sqrt{3}$ as shown in the figure. The gravitational force exerted by the sphere on the ring will be



A. $\frac{GMm}{8r^2}$

B. $\frac{GMm}{4r^2}$

C. $\sqrt{3}\frac{GMm}{8r^2}$

D. $\frac{GMm}{8r^3\sqrt{3}}$

Answer: C

Watch Video Solution

58. A tunnel is dug along a diameter of the earth. Find the force on a particle of mass m placed in the tunnel at a distance x from the centre.

A. $\frac{GM_e m}{R_e^3}$

B. $\frac{GM_e m}{R_e^3 r}$

C. $\frac{GMmR_e^3}{r}$

D. $\frac{GMm}{R_e^2}$

Answer: A

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59. The value of g at a certain height h above the free surface of the earth is $x/4$ where x is the value of g at the surface of the earth. The height h is

A. R

B. $2R$

C. $3R$

D. $4R$

Answer: A

Watch Video Solution

60. A planet moving along an elliptical orbit is closest to the sun at a distance r_1 and farthest away at a distance of r_2. If v_1 and v_2 are the linear velocities at these points respectively, then the ratio $\frac{v_1}{v_2}$ is

A. $\frac{r_{\max}}{r_{\min}}$

B. $\frac{r_{\min}}{r_{\max}}$

C. $\frac{r_{\min}+r_{\max}}{r_{\max}-r_{\min}}$

D. none of these

Answer: A

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61. Masses of $1kg$ each are placed $1m, 2m, 4m, 8m,$ ... from a point P. The gravitational field intensity at P due to these masses is

A. G

B. G

C. $4G$

D. $4G/3$

Answer: D

Watch Video Solution

62. Suppose that the acceleration of a free fall at the surface of a distant planet was found to be equal to that at the surface of the earth. If the diameter of the planet were twice the diameter of the earth, then the ratio of mean density of the planet to that of the earth would be

A. $4:1$

B. $2:1$

C. $1:1$

D. $1:2$

Answer: D

Watch Video Solution

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

A. $\frac{Gm^2}{r^2}$

B. $\frac{Gm^2}{4r^2}$

C. $\sqrt{2}\frac{Gm^2}{4r^2}$

D. $\sqrt{3}\frac{Gm^2}{4r^2}$

Answer: D

Watch Video Solution

64. 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

A. mgh

B. $\frac{4}{5}mgh$

C. $\frac{5}{6}mgh$

D. $\frac{6}{7}mgh$

Answer: C

Watch Video Solution

65. A man weighs $80kg$ on the surface of earth of radius r. At what height above the surface of earth his weight will be $40kg$?

A. $\frac{R}{2}$

B. $\sqrt{2}R$

C. $(\sqrt{2}-1)R$

D. $(\sqrt{2}+1)R$

Answer: C

Watch Video Solution

66. The gravitational potential energy of an isolated system of three particles, each of mass m, at the three corners of an equilateral triangle of side l is

A. $-\frac{Gm^2}{l}$

B. $-\frac{Gm^2}{2l}$

C. $-\frac{2Gm^2}{l}$

D. $-\frac{3Gm^2}{l}$

Answer: D

Watch Video Solution

67. A diametrical tunnel is dug across the earth. A ball dropped into the tunnel from one side. The velocity of the ball when it reaches the centre of the earth is [Given: gravitational potential at the centre of earth $= -3/2(GM/R)$]

A. $\sqrt{R}$

B. $\sqrt{gR}$

C. $\sqrt{2.5gR}$

D. $\sqrt{7.1gR}$

Answer: B

Watch Video Solution

68. Consider two solid uniform spherical objects of the same density ρ. One has radius R and the other has radius $2R$. They are in outer space where the gravitational fields from other objects are negligible. If they are arranged with their surface touching, what is the contact force between the objects due to their traditional attraction?

A. $G\pi^2 R^4$

B. $\frac{128}{81} G\pi^2 R^4 \rho^2$

C. $\frac{128}{81} G\pi^2$

D. $\frac{128}{87} \pi^2 R^2 G$

Answer: B

Watch Video Solution

69. A body starts from rest from a point distant r_0 from the centre of the earth. It reaches the surface of the earth whose radius is R. The velocity acquired by the body is

A. $2GM\sqrt{\frac{1}{R}-\frac{1}{r_0}}$

B. $\sqrt{2GM\left(\frac{1}{R}-\frac{1}{r_0}\right)}$

C. $GM\sqrt{\frac{1}{R}-\frac{1}{r_0}}$

D. $\sqrt{GM\left(\frac{1}{R}-\frac{1}{R_0}\right)}$

Answer: B

Watch Video Solution

70. Four particles, each of mass M, move along a circle of radius R under the action of their mutual gravitational attraction. The speed of each particle is

A. $\frac{GM}{R}$

B. $\sqrt{2\sqrt{2}\frac{GM}{R}}$

C. $\sqrt{\frac{GM}{R}(2\sqrt{2}+1)}$

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

Answer: D

Watch Video Solution

71. The mass of the earth is 81 times the mass of the Moon and the distance between the earth and the Moon is 60 time the, radius of the earth. If R is the radius of the earth, then the distance between the Moon and the point on the in joining the Moon and the earth where the gravitational force becomes zero is

A. $30R$

B. $15R$

C. $6R$

D. $5R$

Answer: C

Watch Video Solution

72. Three equal masses m are placed at the three corners of an equilateral triangle of side a. find the force exerted by this system on another particle of mass m placed at (a) the mid point of a side (b) at the center of the triangle.

A. $0, \dfrac{4GM^2}{3a^2}$

B. $\dfrac{4GM^2}{3a^2}, 0$

C. $\dfrac{3GM^2}{a^2}, \dfrac{GM^2}{a^2}$

D. $0, 0$

Answer: B

Watch Video Solution

73. 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^{n}

B. $R^{\frac{(n+1)}{2}}$

C. $R^{\frac{(n-1)}{2}}$

D. R^{-n}

Answer: B

Watch Video Solution

74. Two astronauts have deserted their spaceship in a region of space far from the gravitational attraction of any other body. Each has a mass of $100kg$ and they are $100m$ apart. They are initially at rest relative to one another. How long will it be before the gravitational attraction brings them $1cm$ closer together?

A. 2.52days

B. 1.41 days

C. 0.70 days

D. $1.41s$

Answer: B

Watch Video Solution

75. A satellite of mass m revolves around the earth of radius R at a height x from its surface. It g is the acceleration due to gravity on the surface of the earth, the orbit speed of the satellite is

A. gx

B. $\frac{gR}{R-x}$

C. $\frac{gR^2}{R+x}$

D. $\left(\frac{gR^2}{R+x}\right)^{\frac{1}{2}}$

Answer: D

Watch Video Solution

76. A projectile is fired from the surface of earth of radius R with a velocity kv_e (where v_e is the escape velocity from surface of earth and

$k < 1$). Neglecting air resistance, the maximum height of rise from centre of earth is

A. $\frac{1-k^2}{R}$

B. $\frac{R}{1-k^2}$

C. $R(1-k^2)$

D. $\frac{R}{1+k^2}$

Answer: B

Watch Video Solution

77. An artificial satellite is moving in a circular orbit around the earth with a speed equal to half the magnitude of escape velocity from the surface of earth. (Radius of earth $= 6400 km$)

(a) Dentermine the height of the satellite above the earth's surface.

(b) If the satellite is stopped suddenly in its orbit and allowed to fall freely on the earth, find the speed with which it hits the surface of earth.

A. $2R$

B. $\frac{R}{2}$

C. R

D. $\frac{R}{4}$

Answer: C

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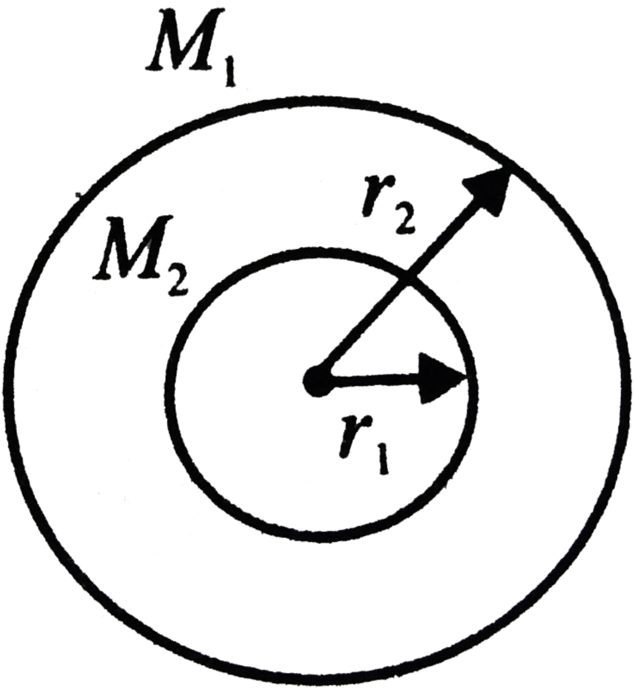
78. Two concentric shells of masses M_1 and M_2 are having radii r_1 and r_2. Which of the following is the correct expression for the gravitational field on a mass m?



A. $F = \frac{G(M_1 + M_2)}{r^2}$, for $r < r_1$

B. $F = \frac{G(M_1 + M_2)}{(r^2)}$, for $r < r_2$

C. $F = \frac{GM_2}{r^2}$, for $r_1 < r < r_2$

D. $F = G\frac{M_1}{r^2}$, for $r_1 < r < r_2$

Answer: C

Watch Video Solution

79. A satellite of mass m is circulating around the earth with constant angular velocity. If the radius is R_0 and mass of earth is M, then the angular momentum about the centre of the earth is

A. m

B. M

C. h

D. none of these

Answer: D

Watch Video Solution

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

A. $-\dfrac{GM}{R}$

B. $-\frac{GM}{r}$

C. $-G\left[\frac{M}{R}-\frac{m}{r}\right]$

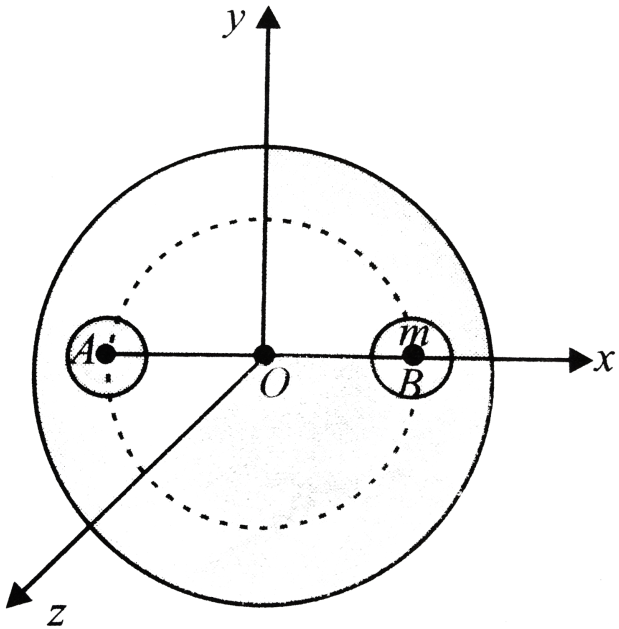
D. $-G\left[\frac{M}{R}+\frac{m}{r}\right]$

Answer: D

Watch Video Solution

81. 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 I 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 the figure.



Then

A. $\dfrac{31GM}{1024}$

B. $\dfrac{Gm}{1024}$

C. $31GM$

D. zero

Answer: D

Watch Video Solution

82. Three equal masses m are placed at the three corners of an equilateral triangle of side a. find the force exerted by this system on another particle of mass m placed at (a) the mid point of a side (b) at the center of the triangle.

A. $\frac{3GMm}{4l^2}$

B. $\frac{4GMm}{3l^2}$

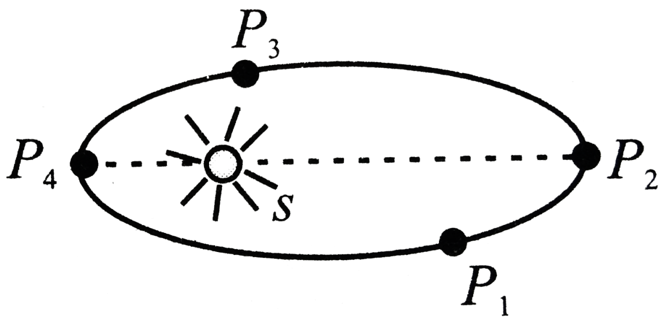
C. $\frac{GMm}{4l^2}$

D. $\frac{4GMm}{l^2}$

Answer: B

Watch Video Solution

83. Figure shows a planet in an elliptical orbit around the Sun S. Where is the kinetic energy of the planet maximum?



A. P_1

B. P_2

C. P_3

D. P_4

Answer: D

Watch Video Solution

84. The escape velocity corresponding to a planet of mass M and radius R is $50 km s^{-1}$. If the planet's mass and radius were $4M$ and R, respectively, then the corresponding escape velocity would be

A. $100 km s^{-1}$

B. $50 km s^{-1}$

C. $200 kms^{-1}$

D. $25 kms^{-1}$

Answer: A

Watch Video Solution

85. A planet is revolving around the Sun in an elliptical orbit. Its closest distance from the Sun is r and farthest distance is R. If the orbital velocity of the planet closest to the Sun is v, then what is the velocity at the farthest point?

A. $\dfrac{vr}{R}$

B. $\dfrac{vR}{r}$

C. $v\sqrt{\dfrac{r}{R}}$

D. $v\sqrt{\dfrac{R}{r}}$

Answer: A

Watch Video Solution

86. 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 (g_1 / g_2) at their surfaces is

A. $r_1\rho_1 : r_2\rho_2$

B. $r_1\rho_1^2 : \rho_2\rho_2^2$

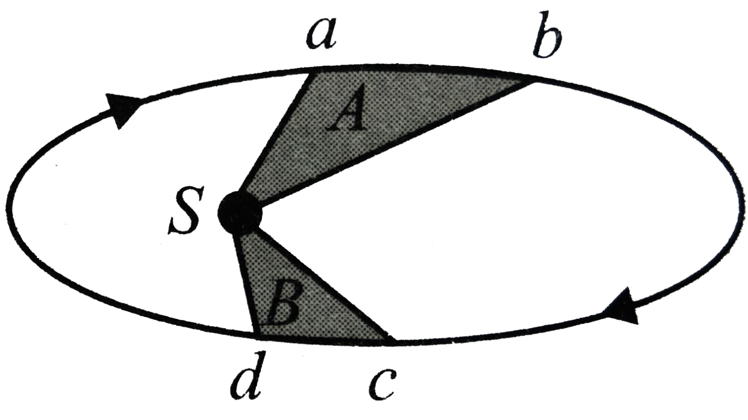
C. $r_1^2\rho_1 : r_2^2\rho_2$

D. $r_1\rho_2 : r_2\rho_1$

Answer: A

Watch Video Solution

87. Figure shows the motion of a planet around the Sun S in an elliptical orbit with the 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 taken for the planet to move from a to b and c to d, respectively then



A. $t_1 < t_2$

B. $t_1 > t_2$

C. $t_1 = t_2$

D. from the given information the relation between t_1 and t_2 cannot be determined

Answer: C

Watch Video Solution

88. A body is fired with a velocity of magnitude $\sqrt{gR} < V < \sqrt{2gR}$ at an angle of 30° with the radius vector of the earth. If at the highest point, the speed of the body is $V/4$, the maximum height attained by the body is equal to

A. $\frac{V^2}{8g}$

B. R

C. $\sqrt{2}R$

D. none of these

Answer: B

Watch Video Solution

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

A. $\frac{T_A}{T_B} = \left(\frac{r_A}{r_B}\right)^{\frac{3}{2}}$

B. $T_A > T_B$ (if $r_A > r_B$)

C. $T_A > T_B$ (if $m_A > m_B$)

D. $T_A = T_B$

Answer: D

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90. Two spherical bodies of masses M and 5M and radii R and 2R are released in free space with initial separation between their centres equal to 12 R. if they attract each other due to gravitational force only, then the distance convered by the smaller body before collision is

A. $2.5R$

B. $4.5R$

C. $7.5R$

D. $1.5R$

Answer: C

Watch Video Solution

91. IF the change in the value of g at the 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)

A. $d = \frac{h}{2}$

B. $d = \frac{3h}{2}$

C. $d = 2h$

D. $d = h$

Answer: C

Watch Video Solution

92. A particle of mass 10g is kept on the surface of a uniform sphere of masss 100kg and radius 10cm. Find the work to be done against the gravitational force between them to take the particel far away from the sphere (you may take

$G = 6.67 \times 10^{-11} N \frac{m^2}{k} g^2)$

A. $13.34 \times 10^{-10} J$

B. $3.33 \times 10^{-10} J$

C. $6.67 \times 10^{-9} J$

D. $6.67 \times 10^{-10} J$

Answer: D

Watch Video Solution

93. A tunnel is dug along the diameter of the earth. There is particle of mass m at the centre of the tunnel. Find the minimum velocity given to the particle so that is just reaches to the surface of the earth. ($R =$ radius of earth)

A. $\sqrt{\frac{GM}{R}}$

B. $\sqrt{\frac{GM}{2R}}$

C. $\sqrt{\frac{2GM}{R}}$

D. it will reach will the help of a negligible velocity.

Answer: A

Watch Video Solution

94. A cavity of radius $R/2$ is made inside a solid sphere of radius R. The centre of the cavity is located at a distance $R/2$ from the centre of the sphere. The gravitational force on a particle of a mass $'m'$ at a distance $R/2$ from the centre of the sphere on the line joining both the centres of sphere and cavity is (opposite to the centre of cavity). [Here

$g = GM/R^2$, where M is the mass of the solide sphere]

A. $\frac{mg}{2}$

B. $\frac{3mg}{8}$

C. $\frac{mg}{16}$

D. none of these

Answer: B

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95. A satellite is seen after every 8 hours over the equator at a place on the earth when its sense of rotation is opposite to the earth. The time interval after which it can be seen at the same place when the sense of rotation of earth and satellite is same will be:

A. $8h$

B. $12h$

C. $24h$

D. $6h$

Answer: C

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96. Four particles, each of mass M, move along a circle of radius R under the action of their mutual gravitational attraction. The speed of each particle is

A. $\left[\frac{Gm}{r}\left(\frac{1+2\sqrt{2}}{4}\right)\right]^{\frac{1}{2}}$

B. $\sqrt{\frac{GM}{r}}$

C. $\sqrt{\frac{GM}{r}(1+2\sqrt{2})}$

D. $\left[\frac{1}{2}\frac{Gm}{r}\left(\frac{1+2\sqrt{2}}{2}\right)\right]^{\frac{1}{2}}$

Answer: A

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97. The gravitational potential of two homogeneous spherical shells A and B (separated by large distance) of same surface mass density at their respective centers are in the ratio $3:4$. If the two shells coalesce into single one such that surface mass density remains same , then the ratio of potential at an internal point of the new shell A is equal to

A. $3:2$

B. $4:3$

C. $5:3$

D. $5:6$

Answer: C

Watch Video Solution

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

A. zero

B. $\sqrt{\frac{2GM}{a}}$

C. $\sqrt{\frac{2GM}{a}(\sqrt{2}-1)}$

D. $\sqrt{\frac{2GM}{a}\left(1-\frac{1}{\sqrt{2}}\right)}$

Answer: D

Watch Video Solution

99. The percentage change in the acceleration of the earth towards the Sun from a total eclipse of the Sun to the point where the Moon is on a side of earth directly opposite to the Sun is

A. (a) $\frac{M_s}{M_m}\frac{r_2}{r_1} \times 100$

B. (b) $\frac{M_s}{M_m}\left(\frac{r_2}{r_1}\right) \times 100$

C. (c) $2\left(\frac{r_1}{r_2}\right)^2\frac{M_m}{M_s} \times 100$

D. (d) $\left(\frac{r_1}{r_2}\right)^2 \frac{M_m}{M_s} \times 100$

Answer: C

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100. A comet is in highly elliptical orbit around the Sun. The period of the comet's orbit is 90 days. Some statements are given regarding the collision between the comet and the earth. Mark the correct statement. [Mass of the Sun

$= 2 \times 10^{30} kg,$ mean distance between the earth and the Sun $= 1.5 \times 10^{11} m.$]

A. Collision is there.

B. Collision is not possible

C. Collision may or may not be there

D. Enough information is not given

Answer: B

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101. Imagine that you are in a spacecraft orbiting around the earth in a circle of radius $7000 km$ (from the centre of the earth). If you decrease the magnitude of mechanical energy of the spacecraft $-$ earth system by 10% by firing the rockets, then what is the greatest height you can take your spacecraft above the surface of the earth? $[R_e = 6400 km]$

A. (a)$6400 km$

B. (b)$540 km$

C. (c)$2140 km$

D. (d)$3000 km$

Answer: C

Watch Video Solution

102. A satellite of mass m is in an elliptical orbit around the earth. The speed of the satellite at its nearest position is $(6GM)/(5r)$ where r is the perigee (nearest point) distance from the centre of the earth. It is desired to transfer the satellite to the circular orbit of radius equal to its apogee (farthest point) distance from the centre of the earth. The change in orbital speed required for this purpose is

A. $0.35\sqrt{\frac{GM_e}{r}}$

B. $0.085\sqrt{\frac{GM_e}{r}}$

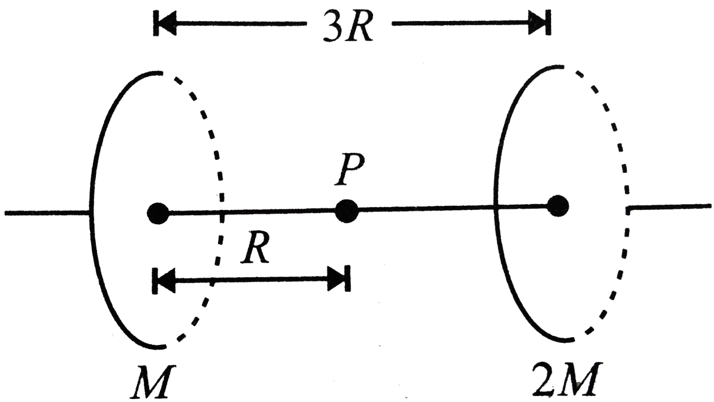
C. $\sqrt{\frac{2GM_3}{r}}$

D. zero

Answer: B

Watch Video Solution

103. Two rings having masses M and $2M$ respectively, having the same radius are placed coaxially as shown in the figure.



If the mass distribution on both the rings is non-uniform, then the gravitational potential at point P is

A. (a) $-\frac{GM}{R}\left[\frac{1}{\sqrt{2}}+\frac{2}{\sqrt{5}}\right]$

B. (b)$-\frac{GM}{R}\left[1+\frac{2}{2}\right]$

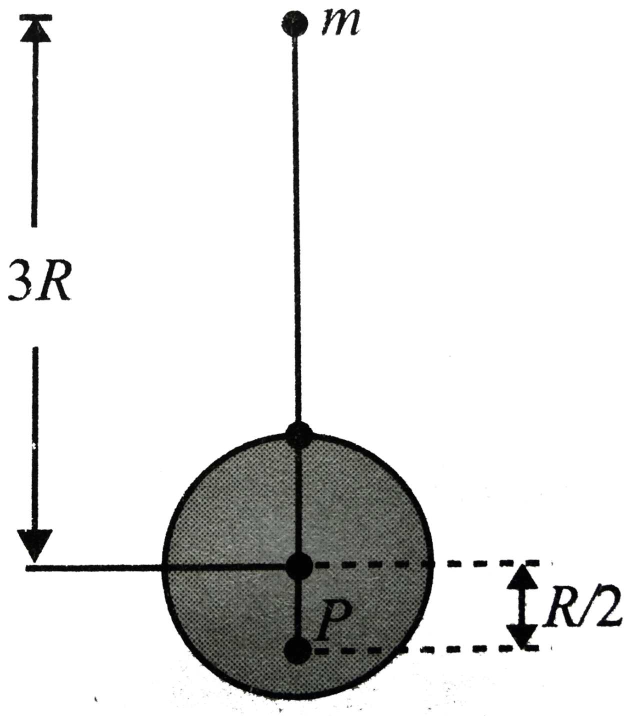
C. (c)zero

D. (d)cannot be determined from the given information

Answer: A

Watch Video Solution

104. A point mass m is released from rest at a distance of $3R$ from the centre of a thin-walled hollow sphere of radius R and mass M as shown. The hollow sphere is fixed in position and the only force on the point mass is the gravitational attraction of the hollow sphere. There is a very small hole in the hollow sphere through which the point mass falls as shown. The velocity of a point mass when it passes through point P at a distance $R/2$ from the centre of the sphere is



A. (a) $\sqrt{\frac{2GM}{3R}}$

B. (b) $\sqrt{\frac{5GM}{3R}}$

C. (c) $\sqrt{\frac{25GM}{24R}}$

D. (d)none of these

Answer: D

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105. A body is thrown from the surface of the earth with velocity $(gR_e)/12$, where R_e is the radius of the earth at some angle from the vertical. If the maximum height reached by the body is $R_e/4$, then the angle of projection with the vertical is

A. $\sin^{-1}\left(\frac{\sqrt{5}}{4}\right)$

B. $\cos^{-1}\left(\frac{\sqrt{5}}{4}\right)$

C. $\sin^{-1}\left(\frac{\sqrt{3}}{2}\right)$

D. none of these

Answer: A

Watch Video Solution

106. The gravitational force exerted by the Sun on the Moon is about twice as great as the gravitational force exerted by the earth on the Moon, but still Moon is not escaping from the gravitational influence of the earth. Mark the option which correctly explains the above system.

A. Escape speed is independent of the direction in which it is projected.

B. The rotational effect of the earth plays a role in computation of escape speed, however small it may be.

C. A body thrown in the eastward direction has less escape speed.

D. None of the above

Answer: C

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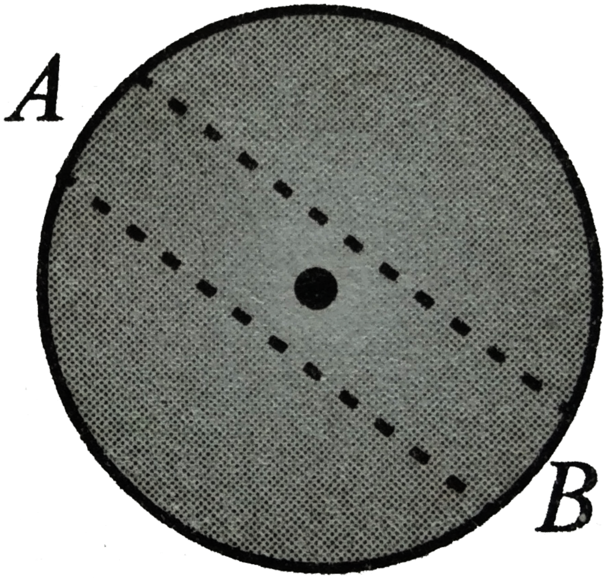
107. A tunnel has been dug into a solid sphere of non-uniform mass density as shown in the figure. As one moves from A to B, the magnitude of gravitational field intensity



A. will continuously decrease

B. will decrease up to the centre of the sphere and then increase

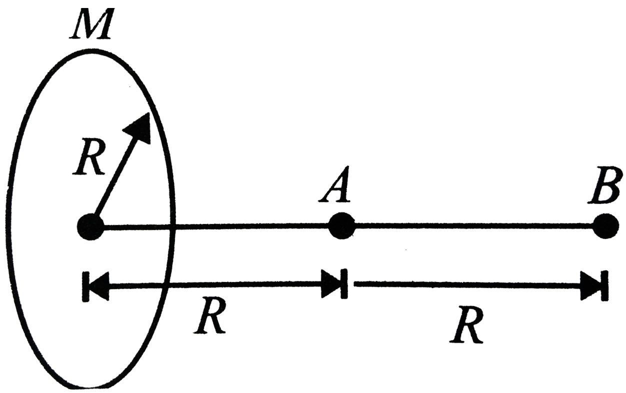
C. may increase or decrease

D. will continuously increase

Answer: C

Watch Video Solution

108. A ring having non-uniform distribution of mass M and radius R is being considered. A point mass m_0 is taken slowly towards the ring. In doing so, work done by the external force against the gravitational force exerted by ring is



A. $\dfrac{GMm_0}{\sqrt{2}R}$

B. $\dfrac{GMm_0}{R}\left[\dfrac{1}{\sqrt{2}}-\dfrac{1}{\sqrt{5}}\right]$

C. $\dfrac{GMm_0}{R}\left[\dfrac{1}{\sqrt{5}}-\dfrac{1}{\sqrt{2}}\right]$

D. It is not possible to find the required work as the nature of distribution of mass is not known.

Answer: B

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109. An artificial satellite of the earth is launched in circular orbit in the equatorial plane of the earth and the satellite is moving from west to east. With respect to a person on the equator, the satellite is completing one round trip in $24h$. Mass of the earth is $M = 6 \times 10^{24} kg$. For this situation the orbital radius of the satellite is

A. $2.66 \times 10^4 km$

B. $6400 km$

C. $36,000 km$

D. $29,600 km$

Answer: A

Watch Video Solution

110. A satellite is orbiting around the earth in a circular orbit of radius r. A particle of mass m is projected from the satellite in a forward direction with a velocity $v = 2/3$ times the orbital velocity (this velocity is given w.r.t. earth). During subsequent motion of the particle, its minimum distance from the centre of earth is

A. $\frac{r}{2}$

B. r

C. $\frac{2r}{3}$

D. $\frac{4r}{5}$

Answer: A

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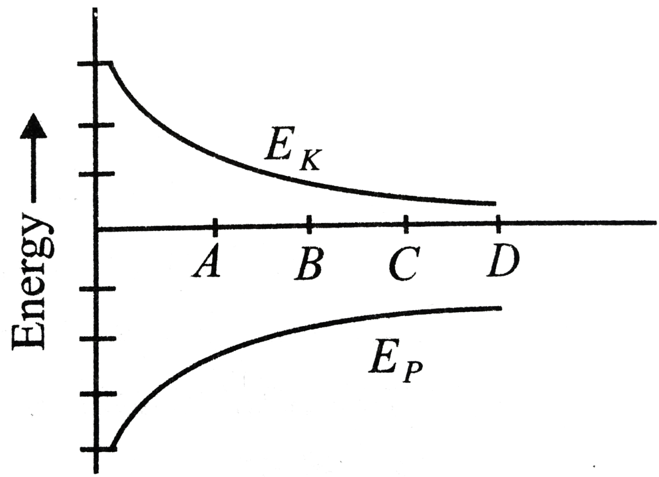
111. Figure shows the kinetic energy (E_k) and potential energy (E_p) curves for a two-particle system. Name the point at which the system is a bound system.



A. A

B. B

C. C

D. D

Answer: A::B::C::D

Watch Video Solution

112. A double star consists of two stars having masses M and $2M$. The distance between their centres is equal to r. They revolve under their mutual gravitational interaction. Then, which of the following statements are not correct?

A. $r^{\frac{3}{2}}$

B. r

C. $m^{\frac{1}{2}}$

D. $m^{-\frac{1}{2}}$

Answer: A::D

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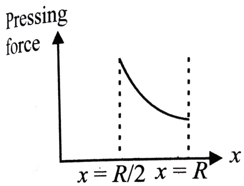
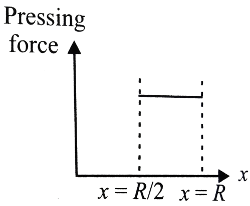
113. A tunnel is dug along a chord of the earth at a perpendicular distance R/2 from the earth's centre. The wall of the tunnel may be assumedd to be frictionless. A particle is released from one end of the tunnel. The pressing force by the particle on the wall and the acceleration of the particle varies with x (distance of the particle from the centre) according to

A. 

a.

B. 

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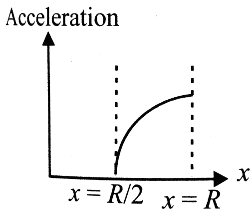
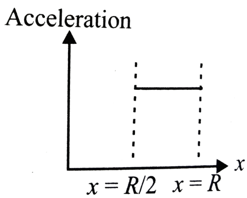
C. 

c.

D. 

d.

Answer: B::C

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114. Consider a planet moving in an elliptical orbit round the sun. The work done on the planet by the gravitational force of the sun

A. is zero in any small part of the orbit

B. is zero in some parts of the orbit

C. is zero in complete revolution

D. is zero in no part of the motion

Answer: B::C

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115. Which of the following statements are true about acceleration due to gravity?

A. g decreases in moving away from the centre if $r > R$.

B. g decreases in moving away from the centre if $r < R$

C. g is zero at the centre of earth

D. g decreases if earth stops rotating on its axis.

Answer: A::C

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116. Let V and E denote the gravitational potential and gravitational field at a point. It is possible to have

A. $V =$ and $E = 0$

B. $V = 0$ and $E \neq 0$

C. $V \neq$ and $E = 0$

D. $V \neq 0$ and $E \neq 0$

Answer: A::C::D

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117. If a body is projected with speed lesser then escape velocity

A. the body can reach a certain height and may fall down following a straight line path

B. the body can reach a certain height and may fall down following a parabolic path

C. the body may orbit the earth in a circular orbit

D. the body may orbit the earth in an elliptical orbit

Answer: A::B::C::D

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118. Earth orbiting satellite will escape if

A. its speed is increased by 41%

B. its speed in the orbit is made $\sqrt{1.5}$ times of its initial value

C. its KE is doubled

D. it stops moving in the orbit

Answer: A::C

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119. In case of an orbiting satellite if the radius of orbit is decreased

A. its KE decreases

B. its PE decreases

C. its ME decreases

D. its speed decreases

Answer: B::C

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120. If two satellites of different masses are revolving in the same orbit, they have the same

A. angular momentum

B. energy

C. time period

D. speed

Answer: C::D

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121. A double star is a system of two stars of masses m and $2m$, rotating about their centre of mass only under their mutual gravitational attraction. If r is the separation between these two stars then their time period of rotation about their centre of mass will be proportional to

A. Heavier star revolves in orbit of radius $2r / 3$.

B. Both the stars revolve with the same speed, period of which is equal to $\left(2\pi / r^{3}\right)\left(2GM^{2} / 3\right)$

C. Kinetic energy of the heavier star is twice that of the other star.

D. None of the above

Answer: A::C

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122. Mark the correct statements.

A. Gravitational potential at the centre of curvature of a thin hemispherical shell of radius R and mass M is equal to GM/R.

B. Gravitational field strength at a point lying on the axis of a thin, uniform circular ring of radius R and mass M is equal to $GMx / \left[\left(R^2 + x^2\right)^{\frac{3}{2}}\right]$ where x is distance of that point from the centre of the ring.

C. Newton's law of gravitation for gravitational force between two bodies is applicable only when bodies have spherical symmetric distribution of mass.

D. None of these

Answer: B::C

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Multiple Correct

1. Suppose an earth satellite, revolving in a circular orbit experiences a resistance due to cosmic dust. Then

A. its kinetic energy will increase

B. its potential energy will decrease

C. it will spiral towards the earth and in the process its angular momentum will remain conserved

D. it will burn off ultimately

Answer: A::B::D

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2. Suppose universal gravitational constant starts to decrease, then

A. length of the day on the earth will increase

B. length of the year will increase

C. the earth will follow a spiral path of decreasing radius

D. kinetic energy of the earth will decrease

Answer: B::D

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3. An astronaut experiences weightlessness in a space satellite. It is because

A. no external force is acting on him

B. he is falling freely

C. no reaction is exerted by the floor of the satellite

D. he is far away from the earth's surface

Answer: B::C

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4. Suppose a smooth tunnel is dug along a straight line joining two points on the surface of the earth and a particle is dropped from rest at its one end. Assume that mass of earth is uniformly distributed over its volume. Then

A. The particle will emerge from the other end with velocity $\frac{GM_e}{2R_e}$, where M_e and R_e are earth's mass and radius, respectively.

B. The particle will come to rest at the centre of the tunnel because at this position, the particle is closest to the earth's centre.

C. Potential energy of the particle will be equal to zero at centre of the tunnel if it is along a diameter.

D. Acceleration of the particle will be proportional to its distance from the mid-point of the tunnel.

Answer: A::B::C

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5. If the radius of the earth suddenly decreases to 80% of its present value, the mass of the earth remaining the same, the value of the acceleration due to gravity will

A. remain unchanged

B. become $\frac{9.8}{0.64} ms^{-2}$

C. increase by 36%

D. increase by about 56%

Answer: B::D

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6. Choose the correct statements from the following

A. The gravitational forces between two particles are an action and reaction pair.

B. Gravitational constant (G) is scalar but acceleration due to gravity (g) is a vector.

C. The values of G and g are to be determined experimentally.

D. G and g are constant everywhere.

Answer: A::B::C

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7. Choose the correct statements from the following:

A. The magnitude of the gravitational force between two bodies of mass $1kg$ each and separated by a distance of $1m$ is $9.8N$.

B. The higher the value of the escape velocity for a planet, the higher is the abundance of the lighter gases in its atmosphere.

C. The gravitational force of attraction between two bodies of ordinary mass is not noticeable because the value of the gravitational constant is extremely small.

D. Force of friction arises due to gravitational attraction.

Answer: B::C

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8. Choose the incorrect statements from the following:

A. It is possible to shield a body from the gravitational field of another body by using a thick shielding material between them.

B. The escape velocity of a body is independent of the mass of the body and the angle of projection.

C. The acceleration due to gravity increases due to the rotation of the earth.

D. The gravitational force exerted by the earth on a body is greater than that exerted by the body on the earth.

Answer: A::C::D

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9. A satellite is orbiting the earth, if its distance from the earth is increased, its

A. angular velocity would increase

B. linear velocity would increase

C. angular velocity would decrease

D. time period would increase

Answer: C::D

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10. Which of the following statements are true?

For a particle on the surface of the earth:

A. the linear speed is minimum at the equator

B. the angular speed is maximum at the equator

C. the linear speed is minimum at the poles

D. the angular speed is $7.3 \times 10^{-5} rads^{-1}$ at the equator

Answer: C::D

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11. Two identical satellites are orbiting are orbiting at distances R and 7R from the surface of the earth, R being the radius of the earth. The ratio of their

A. total energies is 4 and potential and kinetic energies is 2

B. potential energies is 4

C. kinetic energies is 4

D. total energies is 4

Answer: B::C::D

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12. If both the mass and radius of the earth decrease by 1% the value of

A. acceleration due to gravity would decrease by nearly 1%

B. acceleration due to gravity would increase by 1%

C. escape velocity from the earth's surface would decrease by 1%

D. the gravitational potential energy of a body on earth's surface will remain unchanged

Answer: B::D

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13. An object is taken from a point P to another point Q in a gravitational field:

A. assuming the earth to be spherical, if both P and Q lie on the earth's surface, the work done is zero

B. if P is on the earth's surface and Q above it, the work done is minimum when it is taken along the straight line PQ

C. the work done depends only on the position of P and Q and is independent of the path along which the particle is taken

D. there is no work done if the object is taken from P to Q and then brought back to P along any path

Answer: A::C::D

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14. A small mass m is moved slowly from the surface of the earth to a height h above the surface. The work done (by an external agent) in doing this is

A. mgh, for all values of h

B. mgh, for $h < < R$

C. $1/2, mgR$, for $h = R$

D. $-1/2mgR$, for $h = R$

Answer: B::C

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15. Which of the following are correct?

A. If R is the radius of a planet, g is the acceleration due to gravity, the mean density of the planet is $3g/4\pi GR$

B. Acceleration due to gravity is a universal constant.

C. The escape velocity of a body from earth is $11.2kms^{-1}$. The escape velocity from a planet which has double the mass of earth and half its radius is $22.4kms^{-1}$

D. The ratio of gravitational mass and inertial mass of a body at the surface of earth is 1.

Answer: A::C::D

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16. Which of the following are correct?

A. An astronaut going from the earth to the Moon will experience weightlessness once.

B. When a thin uniform spherical shell gradually shrinks maintaining its shape, the gravitational potential at its centre decreases.

C. In the case of a spherical shell, the plot of V versus r is continuous.

D. In the case of a spherical shell, the plot of gravitational field intensity I versus r is continuous

Answer: A::B::C

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17. Which of the following are not correct?

A. The escape velocity for the Moon is $6kms^{-1}$.

B. The escape velocity from the surface of Moon is v.

The orbital velocity for a satellite to orbit very close to the surface of Moon is $v/2$

C. When an earth satellite is moved from one stable orbit to a further stable orbit, the gravitational potential energy increases.

D. The orbital velocity of a satellite revolving in as circular path close to the planet is independent of the density of the planet

Answer: A::D

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18. Which of the following are correct?

A. Out of electrostatic, electromagnetic, nuclear and gravitational interactions, the gravitational interaction is the weakest.

B. If the earth were to 'rotate faster than its present speed, the weight of an object would decrease at the equator but remain unchanged at the poles.

C. The mass of the earth in terms of g, R and G is (gR^2 / G).

D. If the earth stops rotating in its orbit around the Sun there will be no variation in the weight of a body on the surface of earth.

Answer: A::B::C::D

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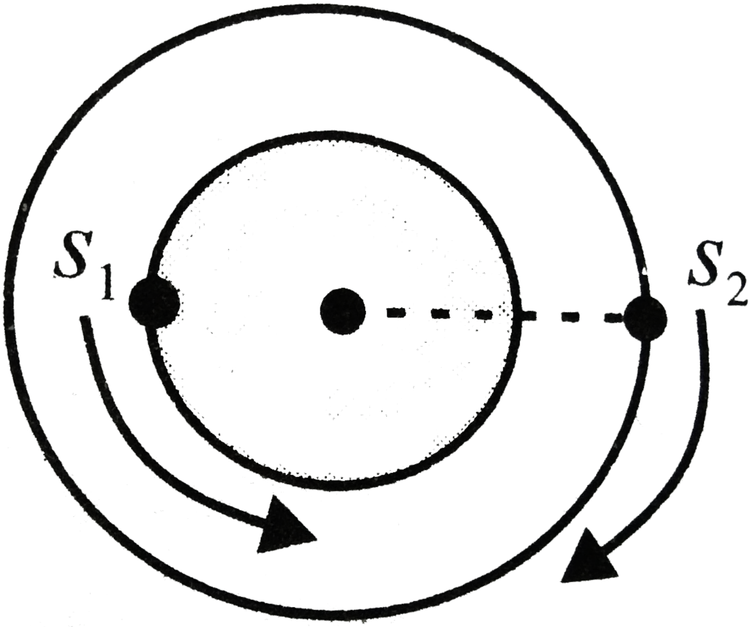
19. Two satellites S_1 and S_2 are revolving around the earth in coplanar concentric orbits in the opposite sense. At $t = 0$, the position of satellites are shown in the diagram. The periods of S_1 and S_2 are $4h$ and $24h$, respectively. The radius of orbit of S_1 is $1.28 \times 10^4 km$. For this situation, mark the correct statement (s).



A. The angular velocity of S_2 as observed by S_1 at $t = 12h$ is $0.468\pi rads^{-1}$

B. The two satellites are closet to each other for the first tme at $t = 12h$ and then after every $24h$ they are closet to each other.

C. The orbital velocity of S_1 is $0.64\pi \times 10^4 km$.

D. The velocity of S_1 relative to S_2 is continuously changing in magnitude and direction both.

Answer: A::B::C::D

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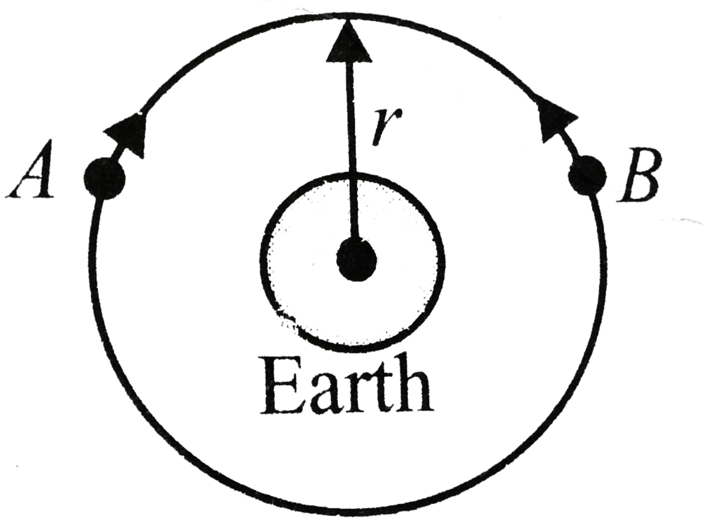
20. Consider two satellites A and B of equal mass m, moving in the same circular orbit about the earth, but in the opposite sense as shown in Fig. The orbital radius is r. The satellites undergo a collision which is perfectly inelastic. For this situation, mark out the correct statement(s). [Take mass of earth as M]



A. The total energy of the two satellites plus earth system just before collision is $-(GMm)/r$

B. The total energy of the two satellites plus earth system just after collision is $-(2GMm)/r$

C. The total energy of two satellites plus. earth system just after collision is $-(GMm)/2r)$

D. The combined mass (two satellites) will fall towards the earth just after collision.

Answer: A::B::D

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21. Assertion: For the plantes 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.

A. Statement I is True, Statement II is True: Statement II is a correct explanation for Statement I.

B. Statement I is True, Statement II is True: Statement II is Not a correct explanation for Statement I.

C. Statement I is True, Statement II is False.

D. Statement I is False, Statement II is True.

Answer: A

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22. Statement I: For a satellite revolving very near to the earth's surface the time period of revolution is given by $1h24$ min.

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

A. Statement I is True, Statement II is True: Statement II is a correct explanation for Statement I.

B. Statement I is True, Statement II is True: Statement II is Not a correct explanation for Statement I.

C. Statement I is True, Statement II is False.

D. Statement I is False, Statement II is True.

Answer: A

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23. Assertion: Kepler's second law can be understood by conservation of angular momentum principle.

Reason: Kepler's second law is related with areal velocity which can further be proved to be used on coservation of angular momentum as $(dA/dt) = (r^2\omega)/2$.

A. Statement I is True, Statement II is True: Statement II is a correct explanation for Statement I.

B. Statement I is True, Statement II is True: Statement II is Not a correct explanation for Statement I.

C. Statement I is True, Statement II is False.

D. Statement I is False, Statement II is True.

Answer: A

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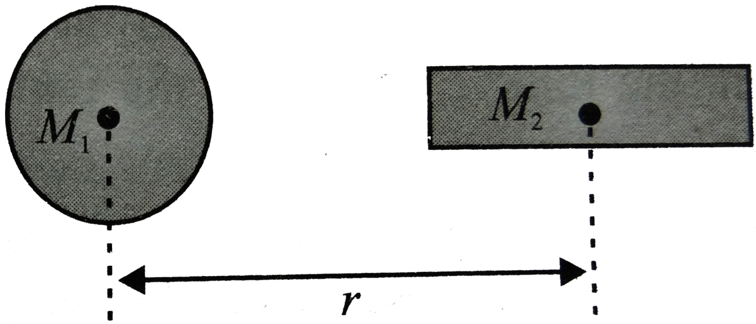
24. Statement I: The force of gravitation between a sphere and a rod of mass M_2 is

$= (GM_1M_2)/r.$

Statement II: Newton's law of gravitation holds correct for point masses.



A. Statement I is True, Statement II is True: Statement II is a correct explanation for Statement I.

B. Statement I is True, Statement II is True: Statement II is Not a correct explanation for Statement I.

C. Statement I is True, Statement II is False.

D. Statement I is False, Statement II is True.

Answer: D

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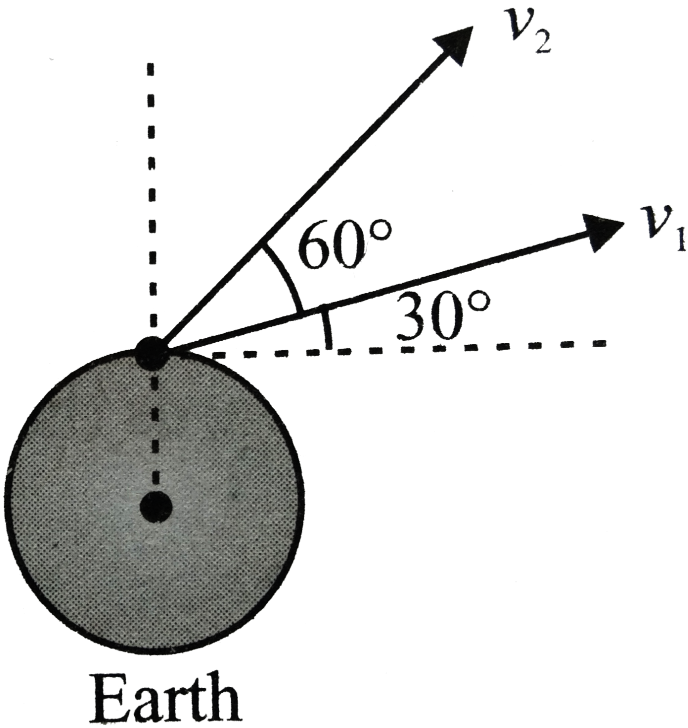
Assertion- Reasoning

1. Statement 1: The value of escape velocity from the surface of earth at 30° and 60° is

$v_1 = 2v_e, v_2 = 2/3v_e.$

Statement II: The value of escape velocity is independent of angle of projection.



A. Statement I is True, Statement II is True: Statement II is a correct explanation for

Statement I.

B. Statement I is True, Statement II is True: Statement II is Not a correct explanation for Statement I.

C. Statement I is True, Statement II is False.

D. Statement I is False, Statement II is True.

Answer: D

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2. Statement I: If the earth suddenly stops rotating about its axis, then the acceleration due to gravity will become the same at all the places.

Statement II: The value of acceleration due to gravity is independent of rotation of the earth.

A. Statement I is True, Statement II is True: Statement II is a correct explanation for Statement I.

B. Statement I is True, Statement II is True: Statement II is Not a correct explanation for Statement I.

C. Statement I is True, Statement II is False.

D. Statement I is False, Statement II is True.

Answer: C

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3.

Statement I: The magnitude of the

gravitational potential at the surface of solid sphere is less than that of the centre of sphere.

Statement II: Due to the solid sphere, the gravitational potential is the same within the sphere.

A. Statement I is True, Statement II is True: Statement II is a correct explanation for Statement I.

B. Statement I is True, Statement II is True: Statement II is Not a correct explanation for Statement I.

C. Statement I is True, Statement II is False.

D. Statement I is False, Statement II is True.

Answer: C

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4. Statement I: The smaller the orbit of a planet around the Sun, the shorter is the time it takes to complete.

Statement II: According to Kepler's third law of planetary motion, square of time period is proportional to cube of mean distance from Sun.

A. Statement I is True, Statement II is True: Statement II is a correct explanation for Statement I.

B. Statement I is True, Statement II is True: Statement II is Not a correct explanation for Statement I.

C. Statement I is True, Statement II is False.

D. Statement I is False, Statement II is True.

Answer: A

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5. Assertion: The value of acceleration due to gravity does not depends upon mass of the body on which force is applied.

Reason: Acceleration due to gravity is a constant quantity.

A. Statement I is True, Statement II is True: Statement II is a correct explanation for

Statement I.

B. Statement I is True, Statement II is True: Statement II is Not a correct explanation for Statement I.

C. Statement I is True, Statement II is False.

D. Statement I is False, Statement II is True.

Answer: C

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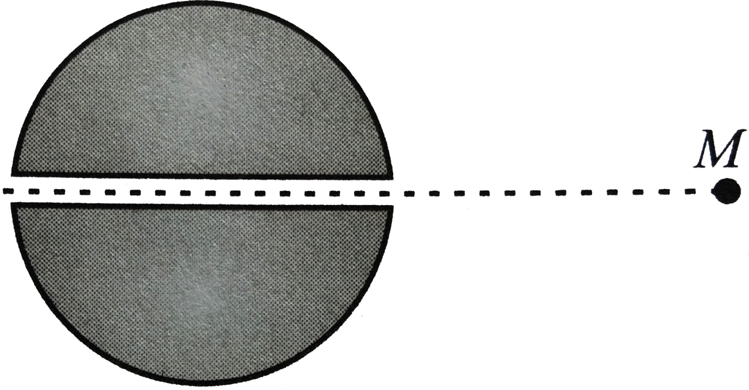
6. Statement I: In free space a uniform spherical planet of mass M has a smooth narrow tunnel along its diameter. This planet and another superdense small particle of mass M start approaching towards each other from rest under action of their gravitational forces. When the particle passes through the centre of the planet, sum of kinetic energies of both the bodies is maximum.



Statement II: When the resultant of all forces acting on a particle or a particle like object (initially at rest) is constant in direction, the kinetic energy of the particle keeps on increasing.

A. Statement I is True, Statement II is True: Statement II is a correct explanation for Statement I.

B. Statement I is True, Statement II is True: Statement II is Not a correct explanation for Statement I.

C. Statement I is True, Statement II is False.

D. Statement I is False, Statement II is True.

Answer: A

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7. Statement I: The earth does not retain hydrogen molecules and helium atoms in its atmosphere, but does retain much heavier molecules, such as oxygen and nitrogen.

Statement II: Lighter molecules in the atmosphere have translational speed that is greater or closer to escape speed of earth.

A. Statement I is True, Statement II is True: Statement II is a correct explanation for Statement I.

B. Statement I is True, Statement II is True: Statement II is Not a correct explanation for Statement I.

C. Statement I is True, Statement II is False.

D. Statement I is False, Statement II is True.

Answer: A

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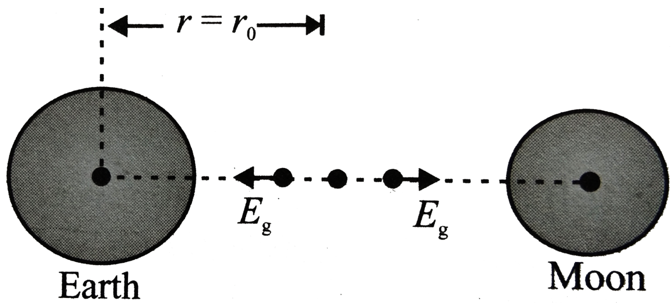
8. Statement I: It takes more fuel for a spacecraft to travel from the earth to the Moon than for the return trip.

Statement II: The point of zero gravitational field intensity due to the earth and the Moon is lying nearer to the Moon, i.e., in the diagram shown, for $r < r_0, E_g$ is towards the earth's centre and for $r > r_0, E_g$ is towards the Moon's centre and at $r = r_0, E_g$ is zero.



A. Statement I is True, Statement II is True: Statement II is a correct explanation for Statement I.

B. Statement I is True, Statement II is True: Statement II is Not a correct explanation for Statement I.

C. Statement I is True, Statement II is False.

D. Statement I is False, Statement II is True.

Answer: A

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9. Statement I: Consider a satellite moving in an elliptical orbit around the earth. As the satellite moves, the work done by the gravitational force of the earth on the satellite for any small part of the orbit is zero.

Statement II: K_E of the satellite in the above described case is not constant as it moves around the earth.

A. Statement I is True, Statement II is True: Statement II is a correct explanation for Statement I.

B. Statement I is True, Statement II is True: Statement II is Not a correct explanation for Statement I.

C. Statement I is True, Statement II is False.

D. Statement I is False, Statement II is True.

Answer: D

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10. Statement I: If a particle projected horizontally just above, the surface of the earth with a speed greater than escape speed, then it will escape from gravitational influence of the earth. Assume that particle has a clear path.

Statement II: Escape velocity is independent of its direction.

A. Statement I is True, Statement II is True: Statement II is a correct explanation for Statement I.

B. Statement I is True, Statement II is True: Statement II is Not a correct explanation for Statement I.

C. Statement I is True, Statement II is False.

D. Statement I is False, Statement II is True.

Answer: A

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11. Statement I: If time period of a satellite revolving in circular orbit in equatorial plane is $24h$, then it must be a, geostationary satellite.

Statement II: Time period of a geostationary satellite is $24h$.

A. Statement I is True, Statement II is True: Statement II is a correct explanation for

Statement I.

B. Statement I is True, Statement II is True: Statement II is Not a correct explanation for Statement I.

C. Statement I is True, Statement II is False.

D. Statement I is False, Statement II is True.

Answer: D

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12. Statement I: Two satellites are following one another in the same circular orbit. If one satellite tries to catch another (leading one) satellite, then it can be done by increasing its speed without changing the orbit.

Statement II: The energy of earth-satellite system in circular orbit is given by $E = (- Gms) / (2a)$, where r is the radius of the circular orbit.

A. Statement I is True, Statement II is True: Statement II is a correct explanation for

Statement I.

B. Statement I is True, Statement II is True: Statement II is Not a correct explanation for Statement I.

C. Statement I is True, Statement II is False.

D. Statement I is False, Statement II is True.

Answer: D

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13. The minimum and maximum distances of a satellite from the center of the earth are $2R$ and $4R$ respectively, where R is the radius of earth and M is the mass of the earth . Find

(a) its minimum and maximum speeds,

(b) radius of curvature at the point of minimum distance.

A. $\sqrt{\frac{GM}{9R}}, \sqrt{\frac{2GM}{R}}$

B. $\sqrt{\frac{GM}{5R}}, \sqrt{\frac{3GM}{2R}}$

C. $\sqrt{\frac{GM}{6R}}, \sqrt{\frac{2GM}{3R}}$

D. $\sqrt{\frac{GM}{3R}}, \sqrt{\frac{5GM}{2R}}$

Answer: C

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Linked Comprehension

1. The minimum and maximum distances of a satellite from the center of the earth are $2R$ and $4R$ respectively, where R is the radius of earth and M is the mass of the earth . Find

(a) its minimum and maximum speeds,

(b) radius of curvature at the point of minimum distance.

A. $\sqrt{\frac{8R}{3}}$

B. $\sqrt{\frac{5R}{3}}$

C. $\sqrt{\frac{4R}{3}}$

D. $\sqrt{\frac{7R}{3}}$

Answer: A

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2. The orbit of Pluto is much more eccentric than the orbits of the other planets. That is, instead of being nearly circular, the orbit is noticeably elliptical. The point in the orbit nearest to the Sun is called the perihelion and the point farthest from the Sun is called the aphelion.

At perihelion, the gravitational potential energy of Pluto in its orbit has

A. its maximum value

B. its minimum value

C. the same value at every other point in the orbit

D. the value which depends on the sense of rotation

Answer: B

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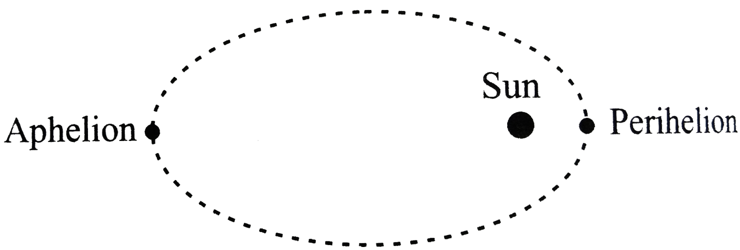
3. The orbit of Pluto is much more eccentric than the orbits of the other planets. That is, instead of being nearly circular, the orbit is noticeably elliptical. The point in the orbit nearest to the Sun is called the perihelion and the point farthest from the Sun is called the aphelion.



At perihelion, the mechanical energy of Pluto's orbit has

A. its maximum value

B. its minimum value

C. the same value at every other point in the orbit

D. the value which depends on the sense of rotation

Answer: C

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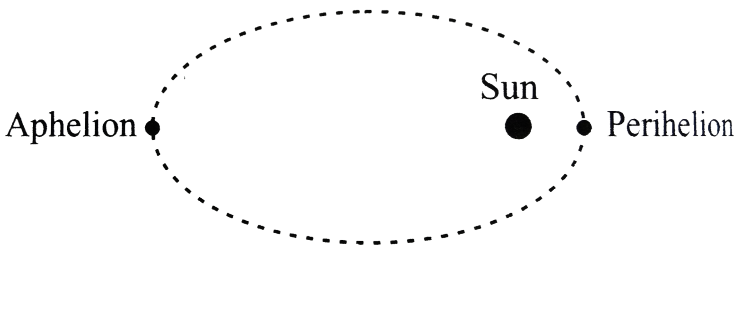
4. The orbit of Pluto is much more eccentric than the orbits of the other planets. That is, instead of being nearly circular, the orbit is noticeably elliptical. The point in the orbit nearest to the Sun is called the perihelion and the point farthest from the Sun is called the aphelion.



As Pluto moves from the perihelion to the aphelion, the work done by gravitational pull of Sun on Pluto is

A. is zero

B. is positive

C. is negative

D. depends on sence of rotation

Answer: C

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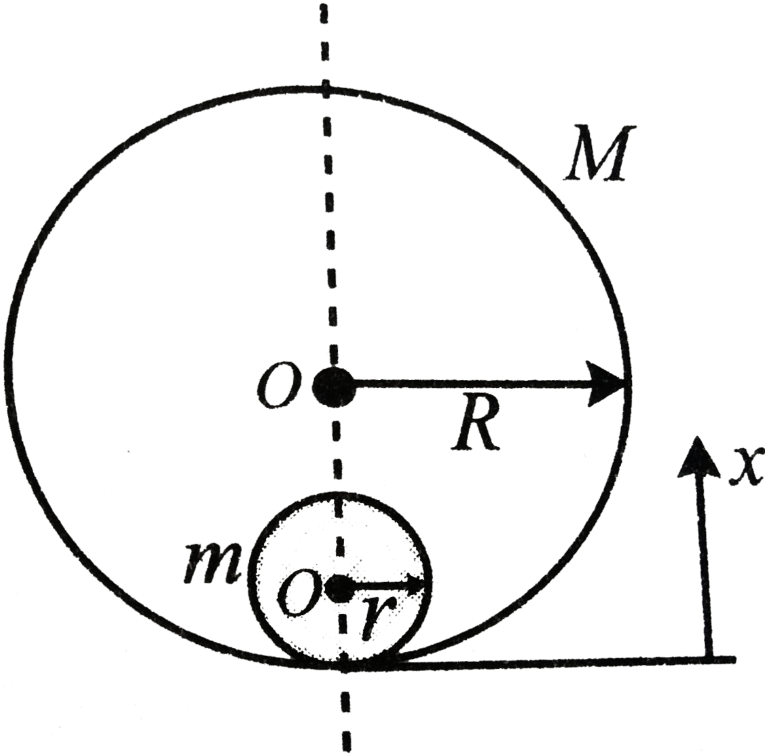
5. A solid sphere of mass m and radius r is placed inside a hollow thin spherical shell of mass M and radius R as shown in the figure. A particle of mass m' is placed on the line joining the two centres at a distance x from the point of contact of the sphere and the shell. Find the magnitude of the resultant gravitational force on this particle due to the sphere and the shell if



$2r < x < 2R$

A. $\dfrac{Gmm'(2r-x)}{2r^3}$

B. $\dfrac{Gmm'(x-r)}{2r^3}$

C. $\dfrac{Gmm'(x-r)}{r^3}$

D. $\dfrac{Gmm'(2x - r)}{r^3}$

Answer: C

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6. a solid sphere of mass m and radius r is placed inside a hollow thin spherical shell of mass M and radius R as shown in figure. A particle of mass m is placed on the line joining the two centers as a distance x from the point of contact of the sphere and the shell. Find the magnitude of the resultant gravitational force on this particle due to the sphere and the shell

if

$a). r < x < 2r, b). 2r < x < 2R$ and $c). x > 2R$

.

A. $\dfrac{Gmm'}{4(x-x)^2}$

B. $\dfrac{Gmm'}{(x-r)^2}$

C. $\dfrac{Gmm'}{(x-r)^3}$

D. $\dfrac{2Gmm'}{(x-r)^2}$

Answer: B

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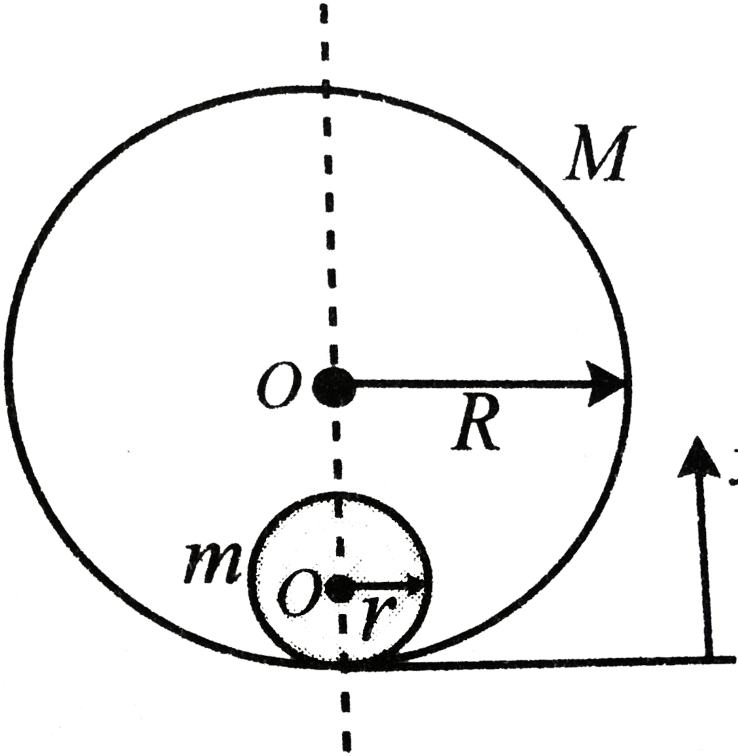
7. A solid sphere of mass m and radius r is placed inside a hollow thin spherical shell of mass M and radius R as shown in the figure. A particle of mass m' is placed on the line joining the two centres at a distance x from the point of contact of the sphere and the shell. Find the magnitude of the resultant gravitational force on this particle due to the sphere and the shell if



$2r < x < 2R$

A. $\frac{2GMm'}{(x-r)^2} + \frac{Gmm'}{(x+r)^2}$

B. $\frac{Gmm'}{2x(x-R)^2} + \frac{2Gmm'}{(x-r)^2}$

C. $\frac{Gmm'}{(x+R)^2} + \frac{Gmm'}{(x+r)^2}$

D. $\frac{GMm'}{(x-R)^2} + \frac{Gmm'}{(x-r)^2}$

Answer: D

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8. The gravitational field in a region is given by $\vec{E} = (5Nkg^{-1})\vec{i} + (12Nkg^{-1})\vec{j}$.. a. find the magnitude of the gravitational force acting on a particle of mass 2 kg placed at the origin b. Find the potential at the points (12m,0) and (0,5m) if the potential at the origin is taken to be zero. c. Find the change in gravitational potential energy if a particle of mass 2 kg is taken from the origin to the point (12m,5m). d. Find the change in potential energy if the particle is taken from (12m,0) to (0,5m)`.

A. $26N$

B. $30N$

C. $20N$

D. $35N$

Answer: A

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9. The gravitational field in a region is given by $\overrightarrow{E} = \left(5Nkg^{-1}\right)\overrightarrow{i} + \left(12Nkg^{-1}\right)\overrightarrow{j}..$ a. find the magnitude of the gravitational force acting on a particle of mass 2 kg placed at the origin b. Find the potential at the points (12m,0) and (0,5m) if the potential at the origin is taken to be zero. c. Find the change in gravitational potential energy if a particle of mass 2 kg is taken from the origin to the point (12m,5m). d. Find the change in potential energy if the particle is taken from (12m,0) to (0,5m)`.

A. $-30Jkg^{-1}, -30Jkg^{-1}$

B. $-40Jkg^{-1}, -30Jkg^{-1}$

C. $-60Kkg^{-1}, -60Jkg^{-1}$

D. $-40Jkg^{-1}, -50Jkg^{-1}$

Answer: C

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10. The gravitational field in a region is given by $\vec{E} = (5Nkg^{-1})\vec{i} + (12Nkg^{-1})\vec{j}$.. a. find the magnitude of the gravitational force acting on a particle of mass 2 kg placed at the origin b. Find the potential at the points (12m,0) and (0,5m) if the potential at the origin is taken to be zero. c. Find the change in gravitational potential energy if a particle of mass 2 kg is taken from the origin to the point (12m,5m). d. Find the change in potential energy if the particle is taken from (12m,0) to (0,5m)`.

A. $-225J$

B. $-240J$

C. $-245J$

D. $-250J$

Answer: B

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11. The gravitational field in a region is given by $\overrightarrow{E} = \left(5Nkg^{-1}\right)\overrightarrow{i} + \left(12Nkg^{-1}\right)\overrightarrow{j}$.. a. find the magnitude of the gravitational force acting on a particle of mass 2 kg placed at the origin b. Find the potential at the points (12m,0) and (0,5m) if the potential at the origin is taken to be zero. c. Find the change in gravitational potential energy if a particle of mass 2 kg is taken from the origin to the point (12m,5m). d. Find the change in potential energy if the particle is taken from (12m,0) to (0,5m)`.

A. $-10J$

B. $-50J$

C. zero

D. $-60J$

Answer: C

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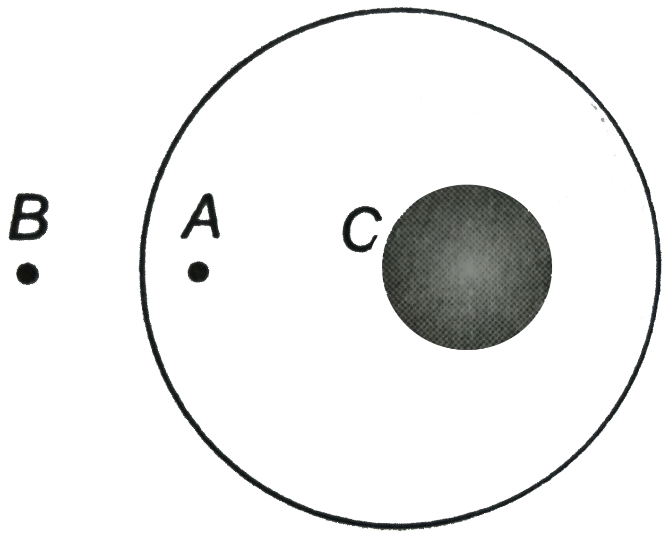
12. A uniform metal sphere of radius R and mass m is surrounded by a thin uniform spherical shell of same mass and radius $4R$. The centre of the shell C falls on the surface of the inner sphere. Find the gravitational fields at points A and B.



A. $\frac{GM}{16a^2}$

B. $\frac{GM}{8a^2}$

C. $(GM)(2a^2)$

D. $\frac{GM}{34a^2}$

Answer: A

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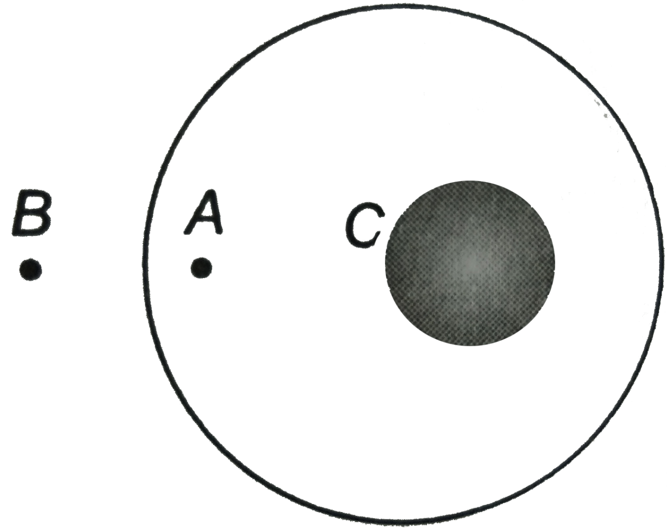
13. A uniform metal sphere of radius R and mass m is surrounded by a thin uniform spherical shell of same mass and radius $4R$. The centre of the shell C falls on the surface of the inner sphere. Find the gravitational fields at points A and B.



A. $\dfrac{21GM}{900a^2}$

B. $\dfrac{61GM}{450a^2}$

C. $\dfrac{61GM}{900a^2}$

D. $\dfrac{61GM}{1800a^2}$

Answer: C

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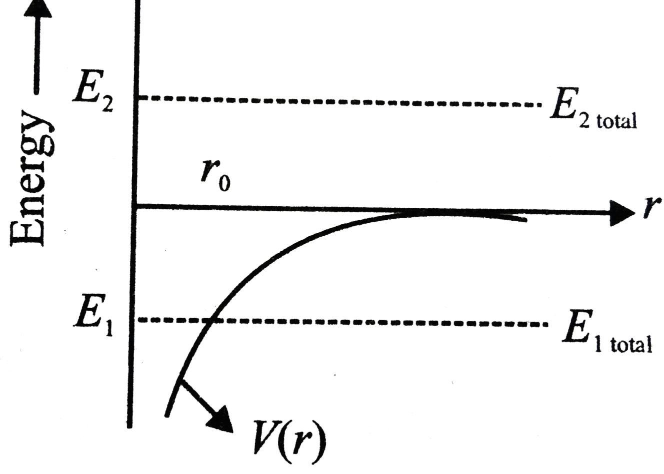
14. In the graph shown, the PE of earth-satellite system is shown by a solid line as a function of distance r (the separation between earth's centre and satellite). The total energy of the two objects which may or may not be bounded to the earth are shown in the figure by dotted lines.



Based on the above information, answer the following questions.

Mark the correct statement(s).

A. The object having the total energy E_1 is bounded one.

B. The object having the total energy E_2 is bounded one.

C. Both the objects are bounded

D. Both the objects are unbounded

Answer: A

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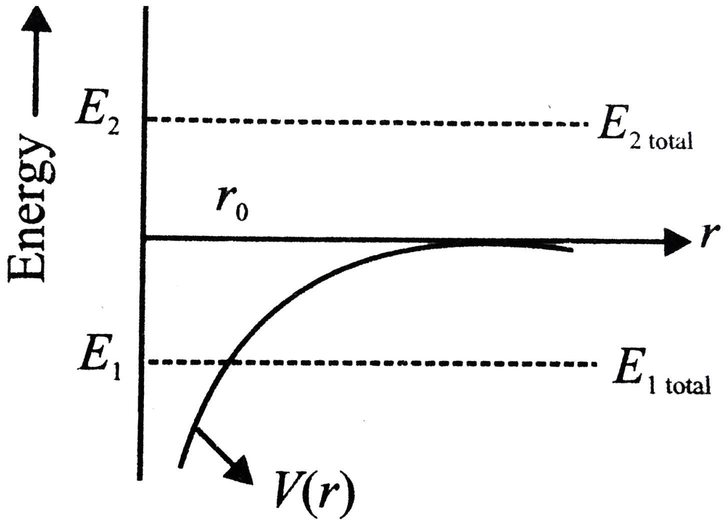
15. In the graph shown, the PE of earth-satellite system is shown by a solid line as a function of distance r (the separation between earth's centre and satellite). The total energy of the two objects which may or may not be bounded to the earth are shown in the figure by dotted lines.



Based on the above information, answer the following questions.

If object having total energy E_1 is having the same PE curve as shown in the figure, then

A. r_0 is the maximum distance of the object from the earth's centre

B. this object and the earth system is bounded one

C. the KE of the object is zero when $r = r_0$

D. all the above

Answer: D

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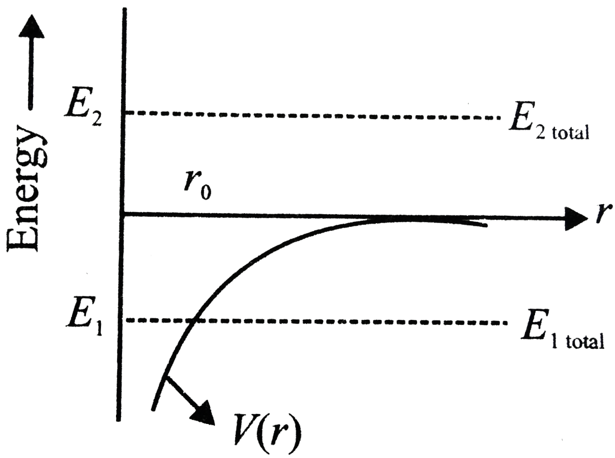
16. In the graph shown, the PE of earth-satellite system is shown by a solid line as a function of distance r (the separation between earth's centre and satellite). The total energy of the two objects which may or may not be bounded to the earth are shown in the figure by dotted lines.



Based on the above information, answer the following questions. If both the objects have the same PE curve as shown in the figure, then

A. for objects having total energy E_2, all values of r are possible

B. for the object having total energy E_2 values of $r < r_0$ are only possible

C. for the object having total energy E_1, all values of r are possible

D. none of the above

Answer: A

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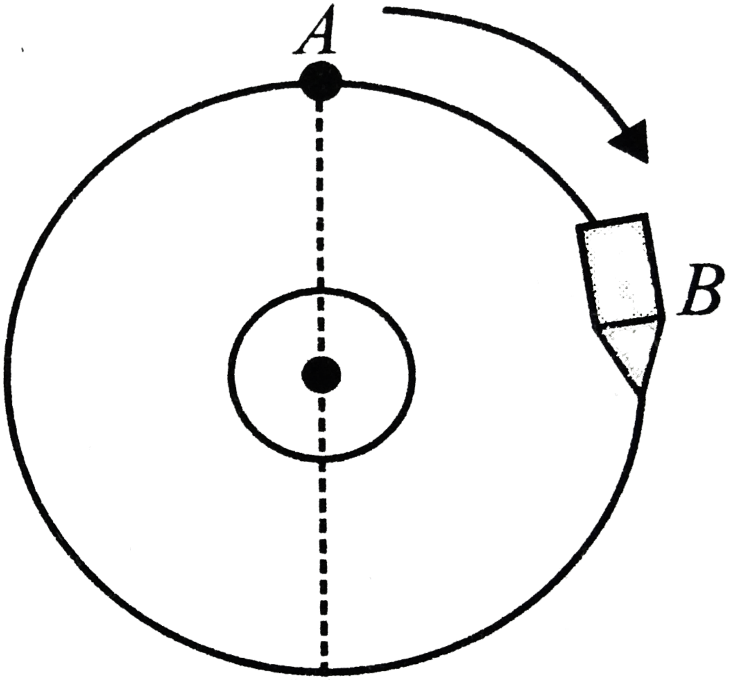
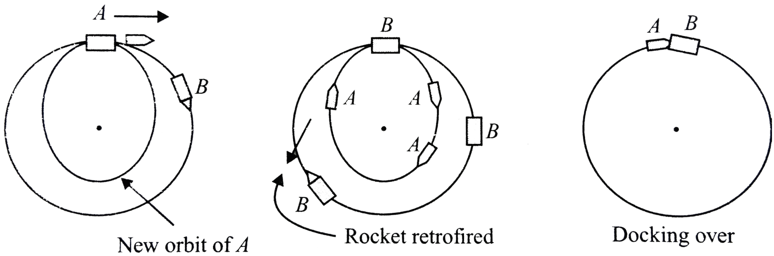
17. An unmanned satellite A and a spacecraft B are orbiting around the earth in the same circular orbit as shown.



The spacecraft is ahead of the satellite by some time. Let us consider that some technical problem has arisen in the satellite and the astronaut from B has made it correct. For this to be done docking of two (A and B) is required (in layman terms connecting A and B

). To achieve this, the rockets of A have been fired in forward direction and docking takes place as shown in the figure below:



Take mass of the earth $= 5.98 \times 10^{24} kg$

Radius of the earth $= 6400 km$

Orbital radius $= 9600 km$

Mass of satellite $A = 320 kg$

Mass of spacecraft $= 3200 kg$

Assume that initially spacecraft B leads satellite A by $100 s$, i.e., A arrives at any particle position after $100s$ of B's arrival. Based on the above information answer the following questions.

To dock A and B in the above-described situation, one can use the rocket system of either one, i.e., either of A or of B. To accomplish docking in the minimum possible time which is the best way?

A. To use rocket system of A.

B. To use rocket system of B.

C. Either (a) or (b).

D. Information insufficient

Answer: C

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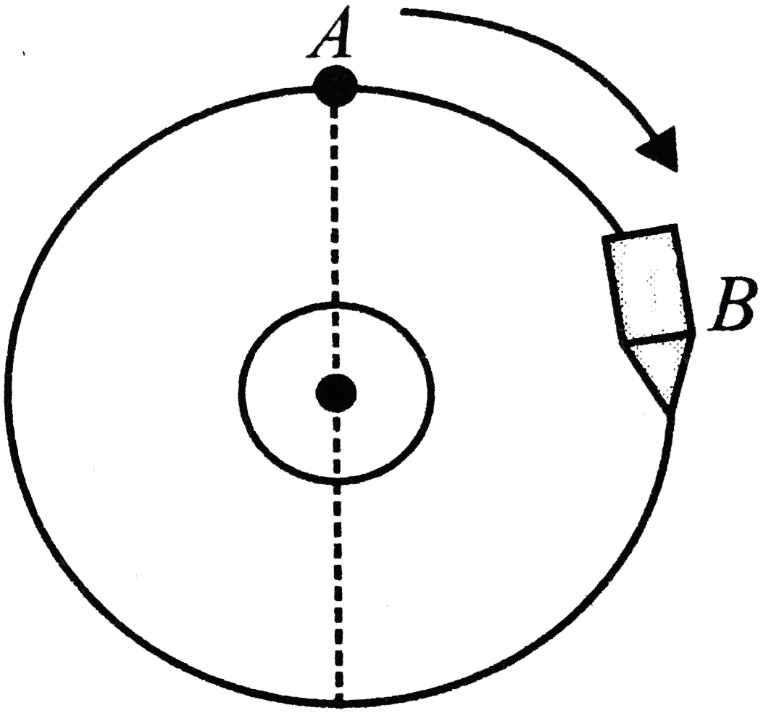
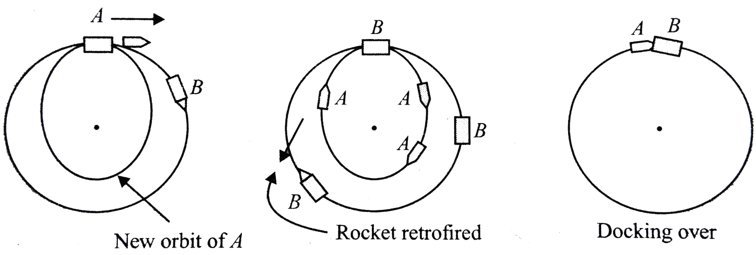
18. An unmanned satellite A and a spacecraft B are orbiting around the earth in the same circular orbit as shown.



The spacecraft is ahead of the satellite by some time. Let us consider that some technical problem has arisen in the satellite and the astronaut from B has made it correct. For this to be done docking of two (A and B) is required (in layman terms connecting A and B

). To achieve this, the rockets of A have been fired in forward direction and docking takes place as shown in the figure below:



Take mass of the earth $= 5.98 \times 10^{24} kg$

Radius of the earth $= 6400 km$

Orbital radius $= 9600 km$

Mass of satellite $A = 320 kg$

Mass of spacecraft $= 3200 kg$

Assume that initially spacecraft B leads satellite A by $100 s$, i.e., A arrives at any particle position after $100s$ of $B's$ arrival. Based on the above information answer the following questions

The initial total energy and time period of satellite are, respectively,

A. $-6.65 \times 10^{10} J, 9358s$

B. $-6.65 \times 10^{9} J, 9358s$

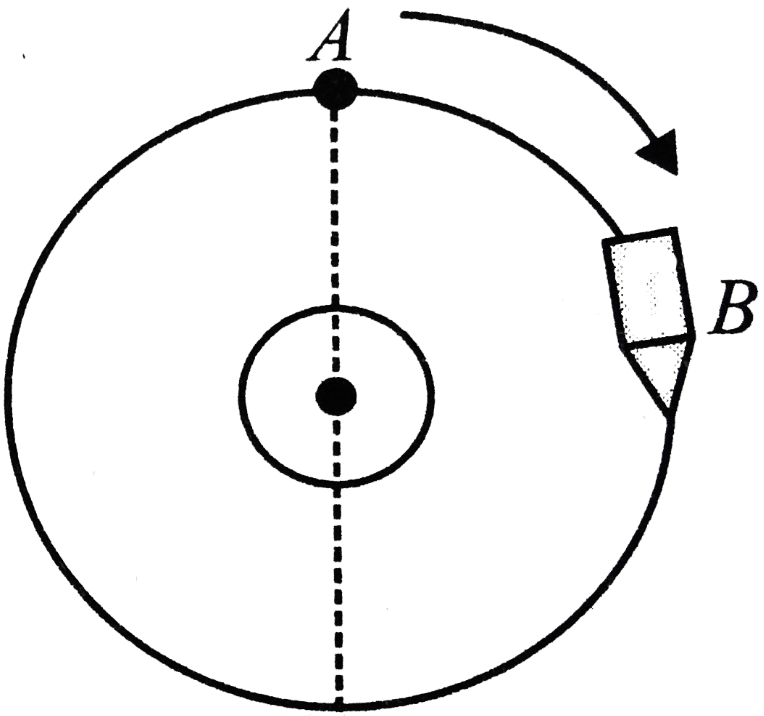
C. $-6.65 \times 10^{10} J, 9140s$

D. $-6.65 \times 10^{9} J, 9140s$

Answer: B

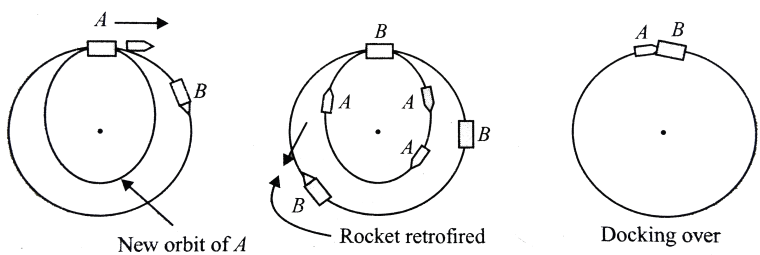
Watch Video Solution

19. An unmanned satellite A and a spacecraft B are orbiting around the earth in the same circular orbit as shown.



The

spacecraft is ahead of the satellite by some time. Let us consider that some technical problem has arisen in the satellite and the astronaut from B has made it correct. For this to be done docking of two (A and B) is required (in layman terms connecting A and B). To achieve this, the rockets of A have been fired in forward direction and docking takes place as shown in the figure below:



Take mass of the earth $= 5.98 \times 10^{24} kg$

Radius of the earth $= 6400km$

Orbital radius $= 9600km$

Mass of satellite $A = 320kg$

Mass of spacecraft $= 3200kg$

Assume that initially spacecraft B leads satellite A by $100s$, i.e., A arrives at any particle position after $100s$ of B's arrival. Based on the above information answer the following questions

The initial total energy and time period of satellite are, respectively,

A. Its orbit becomes elliptical with semi-major axis $9505.3km$.

B. its total energy becomes $-6.714 \times 10^9 J$

C. Its new time period becomes $9219.67s$.

D. All of the above.

Answer: D

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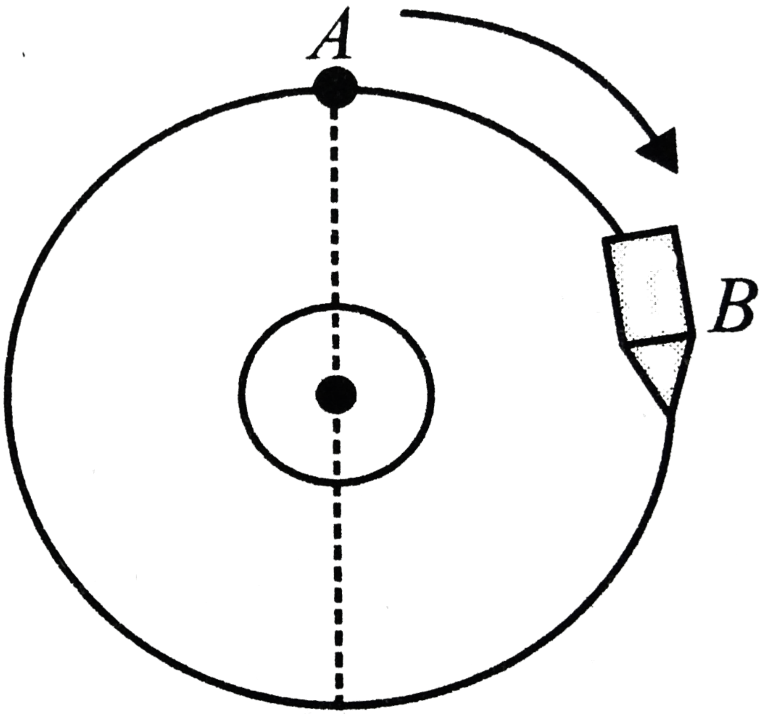
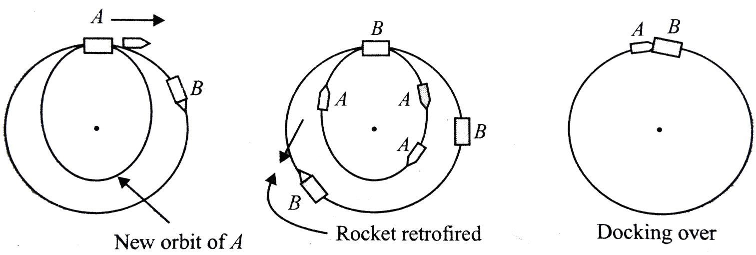
20. An unmanned satellite A and a spacecraft B are orbiting around the earth in the same circular orbit as shown.



The spacecraft is ahead of the satellite by some time. Let us consider that some technical problem has arisen in the satellite and the astronaut from B has made it correct. For this to be done docking of two (A and B) is required (in layman terms connecting A and B). To achieve this, the rockets of A have been fired in forward direction and docking takes place as shown in the figure below:



Take mass of the earth $= 5.98 \times 10^{24} kg$

Radius of the earth $= 6400 km$

Orbital radius $= 9600 km$

Mass of satellite $A = 320 kg$

Mass of spacecraft $= 3200 kg$

Assume that initially spacecraft B leads satellite A by $100s$, i.e., A arrives at any particle position after $100s$ of B's arrival. Based on the above information answer the following questions

The initial total energy and time period of satellite are, respectively,

A. $38s$

B. $138s$

C. Lags by $38s$

D. Lags by $138s$

Answer: A

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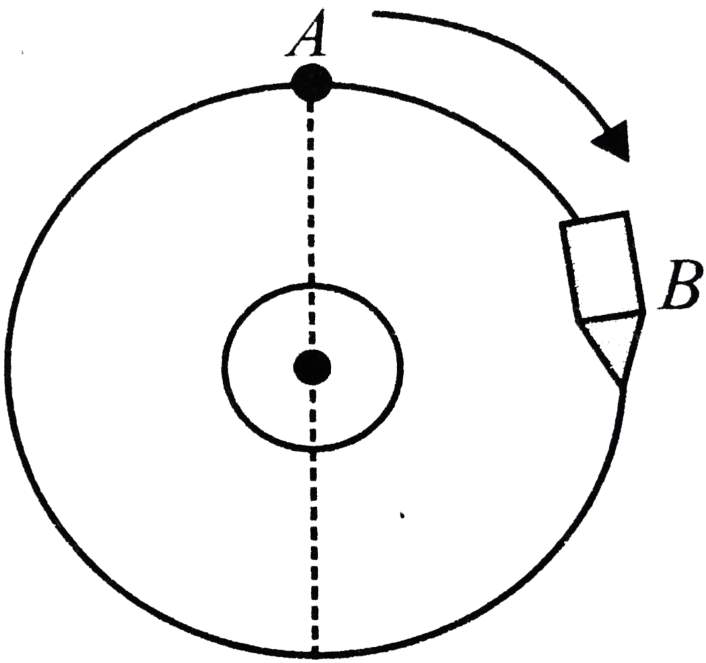
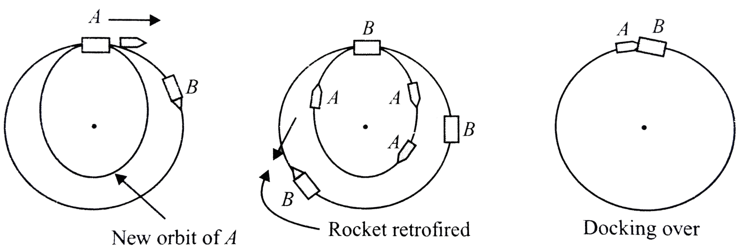
21. An unmanned satellite A and a spacecraft B are orbiting around the earth in the same circular orbit as shown.



The

spacecraft is ahead of the satellite by some time. Let us consider that some technical problem has arisen in the satellite and the astronaut from B has made it correct. For this to be done docking of two (A and B) is required (in layman terms connecting A and B). To achieve this, the rockets of A have been fired in forward direction and docking takes place as shown in the figure below:



Take mass of the earth $= 5.98 \times 10^{24} kg$

Radius of the earth $= 6400km$

Orbital radius $= 9600km$

Mass of satellite $A = 320kg$

Mass of spacecraft $= 3200kg$

Assume that initially spacecraft B leads satellite A by $100s$, i.e., A arrives at any particle position after $100s$ of B's arrival. Based on the above information answer the following questions. After once returning to the original point, i.e., the place from where the rockets have been fired, in which direction and with what extent the rockets have to be fired from the satellite to again come back in the original orbit?

A. Forward direction with the same extent.

B. Backward direction with the same extent.

C. Forward direction with the higher extent.

D. Backward direction with the higher extent.

Answer: B

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22. The satellites when launched from the earth are not given the orbital velocity initially, a multistage rocket propeller carries the spacecraft up to its orbit and during each stage rocket has been fired to increase the velocity to acquire the desired velocity for a particular orbit. The last stage of the rocket brings the satellite in circular/elliptical (desired) orbit.

Consider a satellite of mass $150kg$ in a low circular orbit. In this orbit, we cannot neglect the effect of air drag. This air opposes the motion of satellite and hence the total mechanical energy of earth-satellite system decreases. That means the total energy becomes more negative and hence the orbital radius decreases which causes the increase in KE When the satellite comes in the low enough orbit, excessive thermal energy generation due to air friction may cause the satellite to burn up. Based on the above information, answer the following questions.

It has been mentioned in the passage that as r decreases, E decreases but K increases. The increase in K is [$E =$ total mechanical energy, $r =$ orbital radius, $K =$ kinetic energy]

A. due to increase in gravitational PE

B. due to decrease in gravitational PE

C. due to work done by air friction force

D. both (b) and (c)

Answer: B

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23. The satellites when launched from the earth are not given the orbital velocity initially, a multistage rocket propeller carries the spacecraft up to its orbit and during each stage rocket has been fired to increase the velocity to acquire the desired velocity for a particular orbit. The last stage of the rocket brings the satellite in circular/elliptical (desired) orbit.

Consider a satellite of mass $150kg$ in a low circular orbit. In this orbit, we cannot neglect the effect of air drag. This air opposes the motion of satellite and hence the total mechanical energy of earth-satellite system decreases. That means the total energy becomes more negative and hence the orbital radius decreases which causes the increase in KE When the satellite comes in the low enough orbit, excessive thermal energy generation due to air friction may cause the satellite to burn up. Based on the above information, answer the following questions.

If due to air drag, the orbital radius of the earth decreases from R to $R - \triangle R, \triangle R < < R$, then the expression for increase in the orbital velocity $\triangle v$ is

A. $\frac{\triangle r}{2}\sqrt{\frac{GM}{R^3}}$

B. $-\frac{\triangle R}{2}\sqrt{\frac{GM}{2}}$

C. $\triangle R\sqrt{\frac{GM}{R^3}}$

D. $-\triangle R\sqrt{\frac{GM}{R^3}}$

Answer: A

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Integer

1. A particle of mass m is subjected to an attractive central force of magnitude k/r^2, k being a constant. If at the instant when the particle is at an extreme position in its closed orbit, at a distance a from the centre of force, its speed is $(k/2ma)$, if the distance of other extreme position is b. Then a/b is

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2. The earth $(mass = 10^{24} kg)$ revolves round the Sun with an angular velocity $2 \times 10^{-7} rads^{-1}$ in a circular orbit of radius $1.5 \times 10^{8} km$. Find the force exerted by the Sun on the earth (in $\times 10^{21} N$).

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3. The density of newly discovered planet is twice that of the earth. The acceleration due to gravity at the surface of the planet is equal to that at the surface of the earth. If the radius of the earth is R, the radius of the planet would be

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4. Imagine a new planet having the same density as that of the earth but it is 3 times bigger than the earth in size. If the acceleration due to gravity on the surface of the earth is g and that on the surface of the new planet is g', then

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5. The numerical value of the angular velocity of rotation of the earth should be........ Rad/s in order to make the effective acceleration due to gravity equal to zero.

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Fill In The Blanks

1. According to Kepler's second law, the radius vector to a planet from the Sun sweeps out equal areas in equal intervals of time. This law is a consequence of the conservation of _____________.

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2. A gestationary satellite is orbiting the earth at a height 6 R above the surface of earth, where R is the radius of the earth. The time period of another statellight at a height of 2.5 R from the surface of earth in hours is

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3. The masses and radii of the Earth and the Moon are M_1, R_1 and M_2, R_2 respectively.

Their centres are at a distance d apart. The minimum speed with which a particle of mass m should be projected from a point midway between the two centres so as to escape to infinity is ....

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4. A particle is projected vertically upwards from the surface of earth (radius R) with a kinetic energy equal to half of the minimum value needed for it to escape. The height to which it rises above the surface of earth is

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5. The ratio of earth's orbital angular momentum (about the sun) to its mass is $4.4 \times 10^{15} m^2 / s$. The area enclosed by earth's orbit approximately is (in m^2)

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True/False

1. Is it possible to put an artificial satellite in an orbit in such a way that it always remain visible directly over New Delhi ?

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SCQ_TYPE

1. 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

A. decrease

B. remain unchnaged

C. increase

D. be zero

Answer: C

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2. If g be the acceleration due to gravity of the earth's surface, the gain is 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

A. $\frac{1}{2}mgR$

B. $2mg$

C. mgR

D. $\frac{1}{4}mgR$

Answer: A

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3. A small planet is revolving around a very massive star in a circular orbit of Radius R with a period of revolution T. If the gravitational force between the planet and the star were proportional to $R^{-5/2}$, then T would be proportional to

A. T^2 is proportioinal to R^2

B. T^2 is proportional to $R^{\frac{7}{2}}$

C. T^2 is proportional to $R^{\frac{3}{2}}$

D. T^2 is proportional to $R^{3.75}$

Answer: B

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4. If the distance between the earth and the sun were reduced to half its present value, then the number of days in one year would have been

A. 64.5

B. 129

C. 182.5

D. 730

Answer: B

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5. A satellite S is moving in an elliptical orbit around the earth. The mass of the satellite is very small as comapred to the mass of the earth. Then,

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.

Answer: A

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6. 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 $\frac{T_2}{T_1}$ is

A. 1

B. $\sqrt{2}$

C. 4

D. 2

Answer: D

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7. The geostationalry orbit oif the earth is at a distance of about 36000 km from the earth's surface. Find the weight of a 120 kg equipment placed in a geostationary satellite. The radius of the earth is 6400 km.

A. $\frac{1}{2}h$

B. $1h$

C. $2h$

D. $4h$

Answer: C

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8. A system of binary stars of mass m_A and m_B are moving in circular orbits of radii r_A and r_B respectively. If T_A and T_B are at the time periods of masses m_A and m_B respectively then

A. If $T_A > T_B$, then $R_A > R_B$

B. If $T_A > T_B$, then $M_A > M_B$

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

D. $T_A = T_B$

Answer: D

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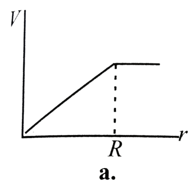
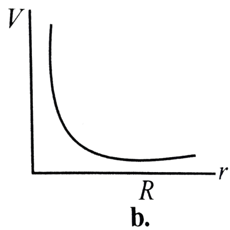
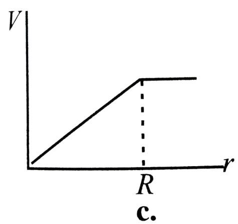
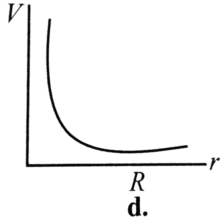
9. A spherically symmetric gravitational system of particles has a mass density $\rho = \begin{cases} \rho_0 & f \text{ or } \quad r < R \\ 0 & f \text{ or } \quad r > R \end{cases}$ where ρ_0 is a constant. A test mass can undergo circular motion under the influence of the gravitational field of particles. Its speed v as a function of distahce $r(0 < r < OO)$ form the centre of the system is represented by

A. 

B. 

C. 

D. 

Answer: C

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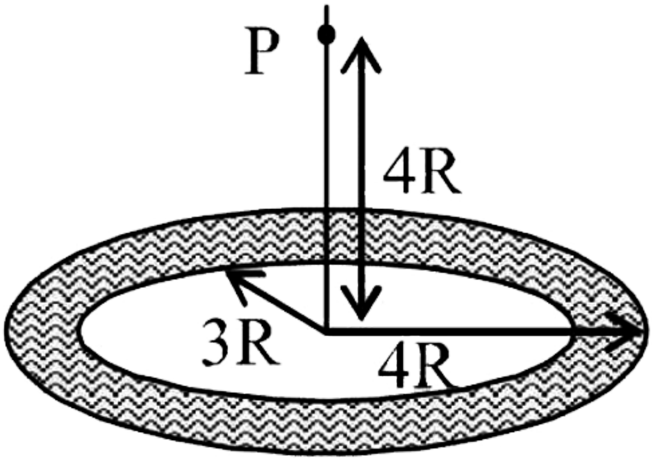
10. A thin uniform disc (see figure) of mass M has outer radius 4R and inner radius 3R. The work required to take a unit mass for point P on its axis to infinity is



A. (a) $\frac{2GM}{7R}(4\sqrt{2}-5)$

B. (b) $-\frac{2GM}{7R}(4\sqrt{2}-5)$

C. (c) $\frac{GM}{4R}$

D. (d) $\frac{2GM}{5R}(\sqrt{2}-1)$

Answer: A

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11. A satellite is 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 :

A. $\frac{1}{2}mV^2$

B. mV^2

C. $\frac{3}{2}mV^2$

D. $2mV^2$

Answer: B

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12. Two bodies, each of mass M, are kept fixed with a separation 2L. A particle of mass m is projected from the midpoint of the line joining their cehntres, perpendicualr to the line. The gravitational constant is G. The correct statement (s) is (are)

A. The minimum initial velocity of the mass m to escape the gravitational field of the two bodies is $4\sqrt{\frac{GM}{L}}$

B. The minimum initial velocity of the mass m to escape the gravitational field of the two bodies is $2\sqrt{\frac{GM}{L}}$

C. The minimum initial velocity of the mass m to escape the gravitational field of the two bodies is $\sqrt{\frac{2GM}{L}}$

D. The energy of the mass m remains constant.

Answer: B

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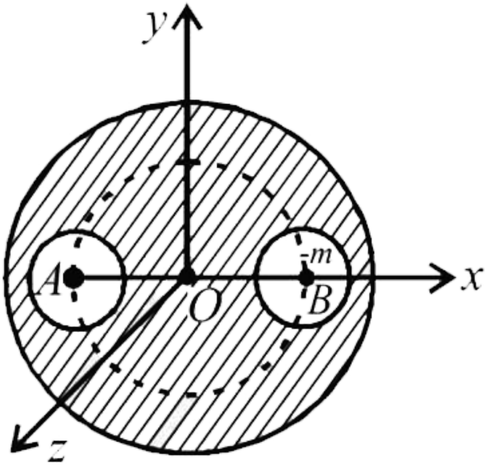
MCQ_TYPE

1. A solid sphere of uniform density and radius 4 units is located with its centre at the origin O of coordinates. Two sphere 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 if fig Then:



A. the gravitational force due to this object at the origin is zero

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

C. the gravitational potential is the same at all points of circle $y^2 + z^2 q = 36$

D. Both (a) and (c)

Answer: A::C::D

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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 (more than one are correct)

A. $\frac{F_1}{F_2} = \frac{r_1}{r_2}$ if $r_1 < R$ and $r_2 < R$

B. $\frac{r_2^2}{r_2}$ 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. $\frac{F_1}{F_2} = \frac{r_1^2}{r_2^2}$ if $r_1 < R$ and $r_2 < R$

Answer: A::B

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3. A satellite S is moving in an elliptical orbit around the earth. The mass of the satellite is very small as comapred to the mass of the earth. Then,

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.

Answer: A::C

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4. Two spherical planets P and Q have the same uniform density ρ, masses M_P and M_Q and surface areas A and $4A$, respectively. A spherical planet R also has uniform density ρ and its mass is $(M_P + M_Q)$. The escape velocities from the planets P, Q and R, are V_P, V_Q and V_R, respectively.

A. $V_Q > V_R > V_P$

B. $V_R > V_Q > V_P$

C. $V_R / V_P = 3$

D. $V_P / V_Q = 1/2$

Answer: B::D

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AR_TYPE

1. Assertion : An astronaut in an orbiting space station above the earth experience weightlessness.

Reason : An object moving around the earth under the infuence of earth's gravitational force is in a state of 'free fall'

A. If both assertion and reason are true and the reason is a correct explanation of the assertion.

B. If both assertion and reason are true but reason is not a correct explanation of assertion.

C. If assertion is true, but the reason is false.

D. If assertion is false but the reason is true.

Answer: A

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INTEGER_TYPE

1. Gravitational acceleration on the surface of a planet is $\frac{\sqrt{6}}{11}g.$ where g is the gravitational acceleration on the surface of the earth. The average mass density of the planet is $\frac{2}{3}$ times that of the earth. If the escape speed on the surface of the earht is taken to be $11 kms^{-1}$ the escape speed on the surface of the planet in kms^{-1} will be

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