Aggarwal CLASSES — A Division of Aggarwal Educare

Daily Practice Problems

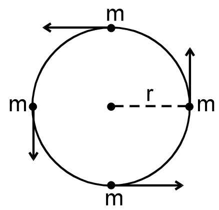
PHYSICS

Topic : Gravitation

A 1. If we ignore the presence of the sun, then there exists a point on the line joining the earth and the moon where gravitational force is zero. The point is located from the moon at a distance of (Given that earth is 81 times heavier than moon and the separation between earth and moon 4×10^8 m) :

(A) 8×10^7 m (B) 4×10^6 m (C) 4×10^7 m (D) 8×10^6 m

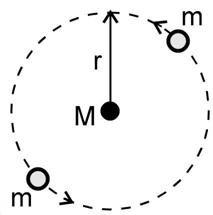
A 2. Four similar particles of mass ma are orbiting in a circle of radius r in the same direction because of their mutual gravitational attractive force. Velocity of a particle is given by



(A) $\left[\frac{Gm}{r}\left(\frac{1+2\sqrt{2}}{4}\right)\right]^{\frac{1}{2}}$ (B) $\sqrt[3]{\frac{Gm}{r}}$

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

A 3. A certain triple-star system consists of two stars, each of mass ' m ' revolving about a central star of mass M in the same circular orbit of radius ' r '. The two stars are always at opposite ends of a diameter of the circular orbit. An expression for the period of revolution of the stars is :

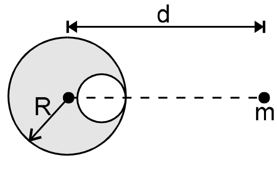


(A) $\frac{4\pi r^{3/2}}{G(M+m)}$ (B) $\frac{4\pi r^{3/2}}{\sqrt{G(4M+m)}}$ (C) $\frac{4\pi r^{3/2}}{\sqrt{G(M+m)}}$ (D) $\frac{4\pi r^{3/2}}{G(4M+m)}$

A 4. An experiment using the Cavendish balance to measure the gravitational constant G found that a mass of 0.800 kg attracts another sphere of mass 4.00×10^{-3} kg with a force of 1.30×10^{-10} N when the distance between the centres of the spheres is 0.0400 m. The acceleration due to gravity at the earth's surface is 9.80 m/s^2 and the radius of the earth is 6380 km. The mass of the earth from these data is (approximately) –

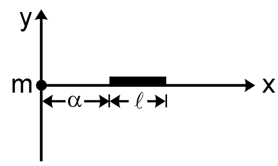
(A) 8×10^{24} kg (B) 8×10^{23} kg (C) 6×10^{23} kg (D) 6×10^{24} kg

A 5 . A spherical hollow cavity is made in a lead sphere of radius R, such that its 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 distance d from the centre of the lead sphere on the straight line connecting the centres of the spheres and that of the hollow, if d = 2R :



(A) $\frac{7GMm}{18R^2}$ (B) $\frac{7GMm}{36R^2}$ (C) $\frac{7GMm}{9R^2}$ (D) $\frac{7GMm}{72R^2}$

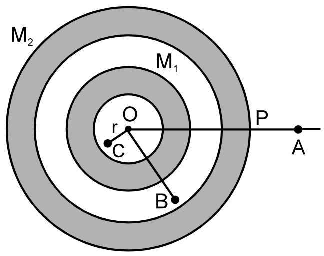
A 6. A straight rod of length ℓ extends from x = α to x = $\ell + \alpha$. If the mass per unit length is $(a + bx^2)$. The gravitational force it exerts on a point mass m placed at x = 0 is given by



(A) $Gm\left(a\left(\frac{1}{\alpha}-\frac{1}{\alpha+\ell}\right)+b\ell\right)$ (B) $\frac{Gm(a+bx^2)}{\ell^2}$

(C) $Gm\left(\alpha\left(\frac{1}{a}-\frac{1}{a+\ell}\right)+b\ell\right)$ (D) $Gm\left(a\left(\frac{1}{\alpha+\ell}-\frac{1}{\alpha}\right)+b\ell\right)$

A 7. Two concentric shells of uniform density of mass M_1 and M_2 are situated as shown in the figure. The forces experienced by a particle of mass m when placed at positions A, B and C respectively are (given OA = p, OB = q and OC = r)



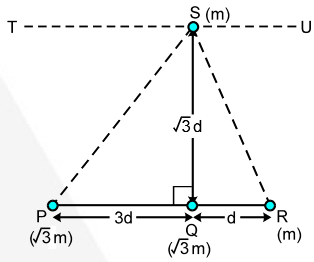
(A) zero, $G\frac{M_1 m}{q^2}$ and $G\frac{(M_1+m_2)m}{p^2}$

(B) $G\frac{(M_1+M_2)m}{p^2}$, $G\frac{(M_1+M_2)m}{q^2}$ and $G\frac{M_1 m}{r^2}$

(C) $G\frac{M_1 m}{q^2}$, $\frac{G(M_1+M_2)m}{p^2}$, $G\frac{M_1 m}{q^2}$ and zero

(D) $\frac{G(M_1+M_2)m}{p^2}$, $G\frac{M_1 m}{q^2}$ and zero

A 8. Three particles P, Q and R are placed as per given figure. Masses of P, Q and R are $\sqrt{3}$ m, $\sqrt{3}$ m and m respectively. The gravitational force on a fourth particle 'S' of mass m is equal to



(A) $\frac{\sqrt{3}\,GM^2}{2d^2}$ in ST direction only

(B) $\frac{\sqrt{3}\,Gm^2}{2d^2}$ in SQ direction and $\frac{\sqrt{3}\,Gm^2}{2d^2}$ in SU direction

(C) $\frac{\sqrt{3}\,Gm^2}{2d^2}$ in SQ direction only

(D) $\frac{\sqrt{3}\,Gm^2}{2d^2}$ in SQ direction and $\frac{\sqrt{3}\,Gm^2}{2d^2}$ in ST direction

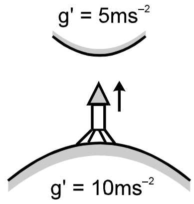
A 9. No two bodies on the earth move towards each other inspite of the force of gravitational attraction between them. Explain why?

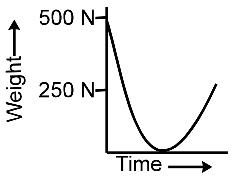
A 10. Do the force of friction, and other contact forces arise due to gravitational attraction? If not, what is the origin of these forces?

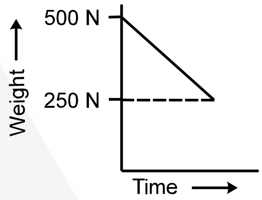
A 11. Solid spheres of same material and same radius 'r' are touching each other. If the density is 'ρ' then find out gravitational force between them.

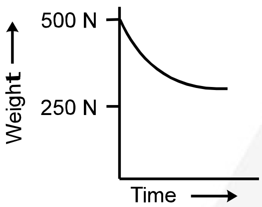
A 12. Suppose a tunnel could be dug through the earth from one side to the other along a diameter and particle of mass M is, dropped into it. If all frictional forces are neglected, the particle will
(A) enter from one side and come out from the other with a velocity greater than that at the centre
(B) stop at the centre of the earth as earth attracts all bodies towards its centre
(C) undergo simple harmonic motion and never stop
(D) take a spiral path in the tunnel till it comes out from the other end

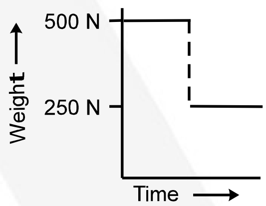
A 13. If acceleration due to gravity is 10 ms^{-2} then let acceleration due to gravitational force at another planet of our solar system be 5 ms^{-2}. An astronaut weighing 50 kg on earth goes to this planet in a spaceship with a constant velocity. The change in the weight of the astronaut with time of flight is roughly given by



(A) 

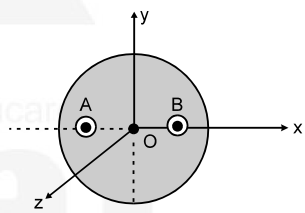
(B) 

(C) 

(D) 

A 14. 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 proportional to $R^{-5/2}$ then
(A) T^2 is proportional to R^3
(B) T^2 is proportional to $R^{7/2}$
(C) T^2 is proportional to $R^{3/2}$
(D) T^2 is proportiona to $R^{3.75}$

A 15. A solid sphere of uniform density and radius 4 units is located with its centre at the origin O of coordinates. Two spheres of equal radii 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 in the figure.



(A) The gravitational field due to this object at the origin is zero.
(B) The gravitational field at the point B(2, 0, 0) is zero
(C) The gravitational field at the point A(–2, 0, 0) is zero.
(D) The gravitational field at points A, O and B is zero.

A 16. In the above question :
(A) The gravitational potential is different at different points of circle $y^2 + z^2 = 36$
(B) The gravitational potential is different at all points of circle $y^2 + z^2 = 4$
(C) The gravitational potential is same at all points of circle $y^2 + z^2 = 36$ and the potential is same at all points of circle $y^2 + z^2 = 4$
(D) Nothing can be said about potetnial with the given data.

A 17. The magnitudes of the gravitational field at distances r_1 and r_2 from the centre of a uniform sphere of radius R and mass M are F_1 and F_2 respectively, then :

(A) $\frac{F_1}{F_2} = \frac{r_1}{r_2}$ if $r_1 < R$ & $r_2 < R$ (B) $\frac{F_1}{F_2} = \frac{r_2^2}{r_1^2}$ if $r_1 > R$ & $r_2 > R$

(C) $\frac{F_1}{F_2} = \frac{r_1}{r_2}$ if $r_1 > R$ & $r_2 > R$ (D) $\frac{F_1}{F_2} = \frac{r_1^2}{r_2^2}$ if $r_1 < R$ & $r_2 < R$

A 18. A satellite is launched into a circular orbit of radius R around the earth A. Second satellite is launched into an orbit of radius 1.01 R. The period of the second satellite is larger than the first one by approximately :
(A) 0.7 % (B) 1.0 % (C) 1.5 % (D) 3.0 %

A 19. Two particle are projected vertically upwards with the same velocity on two different planets with accelerations due to gravities g_1 and g_2 respectively. If they fall back to their initial points of projection after lapse of times t_1 and t_2 respectively, then

(A) $t_1 t_2 = g_1 g_2$ (B) $t_1 g_1 = t_2 g_2$ (C) $t_1 g_2 = t_2 g_1$ (D) $t_1^2 + t_2^2 = g_1 + g_2$

A 20. 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

A 21. Distance between the centres of two stars is 10 a. The masses of these stars are M & 16 M & their radii a & 2 a respectively. A body of mass ' m ' is fired straight from the surface of the larger star towards the smaller star. What should be its minimum initial speed to reach the surface of the smaller star ? Obtain the expression in terms of G, M & a.

A 22. If the radius of the earth be increased by a factor of 5, by what factor its density be changed to keep the value of g the same ?

(A) 1/25 (B) 1/5 (C) $1/\sqrt{5}$ (D) 5

A 23. An artificial satellite moving in a circular orbit around the earth has a total (kinetic + potential) energy E^o. Its potential energy is :
(A) $-E^o$ (B) $1.5\,E^o$ (C) $2\,E^o$ (D) E^o

A 24. The ratio of Earth's orbital angular momentum (about the sun) to its mass is, 4.4×10^{15} m^2/s. The area enclosed by earth's orbit is approximately _______ m^2.

A 25. Two particles, each of mass M, move around in a circle o radius R under the action of their mutual gravitational attraction. The speed of each particle is

(A) $\sqrt{\frac{GM}{R}}$ (B) $\sqrt{\frac{GM}{2R}}$ (C) $\sqrt{\frac{GM}{4R}}$ (D) $\sqrt{\frac{2GM}{R}}$

A 26. At what distance R, from the center of the earth, does the acceleration due to gravity becomes one half of the value that it has on the surface of the earth? (R_e is the earth's radius)

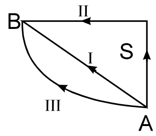
(A) $R = \sqrt{2}\,R_e$ (B) $R = \sqrt{3}\,R_e$ (D) $R = 2R_e$ (D) $R = \sqrt{5}\,R_e$

A 27. A satellite of mass 100 kg is placed initially in a temporary orbit 800 km above the surface of earth. The satellite is to be placed now in a permanent orbit at 2000 km above the surface of earth. Find the amount of work done to move the satellite from the temporary to permanent orbit. The radius of the earth is 6400 km.

A 28. 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 T_2/T_1 is:

(A) 1 (B) $\sqrt{2}$ (C) 4 (D) 2

A 29. A particle of mass m is taken through the gravitational field produced by a source S, from A to B, along the three paths as shown in figure. If the work done along the paths as shown in the figure. If the work done along the paths I, II and III is W_I, W_{II} and W_{III} respectively, then



(A) $W_I = W_{II} = W_{III}$ (B) $W_{II} > W_{III} = W_{II}$
(C) $W_{III} = W_{II} > W_I$ (D) $W_I > W_{u} > W_{III}$

A 30. A double star system consists of two stars A and B which have time period T_A and T_B. Radius R_A and R_B and mass M_A and M_B. Choose the correct option.

(A) If $T_A > T_B$ then $R_A > R_B$ (B) If $T_A > T_B$ then $M_A > M_B$ (C) $\left(\frac{T_A}{T_B}\right)^2 = \left(\frac{R_A}{R_B}\right)^3$ (D) $T_A = T_B$

Answers

A 1. C **A 2.** A **A 3.** B **A 4.** D **A 5 .** B **A 6.** A
A 7. D **A 8.** C

A 9. Gravitational attraction is a weak force, can not over come friction.

A 10. No, Electromagnetic interection between the charges.

A 11. $\frac{4}{9}\pi^2\rho^2 G r^4$

A 12. C **A 13.** A

A 14. B **A 15.** A **A 16.** C
A 17. AB **A 18.** C **A 19.** B

A 20. B **A 21.** $v_{min} = 1.5\sqrt{\frac{5GM}{a}}$

A 22. B **A 23.** C

A 24. $6.93 \times 10^{22}\ m^2$ **A 25.** C

A 26. A **A 27.** 4.06×10^8 J

A 28. D **A 29.** A **A 30.** D