PHYSICS

BOOKS - DC PANDEY PHYSICS (HINGLISH)

GRAVITATION

Example

1. Three point masses 'm' each are placed at the three vertices of an equilateral traingle of side 'a'. Find net gravitational force on any point mass.

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2. Four particles each of mass 'm' are placed at the four vertices of a square 'a' .Find net force on any one the particle.

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3. Six particles each of mass 'm' are placed at six verties A,B,C,D,Eand F of a regular hexagon of side 'a'. A seventh particle of mass 'M' is kept at center 'O' of the hexagon.

(a)Find net force on 'M'.

(b)Find net force on 'M' if particles at A is removed.

(c) Find net force on 'M' if particles at A and C are removed .

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4. Five particles each of mass 'm' are kept at five verties of a regular pentagon . A sixth particles of mass 'M' is kept at center of the pentagon 'O'.Distance between'M' and is 'm' is 'a'. Find

(a) net force on 'M'

(b) magnitude of net force on 'M' if any one particle is removed from one of the verties.

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5. A mass m is at a distance a from one end of a uniform rod of length l and mass M. Find the gravitational force on the mass due to tke rod.

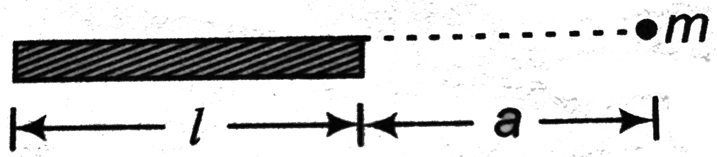

Fig. 13.12

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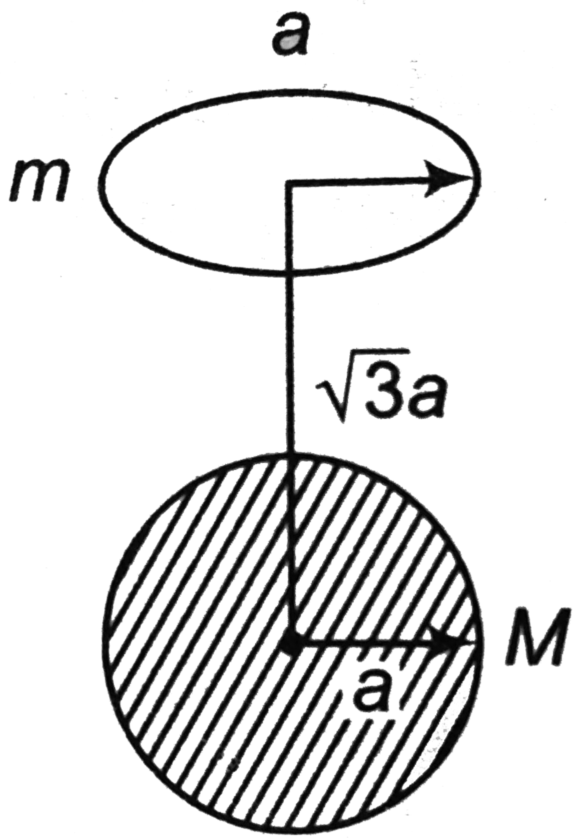
6. A uniform ring of mass m is lying at a distance $\sqrt{3}$ a from the centre of mass M just over the sphere (where a is the radius of the ring as well as that of the sphere). Find the magnitude of gravitational force between



them .

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7. Assuming earth to be a sphere of uniform mass density, how much

would a body wrigh galf way down the centre of rhe centre of the earth , if it weighed 100 N on the surface?

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8. Suppose the earth increases its speed of rotation . At what new time period will the weightof a body on the equator becomes zero? Take $g = 10\frac{m}{s^2}$ and radius of the earth $R = 6400km$.

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9. 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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10. At what depth below the surface of earth, value of acceleration due to gravity is same as the value at height $h = R$, where R is the radius of earth.

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

B. $d = \frac{R}{4}$

C. $d = \frac{3}{2}R$

D. $d = \frac{3}{4}R$

Answer: D

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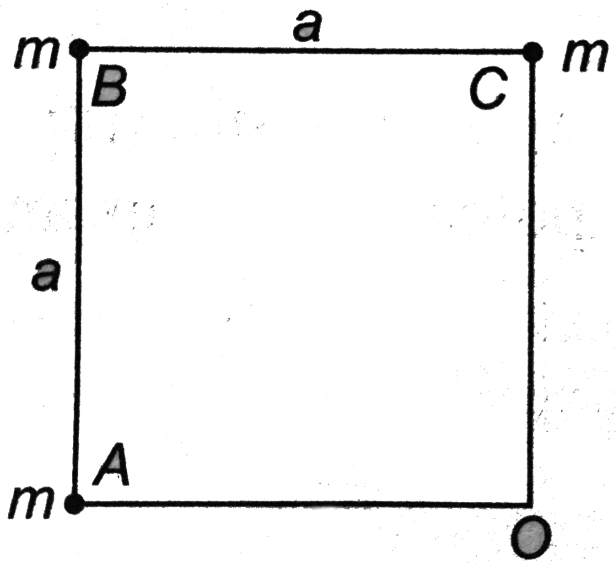
11. Three point masses 'm' each are kept at three verties of a square pf side 'a' as shown in figure. Find gravitation potential and field strength at point O.



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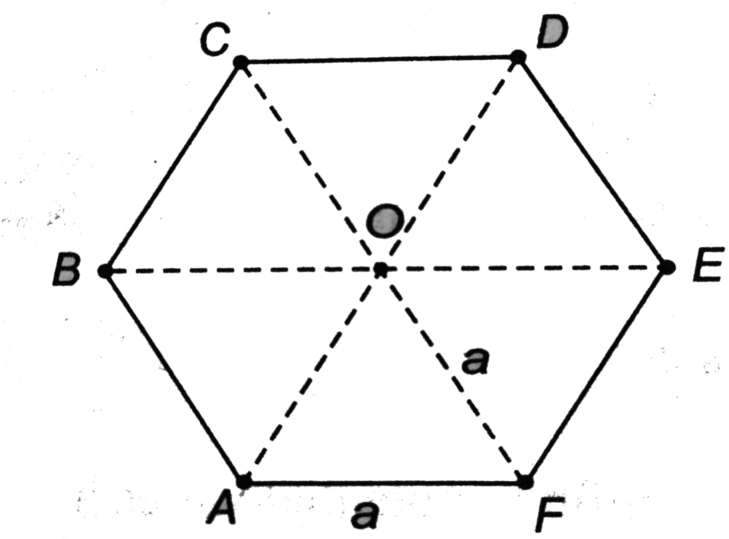
12. Four point masses easch of mass 'm' are placed at four vertieces A, B, C, nd D of a regular hexagon of side 'a' as shown in figure , Find gravitational potential and field strength at the centre O of the hexagon.



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13. At what distance 'd' from the surface of a solid sphere of radius 'R',

(a)potential is sme as at a distance $\frac{R}{2}$ from the centre ?

(b) field strengt is ame as at a distance $\frac{R}{4}$ from centre.

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14. Gravitational potential in $x - y$ plan varies with x and y

coordinates as

$V = x^2y + 2xy$

Find gravitational field strength E.

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15. Gravtational potential at a distance 'r' from a point mass 'm' is

$V = -\frac{GM}{r}$

Find gravitational field strength at that point.

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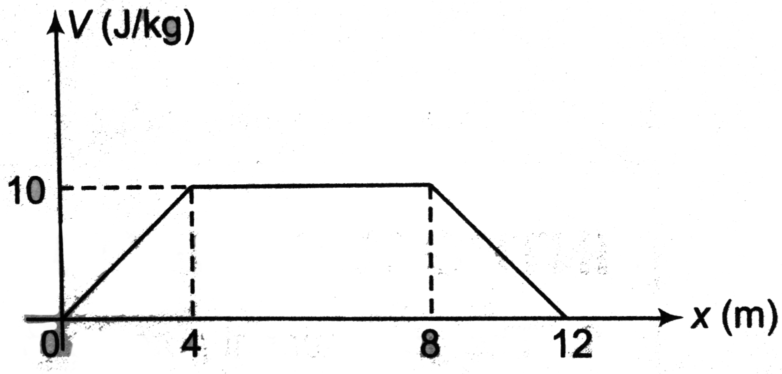
16. Gravtational potential varies alolngl x-axis as shown in figure .



(a) Plot E versus x graph corresponding to given $V - x$ graph.

(b) A mass of 2 kg is kept at $x = 3m$. Find gravitational force on it.

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17. Gravitational field in $x - y$ plane is given as

$E = \left(2x\hat{i} + 3Y^2\hat{j}\right)N/kg$

Fin difference in gravitation potential between two points A and B, where co-ordinates of A and B are $(2m, 4m)$ and $(6m, 0)$.

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18. Three masses of $1kg$, $2kg$, and $3kg$, are placed at the vertices of an equilateral traingle of side $1m$. Find the gravitational potential energy of this system.

Take $G = 6.67 \times 10^{-11} N - m^2 / kg^2$.

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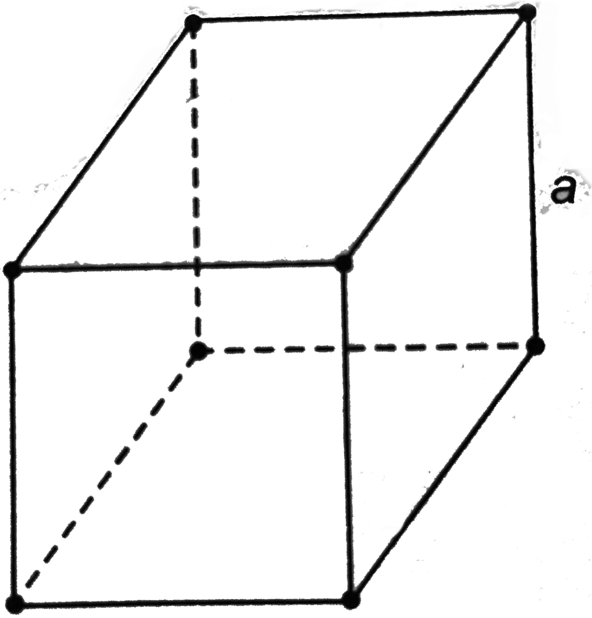
19. Eight particles of mass 'm' each are placed at the verties of a cube of side 'a' . Find gravitational potential energy of this system .



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20. A particle of mass 'm' is raised from the surface of earth to a height h = 2R. Find work done by some external agent in the process. Here, R is the radius of earth and g the acceleration due to gravity on earth's surface.

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21. Aparticle is projected from the surface of the earth with an intial speed of $4.0km/s$.Find the maximum height attained by the particle. Radius of earth = 6400km $g = 9.8m/s^2$.

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22. Calculate the escape velocity from the moon. The mass of the moon $= 7.4 \times 10^{22} kg$ and radius of the moon `=1740km

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23. Kinetic energy of a particle on the surface is e_0 and potential energy is $-\frac{E_0}{2}$.

(a) Will the particle escape to infinity ?

(b) At some height some height its kinetic energy becomes $0.6E_0$. What is potential energy at this height ?

(c) If the particle escape to infinity , what is kinetic energy of the particle at infinity ?

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24. As orbital radius r of a satellite is increased, state which of the following quantities will increase and which will decrease ?

(i) Orbital speed

(ii) Time period

(iii) Frequence

(iv) Angular speed

(v) Kinetic energy

(vi) Potential energy

(vii) Toyal mechanical energy .

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25. A geostationary satellite is orbiting the earth at a height of $6R$ above the surface oof earth where R is the radius of the earth .The time period of another satellite at a distance of $3.5R$ from the centre of the earth is ..... hours.

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

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27. 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?

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28. 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 earth.

(i) Determine the height of the satellite above the earth's surface.

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

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29. Name the physical quantites which remain constant in a planetary motion (in elliptical orbits).

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

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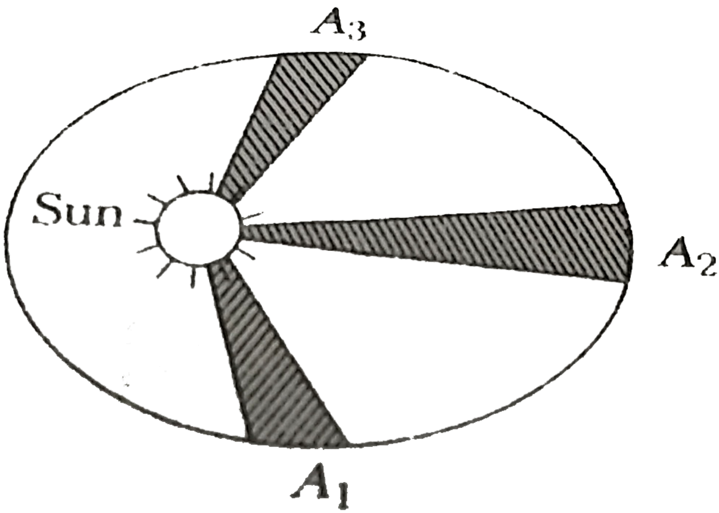
31. A planet moving around sun sweeps area A_1 in 2 days, A_2 in 3 days and A_3 in 6 days, then find the relation between A_1, A_2 and A_3



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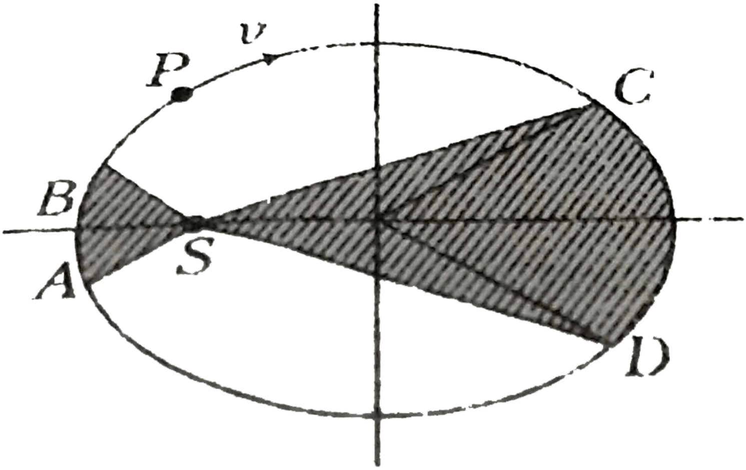
32. The figure shows elliptical orbit of a plant P about the sun S. The shaded area CSD is twice tha shaded area ASB. If t_1 is the time taken by the planet to move from C to D and t_2 is the time to move from A to B, determine the ratio t_1 / t_2



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33. A satellite of time period 2A h is orbiting the earth at a height 6R above the surface of earth, where R is radius of earth. What will be the time period of another satellite at a height 2.5 R from the surface of earth ?

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34. The planet neptune travels around the sun with a period of 165 yr. What is the radius of the orbit approximately, if the orbitt is considered as circular ?

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35. 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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36. If the distance between the two spherical bodies is increased to four times, then by how many times, the mass of one of the bodies to be changed to maintain the same gravitational force ?

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37. Two particles A and B having masses M and 4M respectively are kept at a distance 2.73 m apart. Another small particle of mass m is to be placed so that the net gravitational force on it is zero. What will be its distance from body A ?

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38. Spheres of the same material and same radius r are touching each other. Show that gravitational force between them is directly proportional to r^4.

A. r^2

B. r^3

C. r^4

D. none of the above

Answer: C

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39. Force between two objects of equal masses is F, If 25 % mass of one object is transferred to the other object, then find the new force.

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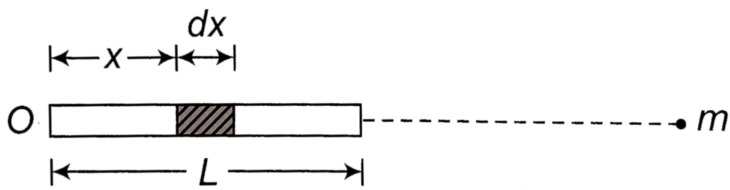
40. (a) A uniform rod of mass M and length L is placed at distance L from a point mass m as shown. Find force on m



(b) A semiconductor wire has a length L and mass M. A particle of mass m is placed at the centre of the circle. find the gravitational attraction on the particle due to the wire.

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41. Two particles of equal mass m_0 are moving round a circle of radius r due to their mutual gravitational interaction. Find the time period of each particle.

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42. Three masses, each equal to M, are placed at the three corners of a square of side a. the force of attraction on unit mass at the fourth corner will be

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43. Three equal masses of 1 kg each are placed at the vertices of an equilateral ΔPQR and a mass of 2kg is placed at the centroid O of the triangle which is at a distance of $\sqrt{2}$m from each the verticles of the triangle. Find the force (in newton) acting on the mass of 2 kg.

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44. The acceleration due to gravity at the moon's surface is $1.67ms^{-2}$. If the radius of the moon is $1.74 \times 10^6 m$, calculate the mass of the moon.

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45. Assume that if the earth were made of lead of relative density 11.3, then what would be the value of acceleration due to gravity on the earth surface ?

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46. What will be the relation between the acceleration due to gravity on the surface of the earth and on a planet respectively, whose mass and radius are four times that of the earth ?

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47. At what height above the earth's surface the acceleration due to gravity will be 1/9 th of its value at the earth's surface? Radius of earth is 6400 km.

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48. At what altitude, the acceleration due to gravity reduces to one fourth of its value as that on the surface of the earth ? Take radius of earth as $6.4 \times 10^6 m$, g on the surface of the earth as $9.8 ms^{-2}$.

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49. At what height the acceleration due to gravity decreasing by 51 % of its value on the surface of th earth ?

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50. At what depth from the surface of the earth, the acceleration due to gravity will be half the value of g on the surface of the earth ?

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51. At which depth from Earth surface, acceleration due to gravity is decreased by 1 % ?

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52. Assuming earth to be a sphere of uniform mass density, how much would a body weigh half way down the centre of the earth, if it weighed 100 N on the surface ?

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53. Determine the decrease in the weight of a body when it is taken 32 km below the earth surface. Take radius of the earth as 6400 km.

A. 1%

B. 0.5%

C. 2%

D. NONE OF THE ABOVE

Answer: B

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54. imagine a new planet having the same density as that of earth but it is 3 times bigger than the earth is size. If the acceleration due to gravity on the surface of earth is g and that on the surface of the new planet is g', then find the relation between g and g'.

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55. Find the imaginary angular velocity of the earth for which the effective acceleration due to gravity at the equator shall be zero. (take $g = 10m/s^2$ for the acceleration due to gravity, if the earth were at rest and radius of earth equal to 6400 km and $\phi = 60^\circ$)

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56. Calculate the angular speed of rotation of the Earth so that the apparent g at the equator becomes half of its value at the surface. Also calculate the length of the day in this situation.

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57. Find the value of angular velocity of axial rotation of the earth, such that weight of a person at equator becomes 3/4 of its weight at pole, Radius of the earth at equator is 6400 km.

A. $62 \times 10^{-4} \text{rads}^{-1}$

B. $52 \times 10^{-4} \text{rads}^{-1}$.

C. $62 \times 10^{-2} \text{rads}^{-1}$.

D. NONE OF THE ABOVE

Answer: A

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58. Suppose the earth increases it speed of rotation. At what new time period will the weight of a body on the equator becomes zero ? (Take, $g = 10 ms^{-2}$ and radius of earth R = 6400 km)

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59. Two point masses of mass 10 kg and 1000 kg are at a distance 1 m apart. At which points on the line joining them, will the gravitational field intensity be zero ?

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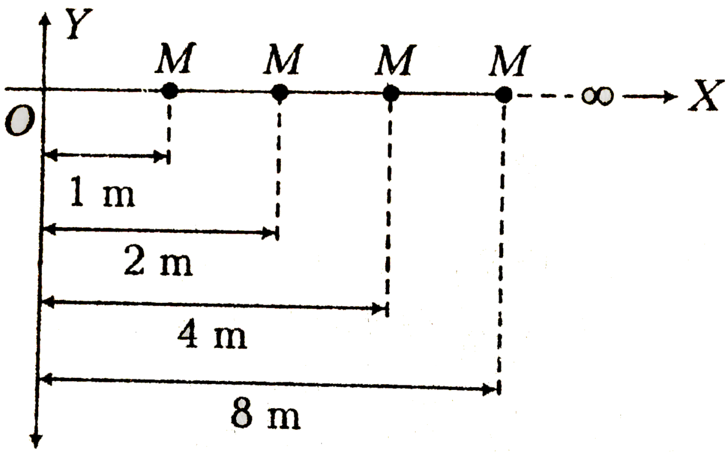
60. Figure shows a system of point masses placed on X-axis. Find the net gravitational field intensity at the origin



Take sum of an infinite GP as $S = \frac{a}{1-r}$

where a= first term and r = Least common ratio.

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61. Two solid spheres of radius 10 cm and masses 800 kg and 600 kg, are at a distance 0.25 m apart. Calculate distance 0.20 m from the 800 kg sphere and 0.1 m from the 600 kg sphere and does not lie on the line joining their centres. Given, $G = 6.6 \times 10^{-11} N - m^2 kg^{-2}$.

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62. Gravitational field at the surface of a solid sphere is $1.5 \times 10^{-4} \text{N kg}^{-1}$. Find the gravitational field at a point situated inside the sphere at a distance equal to half of rhe radius of the solid sphere.

A. $7.5 \times 10^{-4} \text{N kg}^{-1}$

B. $7.5 \times 10^{4} \text{N kg}^{-1}$

C. $70.5 \times 10^{-4} \text{N kg}^{-1}$

D. $= 1.5 \times 10^{-7} \text{N kg}^{-1}$

Answer: A

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63. Two concentric spherical shells have masses m_1 and m_2 and radii r_1 and $r_2 (r_2 > r_1)$. What is the force exerted by this system on a

particle of mass m_3. If it is placed at a distance $r(r_1 < r < r_2)$ from the centre ?

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64. Mass of 20 kg is distributed uniformly over a ring of radius 2m. Find the the grvitational field at a point lies an th axis of the ring at a distance of $2\sqrt{3}$ m from the centre.

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65. A heavy point of mass 15 kg is placed at the origin of coordinate axis. Find the gravitational potential at a point located at $x = 5cm$ on X-axis.

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66. Two heavy point masses of mass 10^3 kg and 10^5 kg are separated by a distance of 200 m. What will be the potential at the mid-point of the line joining them ?

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67. The radius of the earth is 6.37×10^6 m and its mean density is $5.5 \times 10^3 \text{kg m}^{-3}$ and $G = 6.67 \times 10^{-11} \text{N-m}^2 kg^{-2}$ Find the gravitational potential on the surface of the earth.

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68. At a point above the surface of the earth, the gravitational potential is -5.12×10^7 J/kg and the acceleration due to gravity is $6.4 m/s^2$. Assuming the mean radius of the earth to be 6400 km, calculate the height of the point above the earth's surface.

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69. A particle of mass 1 kg is kept on the surface of a uniform thin spherical shell of mass 20 kg and radius 1 m. Find the work to be done against the gravitational force between them to take the particle away from the thin spherical shell.

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70. A particle of mass M is placed at the centre of a spherical shell of same mass and radius a. What will be the magnitude of the gravitational potential at a point situated at a/2 distance from the centre ?

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71. Mass of 10 kg is distributed uniformly over a ring of radius 1m. Find the gravitational potential at a point lies on the axis of the ring at a distance of 1m from the centre.

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72. If gravitational potential is $V = xy^2$, find the gravitational field at $(2, 1)$

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73. If gravitational field is given by $E - x\hat{i} - 2y^2\hat{j}$. When gravitational potential is zero ar (0,0) find potential cat (2,1)

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74. Two point masses 1 kg and 4 kg are separated by a distance of 10 cm. Find gravitational potential energy of the two point masses.

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75. Three masses of 1 kg, 2kg, and 3 kg are placed at the vertices of an equilateral triangle of side 1m. Find the gravitational potential energy of this system

(Take, $G = 6.67 \times 10^{-11} \text{N-m}^{-2} kg^{-2}$)

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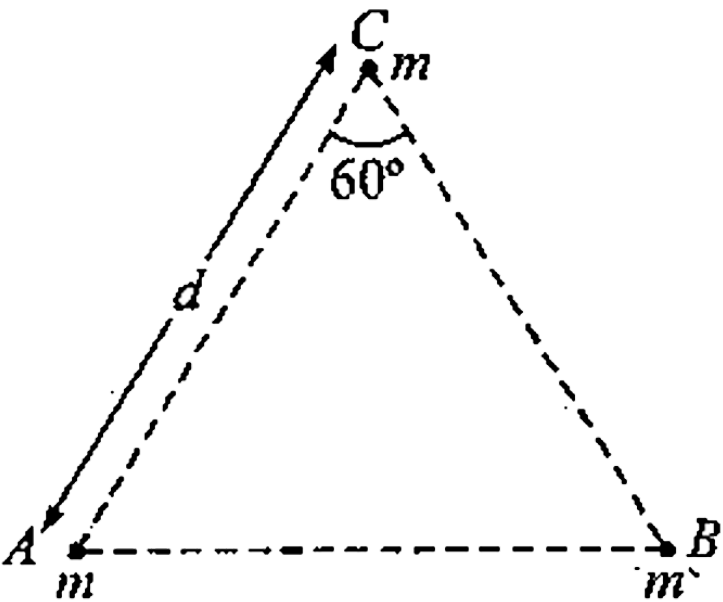
76. Three particle each of mass m are placed at the corners of an equilateral at the corners of an equilateral triangle of side d as shown in figure. Calculate (a) the potential energy of the system, (b) work done on this system if the side of the traingle is changed from d to 2d.



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77. Infinite number of bodies, each of mass 2kg are situated on X-axis at distance $1m, 2m, 4m, 8m,$ respectively from the origin, What is the resulting gravitational potential due to this system at the origin ?

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78. The mass of the earth is $6 \times 10^{24} kg$. The constant of gravitation $G = 6.67 \times 10^{-11} \text{N-m}^{-2} kg^{-2}$. The potential energy of the earth and moon system is $-7.79 \times 10^{28} J$. Determine the mean distance between earth and moon.

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79. A body of mass m is raised to a height 10 R from the surface of the earth, where R is the radius of the earth. Find the increase in potential energy. (G = universal constant of gravitational, M = mass of the earth and g= acceleration due to gravity)

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80. Find the change in the gravitational potential energy when a body of mass m is raised to a height nR above the surface of the earth. (Here, R is the radius of the earth)

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81. An object is dropped from height $h = 2R$ on the surface of earth. Find the speed with which it will collide with ground by neglecting effect of air. (Where R is radius of earth, take mass of earth M)

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82. Find the binding energy of a satellite of mass m in orbit of radius r, (R = radius of earth, g = acceleration due to gravity)

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83. Calculate the escape velocity from the surface of a planet of mass 14.8×10^{22} kg. It is given that radius of the planet is 3.48×10^{6} m.

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84. The ratio of the masses and radii of two planets are $4:6 \text{ and } 8:18$. What is the ratio of the escape speed at their surface ?

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85. Jupiter has a mass 318 times that of earth, and its radius is 11.2 times the earth's radius Estimate the escape velocity of a body from Jupiter's surface, given that the escape velocity from the earth's surface $11.2kms^{-1}$.

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86. At what temperature, hydrogen molecules will escape from the earth's surface ? (Take, radius of earth $R_e = 6.4 \times 10^6 m$, mass of hydrogen molecule $m = 0.34 \times 10^{-26}$kg, Boltzmann constant $k = 1.38 \times 10^{-23} JK^{-1}$ and acceleration due to gravity $= 9.8 \times ms^{-2}$)

also take rms speed of gas as $v_{rms} = \sqrt{\frac{3kT}{m}}$.

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87. A space-ship is launched into a circular orbit close to the Earth,s surface. What additional speed should now be imparted to the spaceship so that it overcome the gravitational pull of the Earth.

Take kinetic energy of the space-ship,

K = total energy of space-ship $= \frac{GMm}{2R}$

where m = mass of space-ship, M= mass of the earth and R = radius of the earth.

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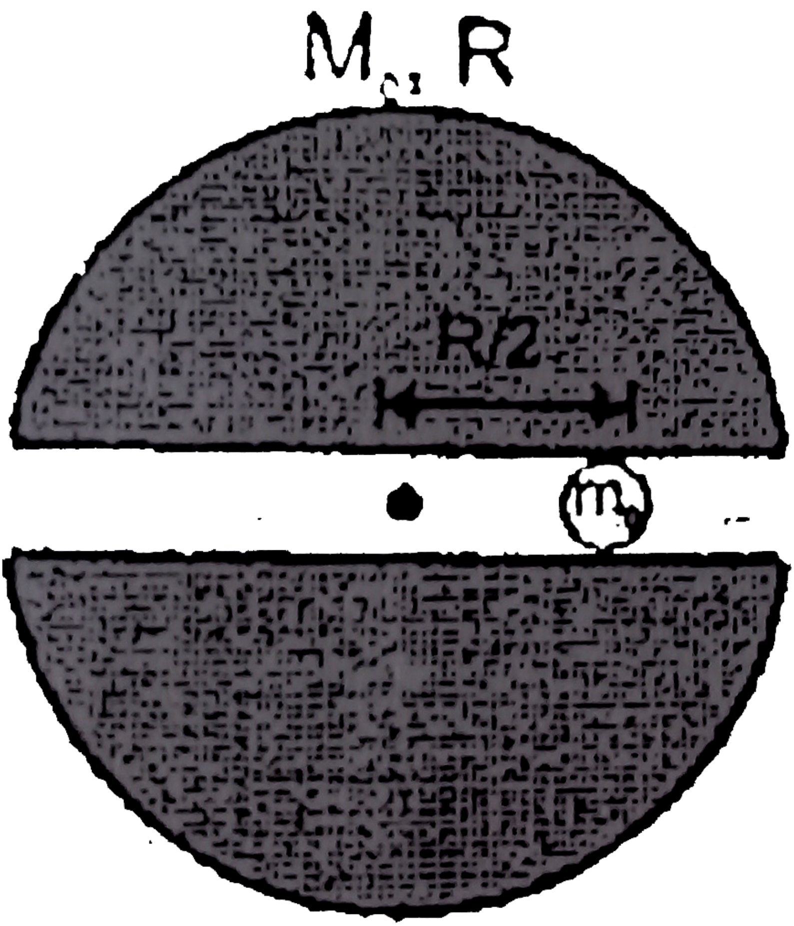

88.

A very small groove is made in the earth, and a particle of mass m_0 is placed at $\frac{R}{2}$ distance from the centre. Find the escape speed of the particle for that place.

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89. The earth is assumed to be a sphere of raduis R. A plateform is arranged at a height R from the surface of the fv_e, where v_e is its escape velocity form the surface of the earth. The value of f is

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90. A body is projected upwards with a velocity of $4 \times 11.2 \text{km s}^{-1}$ from the surface of earth.What will be the velocity of the body when it escapes from the gravitational pull of earth ?

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91. A particle is projected from the surface of earth with intial speed of 4 km/s. Find the maximum height attained by the particle. Radius of earth = 6400 km and $g = 9.8 m / s^2$

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92. A particle is projected vertically upwards the surface of the earth (radius R_e) with a speed equal to one fourth of escape velocity what is the maximum height attained by it from the surface of the earth?

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93. With what velocity must a body be thrown from earth's surface so that it may reach a maximum height of $4R_e$ above the Earth's surface ? (Radius of the Earth $R_e = 6400km, g = 9.8ms^{-2}$).

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94. A satellite circled around the earth at a distance of 100 km. Determine its orbital velocity, if the radius of the earth is 6400 km and $g = 9.8ms^{-2}$

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95. A satellite is launched into a circular orbit close to the earth's surface. What additional velocity has new to be imparted to the satellite in the orbit to overcome the gravitational pull ?

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96. 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 $G = 6.67 \times 10^{-14}\text{N-m}^2 kg^{-2}$. Determine its orbital velocity and period of revolution.

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97. A satellite contructs a circle around the earth in 90 minutes. Determine the height of the satellite above the earth's surface.

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98. If a spaceship orbits the earth at a height of 500 km from its surface, then determine its (i) kinetic energy, (ii) potential energy, and (iii) total energy (iv) binding energy. Mass of the satellite = 300 kg, Mass of the earth $= 6 \times 10^{24} kg$, radius of the earth $= 6.4 \times 10^{6} m$, $G = 6.67 \times 10^{-11} \text{N-m}^{2} kg^{-2}$. Will your answer alter if the earth were to shrink suddenly to half its size ?

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99. What will be the mass of an astronaut in a space satellite if at earth's surface the astronaut weighs 250 N ? (Take $g = 10 ms^{-2}$)

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Solved Examples

1. Three particles, each of the mass m are situated at the vertices of an equilateral triangle of side a. The only forces acting on the particles are their mutual gravitational forces. It is desired that each particle moves in a circle while maintaining the original mutual separation a. Find the initial velocity that should be given to each particle and also the time period of the circular motion. $\left(F = \frac{Gm_1m_2}{r^2}\right)$

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2. In the above problem, find total mechanical energy of the system .

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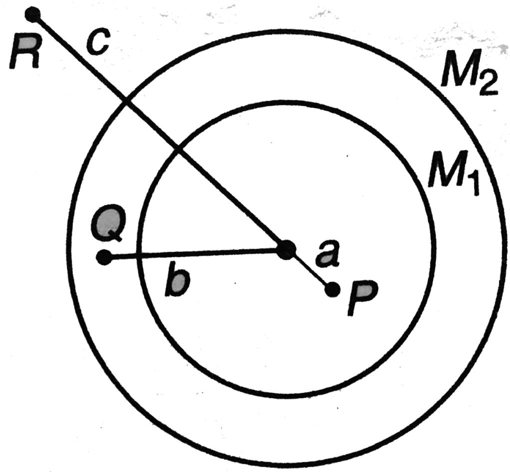
3. Two concentric shells of masses M_1 and M_2 are concentric as shown. Calculate the gravitational force on m due to M_1 at points P,Q and R.



$F = 0$

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4. Gravitational potential energy between two points masses is

$$U = -\frac{Km_1m_2}{r^n}$$

where, K is a positive constant. With what power of 'r' time period of a satellite of mas 'm' varies in circular orbit if mass of planet is M ?

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

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

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

D. r^2

Answer: A

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

(a) T^2 is proportional to R^2

(b) T^2 is proportional to $R^{7/2}$

(c) T^2 is proportional to $R^{3/3}$

(d) T^2 is proportional to $R^{3.75}$.

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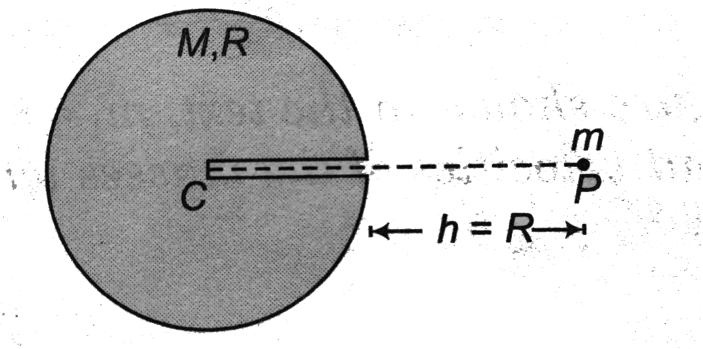
6. There is a smooth tunnel upto centre C of a solid sphere of mass 'M' and radius R.A particle of mass $m(< < M)$ is realeased from point P along the line CP. Find velocity of 'm' while striking at C.



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7. A particle of mass 'm' is projected from the surface of earth with velocity$v = 2v_e$, where v_e is the value of escape velocity from the surface of earth . Find velocity of the particle on reaching to interstellar space (at infinity) in terms of v_e.

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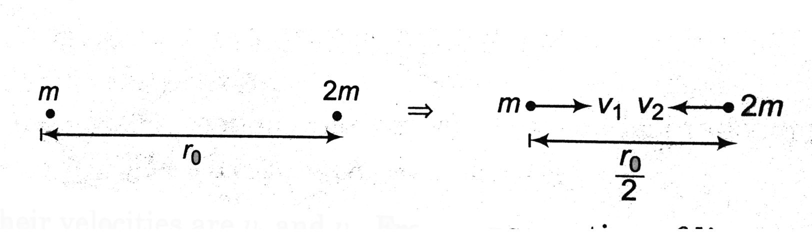
8. In the figure shown in text, $m_1 = m$, $m_2 = 2m$ and initial distance between them is r_0. Find velocities of the masses when separation between them becoms $\frac{r_0}{2}$.



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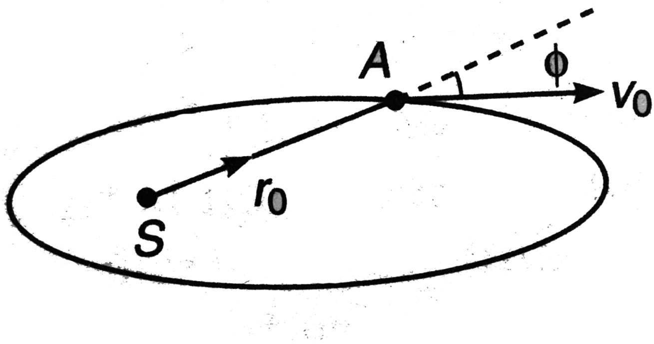
9. Find the maximum and minimum distances of the planet A from the sun S, if at a ceration moment of times it was at a distance r_0 and travelling with the velocity v_0. With the angle between the radius vector and velocity vector being equal to ϕ.



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10. A projectile of mass m is fired from the surface of the earth at an angle $\alpha = 60^\circ$ from the vertical. The initial speed v_0 is equal to $\sqrt{\frac{GM_e}{R_e}}$. How high does the projectile rise ? Neglect air resistance and the earth's rotation.

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11. A plant of mass m_1 revolves round the sun of mass m_2. The distance between the sun the planet is r. Considering the motion of the sun find the total energy of the system assuming the orbits to be circular.

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12. In the problem discussed in the text, find $E - r$ expressions for inside and outside points.

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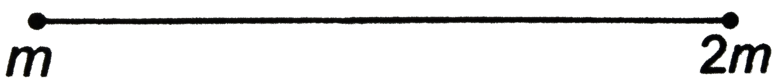
13. Two points masses 'm' and $2m$ are kept at certain distance as shows in figure. Draw $E - r$ and $V - r$ graphs along the line joining them corresponding to given mass system.



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14. In the problem discussed in the text, find the values of E and V at p dua to the remaining mass.

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15. Distance between the centres of two stars is $10a$. The masses of these stars are M and $16M$ ans their radit a nd $2a$ respectively. A body of mass m is fired straight from the surface of the larger star tpwards the surface of the smaller star. What should be its minimum intial speed to reach the surface of the smaller star? Obtain the expression in terms of G, M and a.

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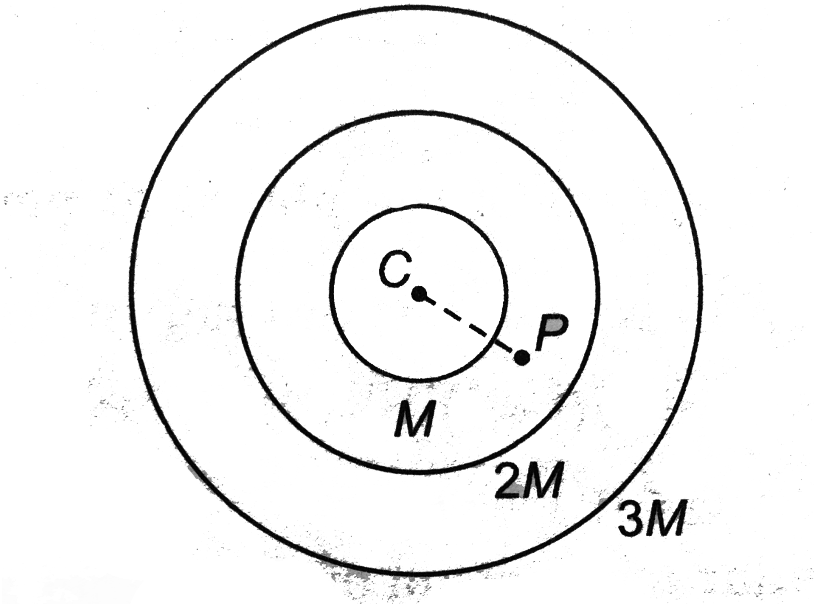
16. Three spherical shells of masses $M, 2M$ and $3M$ have radii $R, 3R$ and $4R$ as shows in figure. Find net potential at point P, where $CP = 2R$.



A. $-\frac{13GM}{12R}$

B. $-\frac{23GM}{6R}$

C. zero

D. $-\frac{23GM}{12R}$

Answer: D

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Miscellaneous Examples

1. Explain the reason of weightlessness inside a satellite.

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2. Find the speeds of a planet of mass m in its perihelion and aphelion postitions. The semimajor axis of its orbit is a, ecentricity is e and te mass of the sun is M. Also find the total energy of the planet in terms of the given parameters.

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3. 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.

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4. A planet of mass m revolves in elliptical orbit around the sun of mass M so that its maximum and minimum distance from the sun equal to r_a and r_p respectively. Find the angular momentum of this planet relative to the sun.

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5. If a planet was suddenly stopped in its orbit supposed to be circular, show that it would fall onto the sun in a time $\frac{\sqrt{2}}{8}$ times the period of the plant's revolution.

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6. A satellite is revolving round the earth in a circular orbit of radius r and velocity v_0. A particle is projected from the satellite in forward direction with realative velocity $v = \left(\sqrt{5/4} - 1\right)v_0$. Calculate its minimum and maximum distances from earth's centre during subsequent motion of the particle.

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7. An earth satellite is revolving in a circular orbit of radius a with velocity v_0. A gun is the satellite and is aimed directly towards the earth. A bullet is fired from the gun with muzzle velocity $\frac{v_0}{2}$. Neglecting resistance offered by cossmic dust and recoil of gun, calculate maximum and minimum distance of bullet from the centre of earth during its subsequency motion.

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8. Binary stars of comparable masses m_1 and m_2 rotate under the influence of each other's gravity with a time period T. If they are stopped suddenly in their motions, find their relative velocity when they collide with each constant of gravitation.

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Exercise 13.1

1. 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.

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2. Four particles having masses, m, 2m, 3m, and 4m are placed at the four corners of a square of edge a. Find the gravitational force acting on a particle of mass m placed at the centre.

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3. Two particles of masses 1.0 kg and 2.0 kg are placed at a separation of 50 cm. Assuming that the only forces acting on the particles are their mutual gravitation find the initial acceleration of the two particles.

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4. Three points A , B and C each of mass are placed in a line with AB=BC=d. Find the gravitational force on a fourth particle P of same mass placed at a distance d from the particle B on the perpendicular bisector of the line AC.

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5. Spheres of the same metarial and same radius r are touching each other. Show that grevitational force between them is directly proportional to r^4.

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Exercise 13.2

1. Value of g on the surface of earth is $9.8m/s^2$. Find its value on the surface of a planet whose mass and radius both are two times that of earth.

Watch Video Solution

2. Value of g on the surface of earth is $9.8m/s^2$. Find its

(a) at height $h = R$ from the surface ,

(b) at depth $d = \frac{R}{2}$ from the surface . ($R =$ radius of earth)

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3. Calculate the distance from the surface of the earth at which above the surface, acceleration due to gravity is the same.

A. $h = \left(\frac{\sqrt{5}-1}{2}\right)R$

B. $h = \frac{(\sqrt{5}-1)}{R}$

C. h = R

D. None of the Above

Answer: A

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4. Calculate the change in the value of g at latitude 45°. Take radius of earth $R = 6.37 \times 10^{3} km$.

A. $-0.168 m/s^2$

B. $-0.0168 m/s^2$

C. $-0.0198 m/s^2$

D. $-0.198 m/s^2$

Answer: B

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5. 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 $R = 6400km$.

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6. Determine the speed with which the earth would have to roate on its axis , so that a person on the equator would weigh $\frac{3}{5}$ th as nuch as at person. Take $R = 6400km$.

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7. A body is weighted by a spring balance to be 1.000 kg at the north pole. How much will it weight at the equator. Account for the earth\'s rotation only.

Watch Video Solution

8. At what rate should the earth rotate so that the apparent g at the equator becomes zero? What will be the length of the day in this situation?

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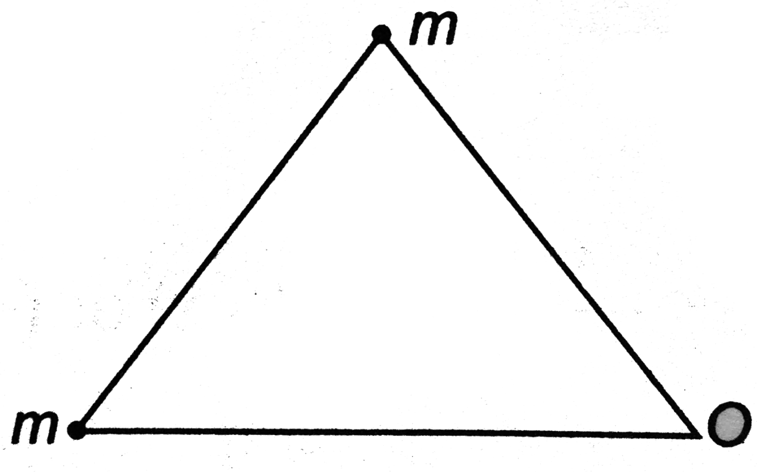
9. Assuming earth to be spherical, at what height above the north pole, value of g is same as that on earth's surface at equator?

Watch Video Solution

Exercise 13.3

1. Two points masses m each are kept at the two verticle of an equaliateral triangle of side 'a' as shows in figure.



Find gravitational potential and magnitude of field strength at O.

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2. Five point masses m each are kept at five vertices of a regular pentagon. Distance of centre of pentagon from any one of the verticle is 'a'. Find gravitational potential and filed strength at centre.

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3. In the above problem, if any one point mass is removed then what is gravitational potential and magnitude of filed strength at centre?

Watch Video Solution

4. A particle of mass M is placed at the centre of a uniform spherical shell of equal mass and radius a. Find the gravitational potential at a point P at a distance $\frac{a}{2}$ from the centre.

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5. A particle of mass $20g$ experiences a gravitational force of $4.0N$ along positive x - direction. Find the gravitational field at that point.

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Exercise 13.4

1. The gravitational potential due to a mass distribution is $V = 3X^2Y + Y^3Z$. Find the gravitational filed.

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2. Gravitational potential at $X = 2m$ is decreasing at a rate of $10J/kg - m$ along the positive x- direction. If implies that the magnitude of gravitational filed at $X = 2m$ is also $10n/kg$. Is this statement true or false?

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3. The gravitational potential in a region is given by, $V = 200(X + Y)J/kg$. Find the magnitude of the gravitational force on a particle of mass $0.5kg$ placed at the orgin.

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4. The gravitational field in a region is given by $E = \left(2\hat{i} + 3\hat{j}\right)N/kg$. Find the work done by the gravitiational filed when a particle of mass $1kg$ is moved on the line $3y + 2X = 5$ from $(1m, 1m)$ to $(-2m, 3m)$.

Watch Video Solution

Exercise 13.5

1. Two small bodies of masses 10 kg and 20 kg are kept a distnce 1.0 m apart and released. Assuming that only mutual gravitational force are acting, find the speeds of the particles when the separation decreases to 0.5 m.

Watch Video Solution

2. Four particles each of mass m are kept at the four vertices of a square of side 'a' . Find graitational potential energy of this system.

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3. 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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4. Show that if a body be projected vertically upward from the surface of the earth so as to reach a height nR above the surface

(i) the increase in its potential energy is $\left(\frac{n}{n+1}\right)mgR,$

(ii) the velocity with it must be projected is $\sqrt{\frac{2ngR}{n+1}}$, where r is the radius of the earth and m the mass of body.

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

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6. A particle is fired vertically upward fom earth's surface and it goes up to a maximum height of 6400 km. find the initial speed of particle.

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Exercise 13.6

1. The kinetic energy needed to project a body of mass m from the earth's surface to infinity is

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2. Mass and radius of a planet are two times the value of earth. What is the value of escape velocity from the surface of this planet?

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3. Kinetic energy of a particle on the surface of earth is E_0 and the potential energy is $-2E_0$.

(a) Will the particle escape to infinity ?

(ii) What is the value of potential energy where speed of the particle becomes zero?

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Exercise 13.7

1. No part of India is situated on the equator. Is it possible to have a geostationary satellilte which always remains over New Delhi?

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2. Two satellites A and B revolve around a planet in two coplanar circular orbits in the same sense with radii $10^4 km$ and $2 \times 10^4 km$ respectively. Time period of A is 28 hours. What is time period of another satellite?

A. $56h$

B. $56\sqrt{2}h$

C. $56\sqrt{3}h$

D. $43\sqrt{2}h$

Answer: B

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3. Two satellites A and B of the same mass are orbiting the earth at altitudes R and $3R$ respectively, where R is the radius of the earth. Taking their orbit to be circular abtain the ratios of their kinetic and potential energies.

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4. As satellite of mass 1000 kg is supposed to orbit the earth at a height of 2000 km above the earth\'s surface. Find a). its speed in the orbit b). its kinetic energy. c). The potential energy of the earth satelilte system and d). its time period. Mass of the earth $= 6 \times 10^{24} kg$.

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5. A sky lab of mass $2 \times 10^3 kg$ is first lauched 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. $(R = 6400 km,$ $g = 10 m / s^2)$

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Level 1 Assertion And Reason

1. Assertion : When two masses come closer, their gravitaional potential energy decreases.

Reason : In moving attract each other.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explantion of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: B

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2. Assertion : In moving from centre of a solid sphere to its surface, gravitational potential increases.

Reason : Gravitational field strength increase.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explantion of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: B

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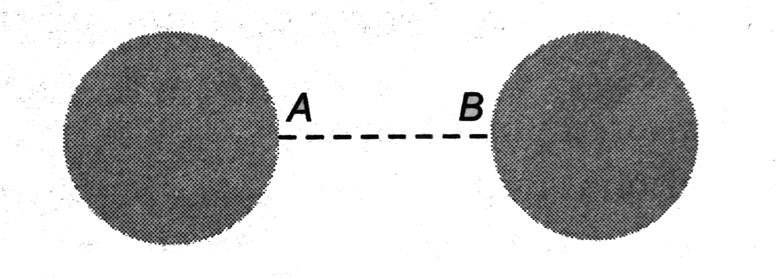
3. Assertion : There are two identical spherical bodies fixed in two positions as shows. While moving from A to B gravitational potential first increases then decreases.



Reason : At centre point of A and B field strength will be zero.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explantion of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: B

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4. Assertion : If we plot potential versus x- coordinate graph along the x-axis, then field strength is zero where slope of $V - x$ graph is zero.

Reason : If potential is function of x- only then

$$E = -\frac{dV}{dx}$$

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explantion of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: D

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5. Assertion : A particle is projected upwards with speed v and it goes to a heigth h. If we double the speed then it will move to height $4h$.

Reason : In case of earth, acceleration due to gravity g varies as

$g \propto \frac{1}{r^2}$ (for $r \geq R$)

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explantion of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: D

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6. Assertion : In planetary motion angular momentum of planet about centre of sun remains constant. But linear momentum of system does not remain constant.

Reason : Net torque on planet any point is zero.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explantion of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: D

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7. Assertion : Plane of space satellite is always equatorial plane.

Reason : On the equator value of g is minimum .

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explantion of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: D

Watch Video Solution

8. 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.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explantion 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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9. Assertion : Plane of geostationary satellites always passes through equator.

Reason : Geostationary satellites always lies above Moscow.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explantion of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: C

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10. Assertion : It we double the circular radius of a satellite, then its potential energy, kinetic energy and total mechanical energy will become half.

Reason : Orbital speed of a satellite.

$$v \propto \frac{1}{\sqrt{r}}$$

where, r is its radius of orbit.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explantion of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: B

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11. Assertion : If the radius of earth is decreased kepping its constant, effective value of g may increase or decrease at pole.

Reason : Value of g on the surface of earth is given by $g = \frac{Gm}{R^2}$.

A. If both Assertion and Reason are true and the Reason is correct explanation of the Assertion.

B. If both Assertion and Reason are true but Reason is not the correct explantion of Assertion.

C. If Assertion is true, but the Reason is false.

D. If Assertion is false but the Reason is true.

Answer: D

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Level 1 Single Correct

1. A satellite orbiting close to the surface of earth does not fall down becouse the gravitational pull of earth

A. is balanced by the gravitational pull of moon

B. is balanced by the gravitational pull of sun

C. provides the necessary acceleration for its motion along the circular path

D. makes it weightless

Answer: C

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2. For the planet - sun system identify the correct satatement.

A. the angular momentum of the planet is conserved about any point

B. the total energy of the system is conserved

C. the momentum of the planet is conserved

D. All of the above

Answer: B

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3. If the earth stops rotating about its axis, then the magnitude of gravity

A. increases everywhere on the surface of earth

B. will increases only at the poles

C. will not change at the poles

D. All of the above

Answer: C

Watch Video Solution

4. For a body to escape from earth, angle from horizontal at which it should be fired is

A. 45°

B. 0°

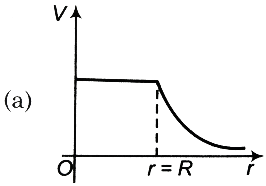
C. 90°

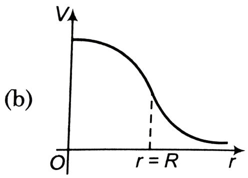
D. any angle

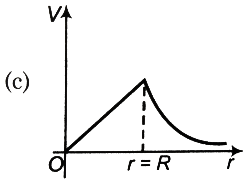
Answer: D

Watch Video Solution

5. The correct variation of gravitational potential V with radius r measured from the centre of earth of radius R is given by

A.


B.


C.


D. None of these

Answer: D

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6. The Gauss' theorem for gravitational field may be written as

A. $\oint g \cdot dS = \frac{m}{G}$

B. $-\oint g \cdot dS = 4\pi mG$

C. $\oint g \cdot dS = \frac{m}{4\pi G}$

D. $-\oint g \cdot dS = \frac{m}{G}$

Answer: B

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7. In the earth-moon system, if T_1 and T_2 are period of revolution of earth and moon respectively about the centre of mass of the system them

A. $T_1 > T_2$

B. $T_1 = T_2$

C. $T_1 < T_2$

D. Insufficient data

Answer: B

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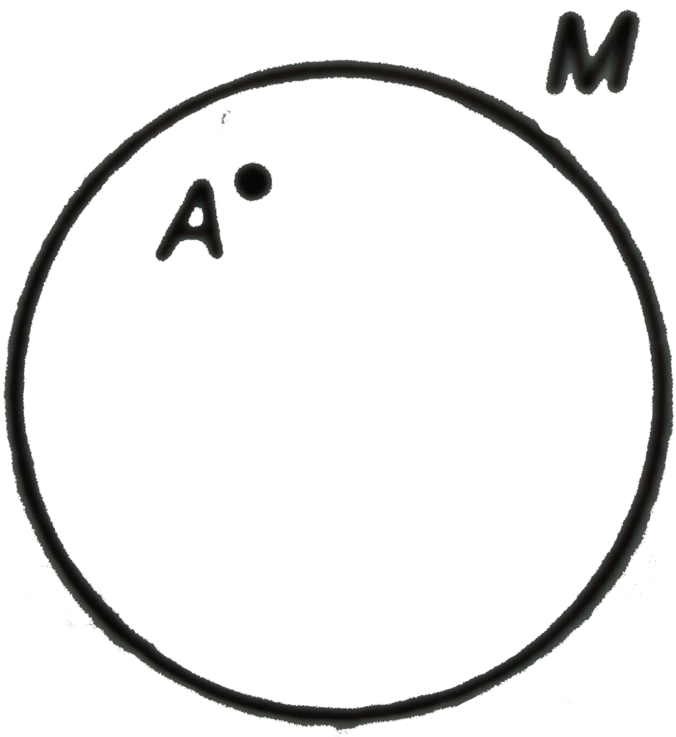
8. The figure shows a spherical shell of mass M. The point a is not at the centre but away from the centre of the shell. If a particle of mass m is placed at A, then



A. it remains at rest

B. it experiences a net force towards the centre

C. it experiences a net force away from the centre

D. None of the above

Answer: A

Watch Video Solution

9. If the distance between the earth and the sun were reduced to half its present value, then the number of days in one year in one year would have been

A. 65

B. 129

C. 183

D. 730

Answer: B

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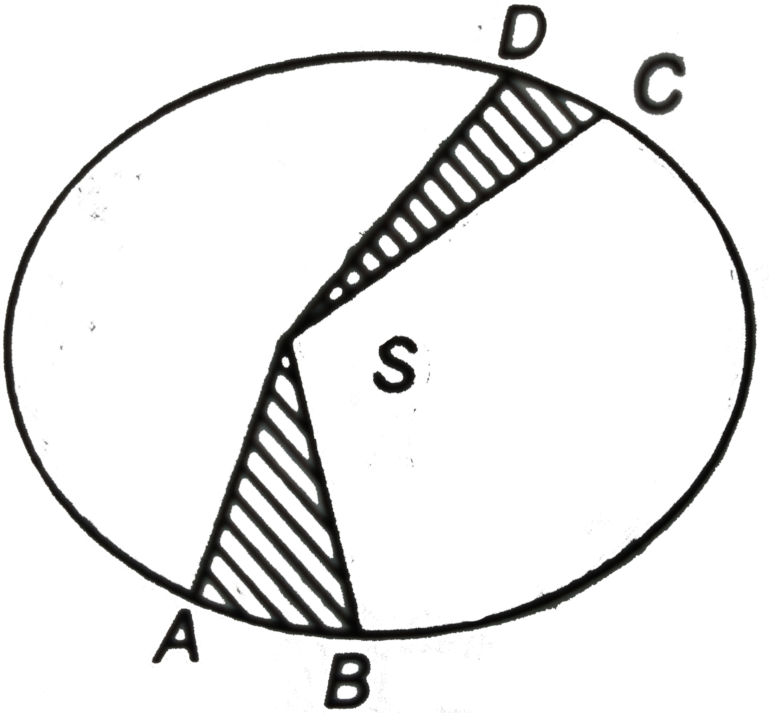
10. The figure represents an elliptical orbit a planet around sun. The planet takes time T_1 to travel from A to B and it takes time T_2 to travel from C to D. If the area CSD is double that of area ASB, them



A. $T_1 = T_2$

B. $T_1 = 2T_2$

C. $T_1 = 0.5T_2$

D. Data insufficient

Answer: C

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11. At what depth from the surface of earth the time period of a simple pendulum is 0.5% more than that on the surface of the Earth? (Radius of earth is $6400km$)

A. $32km$

B. $64km$

C. $96km$

D. $128km$

Answer: B

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12. If M is the mass of the earth and R its radius, the radio of the gravitational acceleration and the gravitational constant is

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

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

C. MR^2

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

Answer: B

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13. The height above the surface of earth at which the gravitational filed intensity is reduced to 1% of its value on the surface of earth is

A. $100R_e$

B. $10R_e$

C. $99R_e$

D. $9R_e$

Answer: D

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14. For a stellite orbiting close to the surface of earth the period of revolution is 84 min . The time period of another satellite orbiting at a geight three times the radius of earth from its surface will be

A. $(84)2\sqrt{2} \text{ min}$

B. $8(84) \text{ min}$

C. $(84)3\sqrt{3} \text{ min}$

D. $3(84) \text{ min}$

Answer: B

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15. The angular speed of rotation of earth about its axis at which the weight of man standing on the equator becomes half of his weight at the poles is given by

A. $0.034 rads^{-1}$

B. $8.75 \times 10^{-4} rads^{-1}$

C. $1.23 \times 10^{-2} rads^{-1}$

D. $7.65 \times 10^{-7} rads^{-1}$

Answer: B

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16. The height from the surface of earth at which the gravitational potential energy of a ball of mass m is half of that at the centre of earth is (where R is the radius of earth)

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

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

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

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

Answer: B

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17. A body of mass m is lifted up from the surface of earth to a height three times the radius of the earth R. The change in potential energy of the body is

A. $3mgR$

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

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

D. $2mgR$

Answer: C

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18. A satellite is revolving around earth in its equatorial plane with a period T. If the radius of earth suddenly shrinks to half without change in the mass. Then, the new period of revolution will be

A. $8T$

B. $2\sqrt{2}T$

C. $2T$

D. T

Answer: D

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19. A planet has twice the density of earth but the acceleration due to gravity on its surface is exactly the same as that on the surface of earth. Its radius in terms of earth's radius R will be

A. $R/4$

B. $R/2$

C. $R/3$

D. $R/8$

Answer: B

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20. The speed of earth's rotation about its axis is ω. Its speed is increased to x times to make the effective acceleration due to gravity equal to zero at the equator, then x is around $\left(g = 10ms^{-2}R = 6400km\right)$

A. 1

B. 8.5

C. 17

D. 34

Answer: C

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21. A satellite is seen every $6h$ over the equator. It is known that it roates opposite to that of earth's direction. Then, the angular velocity (in radius per hour) of satellite about the centre of earth will be

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

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

C. $\frac{\pi}{4}$

D. $\frac{\pi}{8}$

Answer: C

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22. For a planet revolving around sun, if a and b are the respective semi-major and semi-minor axes, then the square of its time period is proportional to

A. $\left(\frac{a+b}{2}\right)^3$

B. $\left(\frac{a-b}{2}\right)^3$

C. b^3

D. a^3

Answer: D

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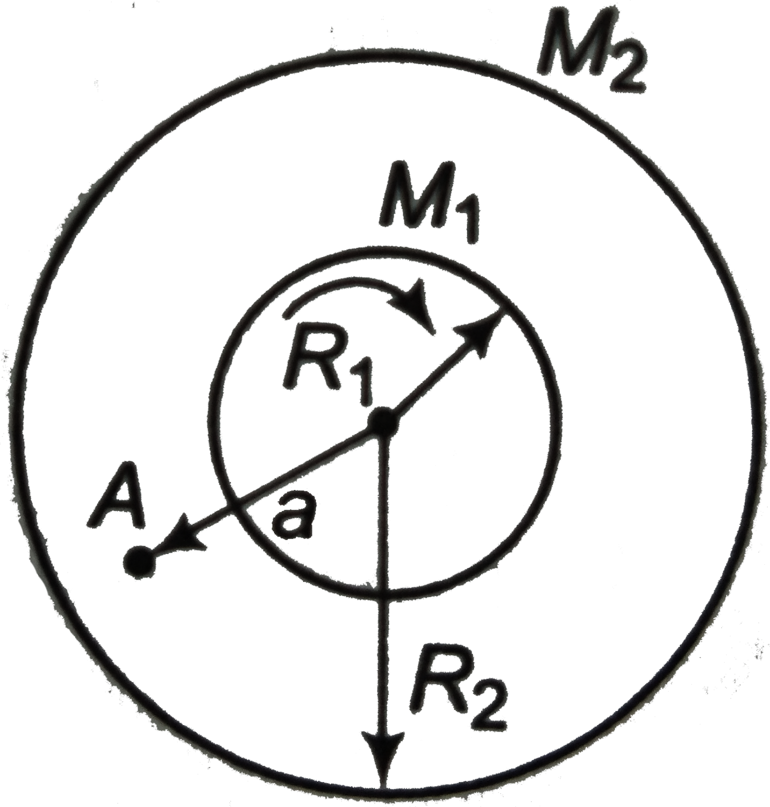
23. The figure represents two concentric shells of radii R_1 and R_2 and masses M_1 and M_2 respectively. The gravitational field intensity at the point A at distance $a(R_1 < a < R_2)$ is



A. $\frac{G(M_1 + M_2)}{a^2}$

B. $\frac{GM_1}{a^2} + \frac{GM_2}{R_2^2}$

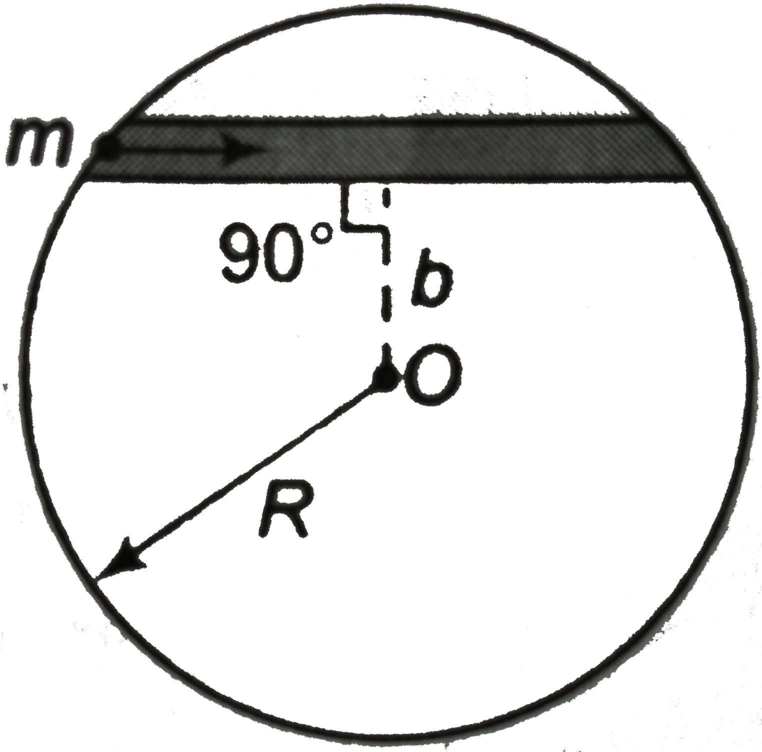
C. $\frac{GM_1}{a^2}$

D. zero

Answer: C

Watch Video Solution

24. A straight tuning is due into the earth as shows in figure at a distance b from its centre. A ball of mass m is dropped from one of its ends. The time it takes to reach the other end is approximately



A. 42 min

B. 84 min

C. $84\left(\frac{b}{R}\right)$ min

D. $42\left(\frac{b}{R}\right)$ min

Answer: A

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25. Three particle of mass m each are placed at the three corners of an equilateral triangle of side a. Find the work which should be done on this system to increase the sides of the triangle to 2a.

A. $-\frac{3}{2}\frac{GM^2}{l}$

B. $\frac{-3GM^2}{l}$

C. $\frac{3}{2}\frac{GM^2}{l}$

D. $\frac{3GM^2}{l}$

Answer: C

Watch Video Solution

26. A particle is throws vertically upwards from the surface of earth and it reaches to a maximum height equal to the radius of earth. The radio of the velocity of projection to the escape velocity on the surface of earth is

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

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

C. $\frac{1}{4}$

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

Answer: A

Watch Video Solution

27. The gravitational potential energy of a body at a distance r from the centre of earth is U. Its weight at a distance $2r$ from the centre of earth is

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

B. $\frac{U}{2r}$

C. $\frac{U}{4r}$

D. $\frac{U}{\sqrt{2}r}$

Answer: C

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Level 1 Subjective

1. A particle of mass $1kg$ is kept on the surface of a uniform sphere of mass $20kg$ and radius $1.0m$. Find the work to be done against the gravitational force between them to take the particle away from the sphere.

Watch Video Solution

2. 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? $(h < < R)$

Watch Video Solution

3. 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.

Watch Video Solution

4. If a satellites is revolving close to a planet of density ρ with period T, show that the quantity ρT_2 is a universal constant.

Watch Video Solution

5. A satellite is revolving around a planet in a circular orbit. What will happen, if its speed is increased from v_0 to

$\sqrt{1.5}v_0$ (b) $2v_0$

Watch Video Solution

6. If the radius of the earth contracts to half of its present value without change in its mass, what will be the new duration of the day?

Watch Video Solution

7. Two concentric spherical shells have masses m_1, m_2 and radit R_1, $R_2(R_1 < R_2)$. Calculate the force by this system on a particle of mass m, if it is placed at a distance $\frac{(R_1 + R_2)}{2}$ from the centre.

Watch Video Solution

8. A semicircular wire hs a length L and mass M. A paricle of mass m is placed at the centre of the circle. Find the gravitational attraction on the particle due to the wire.

Watch Video Solution

9. A rocket is accelerated to speed $v = 2\sqrt{gR}$ near the earth's surface ($R =$ radius of earth). Show that very far from earth its speed will be $v = \sqrt{2gR}$.

Watch Video Solution

10. Two spheres one of mass M has radius R. Another sphere has mass $4M$ and radius $2R$. The centre to centre distance between them is $12R$. Find the distance from the centre of smaller sphere where

(a) net gravitational field is zero,

(b) net gravitational potential is half the potential on the surface of larger sphere.

Watch Video Solution

11. A uniform solid sphere of mass M and radius a is surrounded symmetrically by a uniform thin spherical shell of equal mass and radius 2a. Find the gravitational field at a distance a). 3/2 a from the centre , b). 5/2 as from the centre.

Watch Video Solution

12. The density inside a solid sphere of radius a is given by $\rho = \frac{\rho_0}{r}$, where ρ_0 is the density at the surface and r denotes the distance from the centre. Find the gravitational field due to this sphere at a distance 2a from its centre.

Watch Video Solution

13. Two neutron stars are separated by a distance of $10^{10} m$. They each have a mass of $10^{30} kg$ and a radius of $10^{5} m$. They are initially at rest with respect to each other.

As measured from the rest frame, how fast are they moving when

(a) their separation has decreaed to one - half its initial value,

(b) they are about to collide .

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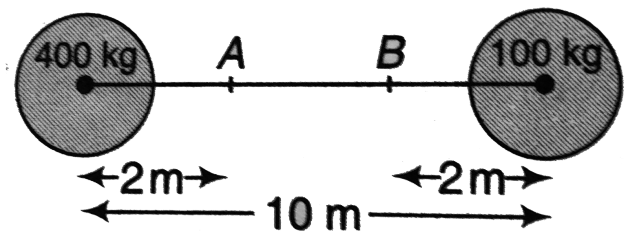
14. A mass m is taken to a height R from the surface of the earth and then is given a vertical velocity v. Find the minimum value of v, so that mass never returns to the surface of the earth. (Radius of earth is R and mass of the earth m).

Watch Video Solution

15. In the figure masses $400kg$ and $100kg$ are fixed.



(a) How much work must be done to move a $1kg$ mass from point A to point B?

(b) What is the minimum kinetic with which the $1kg$ mass must be projected from A to the right to reach the point B?

Watch Video Solution

16. Two identical stars of mass M orbit around their centre of mass. Each orbit is circular and has radius R, so that the two stars are always on opposite of the circle.

(a) Find the gravitational force of one star on the other.

(b) Find the orbital speed of each star and the period of the orbit.

(c) What minimum energy would be required to separate the two stars to infinity?

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17. 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.

Watch Video Solution

18. In a certain binary star system, each star has the same mass as our sun. They revolve about their centre of mass. The distance between them is the same as the distance between earth and the sun. What is their period of revolution in years ?

Watch Video Solution

19. (a) Does it take more energy to get a satellite upto $1500 km$ above earth than to put in circular orbit once it is there.

(b) What about $3185km$?

(c) What about $4500km$? (Take $R_e = 6370km$)

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Level 2 Single Correct

1. An artifical satellite of mass m is moving in a circular orbit at a height equal to the radius R of the earth. Suddenly due to intensity explosion the satellite breakes into two parts of equal pieces. One part of the satellite stops just after the explosion. The increase in the mechanical energy of the system due to explosion will be

(Given, acceleration due to gravity on the surface of earth is g)

A. mgR

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

C. $\frac{mgR}{4}$

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

Answer: C

Watch Video Solution

2. A semicircular wire hs a length L and mass M. A paricle of mass m is placed at the centre of the circle. Find the gravitational attraction on the particle due to the wire.

A. $\frac{GM}{l^2}$ along x- axis

B. $\frac{GM}{\pi l^2}$ along y-axis

C. $\frac{2\pi GM}{l^2}$ along x-axis

D. $\frac{2\pi GM}{l^2}$ along y-axis

Answer: D

Watch Video Solution

3. Four particles, each of mass M and equidistant from each other, move along a circle of radius R under the action of their mutual gravitational 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. $\sqrt{\frac{GM}{R}\frac{2\sqrt{2}+1}{4}}$

Answer: D

Watch Video Solution

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

B. $k^2 R$

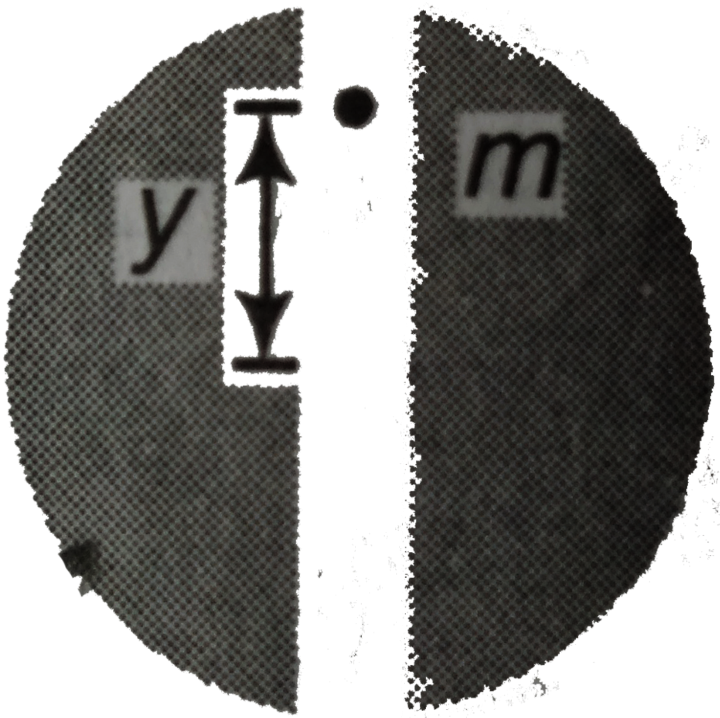
C. $\frac{R}{1 - k^2}$

D. kR

Answer: C

Watch Video Solution

5. Suppose a verticle tunnel is dug along the diametal of earth , which is assumed to be a sphere of unifrom mass density ρ. If a body of mass m is throws in this tunal, its acceleration at a distance y from the centre is given by



A. $\frac{4\pi}{3}G\rho Ym$

B. $\frac{3}{4}\pi\rho Y$

C. $\frac{4}{3}\pi\rho Y$

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

Answer: D

Watch Video Solution

6. A train of mass m moves with a velocity v on the equator from east to west. If ω is the angular speed of earth about its axis and R is the radius of the earth then the normal reaction acting on the train is

A. $mg\left[1-\frac{(\omega R-2v)\omega}{g}-\frac{v^2}{Rg}\right]$

B. $mg\left[1-2\frac{(\omega R-v)\omega}{g}-\frac{v^2}{Rg}\right]$

C. $mg\left[1-\frac{(\omega R-2v)\omega}{g}-\frac{v^2}{Rg}\right]$

D. $mg\left[1-2\frac{(\omega R-v)\omega}{g}-\frac{v^2}{Rg}\right]$

Answer: A

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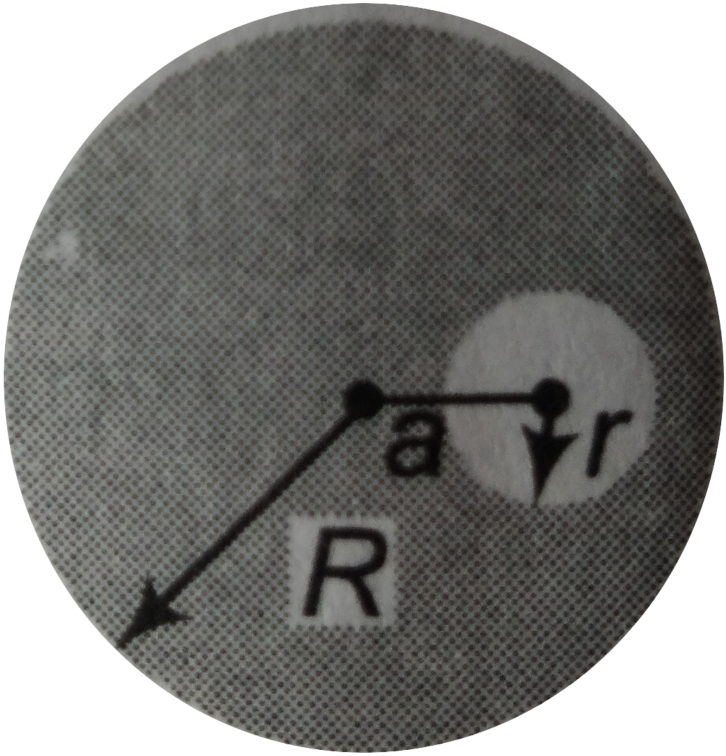
7. The figure represents a solid uniform sphere of mass M and radius R. A spherical cavity of radius r is at a distance a from the centre of the sphere. The gravitational field inside the cavity is



A. non - uniform

B. towards the center of the cavity

C. directly proportional to a

D. All of these

Answer: C

Watch Video Solution

8. If v_e is the escape velocity for earth when a projectile is fired from the surface of earth. Then, the escape velocity if the same projectile is fired from its centre is

A. $\sqrt{\frac{3}{2}}v_e$

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

C. $\sqrt{\frac{2}{3}}v_e$

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

Answer: A

Watch Video Solution

9. If the gravitational field intensity at a point is given by $g = \frac{GM}{r^{2.5}}$. Then, the potential at a distance r is

A. $\frac{-2GM}{3r^{1.5}}$

B. $\frac{-GM}{r^{2.5}}$

C. $\frac{2GM}{3r^{1.5}}$

D. $\frac{GM}{r^{3.5}}$

Answer: A

Watch Video Solution

10. Three identical particles each of mass M move along a common circlar path of radius R under the mutual interaction of each other. The velocity of each particle is

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

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

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

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

Answer: B

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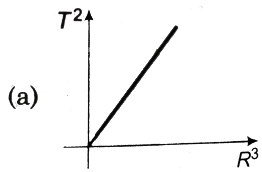
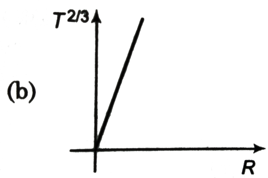
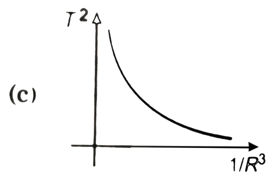
11. If T be the period of revolution of a plant revolving around sun in an orbit of mean radius R, then identify the incorrect graph.

A. 

B. 

C. 

D. None of these

Answer: D

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12. A person brings a mass of $1kg$ from infinty to a point A. Initially, the mass was at rest but it moves at a speed of $3m/s$ as it reaches A. The work done by the person on the mass is $-5.5J$. The gravitational potential at A is

A. $-1J/kg$

B. $-4.5J/kg$

C. $-5.5J/kg$

D. $-10J/kg$

Answer: D

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13. With what minmum speed should m be projected from point C in presence of two fixed masses M each at A and B as shows in the figure such that mass m should escape the gravitational of A and B ?

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

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

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

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

Answer: B

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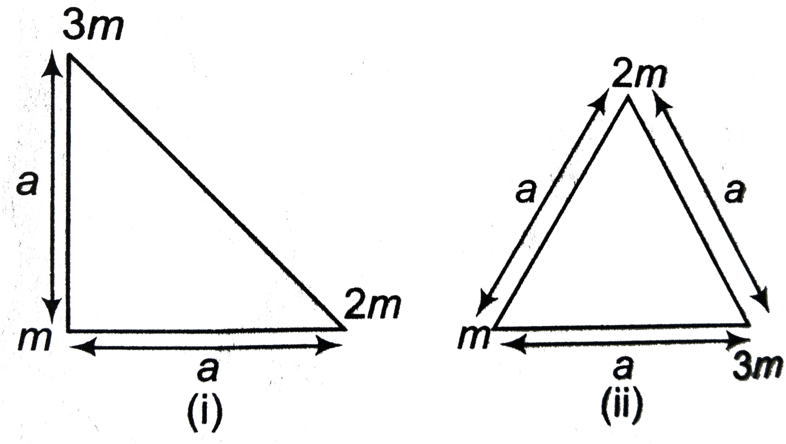
14. Consider two configurations of a system of three particles of masses $m, 2m$ and $3m$. The work done by gravity in changing the configuration of the system from figure (i) to figure (ii) is



A. zero

B. $\frac{6Gm^2}{a}\left\{1+\frac{1}{\sqrt{2}}\right\}$

C. $\frac{6Gm^2}{a}\left\{1-\frac{1}{\sqrt{2}}\right\}$

D. $\frac{6Gm^2}{a}\left\{2-\frac{1}{\sqrt{2}}\right\}$

Answer: C

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15. A tuning is dug along the diameter of the earth. There is particle of mass m at the centre of the tunel. 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 with the help of negligible velocity

Answer: A

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16. A body is projected horizontally from the surface of the earth (radius $= R$) with a velocity equal to n times the escape velocity. Neglect rotational effect of the earth. The maximum height attained by the body from the earth s surface is $R/2$. Then, n must be

A. $\sqrt{0.6}$

B. $(\sqrt{3})/2$

C. $\sqrt{0.4}$

D. $1/2$

Answer: A

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17. A tunnel is dug in the earth across one of its diameter. Two masses m and $2m$ are dropped from the two ends of the tunel. The masses collide and stick each other. They perform SHM, the ampulitude of which is $(R =$ radius of earth)

A. R

B. $R/2$

C. $R/3$

D. $2R/3$

Answer: C

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18. There are two planets. The ratio of radius of two planets is k but radio of acceleration due to gravity of both planets is g. What will be the ratio of their escape velocity ?

A. $(kg)^{1/2}$

B. $(kg)^{-1/2}$

C. $(kg)^{2}$

D. $(kg)^{-2}$

Answer: D

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19. A body of mass $2kg$ is moving under the influence of a central force whose potential energy is given by $U = 2r^3 J$. If the body is moving in a circular orbit of $5m$, its energy will be

A. $625J$

B. $250J$

C. $500J$

D. $125J$

Answer: A

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20. A research satellite of mass $200kg$ circles the earth in an orbit of average radius $3R/2$, where R is the radius of the earth. Assuming the gravitational pull on the mass of $1kg$ on the earth's surface to be $10N$, the pull (in Newton) on the satellite will be

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

A. $\sqrt{gx}$

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

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

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

Answer: D

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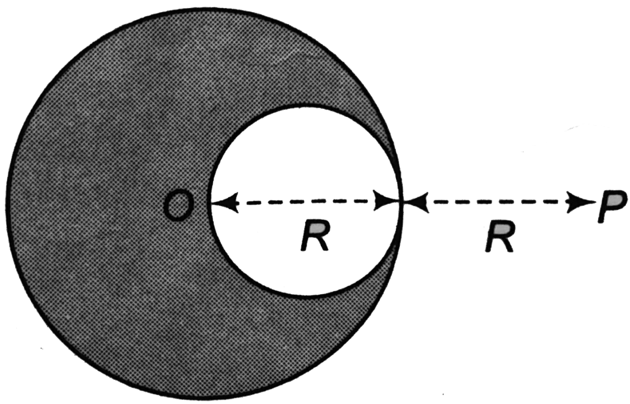
22. A solid sphere of uniform density and radius R applies a gravitational force attraction equal to F_1 on a particle placed at P, distance $2R$ from the centre O of the sphere. A spherical cavity of radius $R/2$ is now made in the sphere as shows in figure. The particle with cavity now applies a gravitational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



A. $1/2$

B. $7/9$

C. 3

D. 7

Answer: B

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Level 2 More Than One Correct

1. Three planets of same density have radii R_1, R_2 and R_3 such that $R_1 = 2R_2 = 3R_3$. The gravitational field at their respective surfaces are g_1, g_2 and g_3 and escape velocities from their surfeces are v_1, v_2 and v_3, then

A. $g_1 / g_2 = 2$

B. $g_1 / g_3 = 3$

C. $v_1 / v_2 = 1/4$

D. $v_1 / v_3 = 3$

Answer: A::B::D

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2. For a geostationary satellite orbiting around the earth identify the necessary condition.

A. it must lie in the equatorial plane of earth

B. its height from the surface of earth must be $36000km$

C. it period of revolution must be $2\pi\frac{\sqrt{R}}{g}$, where R is the radius of earth

D. its period of revolution must be $24hrs$

Answer: A::B::D

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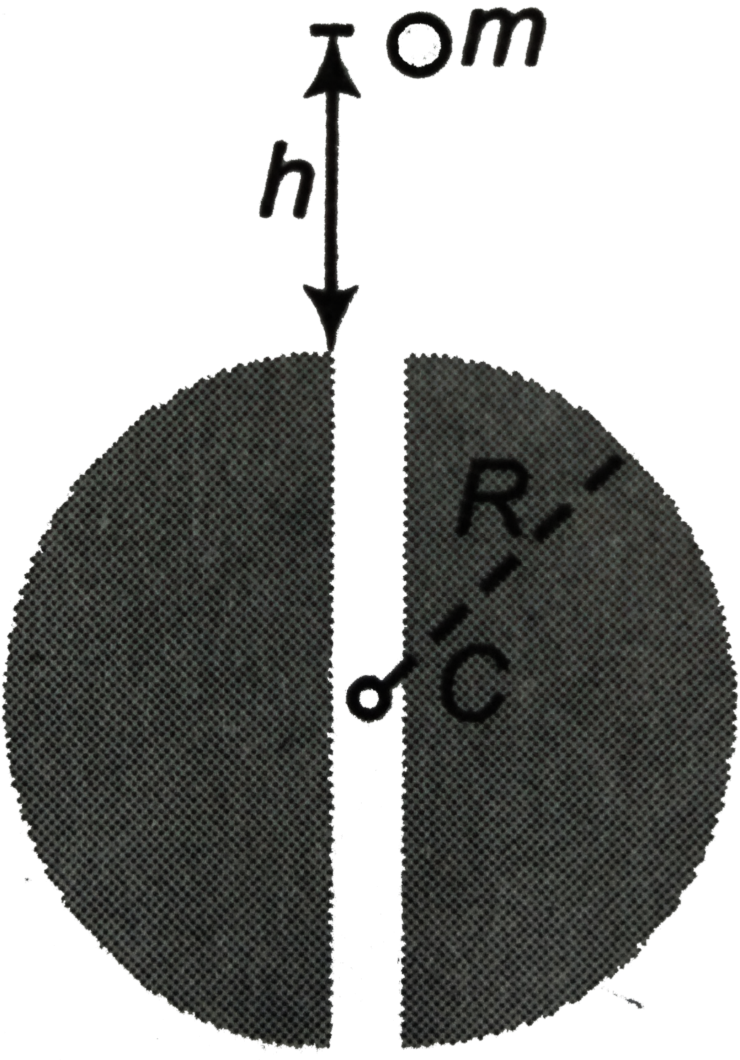
3. A ball of mass m is dropped from a height h equal to the radius of the earth above the tunnel dug through the earth as shows in the figure.

Choose the correct options. (Mass of earth $= M$)



A. Particle will oscillate through the earth to a height h on both sides

B. Particle will execute simple harmonic motion

C. Motion of the particle is periodic

D. Particle passes the centre of earth with a sped $v = \sqrt{\frac{2GM}{R}}$

Answer: A::C::D

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4. Two point masses m and $2m$ are kept at points A and B as shown. E represents magnitude of gravitational field strength and V the gravitational potential. As we move from A to B

A. E will first decreases then increases

B. E will first increases then decreases

C. V will first decreases then increases

D. V will first increases then decrease

Answer: A::D

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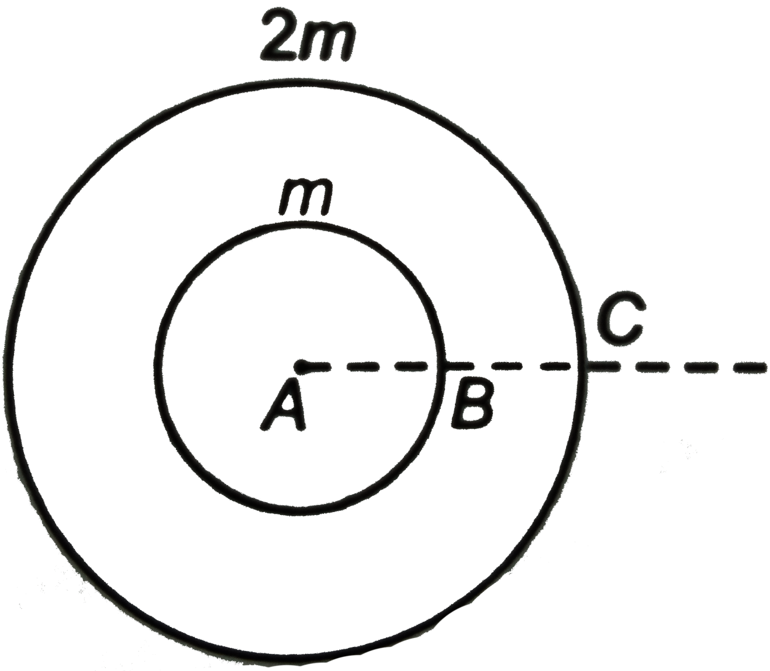
5. Two spherical shells have masses $m$and $2m$ as shows. Choose the correct options.



A. Between A and B gravitational field strength is zero

B. Between A and B gravitional potential is constant

C. There will be two points one lying between B and C and other lying between C and infinity when gravitational field strength are same

D. There will be a point between B and C where gravitational potential will be zero

Answer: A::B::C

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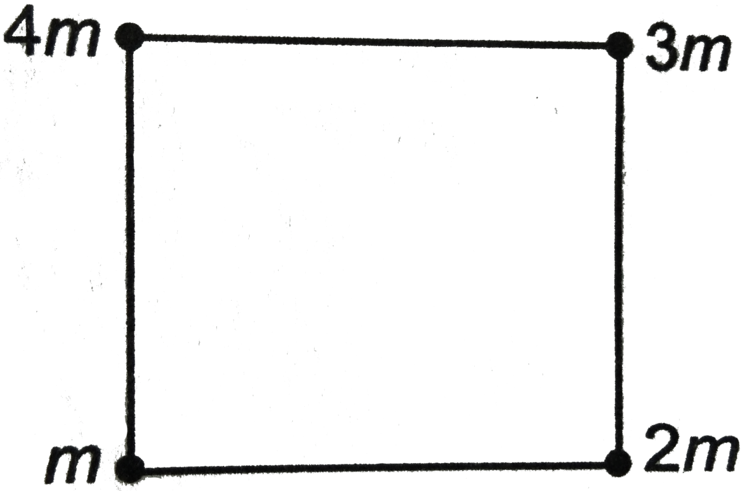
6. Four point masses are plaaced at four corners of a square as shows. When positions of $m$and $2m$ are interchanged



A. gravitational field strength at centre will increases

B. gravitational field strength at centre will decreases

C. gravitational potential at centre will remain unchanged

D. gravitational potential at centre will decrease

Answer: A::C

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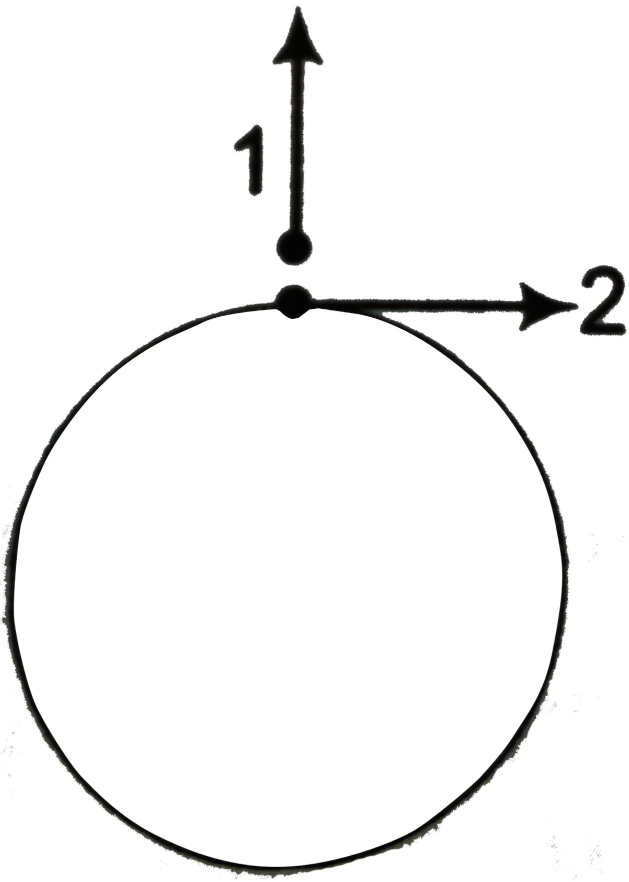
7. Two identical particles 1 and 2 are projected from surface of earth with same velocities in the directions shows in figure.



A. Both the particles will stop momentarily (before striking with ground)at different times

B. Particle -1 will rise upto lesser height compared to particle-2

C. Minimum speed of particle -2 is more than that of particle -1

D. Particle -1 will strike the ground earlier

Answer: B::C::D

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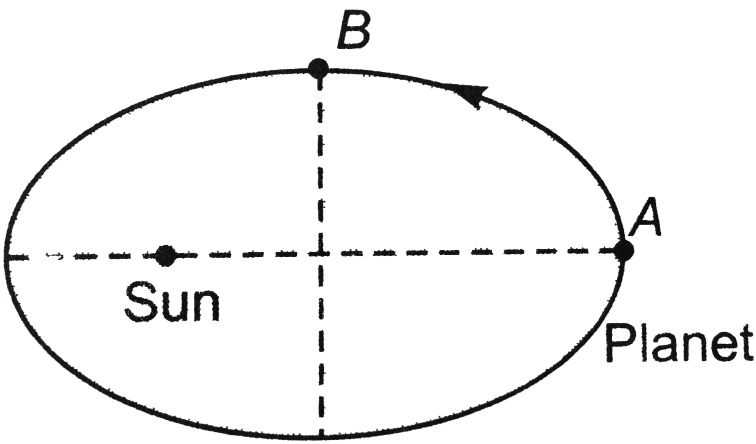
8. A plantet is moving round the sun in an elliptical orbit as shows. As the planet moves from a to B



A. its kinetic enargy will decrease

B. its potential energy will remain unchanged

C. its angular momentum about centre of sun will remain unchanged

D. its speed is minimum at A

Answer: C::D

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9. A satellite of mass m is just placed over the surface of earth. In this position mechanical energy of satellite is E_1. Now it starts orbiting round the earth in a circular path at height $h =$ radius of earth. In this position, kinetic energy potential energy and total mechancial energy of satellite are K_2, U_2 and E_2 respectively. Then

A. $U_2 = \frac{E_1}{2}$

B. $E_2 = \frac{E_1}{4}$

C. $K_2 = -E_2$

D. $K_2 = -\frac{U_2}{2}$

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

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10. A satellite is revolving round the earth in circular orbit

A. if mass of earth is made four times, keeping other factors constant, orbital speed of satellite will become two times

B. corresponding to change in part(a), times period of satellite will become half

C. when value of G is made two times orbital speed increases and time period decreases

D. G has no effect on orbital speed and time period

Answer: A::B::C

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Level 2 Subjective

1. Three particle of mass m each are placed at the three corners of an equilateral triangle of side a. Find the work which should be done on this system to increase the sides of the triangle to 2a.

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2. A man can jump vertically to a height of $1.5m$ on the earth. Calculate the radius of a planet of the same mean density as that of the earth from whose gravitational field he could escape by jumping. Radius of earth is $6.41 \times 10^5 m$.

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3. 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 earth.

(i) Determine the height of the satellite above the earth's surface.

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

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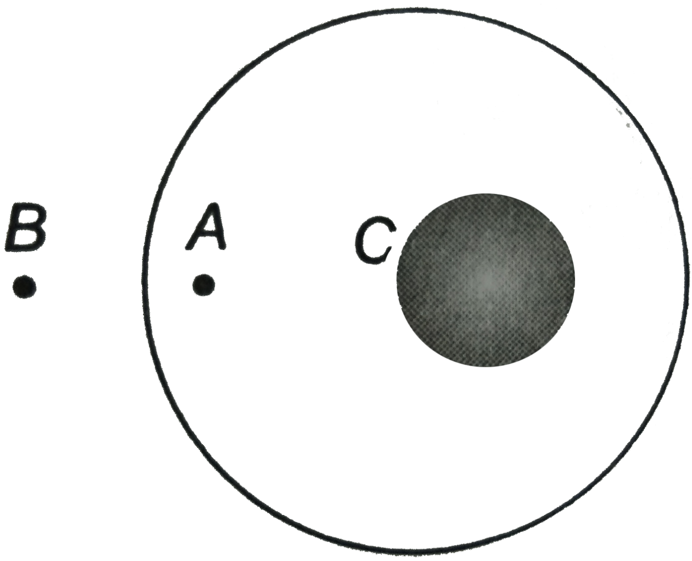
4. A uniform metal sphere of radius R and mass m is surrounded by a thin uniform spherical shell of same mass and radius $4R$. The centre of the shell C falls on the surface of the inner sphere. Find the gravitational fields at points A and B.



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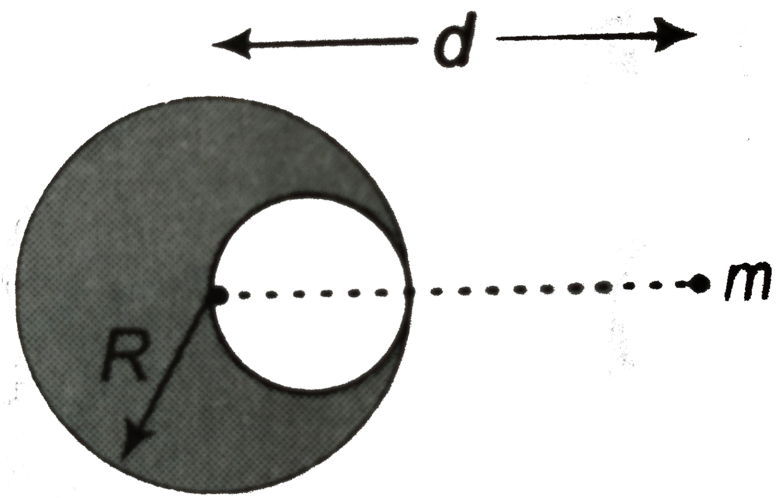
5. Figure shows a spherical cavity inside a lead sphere. The surface of the cavity passes through the centre of the sphere and touches the right side of the sphere. The mass of the sphere before hollowing was M. With what gravitational force does the hollowed out lead sphere attract a particle of mass 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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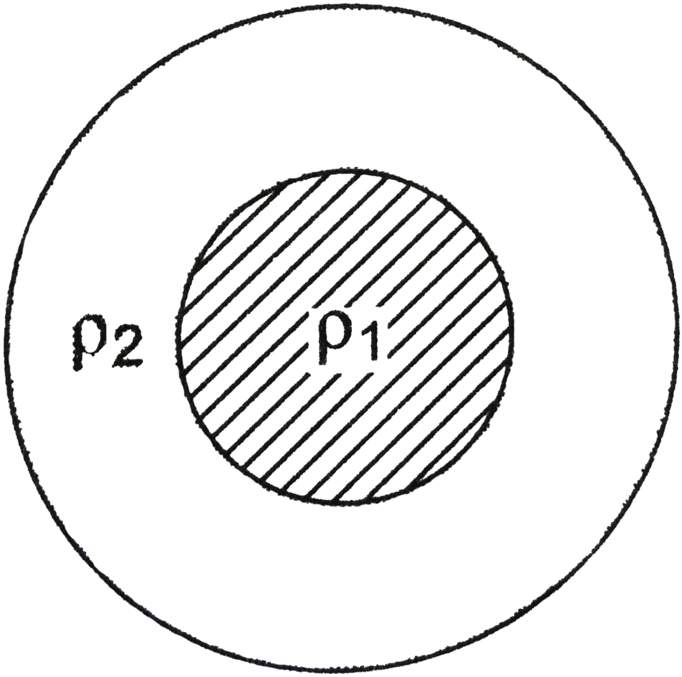
6. The density of the core a planet is ρ_1 and that of the outer shell is ρ_2. The radii of the core and that of the planet are R and $2R$ respectively. The acceleration due to gravity at the surface of the planet is same as at a depth R. Find the radio of $\frac{\rho_1}{\rho_2}$



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7. If a satellite is revolving around a plenet 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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8. A uniform ring of mas m and radius a is placed directly above a uniform sphere of mass M and of equal radius. The centre of the ring is at a distance $\sqrt{3}$ a from the centre of the sphere. Find the gravitational force exerted by the sphere on the ring.

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9. Distance between the centres of two stars is $10a$. The masses of these stars are M and $16M$ and their radii a and $2a$ respectively. A body of mass m is fired straight from the surface of the larger star towards the surface of the smaller star. What should be its minimum initial speed to reach the surface of the smaller star? Obtain the expression in terms of G, M and a.

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10. A smooth tunnel is dug along the radius of earth that ends at centre. A ball is relrased from the surface of earth along tunnel. Caefficient of restitution for collision between soil at centre and ball is 0.5. Caculate the distance travelled by ball just second collision at center. Given mass of the earth is M and radius of the earth is R.

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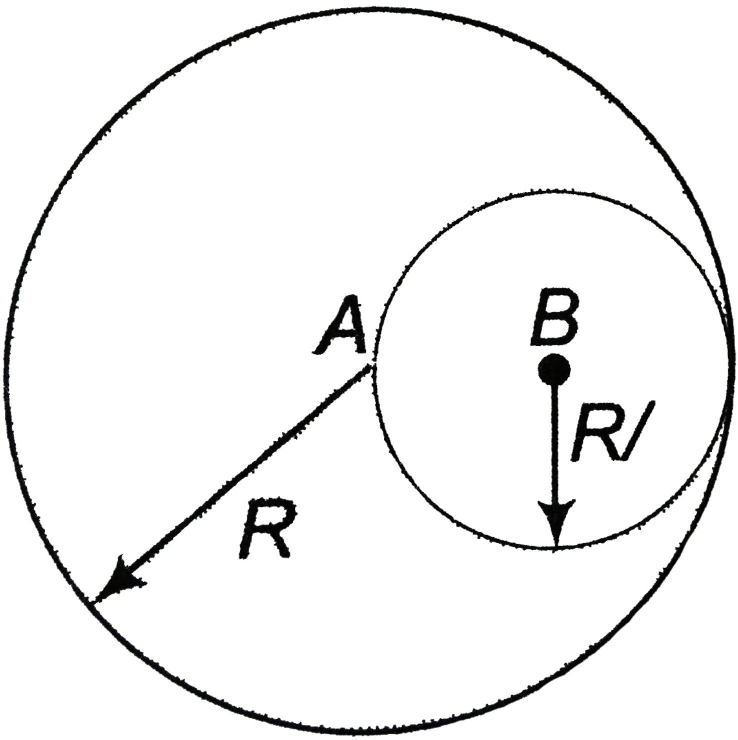
11. Inside a fixed sphere of radius R and uniform density ρ, there is spherical cavity of radius $\frac{R}{2}$ such that surface of the cavity passes through the centre of the sphere as shows in figure. A particle of mass m_0 is released from rest at centre B of the cavity. Caculate velocity with which particle strikes the centre A of the sphere. Neglect earth's gravity.

Initially sphere and particle are at rest.



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12. A ring of radius $R = 4m$ is made of a highly dense material. Mass of the ring is $m_1 = 5.4 \times 10^9 kg$ distributed uniformly over its circumference. A highly dense particle of mass $m_2 = 6 \times 10^8 kg$ is placed on the axis of the ring at a distance $x_0 = 3m$ from the centre. Neglecting

all other forces, except mutual gravitational interacting of the two. Caculate

(i) displacemental of the ring when particle is at the centre of ring, and

(ii) speed of the particle at that instant.

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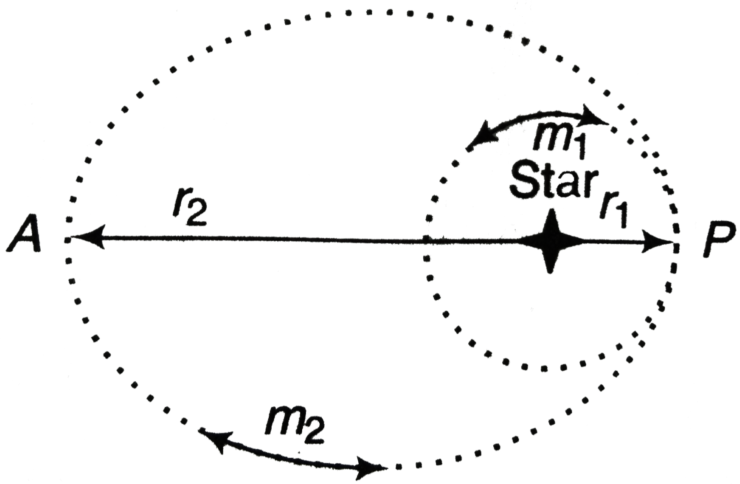
13. Two planets of equal mass orbit a much massive star (figure). Planet m_1 moves in circular orbit of radius $1 \times 10^8 km$ with period $2yr$. Planet m_2 moves in an elliptical orbit with closed distance $r_1 = 1 \times 10^8 km$ and farthest distance $r_2 = 1.8 \times 10^8 km$, as shows.



(a) Using the fact that the mean radius of an elliptical orbit is the length of the semi-major axis, find the period of $m_2{'s}$ orbit.

(b) Which planet has the greater speed at point P? Which has the greater total energy?

(c) Compare the speed of planet m_2 at P with that at A.

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14. 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 eavolution.

(b) the ratio of rheir kintic 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.

Watch Video Solution

Check Point 10.1

1. Kepler's second law is based on

A. Newton's first law

B. Newton's second law

C. special theory of relativity

D. conservation of angular momentum

Answer: D

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2. When a planet moves around the sun

A. areal velocity is constant

B. linear velocity is constant

C. angular velocity is constant

D. All of the above

Answer: A

Watch Video Solution

3. A planet moves around the sun. It is closest to sun to sun at a distance d_1 and have velocity v_1 At farthest distance d_2 its speed will be

A. $\frac{d_1^2 v_1}{d_2^2}$

B. $\frac{d_2 v_1}{d_1}$

C. $\frac{d_1 v_1}{d_2}$

D. $\frac{d_2^2 v_1}{d_1^2}$

Answer: C

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4. For a satellite in elliptical orbit which of the following quantities does not remain constant ?

A. Angular momentum

B. Momentum

C. Areal velocity

D. All of these

Answer: B

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5. The motion of planets in the solar system in an example of conservation of

A. mass

B. momentum

C. angular momentum

D. kinetic energy

Answer: C

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6. Kepler's law starts that square of the time period of any planet moving around the sun in an elliptical orbit of semi-major axis (R) is directly proportional to

A. R

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

C. R^3

D. $\frac{1}{R_3}$

Answer: C

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7. The ratio of mean distances of three planets from the sun are $0.5 : 1 : 1 : 5$, then the square of time periods are in the ratio of

A. $1:4:9$

B. $1:9:4$

C. $1:8:27$

D. $2:1:3$

Answer: C

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8. The period of revolution of planet A round from the sun is 8 times that of B. The distance of A from the sun is how many times greater then tht of B from the sun ?

A. 5

B. 4

C. 3

D. 2

Answer: B

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9. The distance of two planets from the sun are 10^{13} and 10^{12} m respectively. The ratio of the periods of the planet is

A. 100

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

C. $\sqrt{10}$

D. $10\sqrt{10}$

Answer: D

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10. A satellite having time period same as that of the earth's rotation about its own axis is orbiting the earth at a height 8R above the surface of earth. Where R is radius of earth. What will be the time period of another satellite at a height 3.5 R from the surface of earth ?

A. $2\sqrt{2}$ h

B. $4\sqrt{2}$ h

C. $6\sqrt{2}$ h

D. $3\sqrt{2}$ h

Answer: C

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11. A body is orbiting around earth at a mean radius which is two times as greater as the parking orbit of a satellite, the period of body is

A. 4 days

B. 16 days

C. $2\sqrt{2}$ days

D. 64 days

Answer: C

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12. Two point masses each equal to 1 kg attract one another with a force of 10^{-9} kg-wt. the distance between the two point masses is approximately $\left(G = 6.6 \times 10^{-11} \text{MKS units}\right)$

A. 8 cm

B. 0.8 cm

C. 80 cm

D. 0.08 cm

Answer: A

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13. Gravitational force between a point mass m and M separated by a distance is F. Now if a point mass 2m is placed next to m is contact with it. The force on M due to m and the total force on M are

A. 2F, F

B. F, 2F

C. F, 3F

D. F, F

Answer: C

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14. Three equal masses of 2kg each are placed at the vertices of an equilateral triangle and a mass of 4 kg is placed at the centroid of the triangle which is at a distance of $\sqrt{2}$ m from each of the vertices of the triangle. The force, (in newton) acting on the mass of 4 kg is

A. 2

B. $\sqrt{2}$

C. 1

D. zero

Answer: D

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15. The force of gravitation is

A. repulsive

B. attractive

C. conservative

D. Both (b) and (c)

Answer: D

Watch Video Solution

16. Which of the following statements about the gravitational constant is true ?

A. It is a force

B. It has no fruit

C. It has same value in all systems of unit

D. It does not depend on the nature of the medium in which the bodies are kept

Answer: D

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17. 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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18. Two balls, each of radius R, equal mass and density are placed in contact, then the force of gravitation between them is proportional to

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

B. $F \propto R$

C. $F \propto R^4$

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

Answer: C

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19. If the distance between the sun and the earth is increased by three times, then attraction between two will

A. remains constant

B. decrease by 63 %

C. increase by 63 %

D. decrease by 89 %

Answer: D

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20. A spherical planet far out in space has mass 2M and radius a. A particle of mass m is falling freely near its surface. What will be the acceleration of that particle ?

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

B. $\frac{3GM}{a^2}$

C. $\frac{2GM}{a^2}$

D. $\frac{4GM}{a^2}$

Answer: C

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Check Point 10.2

1. The mass of a planet is twice the mass of earth and diameter of the planet is thrie the diameter of the earth, then the acceleration due to gravity on the planet's surface is

A. $g/2$

B. $2g$

C. $2g/9$

D. $3g/\sqrt{2}$

Answer: C

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2. If the earth suddenly shrinks (without changing mass) to half of its present radius, then acceleration due to gravity will be

A. $g/2$

B. $4g$

C. $g/4$

D. $2g$

Answer: B

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3. The diameters of two planets are in the ratio $4:1$ and their mean densities in the ratio $1:2$ The acceleration due to gravity on the particles wil be in ratio.

A. $1:2$

B. $2:3$

C. $2:1$

D. $4:1$

Answer: C

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4. If M is the mass of the earth and R its radius, then ratio of the gravitational acceleration and the gravitational constant is

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

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

C. MR^2

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

Answer: B

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5. If G is universal gravitational constant and g is acceleration due to gravity then the unit of the quantity $\frac{G}{g}$ is

A. km-m^2

B. kgm^{-1}

C. kgm^{-2}

D. m^2kg^{-1}

Answer: D

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6. If density of earth increased 4 times and its radius become half of what it is, our weight will ?

A. be four times its present value

B. be doubled

C. remain same

D. be halved

Answer: B

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7. The acceleration due to gravity g and mean density of earth ρ are related by which of the following relations ?

(G = gravitational constant and R = radius of earth)

A. $\rho = \frac{4\pi g R^2}{3G}$

B. $\rho = \frac{4\pi g R^3}{3G}$

C. $\rho = \frac{3g}{4\pi G R}$

D. $\rho = \frac{3g}{4\pi G R^3}$

Answer: C

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8. If a planet consists of a satellite whose mass and radius were both half that of the earh, then acceleration due to gravity at its surface would be

A. 4.9ms^{-2}

B. 9.8ms^{-2}

C. 19.6ms^{-2}

D. 29.4ms^{-2}

Answer: C

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9. The height above the surface of the earth where acceleration due to gravity is 1/64 of its value at surface of the earth is approximately.

A. 45×10^6 m

B. 54×10^6 m

C. 102×10^6 m

D. 72×10^6 m

Answer: A

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10. If radius of earth is R, then the height h at which the value of g becomes (1/49)th of its value at the surface is

A. 2R

B. 3R

C. 6R

D. 4R

Answer: C

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11. A body has a weight 72 N. When it is taken to a height $h = R$= radius of earth, it would weight

A. 72 N

B. 36 N

C. 18 N

D. zero

Answer: C

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12. 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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13. The depth d, at which the value of acceleration due to gravity becomes 1/n times the value at the surface is (R = radius of the earth)

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

B. $R\left(\frac{n-1}{n}\right)$

C. $\frac{R}{n^2}$

D. $R\left(\frac{n}{n+1}\right)$

Answer: B

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14. If the change in the value of g at a height h above the surface of earth is the same as at a depth d below it (both h and d are much smaller than the radius of the earth), then

A. $d = h$

B. $d = 2h$

C. $d = h/2$

D. $d = h^2$

Answer: B

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15. At what depth below the surface of the earth acceleration due to gravity will be half its value at 1600 km above the surface of the earth ?

A. 4.3×10^6 m

B. 2.4×10^6 m

C. 3.2×10^6 m

D. 1.6×10^6 m

Answer: A

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16. The weight of a body at the centre of the earth is

A. zero

B. infinite

C. same as no the surface of earth

D. None of the above

Answer: A

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17. If earth is supposed to be sphere of radius R, if g_{20} is value of acceleration due to gravity at latitude of 30° and g at the equator, then value of $g - g_{30^\circ}$ is

A. $\frac{1}{4}\omega^2 R$

B. $\frac{3}{4}\omega^2 R$

C. $\omega^2 R$

D. $\frac{1}{2}\omega^2 R$

Answer: B

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18. Weight of a body is maximum at

A. poles

B. equator

C. centre of earth

D. at latitude 45°

Answer: A

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19. The angular speed of earth is $\text{rad}\,\text{s}^{-1}$, so that the object on equator may appear weightless, is (radius of earth = 6400 km)

A. 1.23×10^{-3}

B. 6.20×10^{-3}

C. 1.56

D. 1.23×10^{-5}

Answer: A

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20. When a body is taken from the equator to the poles, its weight

A. remains constant

B. increases

C. decreases

D. increase at n-pole and decrease at s-pole

Answer: B

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Check Point 10.3

1. Three particles each of mass m are kept at vertices of an equilateral triangle of side L. The gravitational field at centre due to these particle is

A. zero

B. $\frac{3GM}{L^2}$

C. $\frac{9GM}{L^2}$

D. $\frac{12GM}{\sqrt{3}L^2}$

Answer: A

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2. At what height the gravitational field reduces by 75 % the gravitational field at the surface of earth ?

A. R

B. 2R

C. 3R

D. 4R

Answer: A

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3. Gravitational field due to a solid sphere

A. remains constant throughout the sphere

B. increase inside the sphere and decreases outside the sphere

C. increases throughout with distance from the center

D. decreases throughout with distance from the centre

Answer: B

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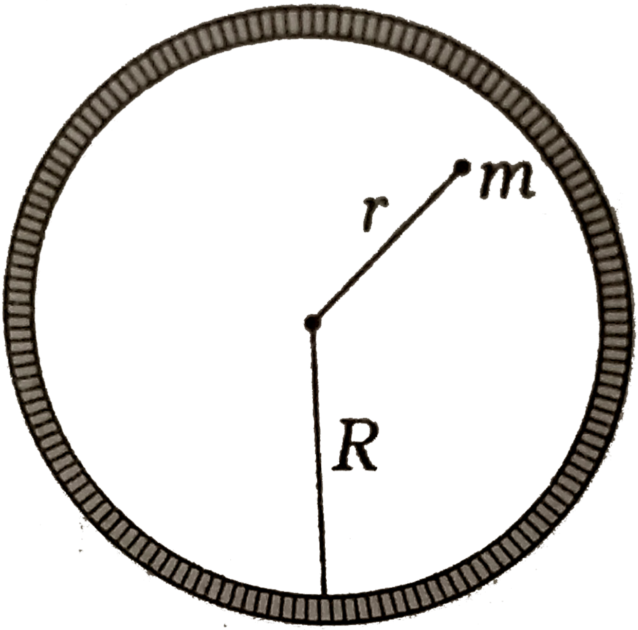
4. A mass m is placed inside a hollow sphere of mass M as shown in figure. The gravitaional force on mass m is



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

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

C. $\frac{GMm}{(R-r)^2}$

D. zero

Answer: D

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5. A uniform solid sphere of mass m and radius r is suspended symmetrically by a uniform thin spherical shell of radius $2r$ and mass m.

A. The gravitational field at a distance of 1.5r from the centre is $\frac{2}{9}\frac{Gm}{r^2}$

B. The gravitational field at a distance of 2.5r from centre is $\frac{8}{25}\frac{Gm}{r^2}$

C. The gravitational field at a distance of 1.5r from centre is zero

D. The gravitational field between the sphere and spherical shell is uniform.

Answer: B

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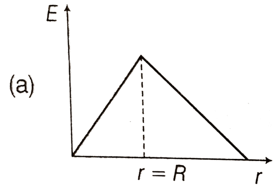
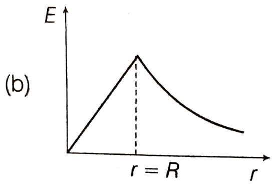
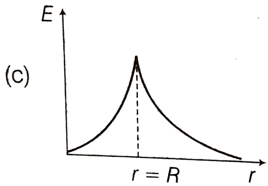
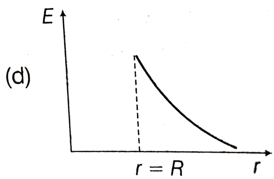
6. Which one of the following graphs represents correctly represent the variation of the gravitational field (E) with the distance (r) from the centre of a spherical shell of mass M radius R ?

A. 

B. 

C. 

D. 

Answer: D

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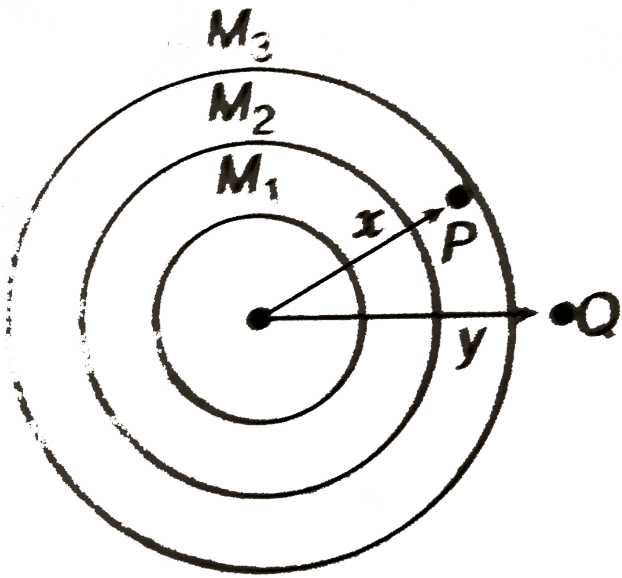
7. Consider three concentric shells of masses M_1, M_2 and M_3 having radii a,b and c respectively are situated as shown in



Gravitational field at a point located at Q and P is

A. $\frac{G(M_1+M_2)}{y^2}, \frac{G(M_1+M_2)}{y^2}$

B. $\frac{G(M_1+M_2+M_3)}{Y^2}, \frac{G(M_1+M_2)}{x^2}$

C. $\frac{G(M_1+M_2+M_3)}{a^2}, \frac{GM_1}{a^2}$

D. $\frac{G(M_1+M_2+M_3)}{C^2}, \frac{GM_2}{b^2}$

Answer: B

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8. Two bodies of masses m and M are placed at distance d apart. The gravitational potential (V) at the position where the gravitational field due to them is zero V is

A. $V = -\frac{G}{d}(m+M)$

B. $V = -\frac{Gm}{d}$

C. $V = -\frac{GM}{d}$

D. $V = -\frac{G}{d}\left(\sqrt{m}+\sqrt{M}\right)^2$

Answer: D

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

A. $-\frac{GM}{L}$

B. $-\frac{GM}{2\pi L}$

C. $-\frac{\pi GM}{2L}$

D. $-\frac{\pi GM}{L}$

Answer: D

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10. A particle is kept on the surface of a uniform sphere of mass 100 kg and radius 10 cm. Find the work to be done per unit mass against the gravitational force between them, to take the particle far away from the sphere (you may take $h = 6.67 \times 10^{-11} \mathrm{Nm}^2 \mathrm{kg}^{-2}$)

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

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

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

D. $6.67 \times 10^{-8} J$

Answer: D

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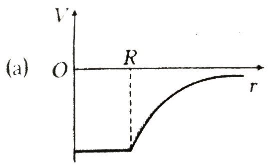
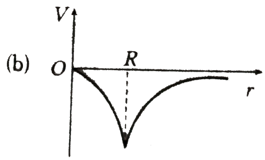
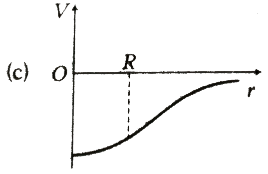
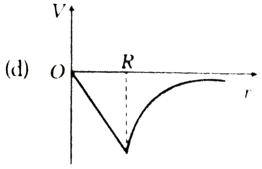
11. The diagram showing the variation of gravitational potential of earth with distance from the centre of earth is

A. 

B. 

C. 

D. 

Answer: C

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12. Inside a uniform shell

A. potential is variable

B. potential is zero

C. potential is constant

D. All of these

Answer: C

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

A. 2 V

B. 3 V

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

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

Answer: C

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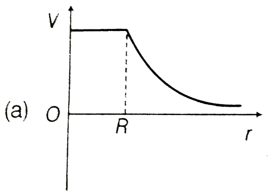
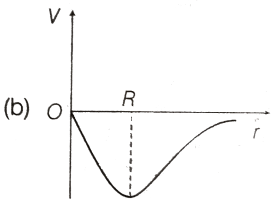
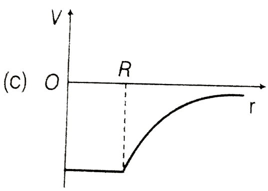
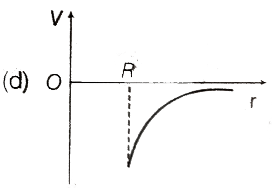
14. By which curve will be variation of gravitational potential of a hollow sphere of radius R with distance be depicted ?

A. 

B. 

C. 

D. 

Answer: C

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15. For a uniform ring of mass M and radius R at its centre

A. field and potential both are zero

B. field is zero but potential is $\frac{GM}{R}$

C. field is zero but potential is $-GM/R$

D. magnitude of field is $\frac{GM}{R^2}$ and potential $-\frac{GM}{R}$

Answer: C

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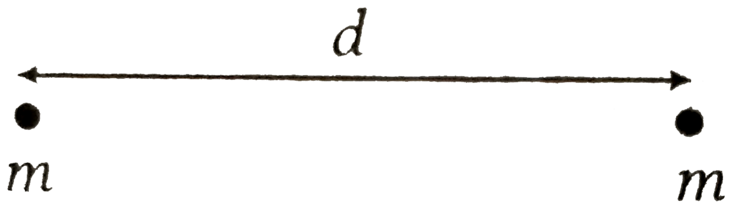
Check Point 10.4

1. Consider the two identical particles shown in the given figure. They are released from rest and may move towards each other influence of mutual gravitational force.

Gravitational potential energy of the two particle system



A. is zero

B. is contant $(\neq 0)$

C. decreases as the separation decreases

D. increases as the separation decreases

Answer: C

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2. In above question 1, find the speed of each speed of each particle, when the separation reduces to half its initial value

A. $\sqrt{\frac{Gm}{d}}$

B. $\sqrt{\frac{2Gm}{d}}$

C. $\sqrt{\frac{Gm}{2d}}$

D. None of these

Answer: A

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3. Find the potential energy of 4-particles, each of mass 1 kg placed at the four vertices of a square of side length 1 m.

A. $+4.0G$

B. $7.5G$

C. $-5.4G$

D. $+6.3G$

Answer: C

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4. The magnitude of gravitational potential energy of a body at a distance r from the centre of earth is u. Its weight at a distance 2r from the centre of earth is

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

B. $\frac{u}{4r}$

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

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

Answer: B

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5. The gravitational potential energy at a body of mass m at a distance r from the centre of the earth is U. What is the weight of the body at this distance ?

A. U

B. Ur

C. $\frac{U}{r}$

D. $\frac{U}{2r}$

Answer: C

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6. When a body id lifted from surface of earth height equal to radius of earth, then the change in its potential energy is

A. mgR

B. $2mgR$

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

D. $4mgR$

Answer: C

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7. Energy required in moving a body of mass m from a distance 2R to 3R from centre of earth of mass M is

A. $\frac{GMm}{12R^2}$

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

C. $\frac{GMm}{8R}$

D. $\frac{GMm}{6R}$

Answer: D

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8. If body of mass $m$has to be taken from the surface to the earth to a height $h = 4R$, then the amount of energy required is (R = radius of the earth)

A. mgR

B. $\frac{mgR}{5}$

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

D. $\frac{mgR}{12}$

Answer: C

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9. If an object of mass m is taken from the surface of earth (radius R) to a height 5R, then the work done is

A. $2mgR$

B. mgR

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

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

Answer: C

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10. A body of mass m is kept at a small height h above the ground. If the radius of the earth is R and its mass is M, the potential energy of the body and earth system (with $h = \infty$ being the reference position) is

A. $\frac{GMm}{R} + mgh$

B. $\frac{-GMm}{R} + mgh$

C. $\frac{GMm}{R} - mgh$

D. $\frac{-GMm}{R} - mgh$

Answer: B

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Check Point 10.5

1. In a gravitational field, if a body is bound with earth, then total mechanical energy is

A. positive

B. zero

C. negative

D. may be positive, negative or zero

Answer: C

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2. The binding energy of an object of mass m placed on the surface of the earth r is (R = radius of earth, g = acceleration due to gravity)

A. $mgR/2$

B. mg R

C. $\frac{mgR}{4}$

D. $\frac{mgR}{8}$

Answer: B

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3. Escape velocity on earth is 11.2kms^{-1} what would be the escape velocity on a planet whose mass is 1000 times and radius is 10 times that of earth ?

A. 112kms^{-1}

B. 11.2kms^{-1}

C. 1.12kms^{-1}

D. 3.7kms^{-1}

Answer: A

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4. When escape velocity is given to a particle on surface of earth, its total energy is

A. zero

B. greater than zero

C. less than zero

D. $-GMm/2R$

Answer: A

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5. The escape velocity for a body of mass 1 kg from the earth surface is 11.2kms^{-1}. The escape velocity for a body of mass 100 kg would be

A. $11.2 \times 10^2 \text{ kms}^{-1}$

B. $112 \ \text{kms}^{-1}$

C. $11.2 \ \text{kms}^{-1}$

D. $11.2 \times 10^{-2} \ \text{kms}^{-1}$

Answer: C

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6. The escape velocity of a body projected vertically upward from the earth's surface is $11.2 \ \text{kms}^{-1}$. If the body is projected in a direction making 30° angle to the vertical, its escape velocity in this case will be

A. $11.2 \ \text{kms}^{-1}$

B. $\frac{11.2}{2} \ \text{kms}^{-1}$

C. $11.2 \times \frac{\sqrt{3}}{2} \text{kms}^{-1}$

D. $\frac{11.2}{3} \text{kms}^{-1}$

Answer: A

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7. The escape velocity of a particle of mass m varies as

A. m^2

B. m

C. m^0

D. m^{-1}

Answer: C

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8. The ratio of the radius of the earth to that of the motion is 10. the ratio of the acceleration due to gravity on the earth to that on the moon is 6. The ratio of the escape velocity from the earth's surface to that from the moon is

A. 4

B. 6

C. 12

D. None of these

Answer: D

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9. At what angle with the horizontal should a projectile be fired with the escape velocity to enable it escape from gravitational pull of the earth ?

A. Less than 45°

B. 45°

C. More than 45°

D. Any angle

Answer: D

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10. The velocity with which a projectile must be fired to escape from the earth does not depend upon

A. mass of earth

B. mass of projectile

C. radius of earth

D. None of these

Answer: B

Watch Video Solution

11. What will be the escape speed from a planet having mass 16 times that of earth and diameter 8 times that of the earth ? $\left(v_e = 11.2 \text{kms}^{-1}\right)$

A. 12.82kms^{-1}

B. 15.84km s^{-1}

C. 13.85km s^{-1}

D. 10.54km s^{-1}

Answer: B

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12. There are two planets and the ratio of radius of the two planets is k but ratio of acceleration due to gravity of both planets is g. What will be the ratio of their escape velocities ?

A. $(Kg)^{1/2}$

B. $(Kg)^{-1/2}$

C. $(Kg)^{2}$

D. $(Kg)^{-2}$

Answer: A

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13. Escape velocity from a planet is v_e. If its mass is increased to 16 times and its radius is increased to 4 times, then the new escape velocity would be

A. v_e

B. $\sqrt{2}v_e$

C. $2v_e$

D. $2\sqrt{2}v_e$

Answer: C

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

I. Mass of the planet

II. Mass pf the particle escaping

III. Temperature of the planet

IV. Radius of the planet

Select the correct answer from the codes given below.

A. I and II

B. II and IV

C. I and IV

D. I, II and IV

Answer: C

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

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

B. $2mgR$

C. mgR

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

Answer: C

Watch Video Solution

16. The escape velocity from earth is v_e. A body is projected with velocity $2v_e$. With what constant velocity will it move in the inter planetary space ?

A. v_e

B. $\sqrt{2}v_e$

C. $\sqrt{3}v_e$

D. $\sqrt{5}v_e$

Answer: C

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17. 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

A. R

B. 2 R

C. 3 R

D. 4 R

Answer: A

View Text Solution

18. A body is projected upwards with a velocity of $3 \times 11.2 \mathrm{km\,s}^{-1}$ from the surface of earth. What will be the velocity of the body when it escapes from the gravitational pull of earth ?

A. 11.2km s^{-1}

B. $\sqrt{2} \times 11.2\text{km s}^{-1}$

C. $\sqrt{3} \times 11.2\text{km s}^{-1}$

D. $\sqrt{8} \times 11.2\text{km s}^{-1}$

Answer: D

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19. With what velocity should a particle be projected so that its maximum height attained becomes equal to radius of earth ?

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

B. $\left(\frac{8GM}{R}\right)^{1/2}$

C. $\left(\frac{2GM}{R}\right)^{1/2}$

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

Answer: A

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20. A body is projected vertically upwards from the surface of a planet of radius R with a velocity equal to 1/3rd the escape velocity for the planet. The maximum height attained by the body is

A. $R/2$

B. $R/3$

C. $R/5$

D. $R/9$

Answer: D

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Check Point 10.6

1. The centripetal force on a satellite orbiting round the earth and the gravitational force of earth acting on the satellite both equal F. The net force on the satellite is

A. zero

B. F

C. $F\sqrt{2}$

D. 2 F

Answer: B

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2. 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. $\frac{3}{2}$ v

B. $\sqrt{\frac{3}{2}}$ v

C. $\sqrt{\frac{2}{3}}$ v

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

Answer: C

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

A. 12 v

B. 6 v

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

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

Answer: B

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4. The orbital velocity of a body close to the earth's surface is

A. 8kms^{-1}

B. 11.2kms^{-1}

C. $3 \times 10^8 \text{ms}^{-1}$

D. $2.2 \times 10^3 \text{kms}^{-1}$

Answer: A

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5. A satellite is revolving in circular orbit of radius r around the earth of mass M. Time of revolution of satellite is

A. $T \propto \frac{r^5}{GM}$

B. $T \propto \sqrt{\frac{r^3}{GM}}$

C. $T \propto \sqrt{\frac{r}{\frac{GM^2}{3}}}$

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

Answer: B

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6. The period of a satellite in a circular orbit around a planet is independent of

A. the mass of the planet

B. the radius of the planet

C. the mass of the satellite

D. All the three parameters (a), (b) and (c)

Answer: C

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7. Which of the following quantities does not depend upon the orbital radius of a satellite ?

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

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

C. $\frac{T^2}{R^2}$

D. $\frac{T^2}{R^3}$

Answer: D

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8. The ratio of distance of two satellites from the centre of earth is $1:4$. The ratio of their time periods of rotation will be

A. $1:4$

B. $4:1$

C. $1:8$

D. $8 : 1$

Answer: C

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

A. 8 R

B. 4 R

C. 2 R

D. R

Answer: B

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10. Satellite is revolving around earth. If it's radius of orbit is increased to 4 times of the radius of geostationary statellite, what will become its time period ?

A. 8 days

B. 4 days

C. 2 days

D. 16 days

Answer: A

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11. If mean radius of earth is R, its angular velocity is ω and the acceleration due to gravity at the surface of the earth is g. Then the cube of the radius of the orbit of geostationary satellite will be

A. $\frac{R^2 g}{\omega^2}$

B. $\frac{R^2\omega^2}{g}$

C. $\frac{R^2 g}{\omega}$

D. $\frac{Rg}{\omega^2}$

Answer: D

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12. For a satellite orbiting very close to earth's surface, total energy is

A. zero

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

C. $-\frac{GMm}{R}$

D. $-\frac{GMm}{2R}$

Answer: D

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13. Two satellite A and B, ratio of masses $3:1$ are in circular orbits of radii r and $4r$. Then ratio mechanical energy of A and B is

A. $1:3$

B. $3:1$

C. $3:4$

D. $12:1$

Answer: D

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14. An artificial moving in a circular orbit around the earth has total mechanical energy E_0. Its kinetic energy is

A. $-2E_0$

B. $1.5E_0$

C. $2E_0$

D. $-E_0$

Answer: D

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

A. its kinetic energy decreases

B. its potentia energy increases

C. Both (a) and (b) are correct

D. Both (a) and (b) are wrong

Answer: D

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16. An artificial satellite moving in a circular orbit around the earth has a total (kinetic + potential) energy E_0. Its potential energy and kinetic energy respectively are

A. $2E_0$ and $-2E_0$

B. $-2E_0$ and E_0

C. $2E_0$ and $-E_0$

D. $-2E_0$ and $-E_0$

Answer: C

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17. 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. kinetic energies is 4

B. potential energies is 4

C. total energies is 4

D. All of these

Answer: D

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18. Two satellites P and Q ratio of masses $3:1$ are in circular orbits of radii r and $8r$. Then ratio of total mechanical energy of A to B is

A. $1:3$

B. $3:1$

C. $3:4$

D. $24:1$

Answer: D

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19. What is the energy required to launch a m kg satellite from earth's surface in a circular orbit at an altitude of 7R ? (R = radius of the earth)

A. $\frac{12}{13}mgR$

B. mgR

C. $\frac{15}{16}mgR$

D. $\frac{1}{9}mgR$

Answer: C

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

A. the gravitational force is small at that location in space

B. the gravitational force is large at that location in space

C. the astronaut experiences no gravity

D. the gravitational force is infinitely large at that location in space.

Answer: C

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(A) Chapter Exercises

1. Reason of weightlessness in a satellite is

A. zero gravity

B. no atmosphere

C. zero reaction force by satellite surface

D. None of the above

Answer: C

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2. The acceleration due to gravity near the surface of a planet of radius R and density d is proportional to

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

B. dR^2

C. dR

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

Answer: C

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3. A satellite of the earth is revolving in a circular orbit with a uniform speed v. If gravitational force suddenly disappears, the satellite will

A. continue to move speed v along the original orbit

B. move with the velocity v tangentially to the original orbit

C. fall downward with increasing velocity

D. ultimately come to rest somewhere on the original orbit

Answer: B

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

A. $w_1 < w_2 < w_3$

B. $w_1 = w_2 = w_3$

C. $w_1 < w_2 < w_3$

D. $w_1 > w_2 > w_3$

Answer: A

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5. A body is projected from earth's surface to become its satellite, its time period of revolution will not depend upon

A. mass of earth

B. its own mass

C. gravitational constant

D. radius or orbit

Answer: B

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6. If orbit velocity of planet is given by $v = G^a M^b R^c$, then

A. $a = \frac{1}{3}, b = \frac{1}{3}, c = -\frac{1}{3}$

B. $a = \frac{1}{3}, b = \frac{1}{2}, c = -\frac{1}{2}$

C. $a = \frac{1}{2}, b = -\frac{1}{2}, c = \frac{1}{2}$

D. $a = \frac{1}{2}, b = -\frac{1}{2}, c = -\frac{1}{2}$

Answer: B

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7. A planet is revolving round the sun in an elliptical orbit, If v is the velocity of the planet when its position vector from the sun is r, then areal velocity of the planet is

A. $|v \times r|$

B. $2|r \times v|$

C. $\left|\frac{1}{2}(r \times v)\right|$

D. None of these

Answer: C

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8. A planet of mass m is in an elliptical orbit about the sun with an orbital period T. If A be the area of orbit, then its angular momentum would be

A. $\frac{2mA}{T}$

B. mAT

C. $\frac{mA}{2T}$

D. $2mAT$

Answer: A

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9. To required kinetic energy of an object of mass m, so that it may escape, will be

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

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

C. mgR

D. $2mgR$

Answer: C

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10. 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 ? $(h < < R)$

A. $\frac{-h}{R}$

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

C. $\frac{-3h}{R}$

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

Answer: B

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11. The earth is an approximate sphere. If the interior contained matter which is not of the same density everywhere, then on the surface of the earth, the acceleration due to gravity.

A. will be directed towards the centre but not the same everywhere

B. will have the same value everywhere but not directed towards the centre

C. will be same everywhere in magnitude directed towards the same

D. cannot be zero at any point

Answer: D

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12. As observed from the earth, the sun appears to move in an approxite circular orbit. For the motion of another planet like mercury as observed from the earth, this would

A. be similarly true

B. not be true because the force between the earth and mercury is not inverse square law

C. not be true because the major gravitational force on mercury is due to the sun

D. not be true because mercury is influenced by forces other than gravitational forces

Answer: C

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13. Satellite orbitting the earth have finite life and sometimes debris of satellites fall to the earth. This is because

A. the solar cells and batteries in satellites run out

B. the law of gravitation predict a trajectory spiralling inwards

C. of viscous forces causing the speed of satellite and hence height to gradually decrease

D. of collisions with other satellites

Answer: C

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14. Both the earth and the moon are subject to the gravitational force of the sun. As observed from the sun, the orbit of the moon

A. will be elliptical

B. will not be strictly elliptical because the total gravitational force on it is not central

C. is not elliptical but will necessarily be a closet curve

D. deviates considerably from being elliptical due to influence of planets other than the earth

Answer: B

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15. In our solar system, the inter-planetary region has chunks of matter (much smaller in size compared to planets) called asteroids.They

A. will not move around the sun, since they have very small masses compared to the sun

B. will move in an irregular way because of their small masses and will drift away into outer space

C. will move around the sun in closed orbits but not obey Kepler's laws

D. will move in orbits like planets and obey Kepler's law

Answer: D

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16. Choose the wrong option

A. Inertial mass is a measure of difficulty of accelerating a body by an external force whereas the gravitational force on it by an external mass

B. That the gravitational mass and inertial mass are equal is an experimental result

C. That the acceleration due to gravity on the earth is the same for all bodies is due to the equality of gravitational mass and inertial mass

D. Gravitational mass of a particle like proton can depend on the presence of neighbouring heavy objects but the inertial mass cannot

Answer: D

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17. Different pounts in the earth are at slightly different distances from the sun and hence experience different forces due to gravitation.

For a rigid body, we know that if various forces act at various points in it, the resulant motion is as if net force acts on the CM (centre of mass) causing translation and a net torque at the CM causing rotation around an axis through the CM. For the earth-sun system (approximating the earth as a uniform density sphere)

A. the torque is zero

B. the torque causes the earth to spin

C. the rigid body result is not applicable since the earth is not even approximately a rigid body

D. the torque causes the earth to move around the sun

Answer: A

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18. Two satellite of same mass are launched in the same orbit of radius r around the earth so as to rotate opposite to each other. If they collide inelastically and stick together as wreckage, the total energy of the system just after collision is

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

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

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

D. zero

Answer: A

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19. Compute the additional velocity required by a satellite orbiting around earth with radius 2R to become free from earth's gravitational field. Mass of earth is M.

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

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

C. $\sqrt{\frac{GM}{R}}(\sqrt{3}-1)$

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

Answer: A

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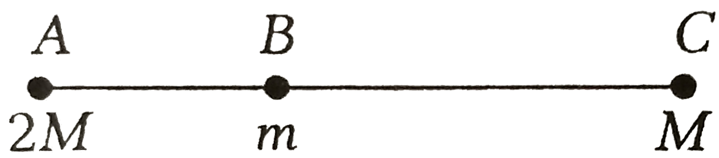
20. Particles of masses 2M, m and M are respectively at points A, B and C with $\sqrt{\frac{GM}{R}}(\sqrt{2}+1)$ is much-much smaller than M and at time $t=0$, they are all at rest as given in figure



At subsequent time before any collision takes place.

A. m will remain at rest

B. m will move towards M

C. m will move towards 2M

D. m will have oscillatory motion

Answer: C

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21. Earth orbiting satellite will escape if

A. its speed is increased by 41 %

B. its KE is doubled

C. Both (a) and (b) are correct

D. Both (a) and (b) are wrong

Answer: C

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22. Energy required in moving a body of mass m from a distance 2R to 3R from centre of earth of mass M is

A. $\frac{GMm}{12R^2}$

B. $\frac{GMm}{3R^2}$

C. $\frac{GMm}{8R}$

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

Answer: D

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23. A body attains a height equal to the radius of the earth. The velocity of the body with which it was projected is

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

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

C. $\sqrt{\frac{1}{4}\frac{GM}{R}}$

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

Answer: A

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24. Suppose the gravitational attraction varies inversely as the distance from the earth. The orbital velocity of a satellite in such a case varies as nth power of distance where n is equal to

A. -1

B. zero

C. $+1$

D. $+2$

Answer: B

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25. The rotation of the earth about its axis speeds up such that a man on the equator becomes weightness. In such a situation, what would be the duration of one day ?

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

B. $\frac{1}{2\pi}\sqrt{\frac{R}{g}}$

C. $2\pi\sqrt{Rg}$

D. $\frac{1}{2\pi}\sqrt{Rg}$

Answer: A

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26. The rotation of the earth radius R about its axis speeds upto a value such that a man at latitude angle 60° feels weightless. The duration of the day in such case will be

A. $\pi\sqrt{\frac{R}{g}}$

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

C. $\frac{\pi}{3}\sqrt{\frac{R}{g}}$

D. $\pi\sqrt{\frac{g}{R}}$

Answer: A

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27. Assuming the radius of the earth to be 6.5×10^6 m. What is the time period T and speed of satellite for equatorial orbit at 1.4×10^3 km above the surface of the earth.

A. $6831s$ and 7174 ms^{-1}

B. $34155s$ and 3204 ms^{-1}

C. $6831s$ and 2144 ms^{-1}

D. $2431s$ and 3514ms^{-1}

Answer: A

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28. If gravitational attraction between two points masses be given by $F = G\frac{m_1 m_2}{r^n}$. Then the period of a satellite in a circular orbit will be proportional to

A. r

B. r^2

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

D. independent of n

Answer: B

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29. 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. $r^{\frac{1}{2}(n+1)}$

B. $r^{\frac{1}{2}(n-1)}$

C. r^{n}

D. $r^{\frac{1}{n}(n-2)}$

Answer: A

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30. A body is projected vertically upwards from the surface of the earth with a velocity equal to half of escape velocity of the earth. If R is radius of the earth, maximum height attained by the body from the surface of the earth is

A. $\frac{R}{6}$

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

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

D. R

Answer: B

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31. A particle takes a time t_1 to move down a straight tunnel from the surface of earth to its centre. If gravity were to remain constant this time would be t_2 calculate the ratio $\frac{t_1}{t_2}$

A. $\frac{\pi}{2\sqrt{2}}$

B. $\frac{\pi}{\sqrt{2}}$

C. $\sqrt{2}\pi$

D. $\frac{\pi}{\sqrt{2}}$

Answer: A

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

A. $\frac{gR^2}{R+h}$

B. gR

C. $\frac{gR}{R+h}$

D. $\sqrt{\frac{gR^2}{R+h}}$

Answer: D

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33. A body which is initially at rest at a height R above the surface of the earth of radius R, falls freely towards the earth. Find out its velocity on reaching the surface of earth. Take $g =$ acceleration due to gravity on the surface of the Earth.

A. $\sqrt{(2gR)}$

B. $\sqrt{(gR)}$

C. $\sqrt{\frac{3}{2}gR}$

D. $\sqrt{(4gR)}$

Answer: B

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34. A planet of mass m moves around the Sun of mass Min an elliptical orbit. The maximum and minimum distance of the planet from the Sun are r_1 and r_2, respectively. Find the relation between the time period of the planet in terms of r_1 and r_2.

A. $r_1^{3/2}$

B. $(r_1 + r_2)^{3/2}$

C. $(r_1 - r_2)^{3/2}$

D. $r_1^{3/2}$

Answer: B

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35. A rocket is launched vertical from the surface of the earth of radius R with an initial speed v. If atmospheric resistance is neglected, then maximum height attained by the rocket is

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

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

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

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

Answer: A

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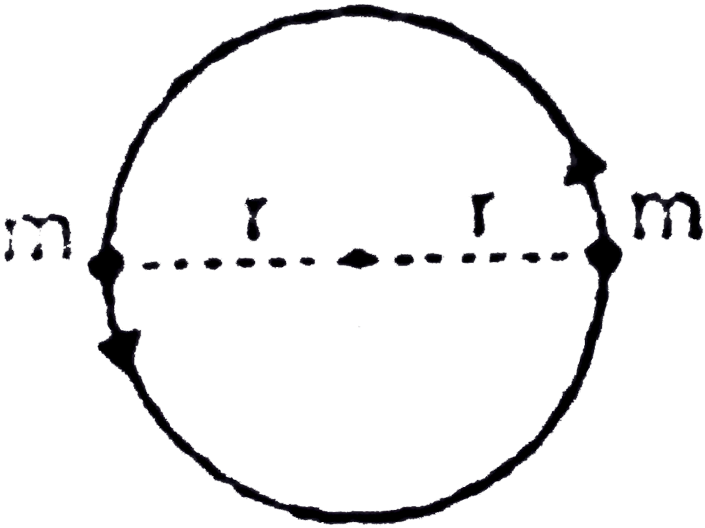
36.



Two particles of equal mass (m) each move in a circle of radius (r) under the action of their mutual gravitational attraction find the speed of each particle.

A. $v = \sqrt{\frac{Gm}{R}}$

B. $v = \sqrt{\frac{Gm}{2R}}$

C. $v = \frac{1}{2}\sqrt{\frac{Gm}{R}}$

D. $v = \sqrt{\frac{4Gm}{R}}$

Answer: C

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37. 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 the earth is uniformly distributed over its volume. Then, which of the following statements are not correct?

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

B. the overlapping will come to rest at centre of the tunnel

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

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

Answer: D

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38. A satellite is moving in a circular orbit round the earth with a diameter of orbit 2R. At a certain point a rocket fixed to the satellite is fired such that it increases the velocity of the satellite tangentially. The resulting orbit of the satellite would be

A. same as before

B. circular orbit with diameter greater than 2R

C. elliptical orbit with minimum distance from the earth equal to R

D. elliptical orbit with maximum distance from the earth equal to R.

Answer: C

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39. If the mass of moon is $\frac{M}{81}$, where M is the mass of earth, find the distance of the point where gravitational field due to earth and moon cancel each other, from the centre of moon. Given the distance between centres of earth and moon is 60 R where R is the radius of earth

A. 4 R

B. 8 R

C. 12 R

D. 6 R

Answer: D

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40. What is the energy required to launch a m kg satellite from earth's surface in a circular orbit at an altitude of 7R ? (R = radius of the earth)

A. $\frac{2}{3}mgR$

B. mgR

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

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

Answer: C

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41. The orbital angular momentum of a satellite revolving at a distance r from the centre is L . If the distance is increased to 16 r, then the new angular momentum will be

A. $16L$

B. $64L$

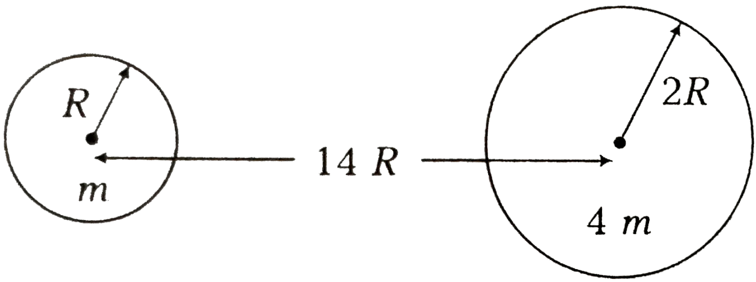
C. $\frac{L}{4}$

D. $4L$

Answer: D

Watch Video Solution

42. Two spherical bodies of masses m and $4m$ and radii R and 2R respectively are released in free space with initial separation between their centres equal to 15 R. If they attract each other due to gravitational force only, then the distance covered by smaller sphere just before collision will be



A. 5 R

B. 9.6 R

C. 2.5 R

D. 6 R

Answer: B

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43. Two spheres of masses m and $2m$ are separated by distance d. A particle of mass $\frac{m}{5}$ is projected straight from $2m$ towards m with a velocity v_0. Which of the following statements is correct ?

A. Velocity of the particle decreases constantly

B. Velocity of the particle increase constantly

C. Acceleration of the particle may become momentarily zero

D. The particle never retraces its path

Answer: C

Watch Video Solution

44. A ring of mass m_1 and radius R is fixed in space at some location. An external agent brings a point mass m_2 from infinity to centre of the ring. Work done by the external agent will be

A. $-\frac{Gm_1m_2}{R}$

B. $\frac{Gm_1m_2}{R}$

C. $\frac{G\sqrt{m_1^2+m_2^2}}{R}$

D. $\dfrac{Gm_1m_2}{R(m_1^2+m_2^2)}$

Answer: A

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45. An artificial satellite is moving in a circular orbit around the earth with a speed of equal to half the magnitude of escape velocity from earth.

(i). Determine the height of the satellite above the earth's surface

(ii). If the satellite is stopped suddenly in its orbit and allowed to fall freely on the earth. Find the speed with it hits and surface of earth. Given `M="mass of earth & R "="Radius of earth"

A. 2 R

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

C. R

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

Answer: C

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46. A person brings a mass of 1 kg from infinity to a point . Initally the mass was at rest but it moves at a speed of 2 ms^{-1} as it reaches A. The work done by the person on the mass is -3J. The potential at A is

A. -3J kg^{-1}

B. -12J kg^{-1}

C. -5J kg^{-1}

D. None of these

Answer: C

Watch Video Solution

47. What impulse need to be given to a body of mass m, released from the surface of earth along a straight tunnel passing through centre of earth, at the centre of earth, to bring it to rest. (Mass of earth M, radius of earth R)

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

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

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

D. zero

Answer: A

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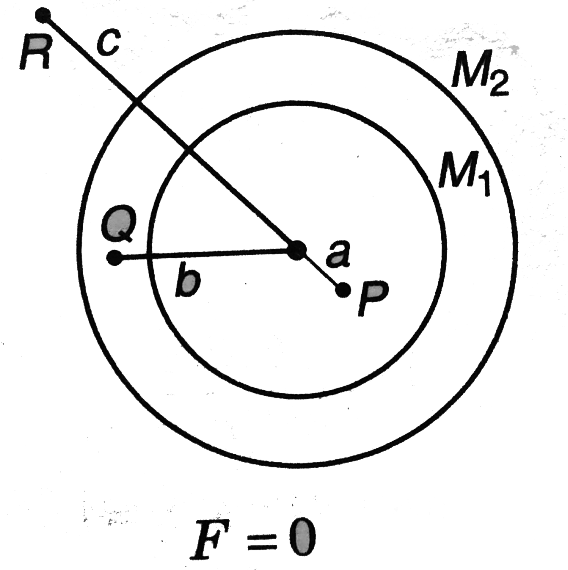
48. Two concentric shells of masses M_1 and M_2 are concentric as shown. Calculate the gravitational force on m due to M_1 and M_2 at points P,Q and R.



A. $F_P = 0$

B. $F_Q = \dfrac{GM_1 m}{b^2}$

C. $F_R = \dfrac{G(M_1 + M_2)}{c^2}$

D. All are correct

Answer: D

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49. Four equal masses (each of mass M) are placed at the corners of a square of side a. The escape velocity of a body from the centre O of the square is

A. $4\sqrt{\frac{2GM}{a}}$

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

C. $\frac{4GM}{a}$

D. $\sqrt{\frac{4\sqrt{2}GM}{a}}$

Answer: B

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50. Energy of a satellite in circular orbit is E_0. The energy required to move the satellite to a circular orbit of 3 times the radius of the initial orbit is

A. $\frac{2}{3}E_0$

B. $2E_0$

C. $\frac{E_0}{3}$

D. $\frac{3}{2}E_0$

Answer: A

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51. Pertaining to two planets, the ratio of escape velocities from respective surfaces is $1:2$, the ratio of the time period of the same simple pendulum at their respective surfaces is $2:1$ (in same order). Then the ratio of their average densities is

A. $1:1$

B. $1:2$

C. $1:4$

D. $8:1$

Answer: C

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52. An object is released from a height twice the radius of the earth on the surface of earth. Find the speed with which it will collide with group by neglecting effect of air. (Take, R radius of earth and mass of earth as M)

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

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

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

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

Answer: A

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53. A planet of mass m revolves in elliptical orbit around the sun of mass M so that its maximum and minimum distance from the sun equal to r_a and r_p respectively. Find the angular momentum of this planet relative to the sun.

A. $m\sqrt{\frac{2GMr_pr_a}{(r_p+r_a)}}$

B. $m\sqrt{\frac{4GMr_pr_a}{(r_p+r_a)}}$

C. $m\sqrt{\frac{GMr_pr_a}{(r_p+r_a)}}$

D. $m\sqrt{\frac{GMr_pr_a}{2(r_p+r_a)}}$

Answer: A

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54. The magnitude of the gravitational field at distance 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:

A. $\frac{F_1}{F_2} = \frac{r_1}{r_2} l$ if $r_1 < R$ and $r_2 < R$

B. $\frac{F_1}{F_2} = \frac{r_1^2}{r_2^2}$, if $r_1 > R$ and $r_2 > R$

C. $\frac{F_1}{F_2} = \frac{r_2}{r_1}$, if $r_1 < R$ and $r_2 < R$

D. $\frac{F_1}{F_2} = \frac{r_2^2}{r_1^2}$, if $r_1 > R$ and $r_2 < R$

Answer: A

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55. 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

A. $\sqrt{\frac{2G(M+m)}{d}}$

B. $\sqrt{\frac{G(M+m)}{d}}$

C. $\sqrt{\frac{G(M+m)}{2d}}$

D. $\sqrt{\frac{G(M+m)}{4d}}$

Answer: A

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56. The ratio of energy required to raise a satellite to a height h above the earth surface to that required to put it into the orbit is

A. $h : 2R$

B. $2h : R$

C. $R : h$

D. $h : R$

Answer: B

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57. A small body of superdense material, whose mass is twice the mass of the earth but whose size is very small compared to the size of the earth, starts form rest at a height $H < < R$ above the earth's surface, and reaches the earth's surface in time t. then t is equal to

A. $t = \sqrt{\frac{h}{g}}$

B. $t = \sqrt{\frac{2h}{g}}$

C. $t = \sqrt{\frac{2h}{3g}}$

D. $t = \sqrt{\frac{4h}{3g}}$

Answer: C

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58. Let E be the energy required to raise a satellite to height h above earth's surface and E' be the energy required to put the same satellite into orbit at that height. Then E / E' is equal to

A. $\frac{2h}{(R+2h)}$

B. $\frac{2h}{(2R+3h)}$

C. $\dfrac{R}{R+h}$

D. $\dfrac{2R}{2h+R}$

Answer: A

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59. A satellite is revolving round the earth with orbital speed v_0 if it is imagined to stop suddenly the speed with which it will strike the surface of the earth would be (v_e - escape speed of a body from earth s surface)

A. $\dfrac{v_e^2}{v_o}$

B. $2v_o$

C. $\sqrt{v_e^2 - v_o^2}$

D. $\sqrt{v_e^2 + 2v_o^2}$

Answer: D

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60. Four particles, each of mass M and equidistant from each other, move along a circle of radius R under the action of their mutual gravitational 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

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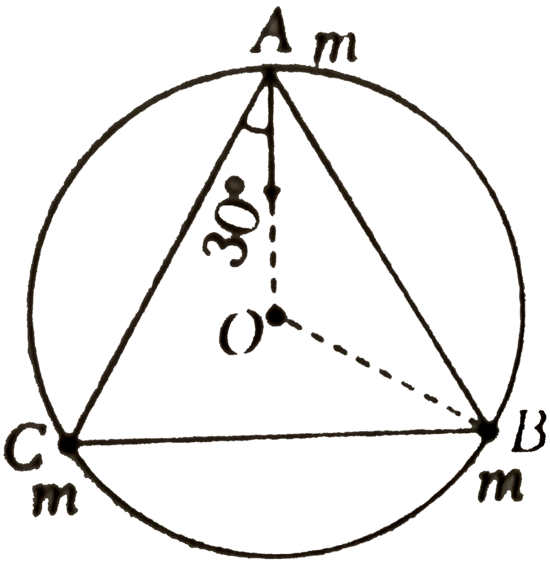
61. Three particle each of mass m, are located at the vertices of an equilateral triangle of side a. At what speed must they move if they all revolve under the influence of their gravitational force of attraction in a circular orbit circumscribing the triangle while still preserving the equilateral triangle ?



A. $\sqrt{\frac{Gm}{a}}$

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

C. $\sqrt{\frac{3Gm}{a}}$

D. $\sqrt{\frac{4Gm}{a}}$

Answer: A

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62. Three point masses each of mass m rotate in a circle of radius r with constant angular velocity ω due to their mutual gravitational attraction. If at any instant, the masses are on the vertices of an equilateral triangle of side a, then the value of ω is

A. $\sqrt{\frac{Gm}{a^3}}$

B. $\sqrt{\frac{3Gm}{a^3}}$

C. $\sqrt{\frac{Gm}{3a^3}}$

D. None of these

Answer: B

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63. Two identical thin rings each of radius R are coaxially placed at a distance R. If the rings have a uniform mass distribution and each has masses $2m$ and $4m$ respectively, then the work done in moving a mass m from centre of one ring to that of the other is

A. zero

B. $\frac{\sqrt{2}Gm^2}{R}(1-\sqrt{2})$

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

D. $\frac{Gm^2}{\sqrt{2}R}$

Answer: B

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64. A solid sphere of mass M and radius R has a spherical cavity of radius R/2 such that the centre of cavity is at a distance R/2 from the centre of the sphere. A point mass m is placed inside the cavity at a distance R/4 from the centre of sphere. The gravitational force on mass m is

A. $\frac{11GMm}{R^2}$

B. $\frac{14GMm}{R^2}$

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

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

Answer: C

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65. A point $P(R\sqrt{3}, 0, 0)$ lies on the axis of a ring of mass M and radius R. The ring is located in yx-plane with its centre at origin O. A small particle of mass m starts from P and reaches O under gravitational attraction only. Its speed at O will be

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

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

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

D. $\sqrt{\frac{2m}{\sqrt{2}R}}$

Answer: A

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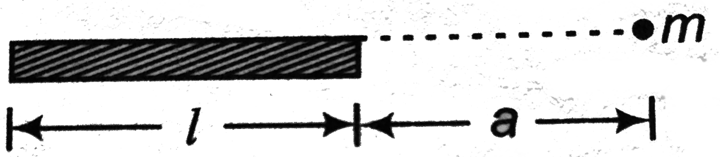
66. A mass m is at a distance a from one end of a uniform rod of length l and mass M. Find the gravitational force on the mass due to the rod.



A. $\dfrac{4GMm}{(a+l)^2}$

B. $\dfrac{4GmM}{4a^2 - l^2}$

C. $\dfrac{GMm}{a^2}$

D. $\dfrac{GmM}{2(l+a)^2}$

Answer: B

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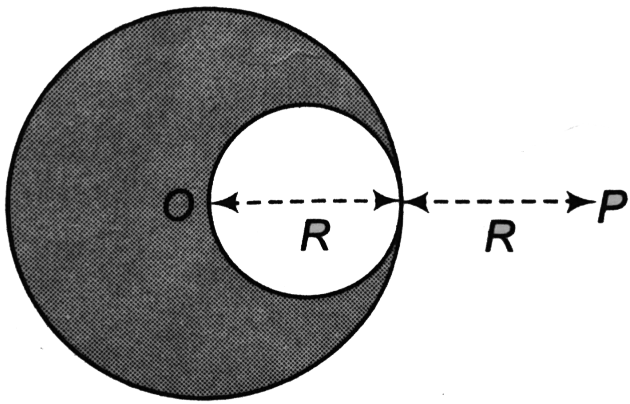
67. A solid sphere of uniform density and radius R applies a gravitational force of attraction equal to F_1 on a particle placed at P, distance $2R$ from the centre O of the sphere. A spherical cavity of radius $R/2$ is now made in the sphere as shown in figure. The particle with cavity now applies a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



A. $\frac{5}{9}$

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

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

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

Answer: D

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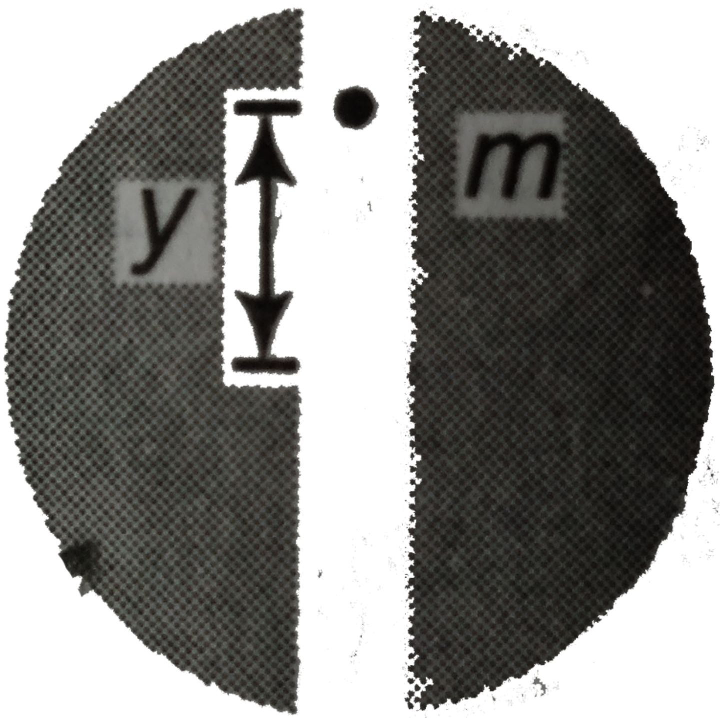
68. Suppose a vertical tunnel is dug along the diameter of earth , which is assumed to be a sphere of uniform mass density ρ. If a body of mass m is thrown in this tunnel, its acceleration at a distance y from the centre is given by



A. $\frac{4\pi}{3}G\rho y m$

B. $\frac{3}{4}\pi\rho y$

C. $\frac{4}{3}\pi\rho y$

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

Answer: D

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(B) Chapter Exercises

1. Assertion : Gravitational force between two masses in air is F. If they are immersed in water, force will remain F

Reason : Gravitational force does not depend on the medium between the masses.

A. If both Assertin and Reason are correct and Reason is the correct explanation of Assertion

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion

C. If Assertion is true but Reason is false

D. If Assertion is false but Reason is true

Answer: A

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2. Assertion : Angular momentum of a planet is constant about any point

Reason : For acting on the planet is a central force.

A. If both Assertin and Reason are correct and Reason is the correct explanation of Assertion

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion

C. If Assertion is true but Reason is false

D. If Assertion is false but Reason is true

Answer: D

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3. Assertion : Kepler's law for planetary motion are consequence of Newton's laws

Reason : Kepler's laws can be derived by using Newton's laws.

A. If both Assertin and Reason are correct and Reason is the correct explanation of Assertion

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion

C. If Assertion is true but Reason is false

D. If Assertion is false but Reason is true

Answer: D

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4. Assertion : The field strength at the centre of a ring is zero

Reason : At the centre of the ring, slope of V-r graph is zero.\

A. If both Assertin and Reason are correct and Reason is the correct explanation of Assertion

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion

C. If Assertion is true but Reason is false

D. If Assertion is false but Reason is true

Answer: A

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

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

A. If both Assertin and Reason are correct and Reason is the correct explanation of Assertion

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion

C. If Assertion is true but Reason is false

D. If Assertion is false but Reason is true

Answer: D

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6. Assertion : Plane of a satellite always passes through the centre of earth

Reason : Gravitational force on satellite is always towards centre of earth.

A. If both Assertin and Reason are correct and Reason is the correct explanation of Assertion

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion

C. If Assertion is true but Reason is false

D. If Assertion is false but Reason is true

Answer: A

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7. Assertion : Gravitational potential and gravitational potentail energy, both are related to the work done by gravitational force in the gravitational field

Reason : Gravitational field strength is related to the gravitaional force in gravitational field.

A. If both Assertin and Reason are correct and Reason is the correct explanation of Assertion

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion

C. If Assertion is true but Reason is false

D. If Assertion is false but Reason is true

Answer: B

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8. Assertion : One two sides of a point mass, gravitational field strength is same at same distance,

Reason : As we move away from a point mass, value of gravitational potential decreases.

A. If both Assertin and Reason are correct and Reason is the correct explanation of Assertion

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion

C. If Assertion is true but Reason is false

D. If Assertion is false but Reason is true

Answer: D

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9. Assertion : If gravitational potential at some point is zero, then gravitational field strength at that point will also be zero.

Reason : Except at infinity gravitational potential due to a system of point masses at some finite distance can't be zero.

A. If both Assertin and Reason are correct and Reason is the correct explanation of Assertion

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion

C. If Assertion is true but Reason is false

D. If Assertion is false but Reason is true

Answer: D

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10. Assertion : If radius of earth suddenly shrinks to half its present without changing its mass value, then the period of an earth's satellite will not change

Reason : Time period of a satellite does not upon the mass of earth.

A. If both Assertin and Reason are correct and Reason is the correct explanation of Assertion

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion

C. If Assertion is true but Reason is false

D. If Assertion is false but Reason is true

Answer: C

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11. Assertion : The centres of two cubes of masses m_1 and m_2 are separated by a distance r. The gravitational force between these two cubes will be $\frac{Gm_1m_2}{r^2}$

Reason : According to Newton's law of gravitation, gravitational force between two point masses m_1 and m_2 separated by a distance r is $\frac{Gm_1m_2}{r^2}$.

A. If both Assertin and Reason are correct and Reason is the correct explanation of Assertion

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion

C. If Assertion is true but Reason is false

D. If Assertion is false but Reason is true

Answer: D

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12. Assertion : If a particle is projected from the surface of earth with velocity equal to escape velocity, then total mechanical energy is zero

Reason : Total mechanical energy of any closed system is always negative.

A. If both Assertin and Reason are correct and Reason is the correct explanation of Assertion

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion

C. If Assertion is true but Reason is false

D. If Assertion is false but Reason is true

Answer: B

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13. Assertion : On earth's satellite, we feel weightlessness. Moon is also satellite of earth. But on the surface on moon, we do not feel weightlessness

Reason : Gravitational force by earth on us on the surface of moon is zero. But gravitational force by moon on us on its surface is non-zero.

A. If both Assertin and Reason are correct and Reason is the correct explanation of Assertion

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion

C. If Assertion is true but Reason is false

D. If Assertion is false but Reason is true

Answer: C

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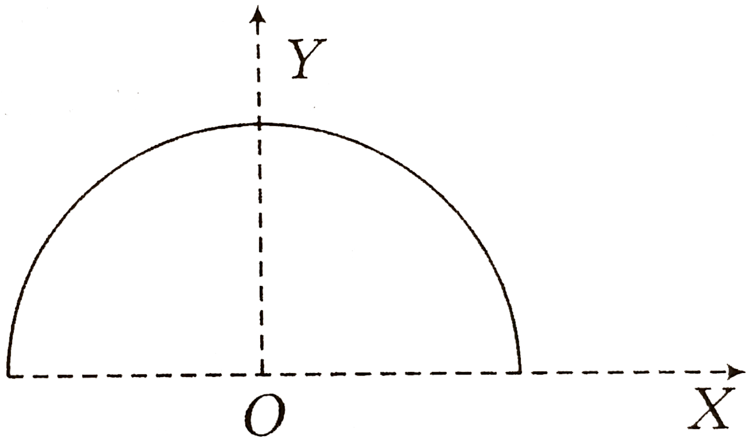
14. Assertion : The centre of semicircular ring of mass m and radius R is the origin O. The potential at origin is $-\frac{Gm}{R}$



Reason : The gravitational field strength is towards Y-axis.

A. If both Assertin and Reason are correct and Reason is the correct explanation of Assertion

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion

C. If Assertion is true but Reason is false

D. If Assertion is false but Reason is true

Answer: B

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15. Assertion : If the projuct of surface area and density is same for both

Reason : Product of surface area and density is proportional to the mass of the planet per unit radius f the planet.

A. If both Assertin and Reason are correct and Reason is the correct explanation of Assertion

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion

C. If Assertion is true but Reason is false

D. If Assertion is false but Reason is true

Answer: A

View Text Solution

16. Assertion : Areal velocity of a planet around of surface area and density is same for two planets, escape velocities will be same for both

Reason : Areal velocity $= \frac{L}{2m}$, Where L is angular momentum of planet about centre of sun.

A. If both Assertin and Reason are correct and Reason is the correct explanation of Assertion

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion

C. If Assertion is true but Reason is false

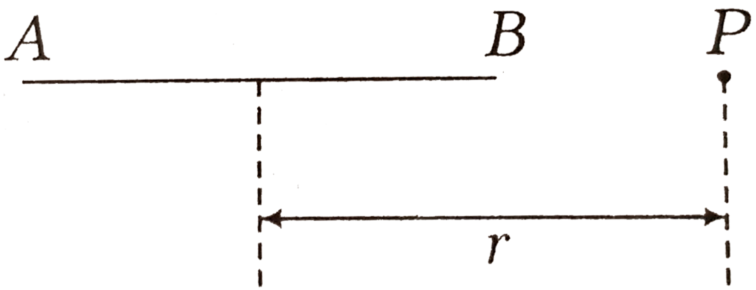
D. If Assertion is false but Reason is true

Answer: D

View Text Solution

17. Assertion : Mass of the rod AB is m_1 and of particle P is m_2. Distance between centre of rod and particle is r. Then the gravitational force between the rod and the particle is

$$F = \frac{Gm_1m_2}{r^2}$$



Reason : The relation $F = \frac{Gm_1m_2}{r^2}$ can be applied directly only to find force between two particles.

A. If both Assertin and Reason are correct and Reason is the correct explanation of Assertion

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion

C. If Assertion is true but Reason is false

D. If Assertion is false but Reason is true

Answer: D

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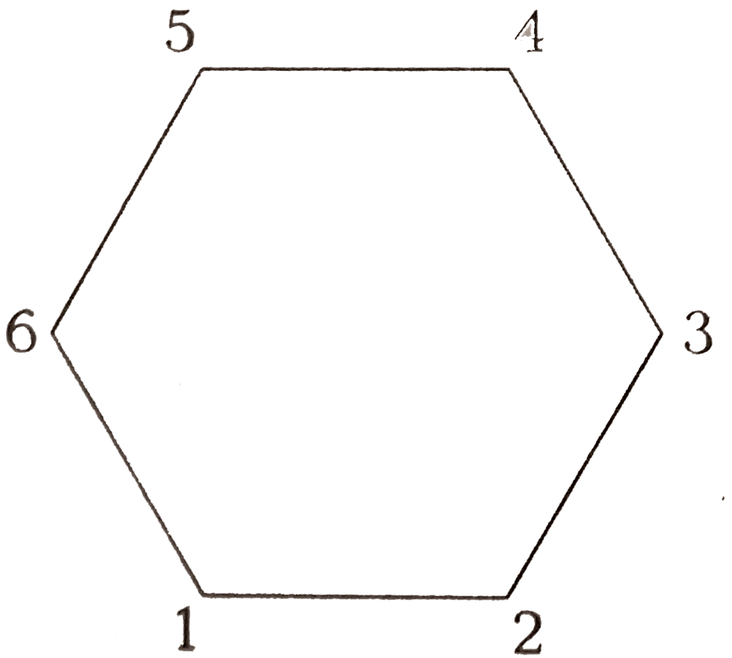
18. Assertion : Four point masses each of mass m are placed at points 1, 2, 3 and 6 of a regular hexagon of side a. Then the gravitational field at the centre of hexagon is $\frac{Gm}{a^2}$



Reason : The field strength due to masses at 3 and 6 are cancelled out.

A. If both Assertin and Reason are correct and Reason is the correct explanation of Assertion

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion

C. If Assertion is true but Reason is false

D. If Assertion is false but Reason is true

Answer: D

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19. Assertion : Let W_1 be the work done in taking away a satellite from the surface of earth to its orbit and then W_2 the work done in rotating the satellite in circular orbit there. Then, $W_1 = W_2$

Reason : $W_2 = \dfrac{GMm}{4R}$

A. If both Assertin and Reason are correct and Reason is the correct explanation of Assertion

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion

C. If Assertion is true but Reason is false

D. If Assertion is false but Reason is true

Answer: D

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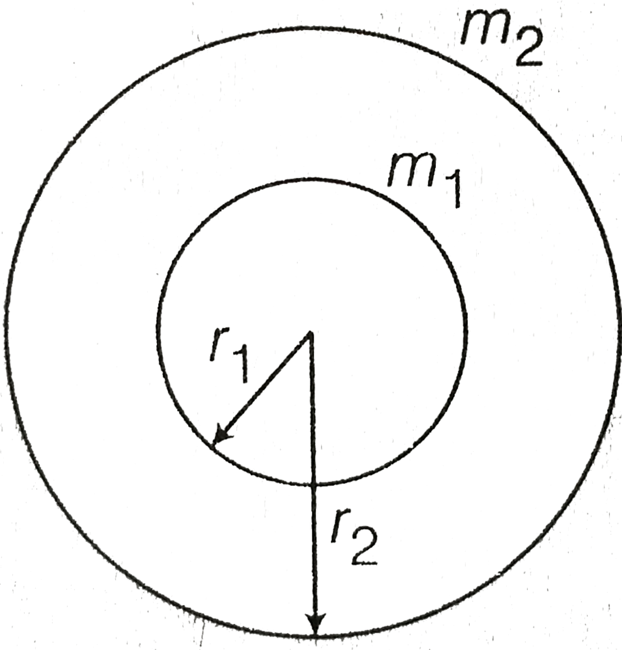
20. Assertion : Two spherical shells have masses m_1 and m_2. Their radii are r_1 and r_2. Let r be the distance of a point from centre. Then gravitational field strength and gravitational potential both are equal to zero for $O < r < r_1$



Reason : In the region $r_1 < r < r_2$, gravitational field strength due to m_2 is zero. But gravitational potential due to m_2 is constant (but non-zero).

A. If both Assertin and Reason are correct and Reason is the correct explanation of Assertion

B. If both Assertion and Reason are correct but Reason is not the correct explanation of Assertion

C. If Assertion is true but Reason is false

D. If Assertion is false but Reason is true

Answer: D

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21. Match the following

	Column-I		Column-II
(A)	Kepler's first law	(p)	$T^2 \propto r^3$
(B)	Kepler's second law	(q)	Areal velocity is constant
(C)	Kepler's third law	(r)	Orbit of planet is elliptical

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22. Density of a planet is two times the density of earth. Radius of this planet is half. Match the following (as compared to earth)

	Column-I		Column-II
(A)	Accleration due to gravity on this planet's surface	(p)	Half
(B)	Gravitational potential on the surface	(q)	Same
(C)	Gravitational potential at centre	(r)	Two times
(D)	Gravitational field strength at centre	(s)	Four times

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23. On the surface of earth acceleration due gravity is g and gravitational potential is V. Match of following columns

	Column-I		Column-II
(A)	At height h=R, value of g	(p)	Decreases by a factor $\frac{1}{4}$
(B)	At depth $h = \frac{R}{2}$,value of g	(q)	Decrease by a factor $\frac{1}{2}$
(C)	At height $h = R$,value of V	(r)	Increase by a factor $\frac{11}{8}$
(D)	At height $h = \frac{R}{2}$,value of V	(s)	Increase by a factor 2
		(t)	None

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24. Let V and E denote the gravitational potential and gravitational field at a point. Then, match the following columns

	Column-I		Column-II
(A)	$E = 0, V = 0$	(p)	At centre of spherical shell
(B)	$E \neq 0, V = 0$	(q)	At centre of solid sphere
(C)	$V \neq 0, E = 0$	(r)	At centre of circular ring
(D)	$V \neq 0, E \neq 0$	(s)	At cetre of two point masses of equal magnitude
		(t)	None

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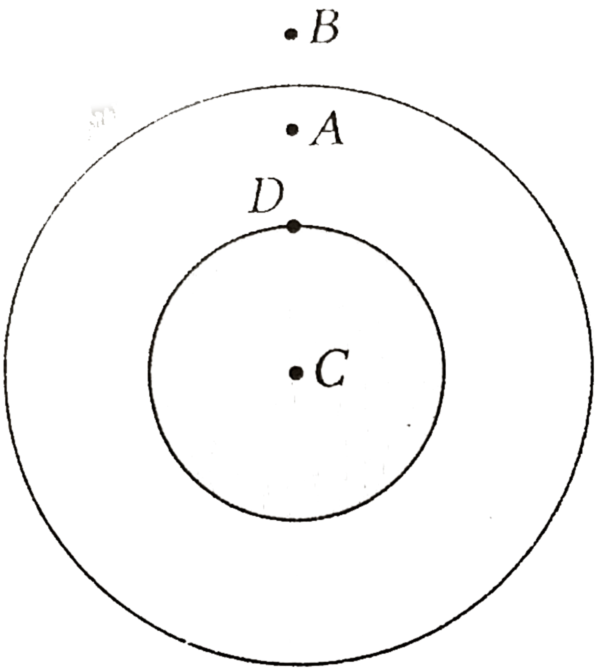
25. Two concentric spherical shells are as shown in figure. Match the following columns



	Column-I		Column-II
(A)	Potential at A	(p)	greater than B
(B)	Gravitational field at A	(q)	less than B
(C)	As one moves from C to D	(r)	Potential remains constant
(D)	As one moves from D to A	(s)	Gravitational field decreases
		(t)	None

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26. Match of following columns

	Column-I		Column-II
(A)	Kinetic enery of a particle in gravitational field is increasing	(p)	Work done by gravitational force should be positive
(B)	Potential energy of a particle in gravitational field is increasing	(q)	Work done by external force should be non-zero
(C)	Mechanical energy of a particle in gravitational field is increasing	(r)	Work done by gravitational force should be negative
		(s)	Cannot say anything

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27. A particle is projected from the surface of earth of mass M and radius R with speed v. Suppose it travels a distance $x(< \, < R)$ when its speed becomes v to $v/2$ and $y(< \, < R)$ when speed changes from $v/2$ to 0. Similarly, the corresponding times are suppose t_1 and t_2. Then

	Column-I		Column-II
(A)	x/y	(p)	$=1$
(B)	t_1/t_2	(r)	>1
		(r)	<1

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28. In elliptical orbit of a planet, as the planet moves from apogee position to perigee position to perigee position, match the following columns

	Column-I		Column-II
(A)	Speed of planet	(p)	Remains same
(B)	Distance of planet from centre of sun	(q)	Decreases
(C)	Potential energy	(r)	Increase
(D)	Angular momentum about centre of sun	(s)	Cannot say

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29. Match the following columns

	Column-I		Column-II
(A)	Time period of an earth satellite in circular orbit	(p)	Independent of mass of satellite
(B)	Orbital velocity of satellite	(q)	Independent of radius of orbit
(C)	Mechanical energy of satellite	(r)	Independent of mass of earth
		(s)	None

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30. If earth decreases its rotational speed. Match the following columns

	Column-I		Column-II
(A)	Value of g at pole	(p)	Will remain same
(B)	Value of g at equator	(q)	Will increase
(C)	Distance of geostationary	(r)	Will decrease
(D)	Energy of geostationary satellite	(s)	Cannot say

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31. Match the following columns. (for a satellite in circular orbit)

	Column-I		Column-II
(A)	Kinetic energy	(p)	$-\frac{GMm}{2r}$
(B)	Potential energy	(q)	$\sqrt{\frac{GM}{r}}$
(C)	Total energy	(r)	$-\frac{GMm}{r}$
(D)	Orbital speed	(s)	$\frac{GMm}{2r}$

A. $(A \rightarrow s, B \rightarrow r, C \rightarrow p, D \rightarrow q)$

B. $(A \rightarrow c, B \rightarrow s, C \rightarrow p, D \rightarrow q)$

C. $(A \rightarrow s, B \rightarrow r, C \rightarrow q, D \rightarrow p)$

D. $(A \rightarrow q, B \rightarrow r, C \rightarrow p, D \rightarrow s)$

Answer: A

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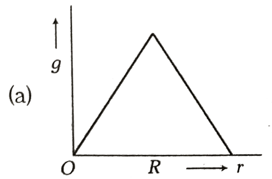
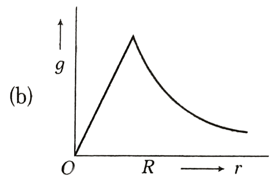
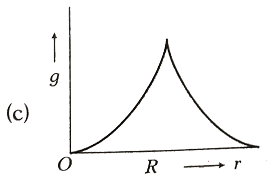
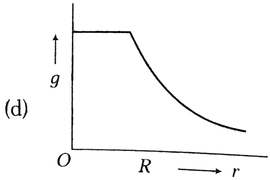
(C) Chapter Exercises

1. Starting from the centre of the earth having radius R, the variation of g (acceleration due to gravity) is shown by

A. 

B. 

C. 

D. 

Answer: B

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

A. $\frac{mg_0R^2}{2(R+h)}$

B. $-\frac{mg_0R^2}{2(R+h)}$

C. $\frac{2mg_0R^2}{R+h}$

D. $-\frac{2mg_0R^2}{R+h}$

Answer: B

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3. At what height from the surface of earth the gravitation potential and the value of g are $-5.4 \times 10^{7} Jkg^{-2}$ and $6.0 ms^{-2}$ respectively ? Take the radius of earth as $6400 km$:

A. 1600 km

B. 1400 km

C. 2000 km

D. 2600 km

Answer: D

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4. The ratio of escape velocity at earth (v_e) to the escape velocity at a planet (v_y) whose radius and density are twice

A. $1:2\sqrt{2}$

B. $1:4$

C. $1:\sqrt{2}$

D. $1:2$

Answer: A

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5. Kepler's third law states that square of period revolution (T) of a planet around the sun is proportional to third power of average distance i between sun and planet i.e. $T^2 = Kr^3$

here K is constant

if the mass of sun and planet are M and m respectively then as per Newton's law of gravitational the force of alteaction between them is $F = \frac{GMm}{r^2}$, here G is gravitational constant. The relation between G and K is described as

A. $GK = 4\pi^2$

B. $GMK = 4\pi^2$

C. $K = G$

D. $K = I/G$

Answer: B

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6. The reading of a spring balance corresponds to 100 N while situated at the north pole and a body is kept on it. The weight record on the same scale if it is shifted to the equator, is (take, $g = 19\ \text{ms}^{2-}$ and radius of the earth, $R = 6.4 \times 10^6$ m)

A. 99.66 N

B. 110 N

C. 97.66 N

D. 106 N

Answer: A

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7. The gravitational field due to an uniform solid sphere of mass M and radius a at the centre of the sphere is

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

B. $\frac{GM}{a^3}$

C. $\frac{GM}{2a}$

D. zero

Answer: D

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8. What would be the value of acceleration due to gravity at a point 5 km below the earth's surface ? $\left(R_E = 6400km, g_E = 9.8\text{ms}^{-2}\right)$

A. $9.6 \quad ms^{-2}$

B. $9.79 \quad ms^{-2}$

C. $9.89 \quad ms^{-2}$

D. $10 \quad ms^{-2}$

Answer: B

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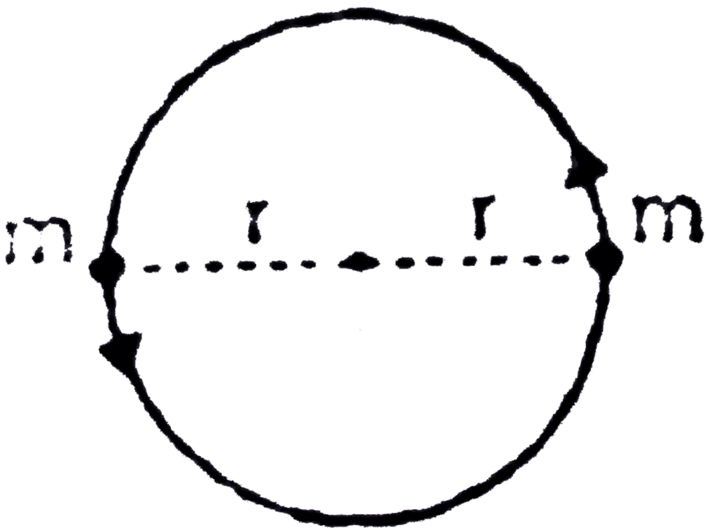

9.

Two particles of equal mass (m) each move in a circle of radius (r) under the action of their mutual gravitational attraction find the speed of each particle.

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

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

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

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

Answer: C

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10. What would be the escape velocity from the moon, it the mass of the moon is 7.4×10^{22} kg and its radius is 1740 km ?

A. $2.4 \quad \text{ms}^{-1}$

B. $2.4 \quad \text{kms}^{-1}$

C. $240 \quad \text{kms}^{-1}$

D. 0.24 kms^{-1}

Answer: B

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11. Two spheres of masses 16 kg and 4 kg are separated by a distance 30 m on a table. Then, the distance from sphere of mass 16 kg at which the net gravitational force becomes zero is

A. 10 m

B. 20 m

C. 15 m

D. 5 m

Answer: B

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12. Orbital velocity of an artificial satellite does not depend upon

A. mass of the earth

B. mass of the satellite

C. radius of the earth

D. acceleration due to gravity

Answer: B

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13. Gravitational potential energy of body of mass m at a height of h above the surface of earth (M = mass of earth , R = radius of earth) is

A. $\frac{GMm}{h}$

B. $\frac{GMm}{(R+h)}$

C. $\frac{-GM}{(R+h)}$

D. $-\frac{GMm}{(R+h)}$

Answer: D

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14. According to Kepler's law of planetary motion, if T represents time period and r is orbital radius, then for two planets these are related as

A. $\left(\frac{T_1}{T_2}\right)^{3/2} = \frac{r_1}{r_2}$

B. $\frac{T_1}{T_2} = \left[\frac{r_1}{r_2}\right]$

C. $\left[\frac{T_1}{T_2}\right]^2 = \left[\frac{r_1}{r_2}\right]^3$

D. $\frac{T_1^2}{T_2} = \frac{r_1^3}{r_1}$

Answer: C

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15. If mass of a body is M on the earth surface, then the mass of the same body on the moon surface is

A. 6 M

B. $\frac{M}{6}$

C. zero

D. M

Answer: D

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16. Two spherical bodies of masses m and 5m and radii R and 2R respectively, 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, the distance covered by smaller sphere just before collision is

A. 2.5 R

B. 4.5 R

C. 7.5 R

D. 1.5 R

Answer: C

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17. The force of gravitation is

A. repulsive

B. electrostatic

C. conservative

D. non-conservative

Answer: C

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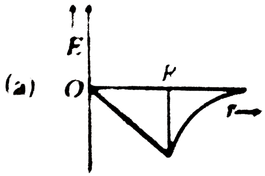
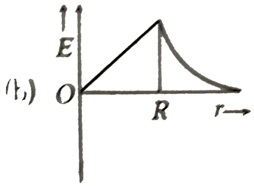
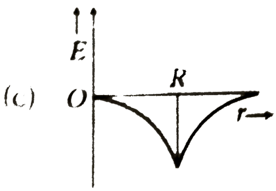
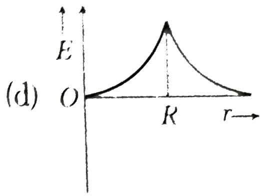
18. Dependence of intensity of gravitational field (E) of earth with distance (r) from centre of earth is correctly represented by

A. 

B. 

C. 

D. 

Answer: B

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19. Keeping the mass of the earth as constant, if its radius is reduced to 1/4th of its initial value, then the period of revolution of the earth about its own axis and passing through the centre, (in hours) is (assume the earth to be a solid sphere and its initial period of rotation as 24 h)

A. 12

B. 3

C. 6

D. 1.5

Answer: A

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20. A body of mass m is raised to a height 10 R from the surface of the earth, where R is the radius of the earth. Find the increase in potential energy. (G = universal constant of gravitational, M = mass of the earth and g= acceleration due to gravity)

A. $\frac{GMm}{11R}$

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

C. $\frac{mgR}{11G}$

D. $\frac{10GMm}{11R}$

Answer: D

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21. An artificial satellite moving in a circular orbit around the earth has a total energy E_0. Its potential energy is

A. $-2E$

B. 2E

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

D. $-\frac{2E}{3}$

Answer: A

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22. What is a period of revolution of the earth satellite ? Ignore the height of satellite above the surface of the earth.

Given,

(i) the value of gravitational acceleration, $g = 10ms^{-2}$

(ii) radius of the earth, $R_g = 6400$ km (take, $\pi = 3.14$)

A. 85 min

B. 156 min

C. 83.73 min

D. 90 min

Answer: C

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23. The time period of the earth's satellite revolving at a height of 35800 km is

A. 24 h

B. 100 min

C. 12 h

D. 48 h

Answer: A

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24. At a height H from the surface of earth, the total energy of a satellite is equal to the potential energy of a body of equal mass at a height 3R from the surface of the earth (R = radius of the earth). The value of H is

A. R

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

C. $3R$

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

Answer: A

Watch Video Solution

25. A body of mass m taken form the earth's surface to the height is equal to twice the radius (R) of the earth. The change in potential energy of body will be

A. $mgR2$

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

C. $3mgR$

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

Answer: B

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26. Infinite number of bodies, each of mass $2kg$, are situated on x-axis at distance $1m, 2m, 4m, 8m$......... respectively, from the origin. The resulting gravitational potential the to this system at the origing will be

A. $-G$

B. $-(8/3)G$

C. $-(4/3)G$

D. $-4G$

Answer: D

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27. The universal law of gravitational is the force law known also as the

A. triangular law

B. square law

C. inverse square law

D. parallelogram law

Answer: C

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28. The value of acceleration due to gravity at the surface of earth

A. is maximum at the poles

B. is maximum at the equator

C. remains constant everywhere on the surface of the earth

D. is maximum at the international time line

Answer: A

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29. The escape velocity of a particle of a particle from the surface of the earth is given by

A. $(gR)^{1/2}$

B. $(2gR)^{1/2}$

C. $(3gR)^{1/2}$

D. $(gR/2)^{1/2}$

Answer: B

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30. If earth were to rotate on its own axis such that the weight of a person at the equator becomes half the weight at the poles, then its time period of rotation is (g = acceleration due to gravity near the poles and R is the radius of earth) (Ignore equatorial bulge)

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

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

C. $2\pi\sqrt{\frac{R}{3g}}$

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

Answer: A

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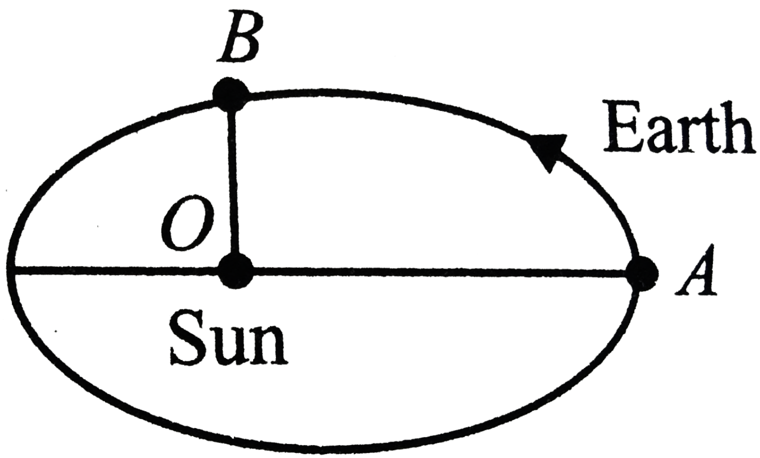
31. The earth moves around the Sun in an elliptical orbit as shown in Fig. The ratio $OA / OB = R$. The ratio of the speed of the earth at B to that at A is nearly



A. R^{-1}

B. $\sqrt{R}$

C. R

D. $R^{2/3}$

Answer: C

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32. If two planets of radii R_1 and R_2 have densities d_1 and d_2, then the ratio of their respective acceleration due to gravity is

A. $R_1d_1 : R_2d_2$

B. $R_1^2d_1 : R_2^2d_2$

C. $R_1^3d_1 : R_2^3d_2$

D. $R_1d_1^2 : R_2^2d_2^2$

Answer: A

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33. The weight of an object is 90 kg at the surface of the earth. If it is taken to a height equal to half of the radius of the earth, then its weight will become

A. 135 kg

B. 45 kg

C. 60 kg

D. 40 kg

Answer: D

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34. The escape velocity of a body from the earth is $11.2km/s$. If a body is projected with a velocity twice its escape velocity, then the velocity of the body at infinity is (in km/s)

A. 11.2 kms^{-1}

B. 22.4 kms^{-1}

C. 19.4 kms^{-1}

D. 15.2 kms^{-1}

Answer: C

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35. 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. $m\sqrt{GM/R_0}$

B. $M\sqrt{GmR_0}$

C. $m\sqrt{GMR_0}$

D. $M\sqrt{GM/R_0}$

Answer: C

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

A. $\frac{Gm}{m_2 R}(\sqrt{2}+1)m$

B. $\frac{Gm(m_1 - m_2)}{\sqrt{2}R}(\sqrt{2}-1)$

C. $\frac{Gm\sqrt{2}}{R}(m_1 + m_2)$

D. zero

Answer: B

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37. If r is the distance between the Earth and the Sun. Then, angular momentum of the Earth around the sun is proportional to

A. $\sqrt{r}$

B. $r^{3/2}$

C. r

D. None of these

Answer: A

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38. A spherical planet far out in space has a mass M_0 and diameter D_0. A particle of mass m falling freely near the surface of this planet will experience an accelertion due to gravity which is equal to

A. $4GM_p / D_p^2$

B. GM_pm / D_p^2

C. GM_pm / D_p^2

D. $4GM_pm / D_p^2$

Answer: A

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39. A geostationary satellite is orbiting the earth at a height of $5R$ above the surface of the earth, $2R$ being the radius of the earth. The time period of another satellite in hours at a height of $2R$ form the surface of the earth is

A. 5

B. 10

C. $6\sqrt{2}$

D. $6/\sqrt{2}$

Answer: C

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40. When a satellite is moving around the earth with velocity v, then to make the satellite escape, the minimum percentage increase in its velocity should be

A. $100\ \%$

B. $82.4\ \%$

C. $41.4\ \%$

D. None of these

Answer: C

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41. A lauching vehicle carrying an artificial satellite of mass m is set for launch on the surface of the earth of mass M and radius R. If the satellite intended to move in a circular orbit of radius $7R$, the minimum energy required to be spent by the launching vehicle on the satellite is

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

B. $-\frac{13GMm}{14R}$

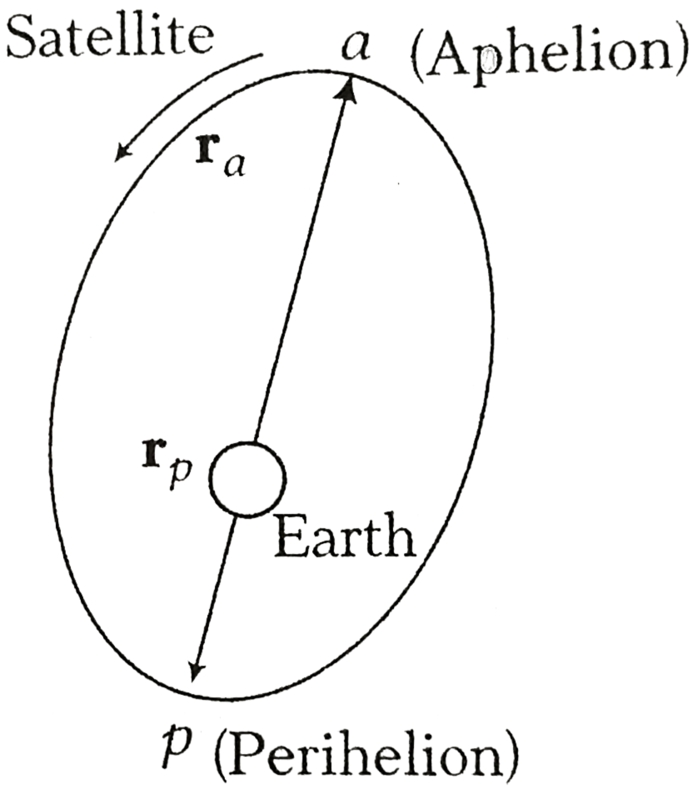
C. $\frac{GMm}{7R}$

D. $\frac{GMm}{14R}$

Answer: B

Watch Video Solution

42. Consider a satellite orbiting the earth as shown in the figure below. Let L_a and L_p represent the angular momentum of the satellite about the earth when at aphelion and perihelion respectively. Consider the following relations



(i) $L_a = L_p$

(ii) $L_a = \; - L_p$

(iii) $r_a \times L_a = r_p \times L_p$

Which of the above relation(s) is/are true ?

A. (i) only

B. (ii) only

C. (iii) only

D. (i) and (iii)

Answer: A

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43. A body is projected vertically upwards from the surface of the earth with a velocity equal to half of escape velocity of the earth. If R is radius of the earth, maximum height attained by the body from the surface of the earth is

A. $R/6$

B. $R/3$

C. $2R/3$

D. R

Answer: B

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44. Find the imaginary angular velocity of the earth for which the effective acceleration due to gravity at the equator shall be zero. (take $g = 10m/s^2$ for the acceleration due to gravity, if the earth were at rest and radius of earth equal to 6400 km and $\phi = 60^\circ$)

A. $1.25 \times 10^{-3} \text{rad s}^{-1}$

B. $2.50 \times 10^{-3} \text{ rad s}^{-1}$

C. $3.75 \times 10^{-3} \text{ rad s}^{-1}$

D. $5 \times 10^{-3} \text{ rad s}^{-1}$

Answer: B

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45. The mass of the moon is $\frac{1}{81}$ of the earth but the gravitational pull is $\frac{1}{6}$ of the earth. It is due to the fact that

A. the radius of earth is $\frac{9}{\sqrt{6}}$ of the moon

B. the radius of moon is $\frac{81}{6}$ of the moon

C. moon is the satellite of the earth

D. None of the above

Answer: A

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