PHYSICS

BOOKS - SUNIL BATRA 41 YEARS IITJEE PHYSICS (HINGLISH)

GRAVITATION

Jee Main And Advanced

1. The numerical value of the angular velocity of rotation of the earth should be........ Rad/s in order to make the effective acceleration due to gravity equal to zero.

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2. A geostationary satellite is orbiting the earth at a height of 6R above the surface of the earth, where R is the radius of the earth. The time period of another satellite at a height of 2.5 R from the surface of the earth is ...... hours.

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

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

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5. it possible to put an artifical1 satellite into orbit in such a way that it will always remain directly over New Delhi.

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6. If the radius of the earth were to shrink by one percent its mass remaining the same, the acceleration due to greavity on the earth's surface would

A. decrease

B. remian unchanged

C. increase

D. be zero

Answer: C

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

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

B. 2mg R (c)

C. mg R

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

Answer: A

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8. If the distance between the earth and the sun were half its present value, the number of days in a year would have been

A. 64.5

B. 129

C. 182.5

D. 730

Answer: B

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9. A geo-stationary stellite orbits around the earth in a circular orbit of radius 36,000km. Then, the time period of a spy stellite orbitting a few hundred km above the earth's surface $(R_{earth} = 6400km)$ will approximately be

A. 1/2 hr

B. 1hr

C. 2hr

D. 4hr

Answer: C

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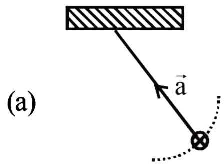
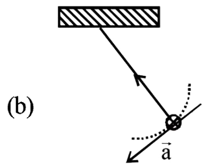
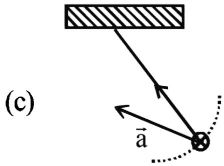
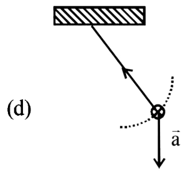
10. A simple pendulum is oscillating without damiping, When the displacement of the bob is less than maximum, its acceleration vector $\vec{a}$ is correctly show in:

A. 

B. 

C. 

D. 

Answer: C

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11. A binary star system consists of two stars A and B which have time period T_A and $T_B, radius R_B a$ and mass M_a and M_B. Then

A. if T_Agt T_B then R_A gt R_B`

B. if $T_A > T_B then M_A > M_B$

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

D. $T_A = T_B$

Answer: D

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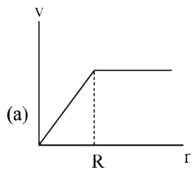
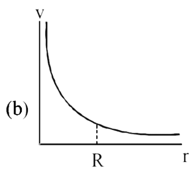
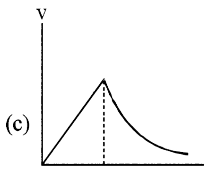
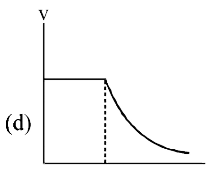
12. A spherically symmetric gravitational system of particles has a mass density $\rho = \begin{cases} \rho_0 & f \text{ or } & r & < & R \\ 0 & f \text{ or } & r & > & R \end{cases}$ where ρ_0 is a constant. A test mass can undergo circular motion under the influence of the gravitational field of particles. Its speed v as a function of distahce $r(0 < r < OO)$ form the centre of the system is represented by

A. 

B. 

C. 

D. 

Answer: C

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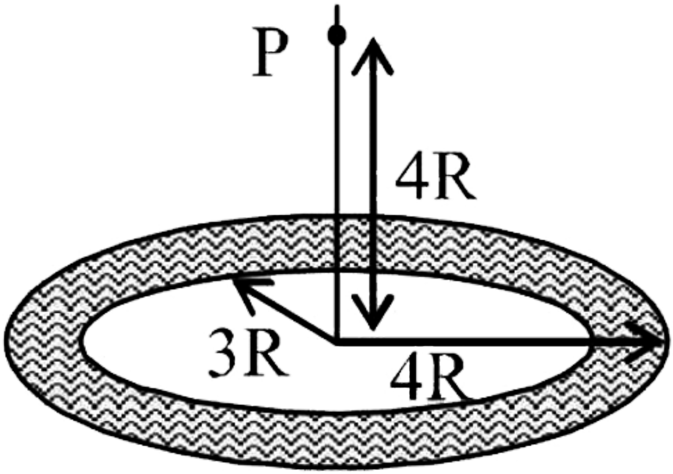
13. A thin uniform disc (see figure) of mass M has outer radius 4R and inner radius 3R. The work required to take a unit mass for point P on its axis to infinity is



A. $\frac{2GM}{7R}\left(4\sqrt{2}-5\right)$

B. $-\frac{2GM}{7R}\left(4\sqrt{-}5\right)$

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

D. $\frac{2GM}{5R}\left(\sqrt{2}-1\right)$

Answer: A

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14. A satellite is moving with a constant speed 'V' in a circular orbit about the earth. An object of mass 'm' is ejected from the satellite such that it just escapes form the gravitational pull of the earth. At the tme of its ejection, the kinetic energy of the object is

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

B. mV^2

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

D. $2mV^2$

Answer: B

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15. A planet of radius $R = \frac{1}{10} \times (radius of Earth)$ has the same mass density as Earth. Scientists dig a well of depth $\frac{R}{5}$ on it and lower a wire of the same length and a linear mass density $10^{-3} kgm(\_1)$ into it. If the wire is not touching anywhere, the force applied at the top of the wire by a person holding it inplace is (take the radius of Earth $= 6 \times 10^6 m$ and the acceleration due to gravity on Earth is $10 ms^{-2}$

A. 96 N

B. 108 N

C. 120 N

D. 150 N

Answer: B

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16. Imagine a light planet revoling around a very massiv star in a circular orbit of radius R with a period of revolution T. if the gravitatinal force of attraction between the planet and the star is proportional to $R-(5/2)$

A. $T^2 is \propto \text{ or } tional \rightarrow R^{-5/2}$

B. $T^2 is \propto \text{ or } \rightarrow nal \rightarrow R^{7/2}$

C. $T^2 is \propto \text{ or } tional \rightarrow R^{3/2}$

D. $T^2 is \propto \text{ or } tional \rightarrow R^{3/2}$

Answer: B

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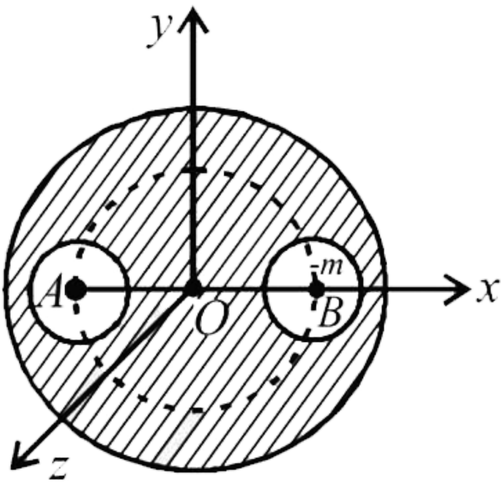
17. A solid sphere of uniform density and radius 4 units is located with its centre at the origin O of coordinates. Two sphere of equal radii 1 unit, with their centres at A(-2,0 ,0) and B(2,0,0) respectively, are taken out of the solid leaving behind spherical cavities as shown if fig Then:



A. The gravitational force due to this object at the origin is zero.

B. the gravitational force at the point B(2,0,0) is zero.

C. the gravitational potential is the same at all points of circle $y^2 + z^2 = 36$

D. the gravitational potential is the same at all points on the circle $y^2 + z^2 = 4$.

Answer: A::C::D

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18. The magnitude of the gravitational field at distance r_1 and r_2

$omthecentreofaun$ if $romsphereofradiusR$ and $massmare$

F_1 and F_2` respectively. Then:

A. $\frac{F_1}{F_2} = \frac{r_1}{r_2}$ if $r_1 < R$ and $r_2 < R$

B. $\frac{F_1}{F_2} = \frac{r_2^2}{r_1^2}$ if $r_1 > R$ and $r_2 > R$

C. $\frac{F_1}{F_2} = \frac{r_1}{r_2}$ if $r_1 > R$ and $r_2 > R$

D. $\frac{F_1}{F_2} = \frac{r_1^2}{r_2^2}$ if $r_1 < R$ and $r_2 < R$

Answer: A::B

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19. A satellite S is moving in an elliptical orbit around the earth. The mass of the satellite is very small compared to the mass of the earth.

A. The acceleration of S is always directin towards the centre of the earth.

B. The angular momentum of S about the centre of the earth changes in direction, but its magnitude remains constant.

C. The total mechanical energy of S varies periodically with time.

D. The linear momentum of S remains constant in magnitde.

Answer: A::C

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20. Two spherical planets P and Q have the same uniform density ρ, masses M_p and M_Q and surface areas A and 4A respectively. A spherical planet R also has uniform density ρ and its mass is $(M_P + M_Q)$. The escape velocities from the plantes P,Q and R are $V_P V_Q$ and V_R respectively. Then

A. $V_Q > V_R > V_P$

B. $V_R > V_Q > V_P$

C. $\frac{V_P}{V_P} = 3$

D. $\frac{V_P}{V_Q} = \frac{1}{2}$

Answer: B::D

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21. Two bodies, each of mass M, are kept fixed with a separation 2L. A particle of mass m is projected from the midpoint of the line joining their centres, perpendicular to the line. The gravitational constant is G. The correct statement (s) is (are)

A. The minimum initial velocity of the mass m to escape the gravitational field of the two bodies in $4\sqrt{\frac{GM}{L}}$

B. The minimum initial velocity of the mass m to escape the gravitational field of the two bodies is $2\sqrt{\frac{GM}{L}}$

C. The minimum initial velocity of the mass m t eacape the gravitational field of the two bodies is $\sqrt{\frac{2GM}{L}}$

D. The energy of the mass m remains constant

Answer: B

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22. Two satellites S_1 and S_2 revole round a planet in coplanar circular orbits in the same sanse. Their periods of revolution are 1 hour and 8 hour respectively. The radius of the orbit of

$S_1 is 10^4 km,$ When $S_2 is closest \to S_1$ find

(i) the speed of $S_2 relative \to$ S_1$(ii) the angar speed of$S_2

$as actually observed by an * ronautis$S_1.`

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23. Three particles, each of mass m, are situated at the vertices of equilateral triangle of side length a. The only forces. It is desired that each particle moves in a circle while maintaining the original mutual speration a. Find the intial velocity that should be given to each particle and also the time period of the circular motion.

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24. 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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25. The distance between the centres of two stars is 10α. The masses of these stars are M and 16M and their radii α and 2α. A body of mass m is fired straight from the surface of the larger star towards the smaller star. What should be its minimum initial speed to reach the surface of teh smaller star?

Obtain the expression interms of G, M and α.

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26. A body is projected vartically upwards from the bottom of a crater of moon of depth $\frac{R}{100}$ where R is the radius of moon with a velocity equal to the escape velocity on the surface of moon. Calculate maximum height attained by the body formt eh surface of the moon.

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27. Assertion : An astronaut in an orbiting space station above the earth experience weightlessness.

Reason : An object moving around the earth under the infuence of earth's gravitational force is in a state of 'free fall'

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28. Assertion : An astronaut in an orbiting space station above the earth experience weightlessness.

Reason : An object moving around the earth under the infuence of earth's gravitational force is in a state of 'free fall'

A. Statement -1 is True, Statement -2 is True, Statement 2 is a correct explanation for Statement -1

B. Statement -1 is True, Statement for Statement -2 is True , Statement - 2 is NOT a correct explanation for Statement -1`

C. Statement -1 is True, Statement -2 is False

D. Statement -1 is False, Statement -2 is True

Answer: A

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29. Graviational acceleration on the surface of plane fo $\frac{\sqrt{6}}{11}g$. where g is the gracitational acceleration on the surface of the earth. The average mass density of the planet is $\frac{2}{3}$ times that of the earth. If the escape speed on the surface of the earht is taken to be $11kms^{-1}$ the escape speed on teh surface of the planet in kms^{-1} will be

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30. A bullet is fired vertically upwards with velocity v form the surface of a spherical planet. If the escape velocity from the planet is $v_{esc} = v\sqrt{N}$, then the value of N is (ignore energy loss due to atmosphere)

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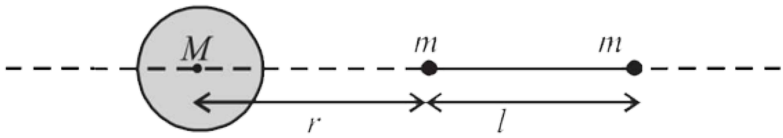
31. A larger spherical mass M is fixed at one position and two identical point masses m are kept on a line passing through the centre of M. The point masses are connected by rigid massless rod of length l and this assembly is free to move along the line connecting them. All three masses interact only throght their mutual gravitational interaction. When the point mass nearer to M is at a distance r =3l form M, the tensin in the rod is zero for $m = k\left(\frac{M}{288}\right)$. The value of k is



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32. The kinetic energy needed to project a body of mass m from the eath surface (radus R) to infinity is

A. mgR/2

B. 2mgR

C. mgR

D. mgR/4

Answer: C

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33. If suddenly the gravitational force of attraction between Earth and a stellite revolving around it becomes zero, then the stellite will

A. continue to move in its orbit with same velocity

B. move tangentially to the original orbit in the same velocity

C. become stationary in its orbit

D. move towards the earth

Answer: B

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34. Energy required to move a body of mass m from an orbit of radius 2R to 3R is

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

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

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

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

Answer: D

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35. The escape velocity of a body depeds upon mass as

A. m^0

B. m^1

C. m^2

D. m^3

Answer: A

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36. The time period of a satellite of earth is 5 hours. If the separation between the earth and the satellite is increased speartion between the earth and the satellite is increased to 4 times the previous value, the new time period will becomes

A. 10 hours

B. 80 hours

C. 40 hours

D. 20 hours

Answer: C

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37. Two spherical bodies of mass M and 5M & radii R & 2R respectively are released in free space with initial separation between their centres equal to 12R. If they attract each other due to gravitational force only, then the distance covered by the smallar body 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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38. The escape velocity for a body projected vertically upwards from the surface of earth is 11km/s. If the body is projected at an angle of 45° with the vertical, the escape velocity will be

A. $11\sqrt{2}k\frac{m}{s}$

B. 22km/s

C. 11km/s

D. $\frac{11}{\sqrt{2}} k \frac{m}{s}$

Answer: C

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39. A satellite of mass m revolves around the earth of radius R at a hight 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. $\frac{gR^2}{R+x}$

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

C. gx

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

Answer: D

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40. The time period of an earth stellite in circuarl orbit is independet fo

A. both the mass and radisu of the orbit

B. radius of its orbit

C. the mass of the satelllite

D. neither the mass of the satellite nor the radius of it orbits.

Answer: C

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41. If 'g' is the potential energy of an object of mass 'm' raised from the surface of the earth to a height equal to the radius 'R' of the earth is

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

B. (1)/(2)mgR`

C. 2mgR

D. mgR

Answer: B

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42. Suppose the gravitational force varies inversely as the nth power of distance. Then the time period of a planet in circular orbit of radius 'R' around the sun will be proportional to

A. R^{n}

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

C. $R^{\frac{n+1}{2}}$

D. $R^{\frac{n-2}{2}}$

Answer: C

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

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

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

C. d= h

D. d =2h

Answer: D

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44. A particle of mass 10g is kept on the surface of a uniform sphere of masss 100kg and radius 10cm. Find the work to be done against the gravitational force between them to take the particel far away from the sphere (you may take $G = 6.67 \times 10^{-11} N \frac{m^2}{k} g^2)$

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

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

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

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

Answer: C

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45. Average density of the earth

A. is a complex function of g

B. does not depend on g

C. is inversely proportional to g

D. is directly proportional to g

Answer: D

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

A. $1.1 kms^{-1}$

B. $11 kms^{-1}$

C. $110 kms^{-1}$

D. $0.11 kms^{-1}$

Answer: C

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47. This question contains Statement -1 and Stantement -2 Of the four choices given after the statements, choose the one that best desctibes the two statemesnts.

Statement -1:

For a mass M kept at the center of a cube of side 'a', the flux of gravitational field passing through its sides $4\pi GM$.

Statement -2:

If the direction of a field due to a point source is radial and its dependence on the distance 'r' from the source is given as $\frac{1}{r^2}$, its flux throught a closed surface depends only on the strength of the source enclosed by the surfcae and not on the size or shape of the surface.

A. Statement -1 is false, Statement -2 is true.

B. Statement-1 is true, Statement -2 is true, Statement -2 is a correct explanation for Statement -1

C. Statement -1 is true, Statement -2 is true, Statement-2 is not a correct explanation for Statement -1

D. Statement -1 is true, Statement -2 is false

Answer: B

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48. The height at which the acceleration due to gravity becomes $\frac{g}{9}$ (where g =the acceleration due to gravity on the surface of the earth) in terms of R, the radius of the earth, is :

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

B. R /2

C. $\sqrt{2}R$

D. 2R

Answer: D

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49. Two bodies of masses m and 4m are placed at a distance r. The gravitational potential at a point on the line joining them where the gravitational field is zero is:

A. $-\frac{4Gm}{r}$

B. $-\frac{6Gm}{r}$

C. $-\frac{9Gm}{r}$

D. zero

Answer: C

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50. The mass of a spaceship is 1000kg. It is to be launched from the earth's surface out into free space. The value of g and R (radius of earth) are $10\frac{m}{s^2}$ and 6400 km respectively. The required energy for this work will be:

A. $6.4 \times 10^{11} Jo\underline{e}s$

B. $6.4 \times 10^{8} Jo\underline{e}s$

C. $6.4 \times 10^{9} Jo\underline{e}s$

D. $6.4 \times 10^{10} Jo\underline{e}s$

Answer: D

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51. What is the minimum energy required to launch a satellite of mass m from the surface of a planet of mass M and radius R in a circular orbit at an altitude of 2R?

A. $\frac{5GmM}{6R}$

B. $\frac{2GmM}{3R}$

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

D. $\frac{GmM}{2R}$

Answer: A

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

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

C. sqrt((GM)/(R) (1+2sqrt2))`

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

Answer: D

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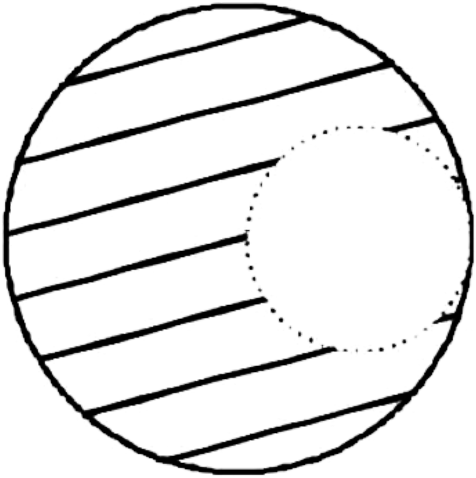
53. From a solid sphere of mass M and radius R, a spherical portion of radius R/2 is removed, as shown in the figure Taking gravitational potential $V = 0 at r = \infty$, the potential at (G =

gravitational constatn)



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

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

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

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

Answer: D

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54. A satellite is revolving in a circular orbit at a height 'h' from the earth's surface (radius of earth R, h ltltR). The minimum increase in its orbital velocity required, So that the satellite could escape from the erth's gravitational field, is close to : (Neglect the effect of atomsphere.)

A. $\sqrt{gR/2}$

B. $\sqrt{gR\left(\sqrt{2-1}\right)}$

C. $\sqrt{2gR}$

D. $\sqrt{gR}$

Answer: B

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