DPP – 1 & 2 (Gravitation)

Video Solution on Website :- https://physicsaholics.com/home/courseDetails/100

Video Solution on YouTube:- https://youtu.be/iqIlbHGVv0I

Written Solution on Website:- https://physicsaholics.com/note/notesDetalis/55

Q 1. Three particles of equal mass m are situated at the vertices of an equilateral triangle of side l. What should be the velocity of each particle, so that they move on a circular path without changing l -

(a) $\sqrt{\frac{GM}{2\ell}}$ (b) $\sqrt{\frac{GM}{\ell}}$

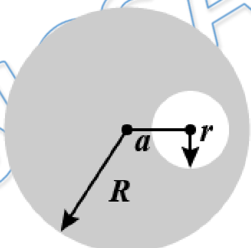
(c) $\sqrt{\frac{2GM}{\ell}}$ (d) $\sqrt{\frac{GM}{3\ell}}$

Q 2. A spherical shell is cut into two pieces along a chord as shown in figure . If I_1 and I_2 are gravitational field strength at P due to upper part and lower part respectively, then

(a) $I_1 > I_2$ (b) $I_1 < I_2$

(c) $I_1 = I_2 = 0$ (d) $I_1 = I_2 \neq 0$

Q 3. 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 center 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

Q 4. Inside a uniform sphere of density ρ there is a spherical cavity whose center is at a distance l from the center of the sphere. Find the strength of the gravitational field inside the cavity.

(a) $E = -\frac{2}{3}\pi G\rho l$ (b) $E = -\frac{4}{3}\pi G\rho l$

(c) $E = -\frac{4}{3}\pi^2 G\rho l$ (d) $E = -\frac{4}{3}\pi G\rho^2 l^2$

Q 5. A straight rod of length l extends from x = a to x = L + a. Find the gravitational force exerts on a point mass m at x = 0 is (if the linear density of rod $\mu = A + Bx^2$)

(a) $Gm\left[\frac{A}{a} + BL\right]$ (b) $Gm\left[A\left(\frac{1}{a} - \frac{1}{a+L}\right) + BL\right]$

(c) $Gm\left[BL + \frac{A}{a+L}\right]$ (d) $Gm\left[BL - \frac{A}{a}\right]$

Q 6. The gravitational field in a region is given by ($2\hat{\imath} + 2\hat{\jmath}$) N /kg. What is the work done by an external agent to slowly shift a particle of mass 10 kg from the point (0,0) to a point (5m, 4m) ?

(a) 180 J (b) – 180 J

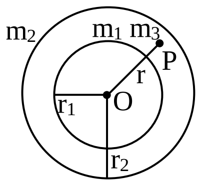
(c) 90 J (d) – 90 J

Q 7. A small body of superdense material , whose mass twice the mass of the earth but whose size is very small compared to the size of the earth , starts from 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) $\sqrt{2H/g}$ (b) $\sqrt{H/g}$

(c) $\sqrt{2H/3g}$ (d) $\sqrt{4H/3g}$

Q 8. Two concentric spherical shells have masses m1 and m2 and radii r1 and r2. Then–



(a) Outer shell will have no contribution in gravitational field at point P

(b) Force on P is directed towards O

(c) Force on P is $\frac{Gm_1m_2}{r^2}$

(d) Force on P is $\frac{Gm_1m_3}{r^2}$

Q 9. A particle of mass m is placed at centre of uniform ring of mass M and radius R . Mass m is slightly displaced along axis and released . If ring is also free to move, angular frequency of shm is

(a) $\sqrt{\frac{G(M+m)}{R^3}}$ (b) $\sqrt{\frac{G(M+m)}{2R^3}}$

(c) $\sqrt{\frac{GM(M+m)}{mR^3}}$ (d) $\sqrt{\frac{Gm(M+m)}{MR^3}}$

Q 10. Gravitational field at surface of earth is $9.8 m/sec^2$ and at height h it is $9.6 m/sec^2$ .Gravitational field at depth h from ground is

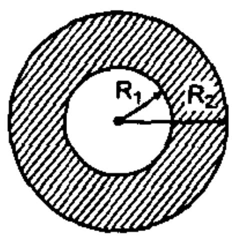
(a) $9.6 m/sec^2$

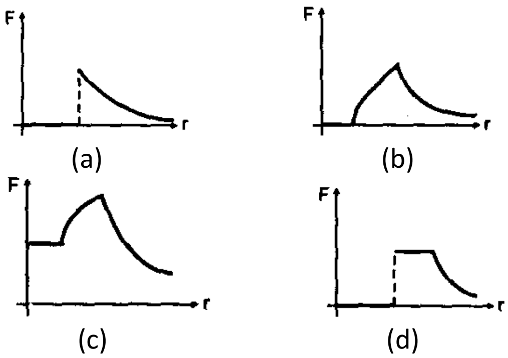
(b) $9.7 m/sec^2$

(c) $9.4 m/sec^2$

(d) $10 \ m/sec^2$

Q 11. A sphere of mass M and radius R_2 has a concentric cavity of radius R_1 as shown in figure. The force F exerted by the sphere on a particle of mass in located at a distance r from the centre of sphere varies as ($0 \le r \le \infty$) :





Q 12. The Earth may be regarded as a spherically shaped uniform core of density ρ_1 and radius R/2 surrounded by a uniform shell of thickness R/2 and density ρ_2. Find the ratio of $\frac{\rho_1}{\rho_2}$ if the value of acceleration due to gravity is the same at surface as at depth R/2 from the surface

(a) 2/1

(b) 5/3

(c) 7/4

(d) 7/3

Q 13. A small body of mass m is projected with a velocity just sufficient to make it reach from the surface of a planet (of radius 2R and mass 3M) to the surface of another planet (of radius R and mass M). The distance between the centers of the two spherical planets is 6R. Find distance of small body from centre of bigger planet when it acquires its minimum speed

(a) $2R[3-\sqrt{3}]$

(b) $3R[2-\sqrt{3}]$

(c) $2R[2-\sqrt{3}]$

(d) $3R[3-\sqrt{3}]$

Q 14. There is a smooth tunnel along a chord of earth. Mass of earth is M and its radius is R. Length of tunnel is R/2. A particle is releases in tunnel from surface of earth(one end of tunnel. Velocity of particle at centre of tunnel is (assuming particle is just fitted in tunnel)

(a) $\frac{1}{2}\sqrt{\frac{GM}{R}}$ (b) $\frac{1}{4}\sqrt{\frac{GM}{R}}$

(c) $\frac{1}{3}\sqrt{\frac{GM}{R}}$ (d) $\frac{1}{5}\sqrt{\frac{GM}{R}}$

Q 15 A uniform spherical shell is devided into two hemispheres as shown in figure. P is a point at deviding surface (not at centre of sphere). Gravitational field at P due to lower hemisphere have direction along

(a) a

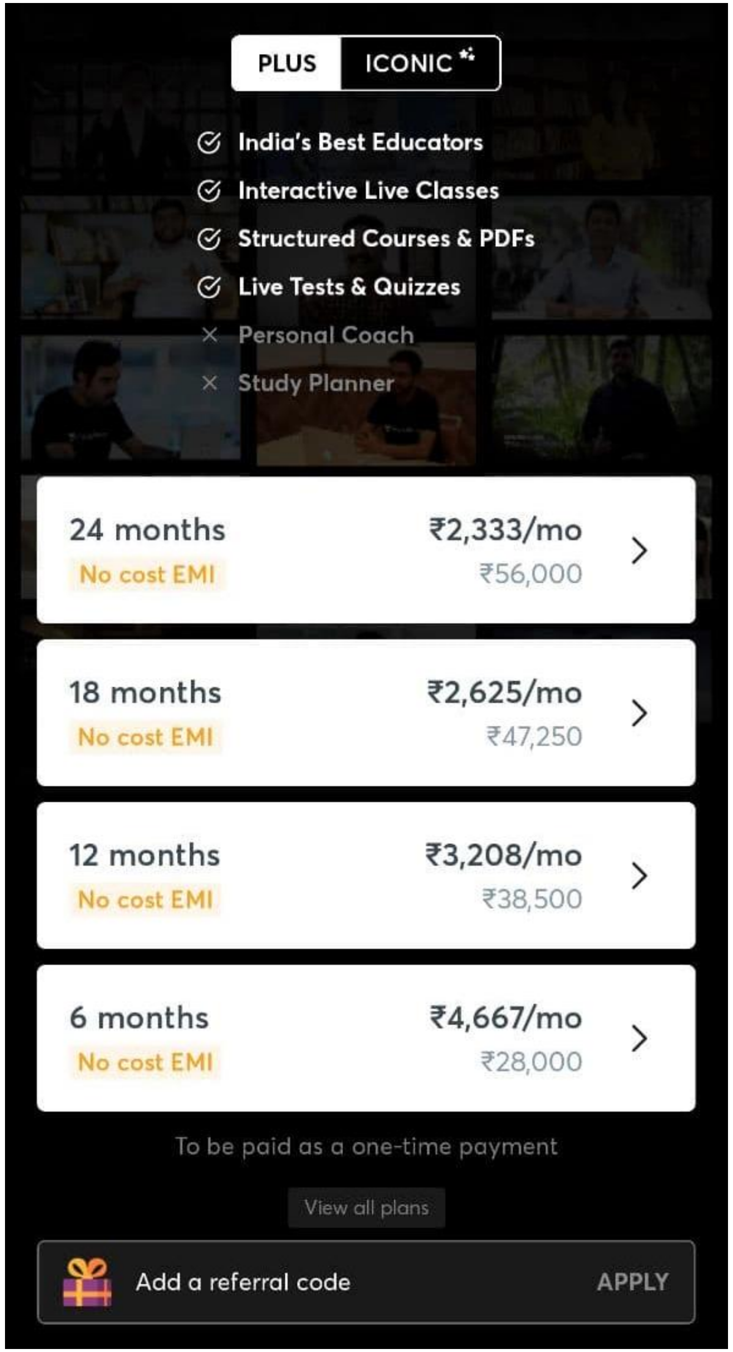
(b) b

(c) c

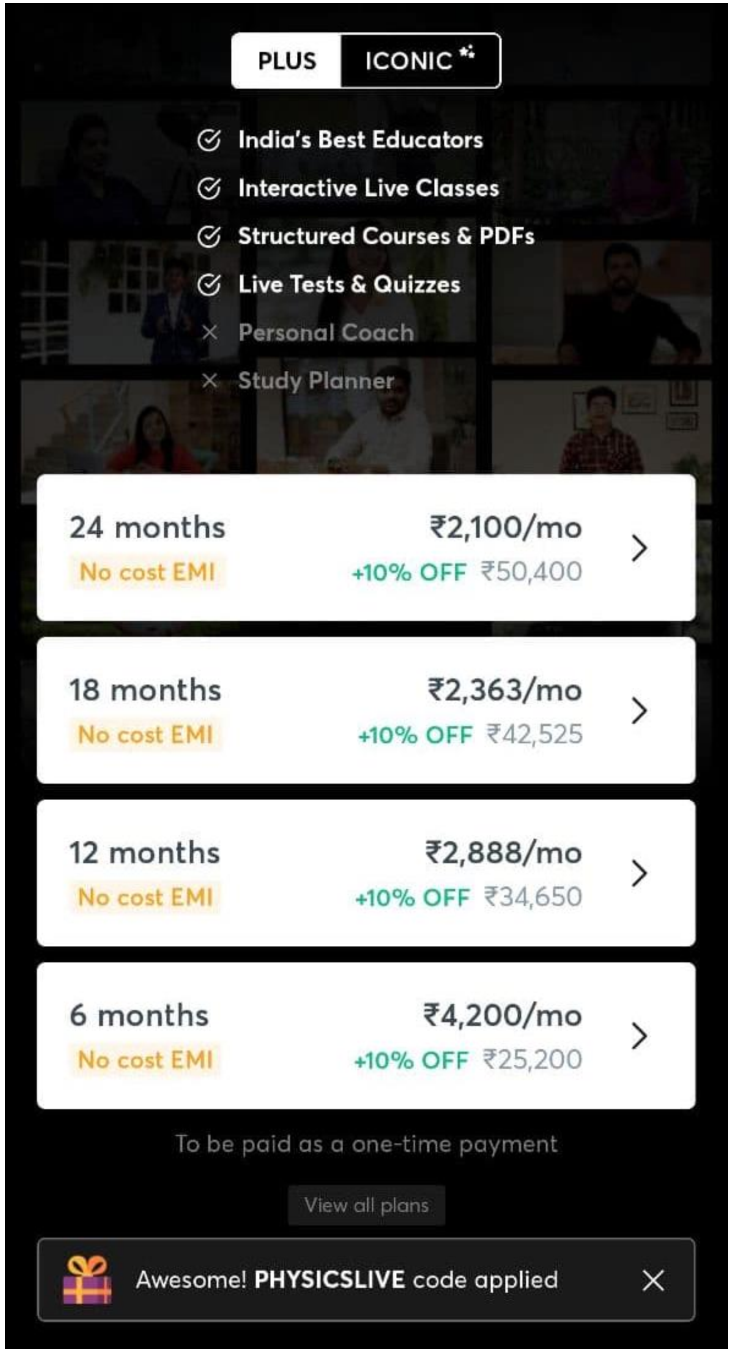
(d) d

Answer Key

Q.1 b	Q.2 d	Q.3 c	Q.4 b	Q.5 b
Q.6 b	Q.7 c	Q.8 a, b, d	Q.9 a	Q.10 b
Q.11 b	Q.12 d	Q.13 d	Q.14 b	Q.15 c



PHYSICSLIVE



Use code PHYSICSLIVE to get 10% OFF on Unacademy PLUS.

Written Solution

DPP-1 & 2 Gravitation: Gravitational Force and Gravitational Field

By Physicsaholics Team

Q.1) Three particles of equal mass m are situated at the vertices of an equilateral triangle of side l. What should be the velocity of each particle, so that they move on a circular path without changing l -

$\cos 30 = \frac{\ell}{2r} = \frac{\sqrt{3}}{2}$

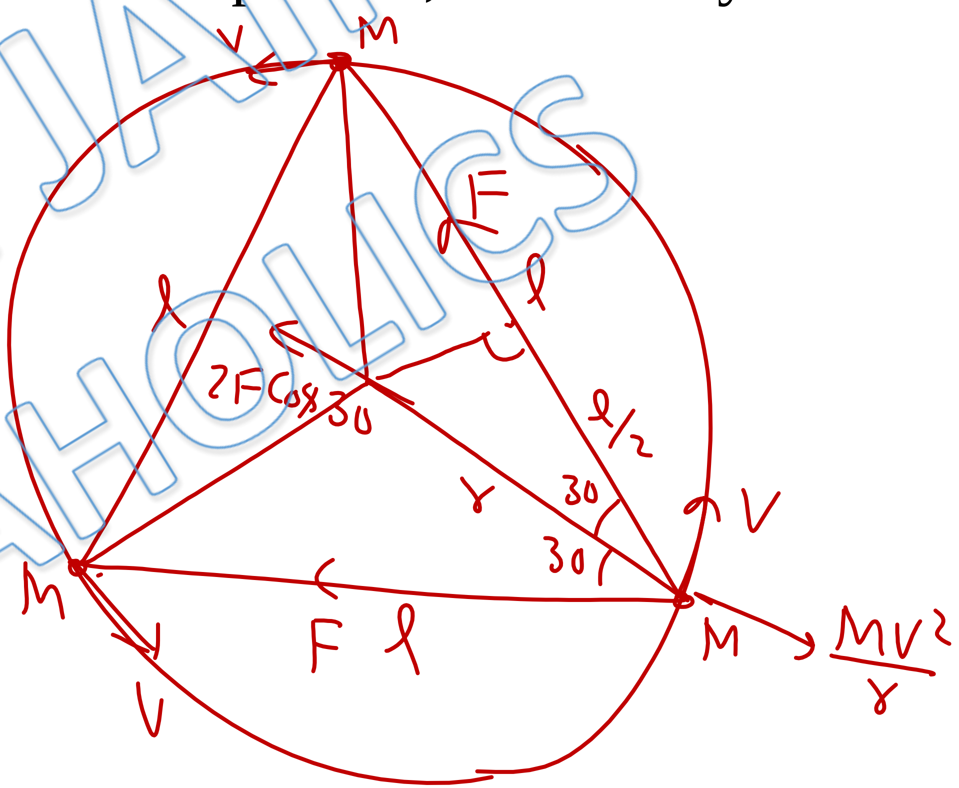
$r = \ell/\sqrt{3}$ — (1)

$F = \frac{GM^2}{\ell^2}$

$2F\cos 30 = \frac{MV^2}{r}$

$\frac{2GM^2}{\ell^2} \times \frac{\sqrt{3}}{2} = \frac{MV^2 \sqrt{3}}{\ell}$

$V = \sqrt{\frac{GM}{\ell}}$



(a) $\sqrt{\frac{GM}{2\ell}}$ (b) $\sqrt{\frac{GM}{\ell}}$

(c) $\sqrt{\frac{2GM}{\ell}}$ (d) $\sqrt{\frac{GM}{3\ell}}$

≠ 0

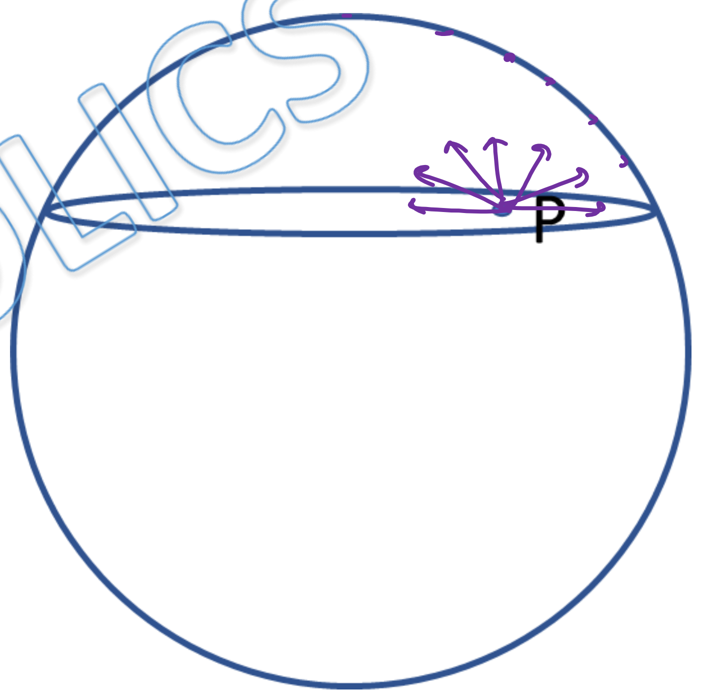
Q.2) A spherical shell is cut into two pieces along a chord as shown in figure . If I_1 and I_2 are gravitational field strength at P due to upper part and lower part respectively, then

$I_1 \neq 0$, $I_2 \neq 0$

Net field at P = 0

$\vec{I_1} + \vec{I_2} = \vec{I}_{net} = 0$

$\vec{I_1} = -\vec{I_2} \Rightarrow I_1 = I_2$



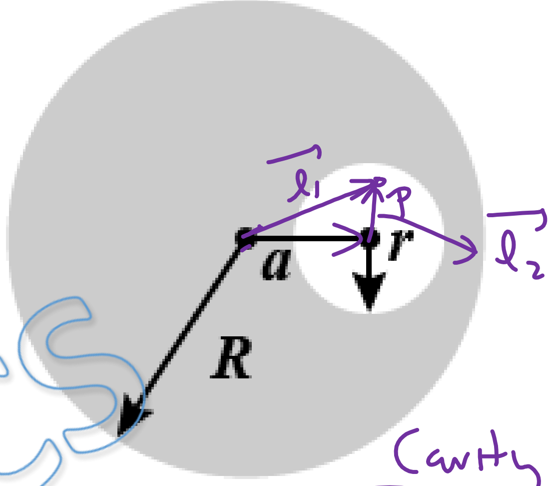
(a) $I_1 > I_2$

(b) $I_1 < I_2$

(c) $I_1 = I_2 = 0$

(d) $I_1 = I_2 \neq 0$

Q.3) 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 center of the sphere. The gravitational field inside the cavity is



G field inside solid sphere

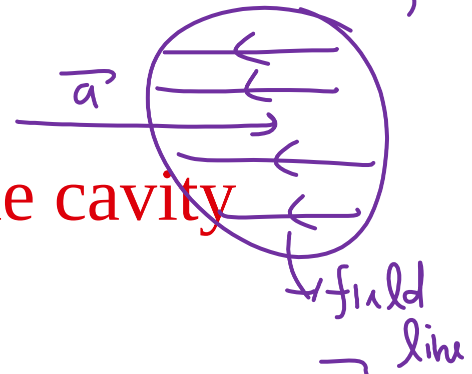
$$\vec{E} = \frac{-\rho \vec{r} \, 4\pi G}{3} = \frac{-4\pi G \rho \vec{r}}{3}$$

(a) non - uniform

(b) towards the center of the cavity

(c) directly proportional to a

(d) All of these



$$\vec{E}_P = \vec{E}_{complete} - \vec{E}_{cavity} = \frac{-4\pi G \rho \vec{l_1}}{3} - \frac{-4\pi G \rho \vec{l_2}}{3}$$

$$= \frac{-4\pi G \rho (\vec{l_1} - \vec{l_2})}{3} = \frac{-4\pi G \rho \vec{a}}{3}$$

Q.4) Inside a uniform sphere of density ρ there is a spherical cavity whose center is at a distance l from the center of the sphere. Find the strength of the gravitational field inside the cavity.

(a) $E = -\frac{2}{3}\pi G\rho l$

(b) $E = -\frac{4}{3}\pi G\rho l$

(c) $E = -\frac{4}{3}\pi^2 G\rho l$

(d) $E = -\frac{4}{3}\pi G\rho^2 l^2$

$\vec{E} = -\frac{4\pi G\rho \vec{l}}{3}$

Q.5) A straight rod of length l extends from x = a to x = L + a. Find the gravitational force exerts on a point mass m at x = 0 is (if the linear density of rod $\mu = A + Bx^2$)

field at origin due to dm

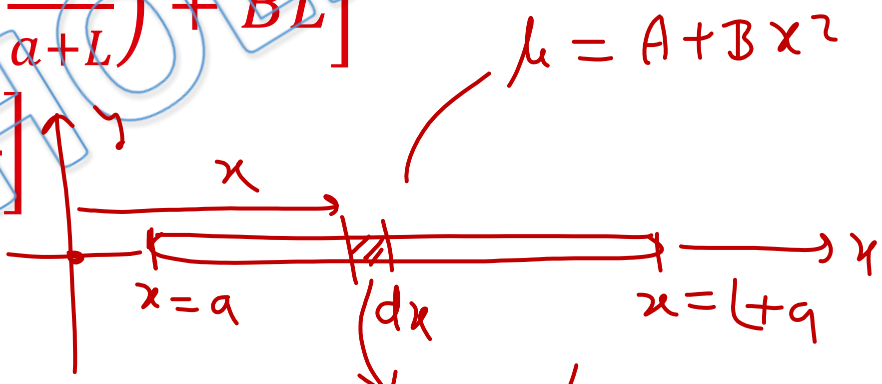
$$dE = \frac{G\,dm}{x^2} = \frac{G(A+Bx^2)dx}{x^2}$$

(a) $Gm\left[\frac{A}{a} + BL\right]$

(b) $Gm\left[A\left(\frac{1}{a} - \frac{1}{a+L}\right) + BL\right]$

(c) $Gm\left[BL + \frac{A}{a+L}\right]$

(d) $Gm\left[BL - \frac{A}{a}\right]$



$dm = (A+Bx^2)dx$

$$E = G\int_a^L (Ax^{-2} + B)dx$$

$$= G\left[-\frac{A}{x} + Bx\right]_a^{L+a} = G\left[\left(B(L+a) - \frac{A}{L+a}\right) - \left(Ba - \frac{A}{a}\right)\right]$$

$$= G\left[BL + A\left(\frac{1}{a} - \frac{1}{L+a}\right)\right]$$

Q.6) The gravitational field in a region is given by $(2\hat{\imath} + 2\hat{\jmath})$ N /kg. What is the work done by an external agent to slowly shift a particle of mass 10 kg from the point (0,0) to a point (5m, 4m) ?

$\vec{F_g} = m\vec{E} = 20\hat{i} + 20\hat{j}$

$\vec{\Delta r} = 5\hat{i} + 4\hat{j}$

Work done by gravity $= \vec{F_g} \cdot \vec{\Delta r} = 100 + 80 = 180 J$

(a) 180 J

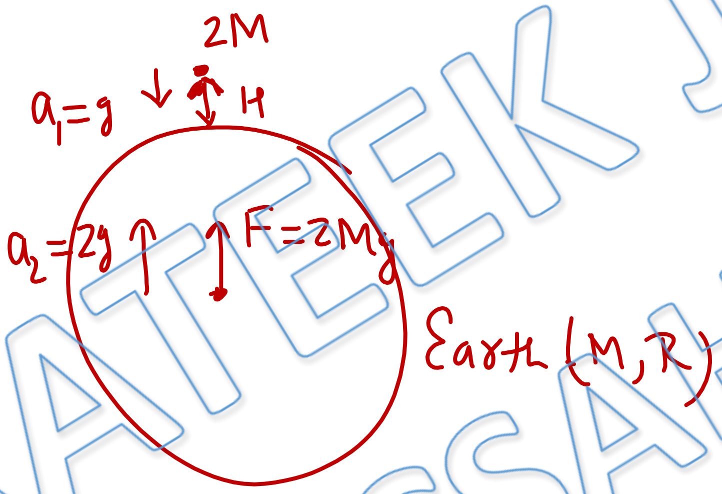
(b) – 180 J

(c) 90 J

(d) – 90 J

Work done by external agent = −180 J

Q.7) A small body of superdense material , whose mass twice the mass of the earth but whose size is very small compared to the size of the earth , starts from 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-



rel acceleration = 3g

" Displacement = H

$x = ut + \frac{1}{2}at^2$

$H = 0 + \frac{1}{2} \times 3g t^2$

$t = \sqrt{\frac{2H}{3g}}$.

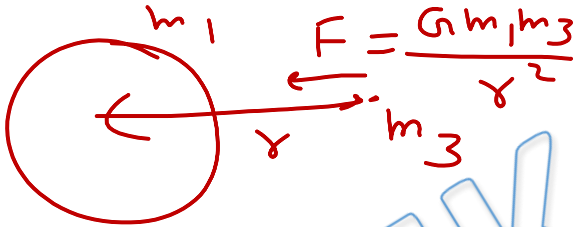
(a) $\sqrt{2H/g}$

(b) $\sqrt{H/g}$

(c) $\sqrt{2H/3g}$ ✓

(d) $\sqrt{4H/3g}$

Q.8) Two concentric spherical shells have masses m1 and m2 and radii r1 and r2. Then–

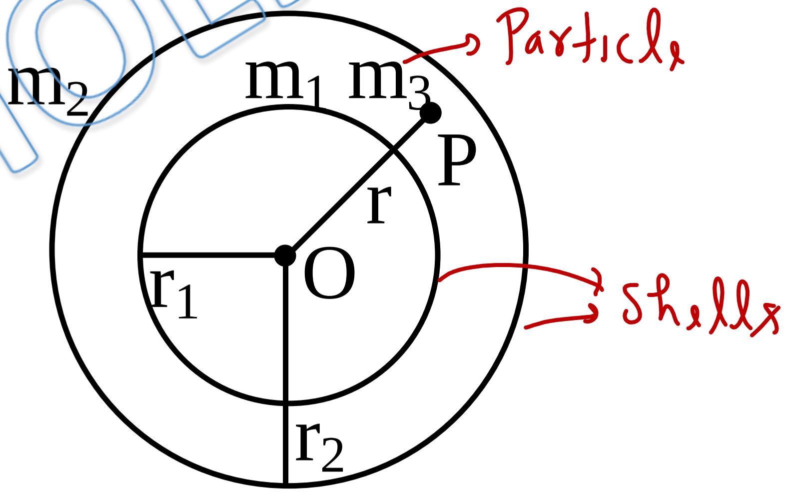


(a) Outer shell will have no contribution in gravitational field at point P

(b) Force on P is directed towards O

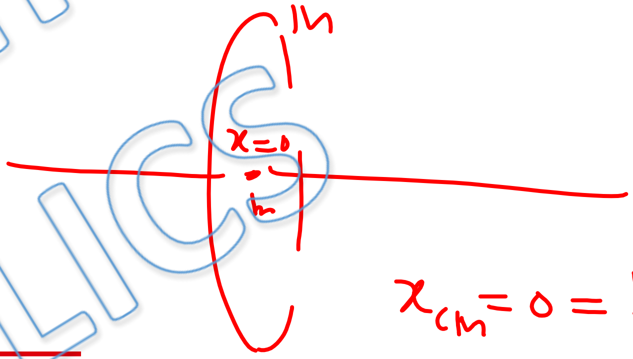
(c) Force on P is $\frac{Gm_1m_2}{r^2}$

(d) Force on P is $\frac{Gm_1m_3}{r^2}$



$$E = \frac{Gmx}{(R^2+x^2)^{3/2}}$$

Q.9) A particle of mass m is placed at centre of uniform ring of mass M and radius R . Mass m is slightly displaced along axis and released . If ring is also free to move, angular frequency of shm is



force on particle at x = x

$$F = \frac{GM(x+x_1)\,m}{\left(R^2+(x+x_1)^2\right)^{3/2}}$$

$$x_{cm} = 0 = \frac{mx - Mx_1}{M+m}$$

$$x_1 = \frac{mx}{M}$$

(a) $\sqrt{\frac{G(M+m)}{R^3}}$ ✓

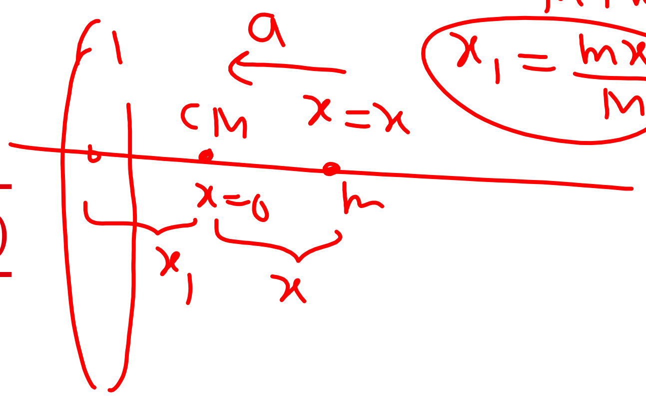
(b) $\sqrt{\frac{G(M+m)}{2R^3}}$

(c) $\sqrt{\frac{GM(M+m)}{mR^3}}$

(d) $\sqrt{\frac{Gm(M+m)}{MR^3}}$

Since x & $x_1 \ll R$

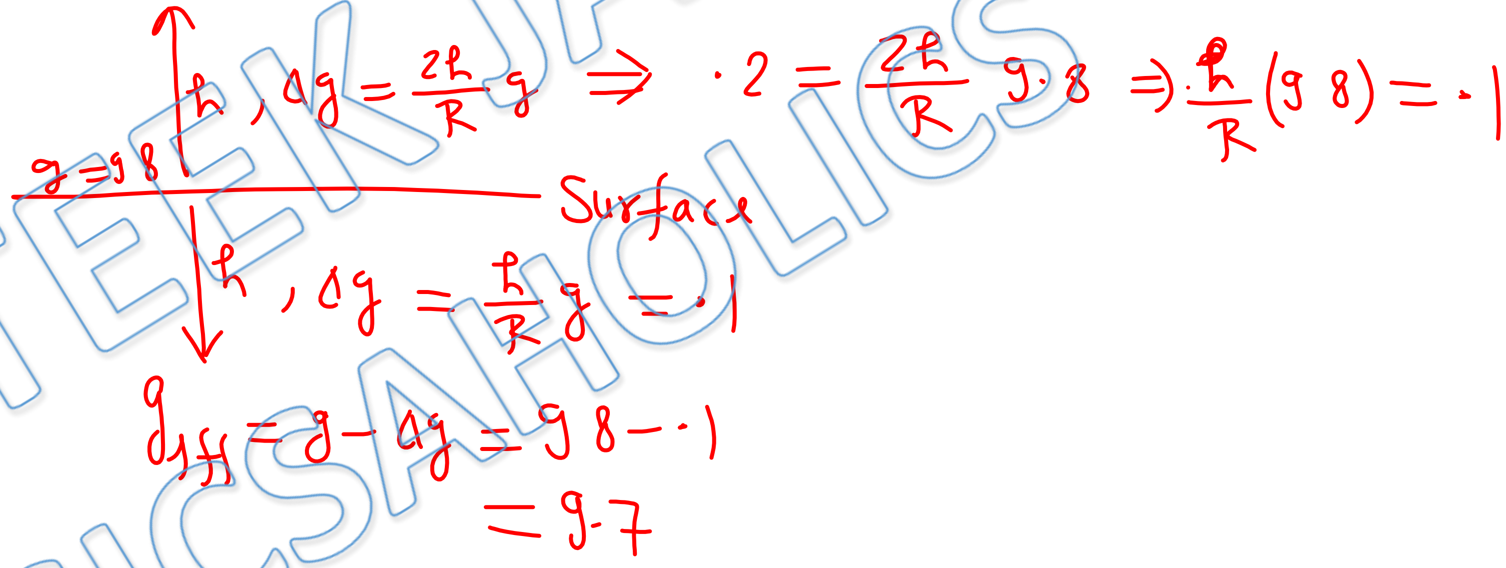
$$ma = \frac{GMm(x+x_1)}{R^3}$$



$$a = \frac{GM}{R^3}\left(x + \frac{mx}{M}\right) = \frac{G(M+m)x}{R^3}$$

Hence SHM

Q.10) Gravitational field at surfave of earth is 9.8m/sec^2 and at height h it is 9.6m/sec^2 .Gravitational field at depth h from ground is



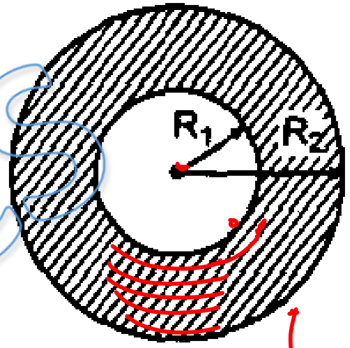
(a) 9.6m/sec^2

(b) 9.7m/sec^2

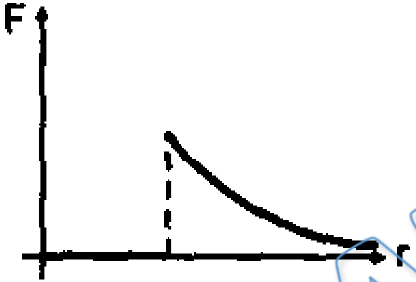
(c) 9.4m/sec^2

(d) 10 m/sec^2

Q.11) A sphere of mass M and radius R_2 has a concentric cavity of radius R_1 as shown in figure. The force F exerted by the sphere on a particle of mass in located at a distance r from the centre of sphere varies as $(0 \leq r \leq \infty)$:

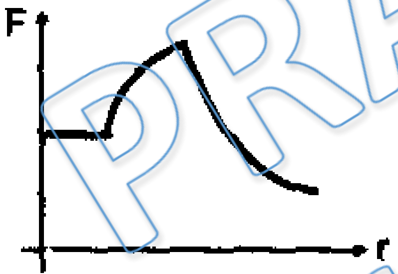


(a)

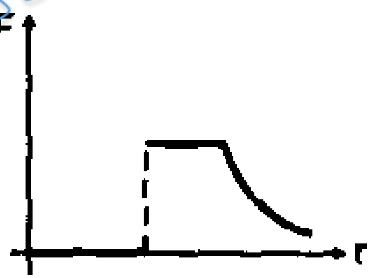


(b)

(c)



(d)



Q.12) The Earth may be regarded as a spherically shaped uniform core of density l_1 and radius R/2 surrounded by a uniform shell of thickness R/2 and density l_2. Find the ratio of $\frac{\rho_1}{\rho_2}$ if the value of acceleration due to gravity is the same at surface as at depth R/2 from the surface.

(a) 2/1

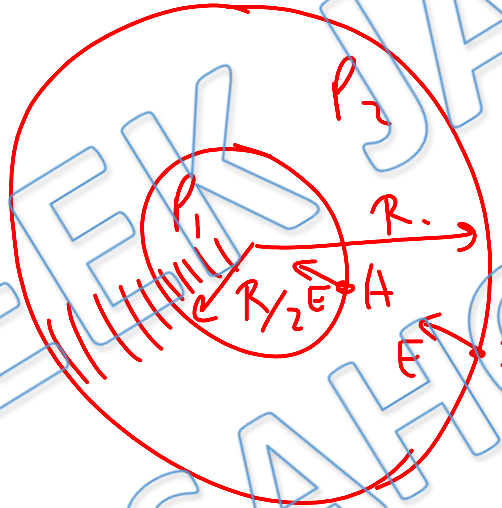
(b) 5/3

(c) 7/4

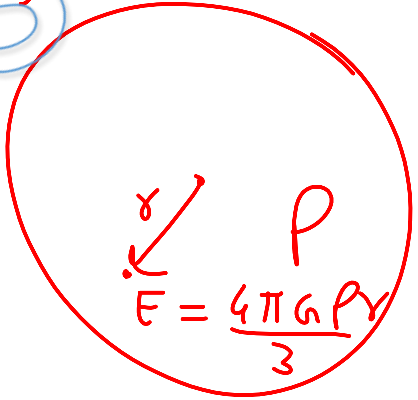
(d) 7/3 ✓

At A

$$E = \frac{4\pi G}{3}\left(\frac{R}{2}\right)\rho_1$$



formula



At B

$$E = \frac{GM_{total}}{R^2} = \frac{G}{R^2}\left(\rho_1 \cdot \frac{4}{3}\pi\frac{R^3}{8} + \rho_2\,\frac{4}{3}\pi\left(R^3 - \frac{R^3}{8}\right)\right)$$

$$\frac{4\pi G}{3}\,\frac{R}{2}\,\rho_1 = G\,\frac{4\pi}{3}\left[\rho_1\frac{R}{8} + \rho_2\,\frac{7R}{8}\right]$$

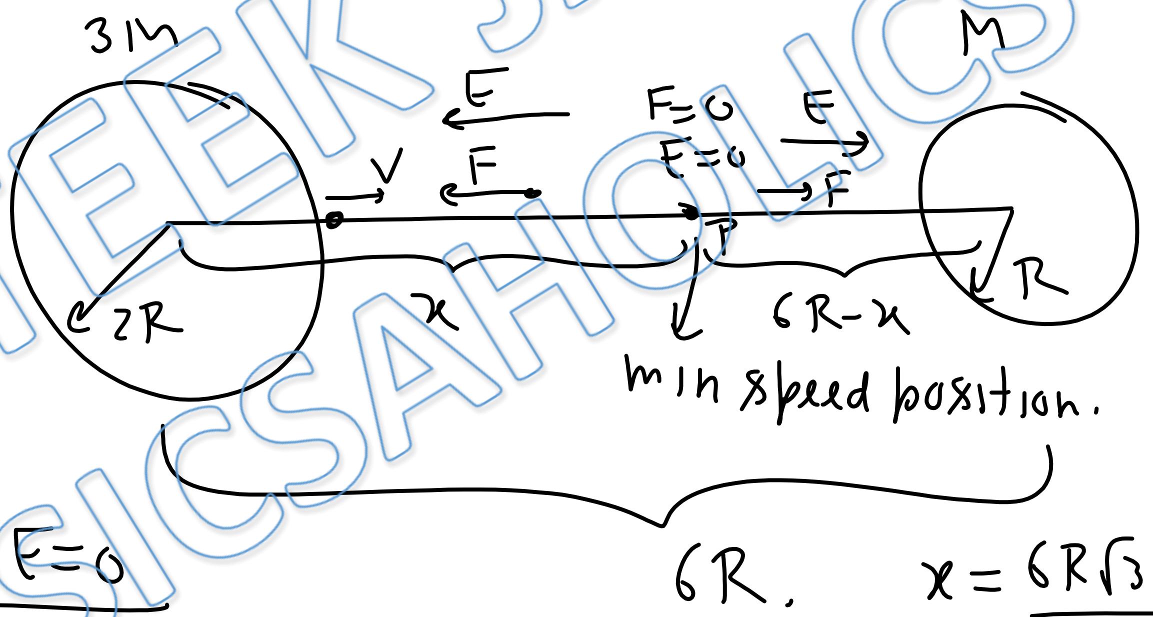
Q.13) A small body of mass m is projected with a velocity just sufficient to make it reach from the surface of a planet (of radius 2R and mass 3M) to the surface of another planet (of radius R and mass M). The distance between the centers of the two spherical planets is 6R. Find distance of small body from centre of bigger planet when it acquires its minimum speed

(a) $2R[3 - \sqrt{3}]$

(a) $3R[2 - \sqrt{3}]$

(b) $2R[2 - \sqrt{3}]$

(d) $3R[3 - \sqrt{3}]$ ✓



At P, F=0

$$\frac{G3M}{x^2} = \frac{GM}{(6R-x)^2}$$

$$\frac{\sqrt{3}}{x} = \frac{1}{6R-x} \Rightarrow$$

$$6R - x = \frac{x}{\sqrt{3}}$$

$$6R = x\left(1 + \frac{1}{\sqrt{3}}\right)$$

$$x = \frac{6R\sqrt{3}}{\sqrt{3}+1}$$

$$x = \frac{6R\sqrt{3}(\sqrt{3}-1)}{3-1}$$

$$= R \times 3\sqrt{3}(\sqrt{3}-1)$$

$$= 3R(3-\sqrt{3})$$

Q.14) There is a smooth tunnel along a chord of earth. Mass of earth is M and its radius is R. Length of tunnel is R/2. A particle is releases in tunnel from surface of earth(one end of tunnel. Velocity of particle at centre of tunnel is (assuming particle is just fitted in tunnel)

O is mean position

(a) $\frac{1}{2}\sqrt{\frac{GM}{R}}$

restoring force $= \frac{GMm}{R^3} r\cos\theta$

(b) $\frac{1}{4}\sqrt{\frac{GM}{R}}$

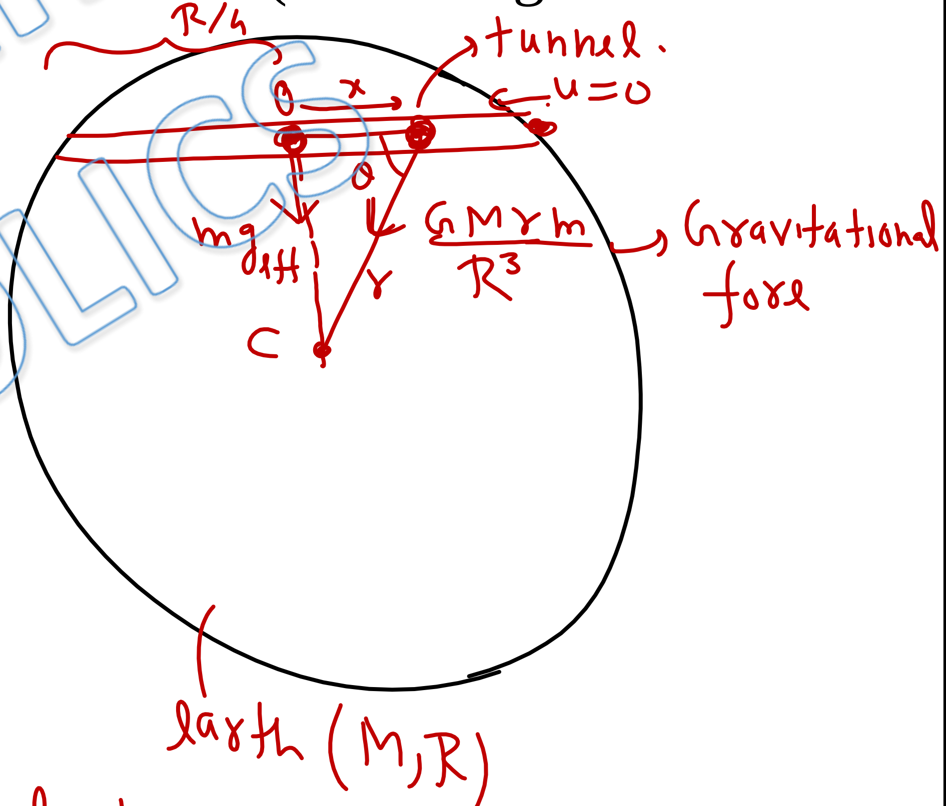
$ma = \frac{GMmx}{R^3}$

(c) $\frac{1}{3}\sqrt{\frac{GM}{R}}$

(d) $\frac{1}{5}\sqrt{\frac{GM}{R}}$

$a = \left(\frac{GM}{R^3}\right)x$ → motion is SHM

$\omega^2 = \frac{GM}{R^3}$



Velocity at Centre = $A\omega$

$= \left(\frac{R}{4}\right)\sqrt{\frac{GM}{R^3}} = \frac{1}{4}\sqrt{\frac{GM}{R}}$

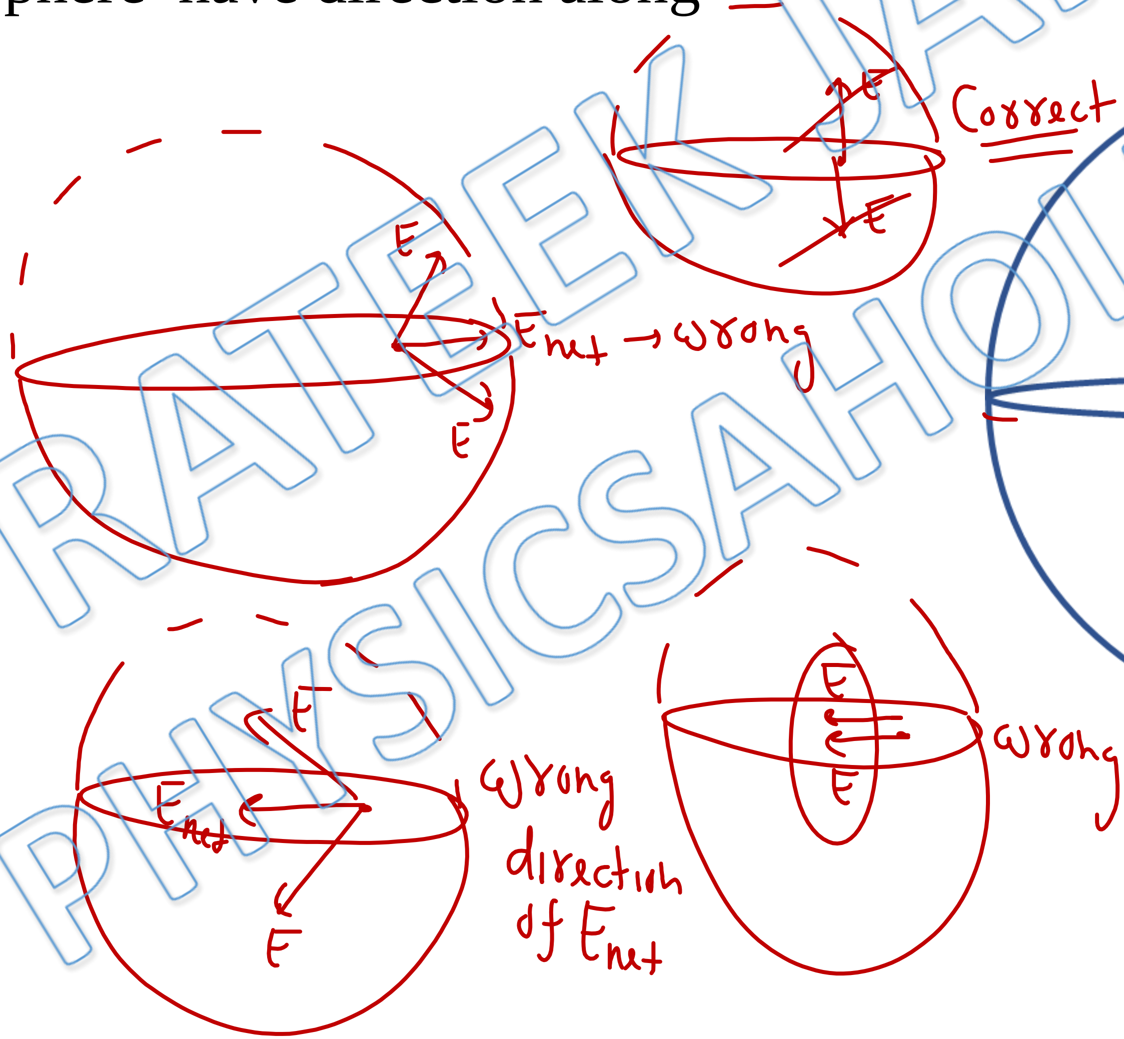
Q.15) A uniform spherical shell is devided into two hemispheres as shown in figure. P is a point at deviding surface (not at centre of sphere). Gravitational field at P due to lower hemisphere have direction along

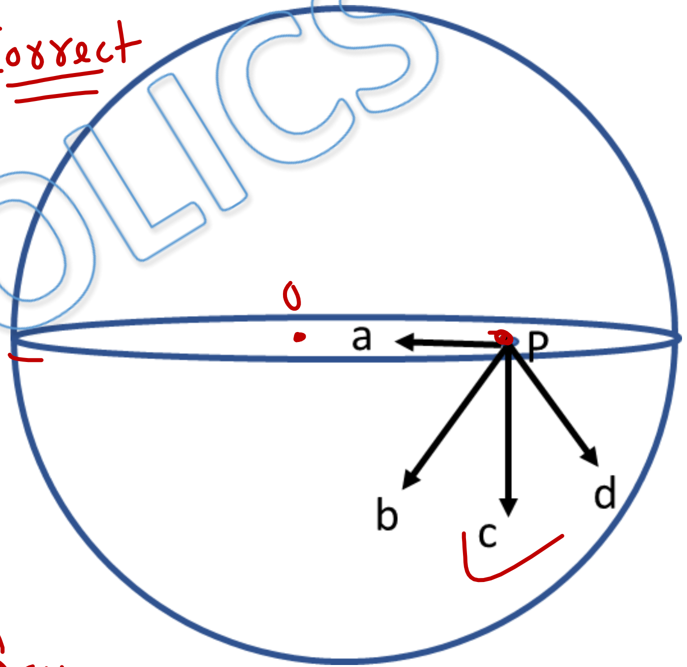
(a) a

(b) b

(c) c

(d) d





For Video Solution of this DPP, Click on below link

Video Solution on Website:- https://physicsaholics.com/home/courseDetails/100

Video Solution on YouTube:- https://youtu.be/iqIIbHGVv0I

Written Solution on Website:- https://physicsaholics.com/note/notesDetalis/55

SUBSCRIBE

@Physicsaholics

@Physicsaholics_prateek

@NEET_Physics
@IITJEE_Physics

physicsaholics.com

Unacademy

CLICK

Chalo Niklo