PHYSICS

BOOKS - DISHA PUBLICATION PHYSICS (HINGLISH)

GRAVITATION

Jee Main 5 Years At A Glance

1. Suppose that angular velocity of rotation of earth is increased. Then, as a consequence :

A. there will be no change in weight anywhere on the earth

B. weight of the object, everywhere on the earth, will decrease

C. Weight of the object, everywhere on the earth , will increase

D. except at poles, weight of the object on the earth will decrerase

Answer: D

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2. A body of mass m is moving in a circular orbit of radius R about a planet of mass M. At some instant, it splits into two equal masses. The first mass moves in a circular orbit of radius $\frac{R}{2}$. And the other mass, in a circular orbit of radius $\frac{3R}{2}$. The difference between the final and initial total energies is :

A. $-\frac{\text{GMm}}{2R}$

B. $+\frac{\text{GMm}}{6R}$

C. $-\frac{\text{GMm}}{6R}$

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

Answer: C

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3. If the earth has no rotational motion, the weight of a person on the equation is W. Detrmine the speed with which the earth would have to rotate about its axis so that the person at the equator will weight $\frac{3}{4}$ W. Radius of the earth is 6400 km and g = 10 m/s^2.

A. 1.1×10^{-3} rad/s

B. 0.83×10^{-3} rad/s

C. 0.63×10^{-3} rad/s

D. 0.28×10^{-3} rad/s

Answer: C

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4.

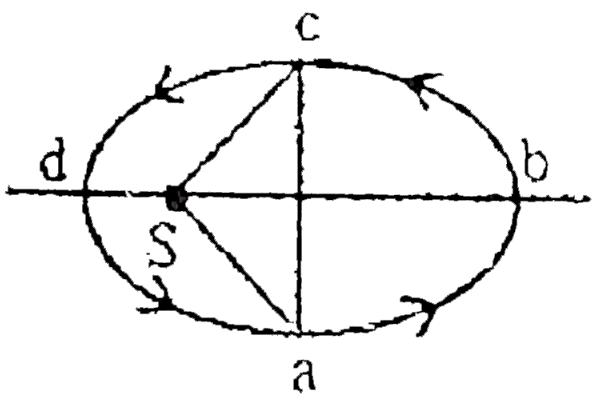

Figure elliptical path abcd of a planet around the sun S such that the area of Delta csa is $\frac{1}{4}$ the area of the ellipse, (see figure) with db as the semimajor axis, and ca as the semiminor axis if t_1 is the time taken for planet to go over path abc and t_2 for path taken over cda then:

A. $t_1 = e t_2$

B. $t_1 = 2 t_2$

C. $t_1 = 3 t_2$

D. $t_1 = t_2$

Answer: C

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5. An astronaut of mass m is working on a satellite orbitting the earth at a distance h from the earth's surface the radius fo the earth is R while its mass is M the gravitational pull F_G on the astronaut is

A. Zero since astronaut feels weightless

B. $\frac{\text{GMm}}{(R+h)^2} < F_G < \frac{\text{GMm}}{R^2}$

C. $F_G = \frac{\text{GMm}}{(R+h)^2}$

D. $0 < F_G < \frac{\text{GMm}}{R^2}$

Answer: C

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

A. $\sqrt{gR/2}$

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

C. $\sqrt{2gR}$

D. $\sqrt{gR}$

Answer: B

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7. 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.

Answer: C

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8. A very long (length L) cylindrical galaxy is made of uniformly distributed mass and has radius R $(R < < L)$ A star outside the galaxy is orbiting the galaxy in a plane perpendicular to the galaxy and passing through its centre. If the time period of star is T and its distance from the galaxy's axis is r, then-

A. $T \propto r$

B. $T \propto \sqrt{r}$

C. $T \propto r^2$

D. $T^2 \propto r^3$

Answer: A

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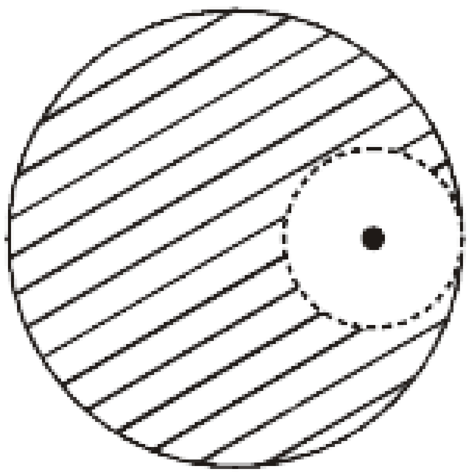
9. From a solid sphere of mass M and radius R, a spherical portion of radiu $\frac{R}{2}$ is removed as shown in the figure. Taking gravitational potential V = 0 at $r = \infty$, the potential at the centre of the cavity thus formed is (G = gravitational constant)



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

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

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

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

Answer: D

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10. The gravitational field in a region is given by $\vec{g}=\left(5\hat{i}+12\hat{j}\right)\mathrm{N\ kg}^{-1}$. The change in the gravitational potentil energy of a particle of mass 2kg when it is taken from the origin to a point $(7m, -3m)$ is

A. 71 J

B. $13\sqrt{58J}$

C. -71 J

D. 1 J

Answer: D

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11. India's Mangalyan was sent to the Mars by launching it into a transfer orbit EOM around then sun. It leaves the earth at E and meets Mars at M. If the semi-major axis of Earth's orbit is $a_e = 1.5 \times 10^{11}$ m, that of Mars orbit $a_m = 2.28 \times 10^{11}$ m , take Kepler's laws give the estimate of time for Mangalyan to reach Mars from Earth to be close to :

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A. 500 days

B. 320 days

C. 260 days

D. 220 days

Answer: B

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12. From a sphere of mass M and radius R, a smaller sphere of radius $\frac{R}{2}$ is carved out such that the cavity made in the original sphere is between its centre and the periphery (see figure.) for the configuration in the figure where the distance between the centre of the original sphere and the removed sphere is 3R, the gravitational force between the two sphere is :

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A. $\frac{41GM^2}{3600R^2}$

B. $\frac{41GM^2}{450R^2}$

C. $\frac{59GM^2}{450R^2}$

D. $\frac{GM^2}{225R^2}$

Answer: A

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

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

Answer: D

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Exercise 1

1. In planetary motion the areal velocity of possition vector of a planet depends of angular velocity (ω) and the distance of the planet from sun (r). If so the correct relation for areal velocity is

A. $\frac{dA}{dt} \propto \omega r$

B. $\frac{dA}{dt} \propto \omega^2 r$

C. $\frac{dA}{dt} \propto \omega r^2$

D. $\frac{dA}{dt} \propto \sqrt{\omega r}$

Answer: C

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2. A planet goes round the sun three times as fast as the earth. If r_p and r_e are the radii of orbit of the planet and the earth respectively then

A. $r_e^3 = 8r_p^3$

B. $r_e^3 = 3r_p^3$

C. $r_e^3 = 9r_p^3$

D. $r_e^3 = \frac{1}{3}r_p^3$

Answer: C

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

A. 10 hours

B. 80 hours

C. 40 hours

D. 20 hours

Answer: C

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4. The maximum and minimum distance of a comet form the sun are $8 \times 10^{12} m$ and $1.6 \times 10^{12} m$. If its velocity when nearest to the sun is $60 m / s$, what will be its velocity in m/s when it is farthest

A. 12

B. 60

C. 112

D. 6

Answer: A

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5. The period of moon's rotation around the earth is approx. 29 days. IF moon's mass were 2 fold its present value and all other things remain unchanged, the period of Moon's rotation would be nearly

A. $29\sqrt{2}$ days

B. $29 / \sqrt{2}$ days

C. 29×2 days

D. 29 days

Answer: D

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6. 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. $r_1^{2/5}$

B. $(r_1 + r_2)^{3/2}$

C. $(r_1 - r_2)^{3/2}$

D. $r^{3/2}$

Answer: B

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7. 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 once in 8 days. The radius of the orbit of the second satellite is

A. 8R

B. 4R

C. 2R

D. R

Answer: B

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8. Figure shows the elliptical path of a planet about the sun. The two shaded parts have equal area. If t_1 and t_2 be the time taken by the planet to go from a to b and from c to d respectively

A. $t_1 < t_2$

B. $t_1 = t_2$

C. $t_1 > t_2$

D. insufficient information ot deduce the relation between t_1 and t_2

Answer: B

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9. A planet moves around the sun. at a given point P, it is closest from the sun at a distance d_1, and has a speed V_1. At another point Q, when it is farthest from the sun at a distance d_2, its speed will be

A. $d_1^2 v_1 / d_2^2$

B. $d_2 v_1 / d_1$

C. $d_1 v_1 / d_2$

D. $d_2^2 v_1 / d_1^2)$

Answer: C

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10. Figure showns a planet in an elliptical orbit around the sun S. Where is the kinetic energy of the planet maximum?

A. A

B. B

C. C

D. D

Answer: A

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11. 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. 10

B. 100

C. $10\sqrt{10}$

D. 1000

Answer: C

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12. A satellite is revolving round the earth in an orbit of radius r with time period T. If the satellite is revolving round the earth in an orbit of radius $r+\Delta r(\Delta r < < r)$ with time period $T+\Delta T(\Delta T < < T)$ then.

A. $\frac{\Delta T}{T}=\frac{3}{2}\frac{\Delta r}{r}$

B. $\frac{\Delta T}{T}=\frac{2}{3}\frac{\Delta r}{r}$

C. $\frac{\Delta T}{T}=\frac{\Delta r}{r}$

D. $\frac{\Delta T}{T}=-\frac{\Delta r}{r}$

Answer: A

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13. Two satellites revolve round the earth with orbital radii 4R and 16 R, if the time period of first satellite is T then that of the other is

A. 4 T

B. $4^{2/3}$T

C. 8T

D. None of these

Answer: C

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14. A comet moves in an elliptical orbit with an eccentricity of e = 0.20 around a star. The distance between the perihelion and the aphelion is 1.0×10^8 km. If the speed of the comet at perihelion is 81 km/s, then speed of the comet at the aphelion is :

A. 182 km/s

B. 36 km /s

C. 121.5 km/s

D. 54 km/s

Answer: D

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15. Two masses m_1 and $m_2 (m_1 < m_2)$ are released from rest from a finite distance. They start under their mutual gravitational attraction

A. acceleration of m_1 is more than that of m_2

B. acceleration of m_2 is more than that of m_1

C. centre of mass of system will remain at rest in all the reference frame

D. total energy of system does not remains constant

Answer: B

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16. Two bodies of masses 4 kg and 9 kg are separated by a distance of 60 cm. A 1 kg mass is placed in between these two masses. If the net force on 1 kg is zero, then its distance from 4 kg mass is

A. 26 cm

B. 30 cm

C. 28 cm

D. 24 cm

Answer: D

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17. A body weighs 72 N on the surface of the earth. What is the gravitational force on it due to earth at a height equal to half the radius of the earth from the surface

A. 32 N

B. 28 N

C. 16 N

D. 72 N

Answer: A

18. If masses of two point objects is doubled and distance between them is tripled, then gravitational force of attraction between then will nearly

A. incease by 225%

B. decrease by 44%

C. decrease by 56%

D. increase by 125%

Answer: C

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19. 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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20. Two concentric uniform shells of mass M_1 and M_2 are as shown in the figure. A particle of mass m is located just within the shell M_2 on its inner surface. Gravitation force on 'm' due to M_1 and M_2 will be

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A. zero

B. $\frac{\mathrm{GM}_1 m}{b^2}$

C. $\frac{G(M_1 + M_2 m)}{b^2}$

D. None of these

Answer: B

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21. Two stars of mass m_1 and m_2 are parts of a binary star system. The radii of their orbits are r_1 and r_2 respectivey, measured from the centre of mass of the system. The magnitude of gravitational force m_1 exerts on m_2 is

A. $\frac{m_1 m_2 G}{(r_1 + r_2)^2}$

B. $\frac{m_1 G}{(r_1 + r_2)^2}$

C. $\frac{m_2 G}{(r_1 + r_2)}$

D. $\frac{(m_1 + m_2)}{(r_1 + r_2)^2}$

Answer: A

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

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

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

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

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

Answer: C

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23. There are two bodies of masses 10^3 kg and 10^5 kg separated by a distance of 1 km. At what distance from the smaller body, the inensity of gravitational field will be zero

A. 1/9 km

B. 1/10 km

C. 1/11 km

D. 10/11 km

Answer: C

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24. Two sphere of masses m and M are situated in air and the gravitational force between them is F. The space around the masses in now filled with a liquid of specific gravity 3. The gravitational force will now be

A. $\frac{F}{9}$

B. 3F

C. F

D. $\frac{F}{3}$

Answer: C

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25. As we go from the equator to the poles, the value of g

A. remains the same

B. decreases

C. increases

D. decreases upto latitude of 45°

Answer: C

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26. The ratio between the values of acceleration due to gravity at a height $1/km$ above and at a depth of 1 km below the Earth's surface is (radius of Earth is R)

A. $\dfrac{R-2}{R-1}$

B. $\dfrac{R}{R-1}$

C. $\dfrac{R-2}{R}$

D. 1

Answer: A

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27. The angular velocity of the earth with which it has to rotate so that the acceleration due to gravity on 60° latitude becomes zero is

A. 2.5×10^{-3} rad/s

B. 5.0×10^{-1}rad/s

C. 10×10^{1} rad/s

D. 7.8×10^{-2} rad/s

Answer: A

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28. In order to make the effective acceleration due to gravity at the equator to zero, the numerical value of the angular velocity of rotation of the earth should be

[Radius of the earth=6400 km, $g = 10\frac{m}{s^2}$]

A. zero

B. $\frac{1}{800}$ rad $\sec^{-1}$

C. $\frac{1}{80} \text{rad} \sec^{-1}$

D. $\frac{1}{8}\text{rad} \quad \sec^{-1}$

Answer: B

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29. What should be the velocity of earth due to rotation about its own axis so that the weight at equator become 3/5 of initial value. Radius of earth on equator is 6400 km

A. 8.7×10^{-7}rad/s

B. 7.8×10^{-4} rad/s

C. 6.7×10^{-4} rad/s

D. 7.4×10^{-3} rad / s

Answer: B

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30. If the density of a small planet is the same as that of earth while the radius of the planet is 0.2 times that of the earth the gravitational on the surface of that planet is :

A. 0.2 g

B. 0.4 g

C. 2g

D. 4g

Answer: A

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31. 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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32. The radius of a planet is n times the radius of earth (R). A satellite revolves around it in a circle of radius 4nR with angular velocity ω. The acceleration due to gravity on planet's surface is

A. $R\omega^2$

B. 16 $R\omega^2$

C. $32nR\omega^2$

D. $64nR\omega^2$

Answer: D

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

A. 6.2 h

B. 1.4 h

C. 28 h

D. 5.6 h

Answer: B

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34. Let g be the acceleration due to gravity at the earth's surface and K the rotational kinetic energy of the earth. Suppose the earth's radius decreases by 2%. Keeping all other quantities constant, then

A. g decreases by 2% and K decreases by 4%

B. g decreases by 4% and K increases by 2%

C. g increases by 4% and K decreases by 4%

D. g decreases by 4% and K increases by 4%

Answer: C

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35. Let ω be the angular velocity of the earth's rotation about its axis. Assume that the acceleration due to gravity on the earth's surface has the same value at the equator and the poles. An object weighed at the equator gives the same reading as a reading taken at a depth d below earth's surface at a pole $(d < \; < R)$. the value of d is-

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

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

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

D. $\dfrac{\sqrt{Rg}}{g}$

Answer: A

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

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

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

C. ω^2 R

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

Answer: B

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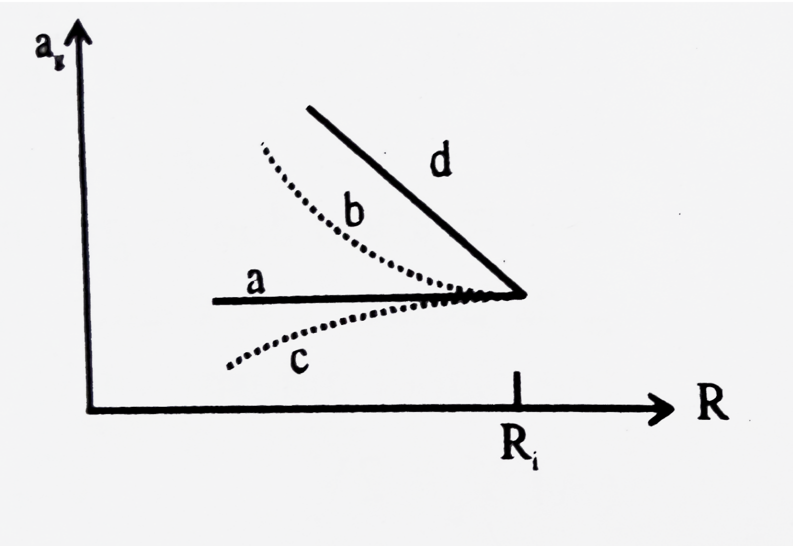
37. A(nonrotating) star collaps onto from an initial radius R_i with its mass remaining unchanged. Which curve in figure best gives the gravitational acceleration a_g on the surface of the star as a function of the radius of the star during the collapse?



A. a

B. b

C. c

D. d

Answer: B

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38. If the mass of earth is eighty times the mass of a planet and diameter of the planet is one fourth that of earth, then acceleration due to gravity on the planet would be

A. 7.8 m/s^2

B. 9.8 m/s^2

C. 6.8 m/s^2

D. 2.0 m/s^2

Answer: D

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39. 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 on the satellite will be

A. 889N

B. 89 N

C. 8889 N

D. 8.9 N

Answer: A

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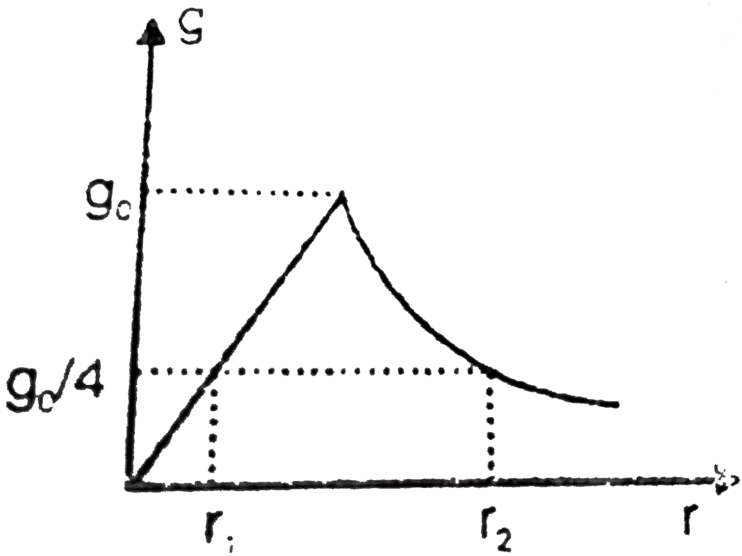
40. Figure shows variation of acceleration due to gravity with distance from centre of a uniform spherical planet, Radius of planet is R. What is $r_2 - r_1$



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Answer: B

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41. The acceleration due to gravity on the planet A is 9 times the acceleration due to gravity on planet B. A man jumps to a height of $2m$ on the surface of A. What is the height of jump by the same person on the planet B?

A. $\frac{2}{3}$ m

B. $\frac{2}{9}$ m

C. 18 m

D. 6m

Answer: C

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42. A roller coaster is designed such that riders experience "weightlessness" as they go round the top of a hill whose radius of curvature is $20m$. The speed of the car at the top of the hill is between

A. 14 m/s and 15 m/s

B. 15 m/s and 16 m/s

C. 16 m/s and 17 m/s

D. 13 m/s and 14 m/s

Answer: A

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43. In a certain region of space gravitational field is given by $I = -(k/r)$. Taking the reference point to be at $r = r_0$, with gravitational potential $V = V_0$, find the gravitational potential at distance r.

A. K log $\frac{r}{r_0} + V_0$

B. K log $\frac{r_0}{r} + V_0$

C. K log $\frac{r}{r_0} - V_0$

D. log $\frac{r_0}{r} - V_0 r$

Answer: A

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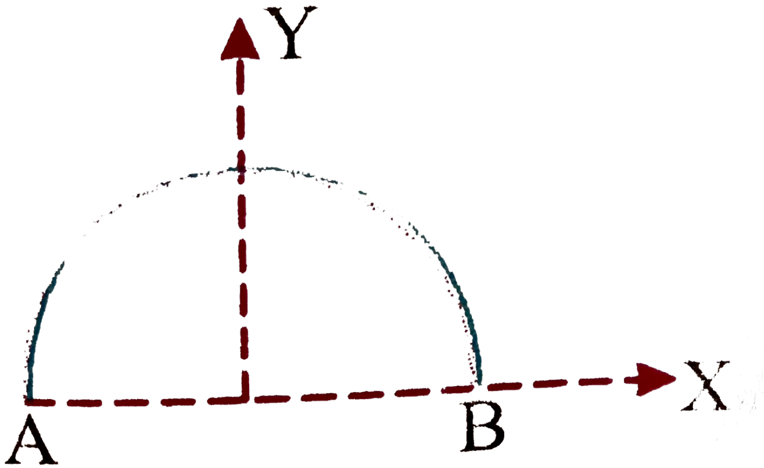
44. Gravitational field intensity at the centre of the semi circle formed by a thin wire AB of mass m and length L is



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

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45. A planet is moving in an elliptic orbit. If T, V, E and L stand, respectively, for its kinetic energy, gravitational potential energy, total energy and angular momentum about the centre of force, then

A. T is conserved

B. V is always positive

C. E is always negative

D. L is conserved but direction of vector L changes continuously

Answer: C

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

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

C. 2 mg R

D. mg R

Answer: B

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47. The magnitude of gravitational potential energy of the moon earth system is U with zero potential energy at infinite separation. The kinetic energy of the moon with respect to the earth is K.

A. $|U| = K$

B. $|U| < K$

C. $|U| > K$

D. either B or C

Answer: C

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

A. -5 unit

B. $+$ 5 unit

C. $+$ 10 unit

D. $+$ 15 unit

Answer: B

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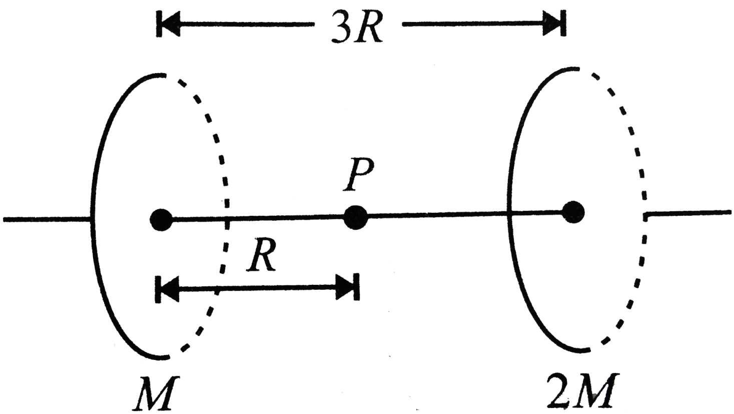
49. Two rings having masses M and $2M$ respectively, having the same radius are placed coaxially as shown in the figure.



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

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

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

C. zero

D. connot be determined from the given information

Answer: A

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50. The escape velocity of an object projected from the surface of a given planet is independent of

A. radius of the planet

B. the direction of projection

C. the mass of the planet

D. None of these

Answer: B

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51. The mean radius of earth is R, its angular speed on its own axis is w and the acceleration due to gravity at earth's surface is g. What will be the radius of the orbit of a geostationary satellite

A. $\left(R^2 g / \omega^2\right)^{1/3}$

B. $\left(R g / \omega^2\right)^{1/3}$

C. $\left(R^2 \omega^2 / g\right)^{1/3}$

D. $\left(R^2 g / \omega\right)^{1/3}$

Answer: A

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52. The moon has a mass of $\frac{1}{81}$ that of the earth and radius of $\frac{1}{4}$ that of the earth. The escape speed from the surface of the earth is 11.2 km/s. The escape speed from surface of the moon is-

A. 1.25 km/s

B. 2.49 km/s

C. 3.7 km/s

D. 5.6 km/s

Answer: B

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53. 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 km s^{-1}

B. 11 km s^{-1}

C. 110 km s^{-1}

D. 0.11 km s^{-1}

Answer: C

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54. 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 3R ?

A. $\frac{7\mathrm{GmM}}{8R}$

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

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

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

Answer: A

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

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

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

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

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

Answer: A

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56. 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

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

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

C. $\sqrt{2}$

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

Answer: D

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57. Three equal masses (each m) are placed at the corners of an equilateral triangle of side a. Then the escape velocity of an object from the circumcentre P of triangle is

A. $\sqrt{\frac{2\sqrt{3}Gm}{a}}$

B. $\sqrt{\frac{\sqrt{3}Gm}{a}}$

C. $\sqrt{\frac{6\sqrt{3}Gm}{a}}$

D. $\sqrt{\frac{3\sqrt{3}Gm}{a}}$

Answer: C

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58. A satellite is revolving round the earth (mass M_e) in a circular orbit of radius a with velocity V_0 A particle of mass m is projected from the satellite in forward direction with relative velocity $v\left[\sqrt{\frac{5}{4}}-1\right]V_0$. During subsequent motion of particle.

A. $-3GM_e$ m/8a

B. zero

C. $-5GM_e$ m/6a

D. ∞

Answer: A

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59. The orbital velocity of an artifical satellite in a circular orbit just above the earth's surface is V_0. For a satellite orbiting at an altitude of half of earth's radius, the orbital velocity is

A. $\left(\sqrt{\left(\frac{2}{3}\right)}\right)v_0$

B. $\frac{2}{3}v_0$

C. $\frac{3}{2}v_0$

D. $\sqrt{\left(\frac{3}{2}\right)}v_0$

Answer: A

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60. 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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Exercise 2

1. 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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2. 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.

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

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

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

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

Answer: C

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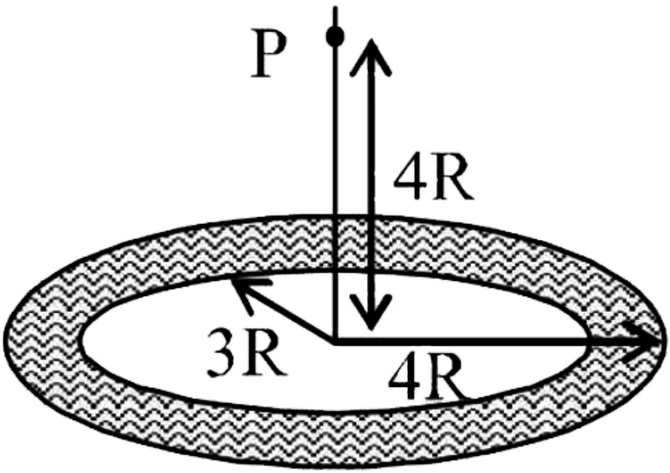
3. A thin uniform disc (see figure) of mass M has outer radius 4R and inner radius 3R. The work required to take a unit mass for point P on its axis to infinity is



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

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

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

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

Answer: A

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4. The density of a newly discovered planet is twice that of earth. The acceleration due to gravity at the surface of the planet is equal to that at the surface of the earth. If the radius of the earth is R, the radius of the planet would be

A. 1/2 R

B. 2R

C. 4R

D. 1/4R

Answer: A

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

A. $\sqrt{\frac{2Gm}{r}(\sqrt{2}-1)}$

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

C. $\sqrt{\frac{2Gm}{r}\left(1-\frac{1}{\sqrt{2}}\right)}$

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

Answer: C

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6. 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. $-\frac{G}{d}\left(M_1 + M_2 + 2\sqrt{M_1}\sqrt{M_2}\right)$

B. $-\frac{G}{d}\left(M_1 + M_2 - 2\sqrt{M_1}\sqrt{M_2}\right)$

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

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

Answer: A

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7. A spherical uniform planet is rotating about its axis. The velocity of a point on its equator is V. Due to the rotation of planet about its axis the acceleration due to gravity g at equator is $1/2$ of g at poles. The escape velocity of a particle on the planet in terms of V.

A. V_e = 2V

B. V_e = V

C. V_e = V/2

D. $V_e = \sqrt{3}V$

Answer: A

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8. The gravitational field, due to the 'left over part' of a uniform sphere (from which a part as shown , has been 'removed out') at a very far off point, P , located as shown, would be (nearly) :

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A. $\frac{5}{6}\frac{GM}{x^2}$

B. $\frac{8}{9}\frac{GM}{x^2}$

C. $\frac{7}{8}\frac{GM}{x^2}$

D. $\frac{6}{7}\frac{GM}{x^2}$

Answer: C

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9. The change in the value of acceleration of earth toward sun, when the moon coomes from the position of solar eclipse to the position on the other side of earth in line with sun is :

(mass of moon $= 7.36 \times 10^{22}$ kg, orbital radius of moon $= 3.8 \times 10^{8}$ m.)

A. $6.73 \times 10^{-5} m / s^2$

B. $6.73 \times 10^{-3} m / s^2$

C. $6.73 \times 10^{-2} m / s^2$

D. $6.73 \times 10^{-4} m / s^2$

Answer: A

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10. find the gravitational force of attraction between a uniform sphere of mass M and a uniform rod of length L and mass m, placed such that r is the distance between the centre of the sphere and the near end of the road.

A. $\frac{\text{GMm}}{r(r+l)}$

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

C. Mmr^2+l

D. (r^2+l)mM

Answer: A

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11. Two bodies of mass m_1 and m_2 are initially at rest placed infinite distance apart. They are then allowed to move towards each other under mutual gravitational attaction. Show that their relative velocity of approach at separation r betweeen them is

$$v = \frac{\sqrt{2G(m_1 + m_2)}}{r}$$

A. $\sqrt{[2G(m_1 + m_2)]}$

B. $\sqrt{\left(\frac{2G(m_1 + m_2)}{d}\right)}$

C. $\sqrt{\left(\frac{2G(m_1 m_2)}{d}\right)}$

D. $\sqrt{\left(\frac{2Gd}{m_1 + m_2}\right)}$

Answer: B

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12. 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. $\frac{Gm(M_2 - M_1)}{a}$

B. $\frac{Gm(M_2 - M_1)}{a\sqrt{2}}(\sqrt{2}+1)$

C. $\frac{Gm(M_2 - M_1)}{a\sqrt{2}}(\sqrt{2}-1)$

D. $\frac{Gm(M_2 - M_1)}{\sqrt{2}}a$

Answer: C

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13. A planet is revolving around the Sun in an elliptical orbit. Its closest distance from the sun is $r_{\min}$. The farthest distance from the sun is $r_{\max}$ if the orbital angular velocity of the planet when it is nearest to the Sun ω then the orbital angular velocity at the point when it i at the farthest distanec from the sun is

A. $\sqrt{(r_{\min}/r_{\max})}\omega$

B. $\sqrt{(r_{\max}/r_{\min})}\omega$

C. $\sqrt{\left(r_{\max}^2/r_{\min}^2\right)}\omega$

D. $\sqrt{\left(r_{\min}^2/r_{\max}^2\right)}\omega$

Answer: D

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14. The radii of two planets are respectively R_1 and R_2 and their densities are respectively ρ_1 and ρ_2.The ratio of the accelerations due to gravity at their surface is

A. $g_1 : g_2 = \frac{\rho_1}{R_1^2} : \frac{\rho_2}{R_2^2}$

B. $g_1 : g_2 = R_1 R_2 : \rho_1 \rho_2$

C. $g_1 : g_1 = R_1 \rho_2 : R_2 \rho_1$

D. $g_1 : g_2 = R_1 \rho_1 : R_2 \rho_2$

Answer: D

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15. Two blocks A and B of masses M_A and M_B respectively, are located 1.0 m apart on a horizontal surface. The coefficient of static friction μ_s between the block and the surface is 0.50. Block A is secured to the surface and cannot move, What is the minimum mass of Block A that provides enough gravitation attraction to move Block B ? Th universal gravitation constant is 6.67 $\times\ 10^{-11} N\frac{m^2}{k} g^2$.

A. 7.5×10^9kg

B. 7.3×10^{10} kg

C. 14.7×10^{11} kg

D. the problem cannnot be solved without knowing the mass of Block B.

Answer: B

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16. A cavity of radius $R/2$ is made inside a solid sphere of radius R. The centre of the cavity is located at a distance $R/2$ from the centre of the sphere. The gravitational force on a particle of a mass $'m'$ at a distance $R/2$ from the centre of the sphere on the line joining both the centres of sphere and cavity is (opposite to the centre of cavity). [Here $g = GM/R^2$, where M is the mass of the solide sphere]

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

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

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

D. None of these

Answer: B

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17. A planet of radius R has an acceleration due to gravity of g_s on its surface. A deep smooth tunne is dug on this planet, radially inward, to reach a point P located at a distance of $\frac{R}{2}$ from the centre of the planet. Assume that the planet has uniform density. The kinetic energy required to be given to a small body of mass m, projected radially outward from P, so that it gains a maximum altitude equal to the thrice the radius of the planet from its surface, is equal to

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A. $\frac{63}{16} m g_s R$

B. $\frac{3}{8} m g_s R$

C. $\frac{9}{8} m g_s R$

D. $\frac{21}{16} m g_s R$

Answer: C

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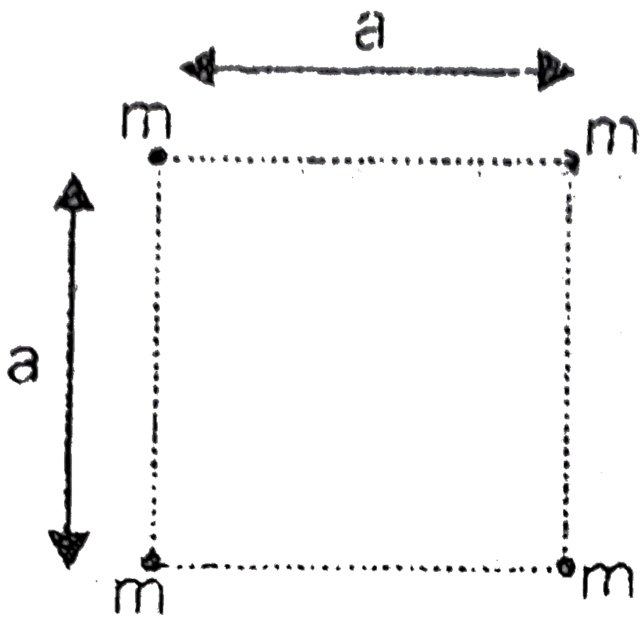
18. Four point masses each of mass 'm' are placed on the corner of square of side 'a' Calculate magnitude of gravitational force experienced each particle



A. $\dfrac{9GMm}{d^2}$

B. $\dfrac{5GMm}{d^2}$

C. $\dfrac{3GMm}{d^2}$

D. $\dfrac{GMm}{d^2}$

Answer: C

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19. In order to simulate different values of g aspiring astronauts are put on a plane which dives in a parabola given by the equation $x^2 = 500y$. Where x is horizontal, y is vertically upwards, both being measured in meter. The x-component of the velocity of the plane is constant throughout, and has the value of $360km/h$. the effective g ("g-force") experienced by an astronaut on the plane equals

A. 4g

B. 3g

C. $\frac{g}{5}$

D. 5g

Answer: D

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20. Two spheres each of mass M are situated at distance 2d (see figure). A particle of mass m ($m << M$) is taken along the path shown in figure. The work done in the process from A to B is

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A. $\frac{7Gms}{d}$

B. $\frac{8GMm}{d}$

C. $-\frac{8GMm}{d}$

D. zero

Answer: D

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21. Two hypothetical planets of masses m_1 and m_2 are at rest when they are infinite distance apart. Because of the gravitational force they move towards each other along the line joining their centres. What is their speed when their separation is 'd' ?

(speed of m_1 is v_1 and that of m_2 is v_2)

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A. $v_1 = v_2$

B.

$$v_1 = m_2\sqrt{\frac{2G}{d(m_1+m_2)}} \qquad v_2 = -m_1\sqrt{\frac{2G}{d(m_1+m_2)}}$$

C.

$$v_1 = m_1\sqrt{\frac{2G}{d(m_1+m_2)}} \qquad v_2 = m_2\sqrt{\frac{2G}{d(m_1+m_2)}}$$

D. $v_1 = m_2\sqrt{\frac{2G}{m_1}} \qquad v_2 = m_1\sqrt{\frac{2G}{m_2}}$

Answer: B

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22. The gravitational potential of two homogeneous spherical shells A and B of same surface density at their respective centres are in the ratio $3:4$. If the two shells collapse into a single one such that surface charge density remains the same, then the ratio of potential at an internal point of the new shell to shell A is equal to

A. $3:2$

B. $4:3$

C. $5:3$

D. $5:6$

Answer: C

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23. A skylab of mass m kg is first launched from the surface of the earth in a circular orbit of radius $2R$ (from the centre of the earth) and then it is shifted from this circular orbit to another circular orbit of radius $3R$. The minimum energy required to place the lab in the first orbit and to shift the lab from first orbit to the second orbit are

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

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

C. mgR, mgR

D. 2mgR, mgR

Answer: B

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24. With what minimum 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 attraction 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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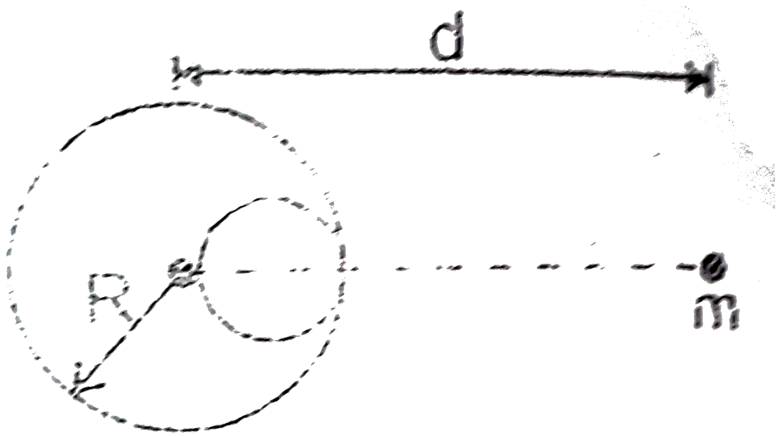
25. A spherical hollow cavity is made in a lead sphere of radius R such that is surface touches the outside surface of the lead sphere and passes through its centre. The mass of the sphere before hollowing was M with what gravitational force will the hollowed out lead sphere attract a small sphere of mass m which lies at a distacne d from the centre of the lead sphere on the straight line connecting the centeres of the spheres and that of the hollow if $d = 2R$



A. $\dfrac{3GMm}{2R^2}$

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

C. $\dfrac{GMm}{R^2}$

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

Answer: D

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

A. $2GM\left(\frac{1}{R}-\frac{1}{R_0}\right)$

B. $\sqrt{2GM\left(\frac{1}{R}-\frac{1}{R_0}\right)}$

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

D. $2GM\sqrt{\left(\frac{1}{R}-\frac{1}{R_0}\right)}$

Answer: B

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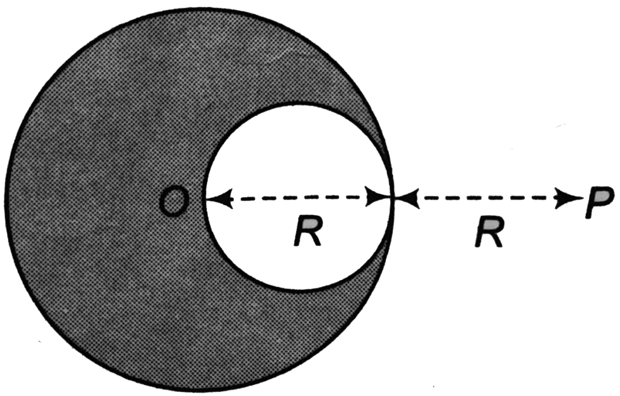
27. A solid sphere of uniform density and radius R applies a gravitational force of attraction equal to F_1 on a particle placed at P, distance $2R$ from the centre O of the sphere. A spherical cavity of radius $R/2$ is now made in the sphere as shown in figure. The particle with cavity now applies a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



A. $1/2$

B. 3

C. 7

D. $1/9$

Answer: D

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28. A small satellite of mass m is revolving around earth in a circular orbit of radius r_0 with speed v_0 . At certain point of its orbit, the direction of motion of satellite is suddenly changed by angle $\theta = \cos^{-1}(3/5)$ by turning its velocity vector , such that speed remains constant. The satellite consequently goes to elliptical orbit around earth. the ratio of speed at perigee to speed at apogee is

A. 3

B. 9

C. $1/3$

D. $1/9$

Answer: B

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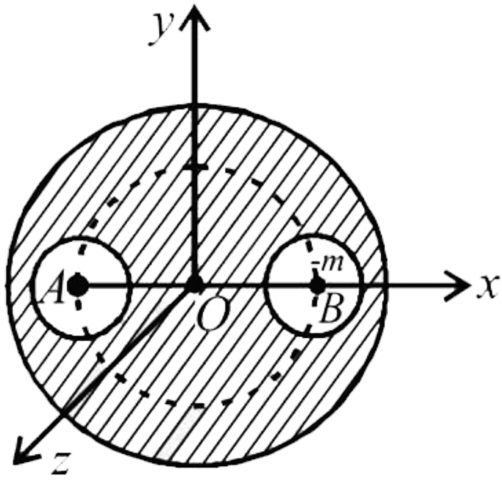
29. A solid sphere of uniform density and radius 4 units is located with its centre at the origin O of coordinates. Two sphere of equal radii 1 unit, with their centres at A(-2,0 ,0) and B(2,0,0) respectively, are taken out of the solid leaving behind spherical cavities as shown if fig Then:



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

B. $\frac{21GM}{1024}$

C. $\frac{11GM}{1024}$

D. $\frac{GM}{3124}$

Answer: A

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

A. $\dfrac{m\sqrt{R}(\sqrt{n}-1)}{a\sqrt{GM}}$

B. $\dfrac{m\sqrt{R}(\sqrt{n}+1)}{a\sqrt{GM}}$

C. $\dfrac{2m\sqrt{R}(\sqrt{n}-1)}{a\sqrt{GM}}$

D. $\dfrac{m\sqrt{R}(\sqrt{n}-1)}{a\sqrt{2GM}}$

Answer: A

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