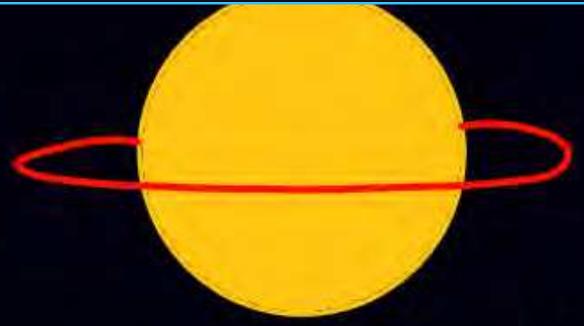
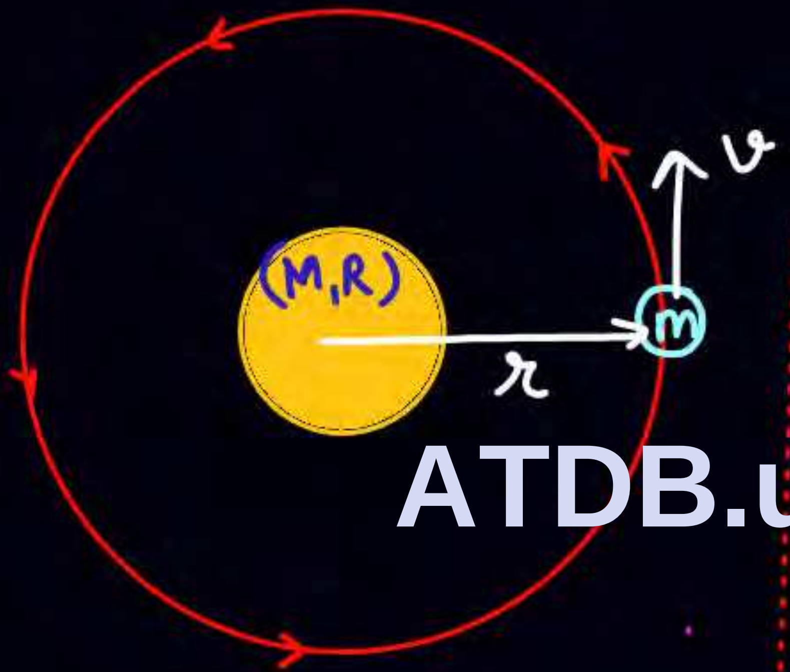

PRAYAS
JEE 2025
Lecture - 02
Physics
Gravitation
By- Saleem Ahmed Sir

Topics *to be covered*

1. Satellite Motion
2.
3.
4.



Sattellite motion



$$\frac{GMm}{r^2} = \frac{mv^2}{r}$$

$$v = \sqrt{\frac{GM}{r}} = \sqrt{\frac{GM}{R+h}}$$

orbital speed.

$$T = \frac{2\pi r}{v} = 2\pi\sqrt{\frac{r^3}{GM}}$$

$$\boxed{T^2 \propto r^3}$$

$$\omega = \frac{2\pi}{T} = \sqrt{\frac{GM}{r^3}}$$

$$(KE) = \frac{1}{2}mv^2 = \frac{1}{2}m\frac{GM}{r} = \frac{GMm}{2r}$$

$$P.E = -\frac{GMm}{r}$$

$$T.E. = KE + PE = \frac{GMm}{2r} + \left(-\frac{GMm}{r}\right)$$

$$\boxed{T.E. = -\frac{GMm}{2r}}$$

$$\boxed{K.E = |T.E| = \frac{|P.E|}{2}}$$

$V = \sqrt{\frac{Gm}{r}}$ $\quad r_A = 2R$ $\quad r_B = 8R$ $\quad KE = \frac{1}{2}mv_0^2 = \frac{1}{2}\frac{GMm}{r}$

1

Q Two sattelite A & B are revolving around the earth at a height R & 7R from surface of earth (R). mass of both sattellite are same.

1 Ratio of their orbital speed.

$$\frac{v_A}{v_B} = \sqrt{\frac{r_B}{r_A}} = \sqrt{\frac{8R}{2R}} = 2$$

2

$$\frac{\omega_A}{\omega_B} = \frac{T_B}{T_A} = 8$$

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

$$\frac{T_B}{T_A} = \left(\frac{r_B}{r_A}\right)^{3/2} = \left(\frac{8R}{2R}\right)^{3/2} = 8$$

3

$$\frac{(KE)_A}{(KE)_B} = \frac{r_B}{r_A} = \frac{8R}{2R} = 4$$

4

$$\frac{(P.E)_A}{(P.E)_B} = 4$$

5

$$\frac{(T.E)_A}{(T.E)_B} = 4$$

Geostationary Sattlite

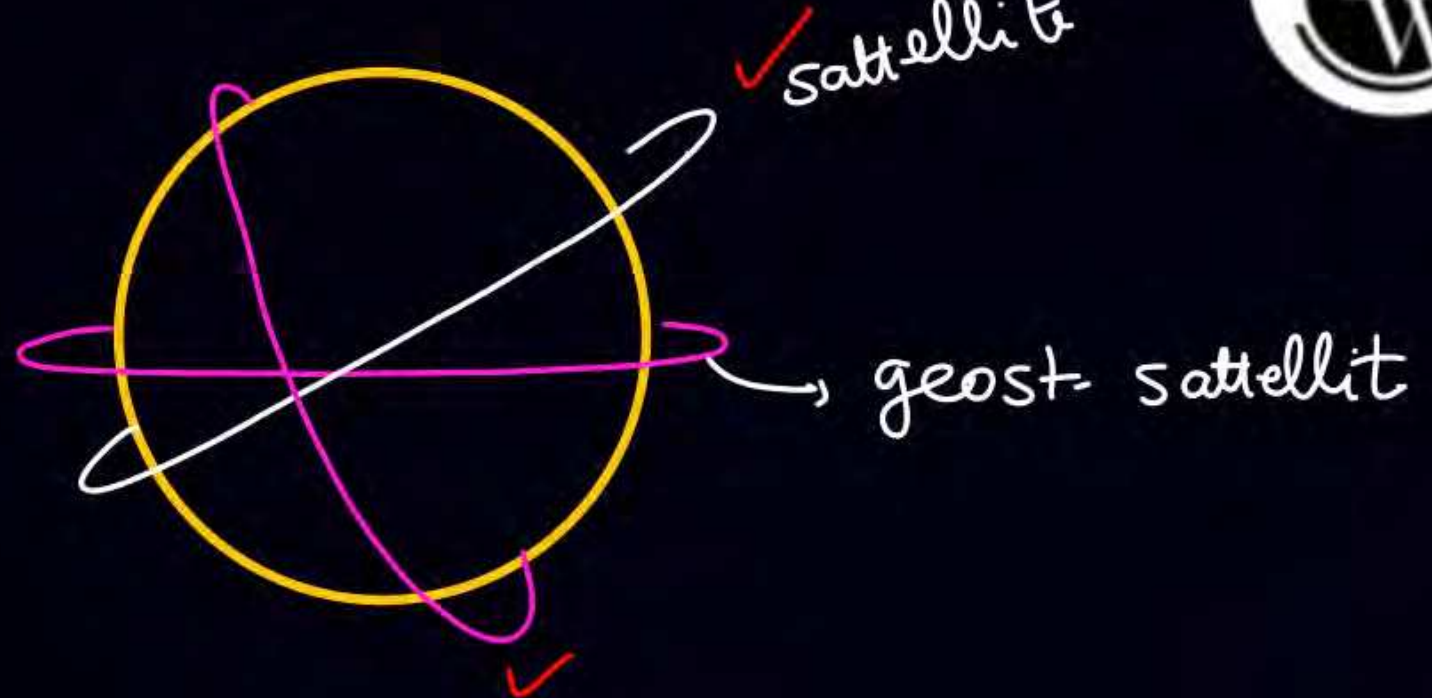
- which is at rest wrt earth.
- $T = 24$ hour = Time period of Geost. sattlite

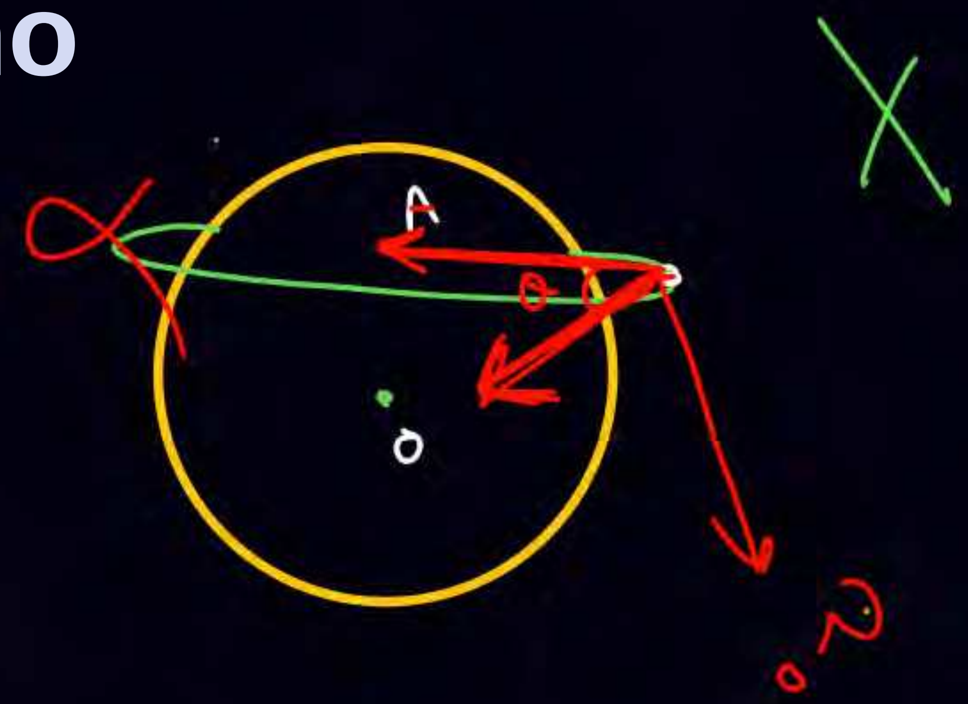
$$T = 2\pi\sqrt{\frac{r^3}{GM_e}} = 24(\text{hour})$$

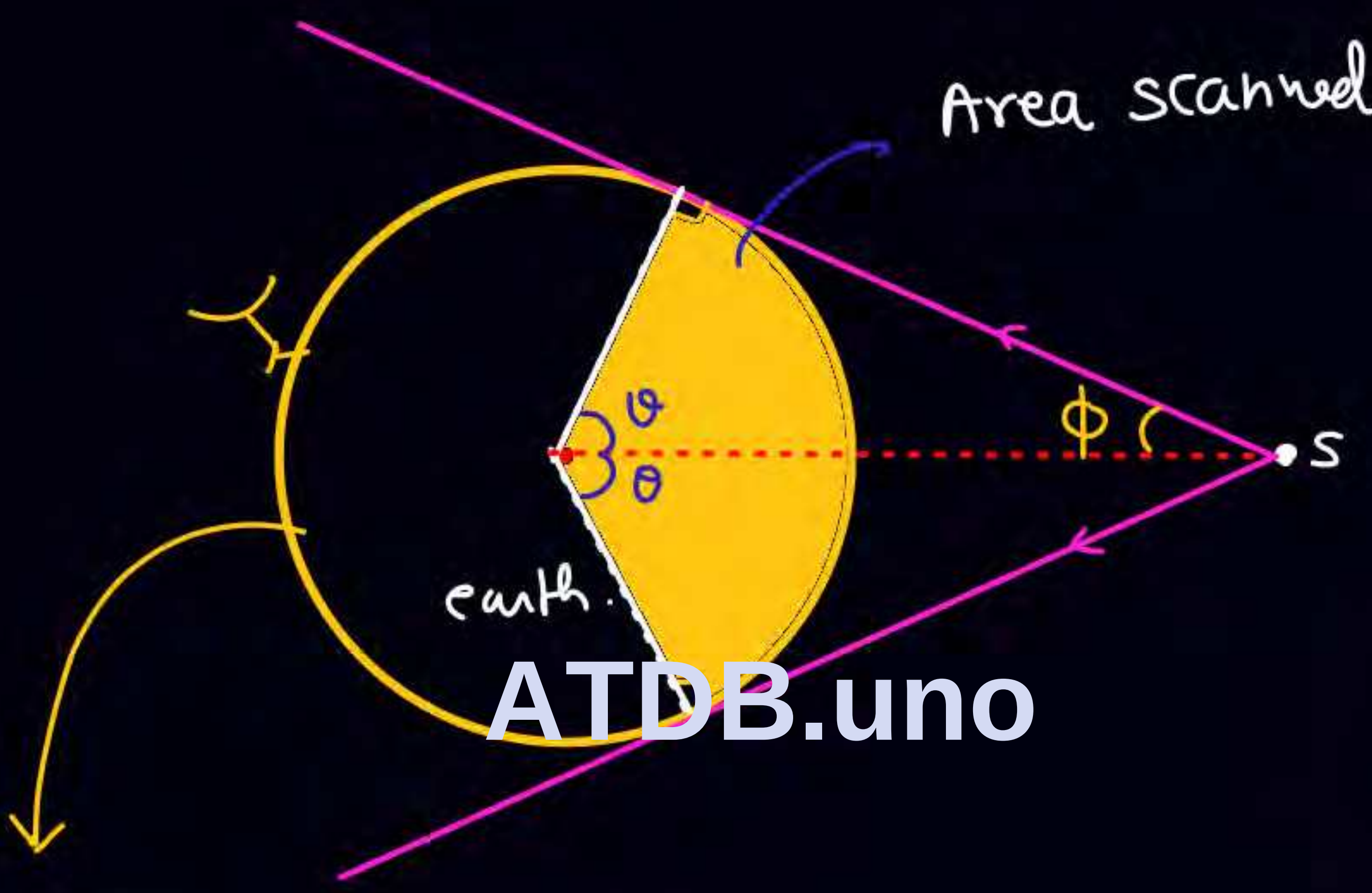
$r \simeq 42000$ km from center of earth

$h \simeq 36000$ km " surface of earth.

- must be rotate in same sense of earth.
- must be in equitorial plane.







Area scanned $= 2\pi R^2(1-\cos\theta)$

$=$ ✓

$\phi \rightarrow$ coaltitude

Area Unscan $= 4\pi R^2 - 2\pi R^2(1-\cos\theta)$

Kepler's Law

① All the plant are moving in a elliptical orbit around sun.

② * $A_1 = A_2$

* Angular momentum of sattelite abt sun is Conserve.

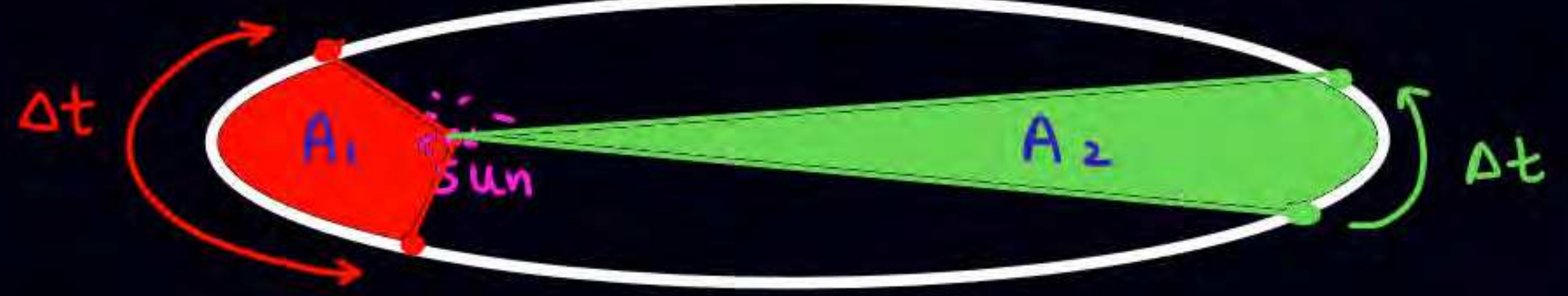
$\tau_{sun} = 0$, $mvr = \text{Const}$

* equal time पे Equal Area swap.

* Areal speed is const $= \frac{J}{2m}$ → Angular moment

→ $\frac{dA}{dt} = \text{Const}$

③ $T^2 \propto r^3$ ↳ Semi major Axis



$A_1 = A_2$

$\cancel{m} v_1 r_1 = \cancel{m} v_2 r_2$

Binary Star

$$\frac{Gm_1m_2}{(r_1+r_2)^2} = m_1 r_1 \omega^2$$

$$\frac{Gm_1m_2}{(r_1+r_2)^2} = m_2 r_2 \omega^2$$

Solve & get

$$\omega = \sqrt{\frac{G(m_1+m_2)}{(r_1+r_2)^3}}$$

$$T = 2\pi \sqrt{\frac{(r_1+r_2)^3}{G(m_1+m_2)}}$$

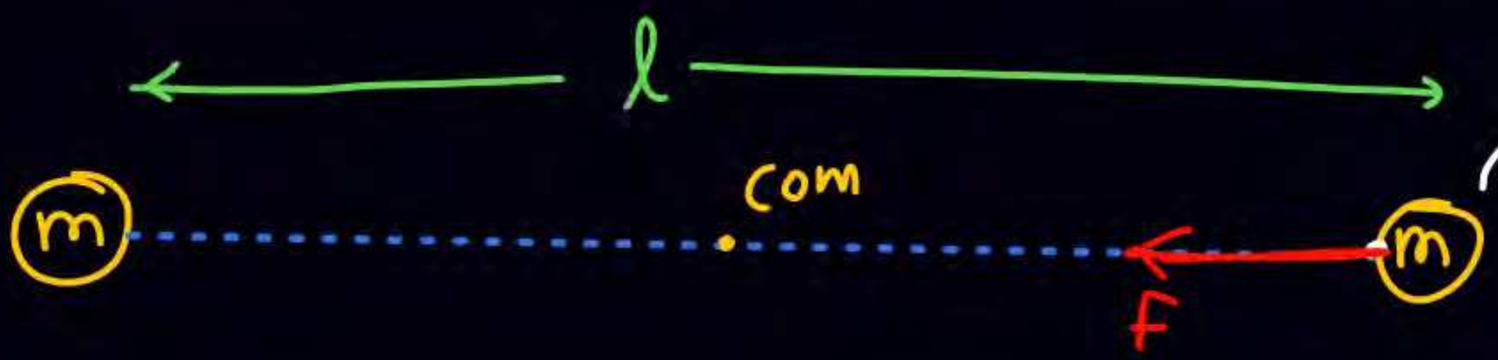
$$\frac{Gm_2}{(r_1+r_2)^2} = r_1 \omega^2$$

$$\frac{Gm_1}{(r_1+r_2)^2} = r_2 \omega^2$$

$$\frac{G}{(r_1+r_2)^2}(m_2+m_1) = (r_1+r_2)\omega^2$$

If $m_1 = m_2$

Q

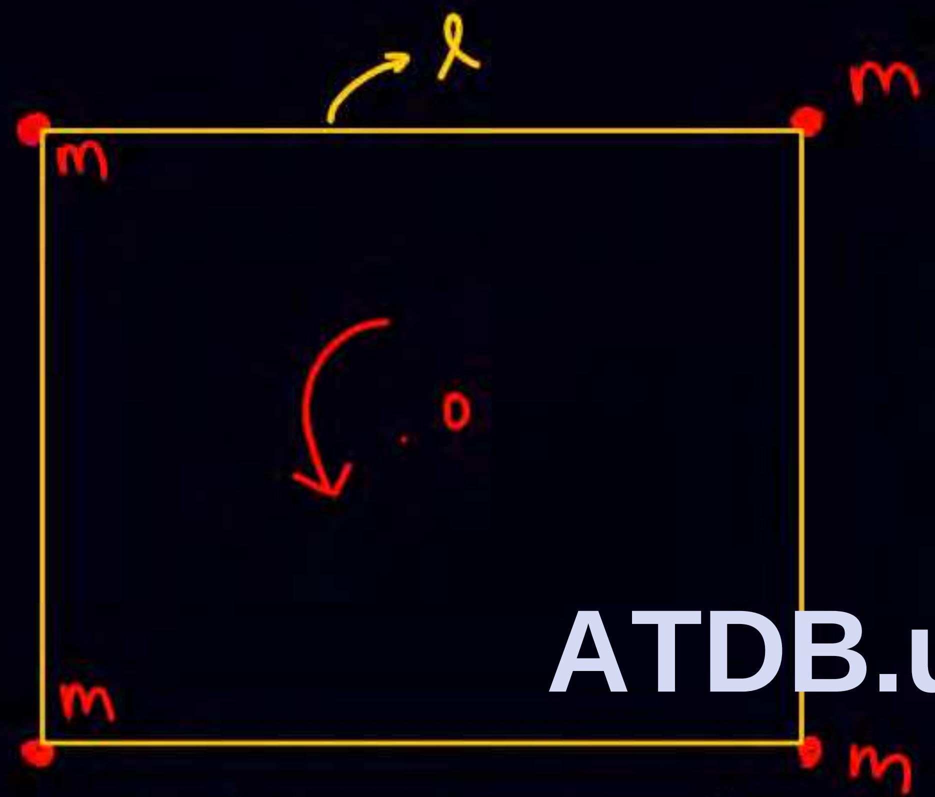


phy

$$\frac{Gmm}{l^2} = m\frac{l}{2}\omega^2$$

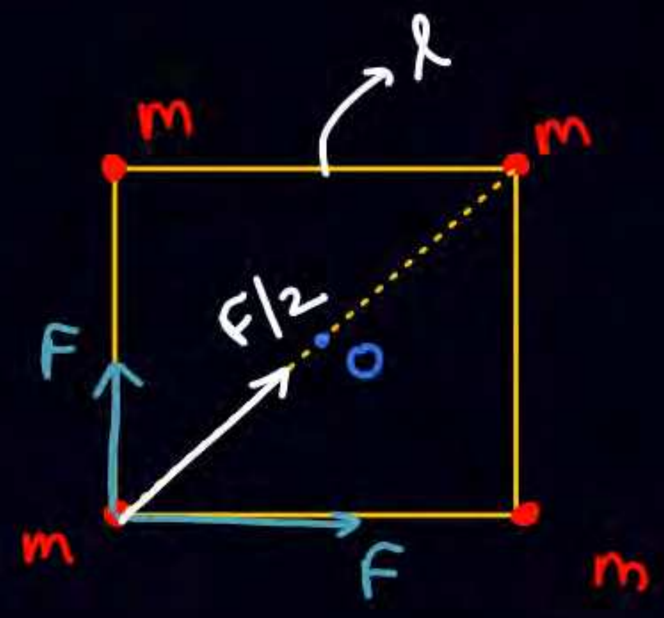
$$T = 2\pi\sqrt{\frac{(r_1+r_2)^3}{G(m_1+m_2)}} = 2\pi\sqrt{\frac{\left(\frac{l}{2}+\frac{l}{2}\right)^3}{G\,2m}}$$

5 Q



four mass at corner of a square 'l' are moving in a circular path Under action of their grav. attraction. find ω, u of them.

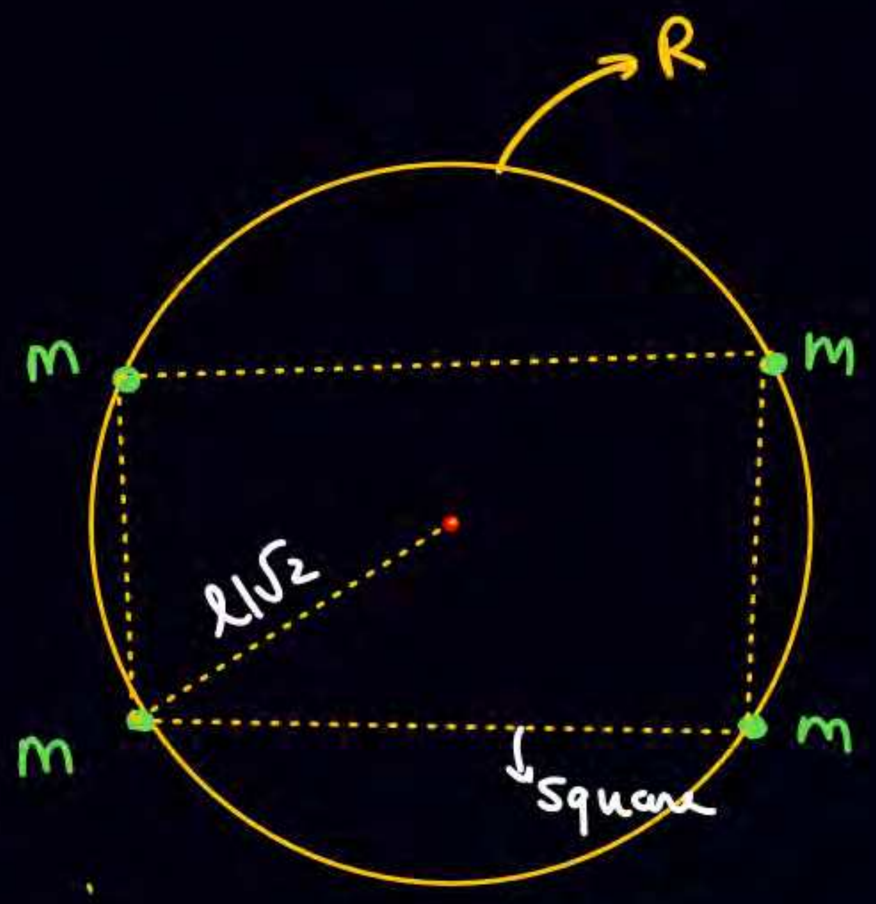
Sol^n



$$F_{net} = F\sqrt{2} + \frac{F}{2} = F\left(\sqrt{2} + \frac{1}{2}\right)$$

$$\frac{Gm^2}{l^2}\left(\sqrt{2} + \frac{1}{2}\right) = m\frac{l}{\sqrt{2}}\cdot \omega^2$$

Q



$$\frac{l}{\sqrt{2}} = R$$

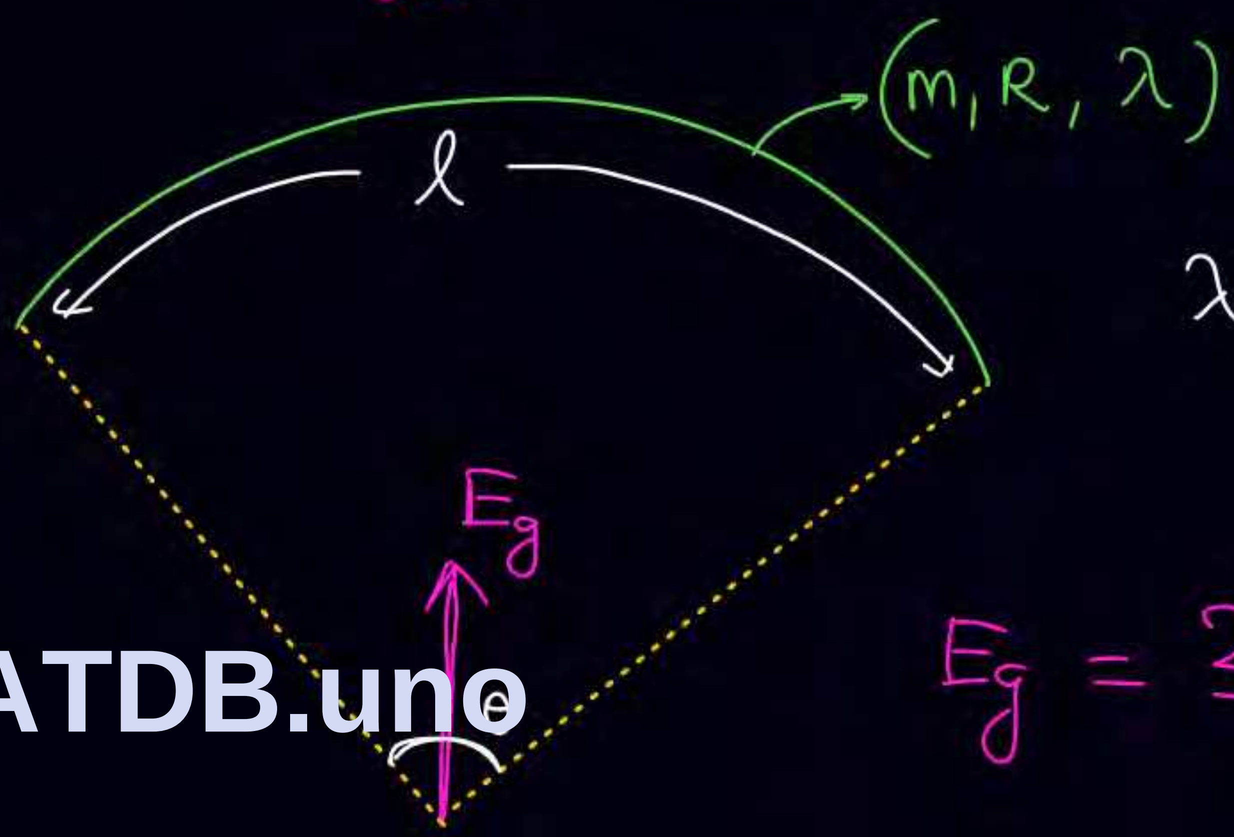
$$2R = l\sqrt{2}$$

Q

$$E = \frac{2k\lambda}{r}\sin(\theta/2)$$

H

arc

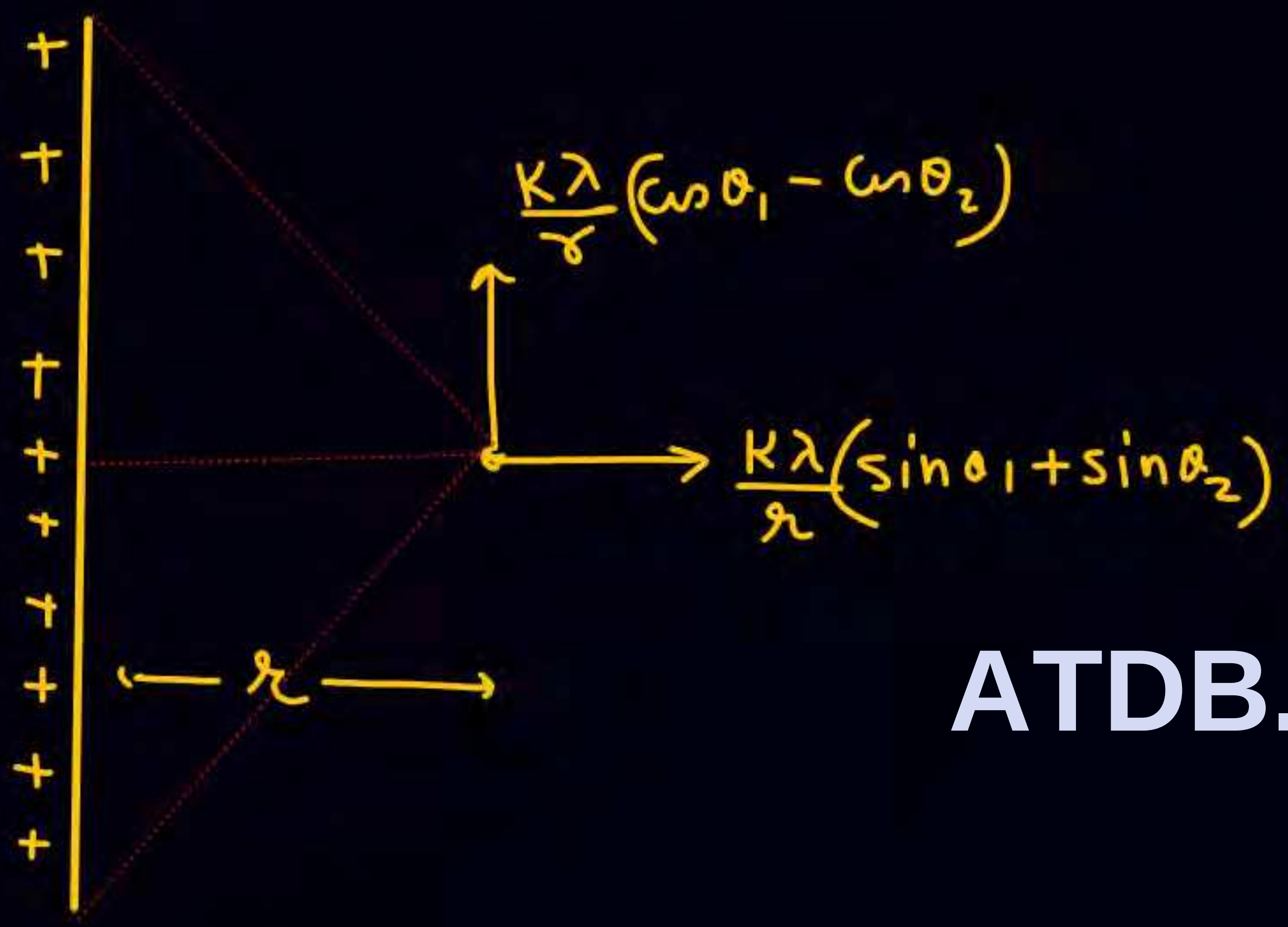


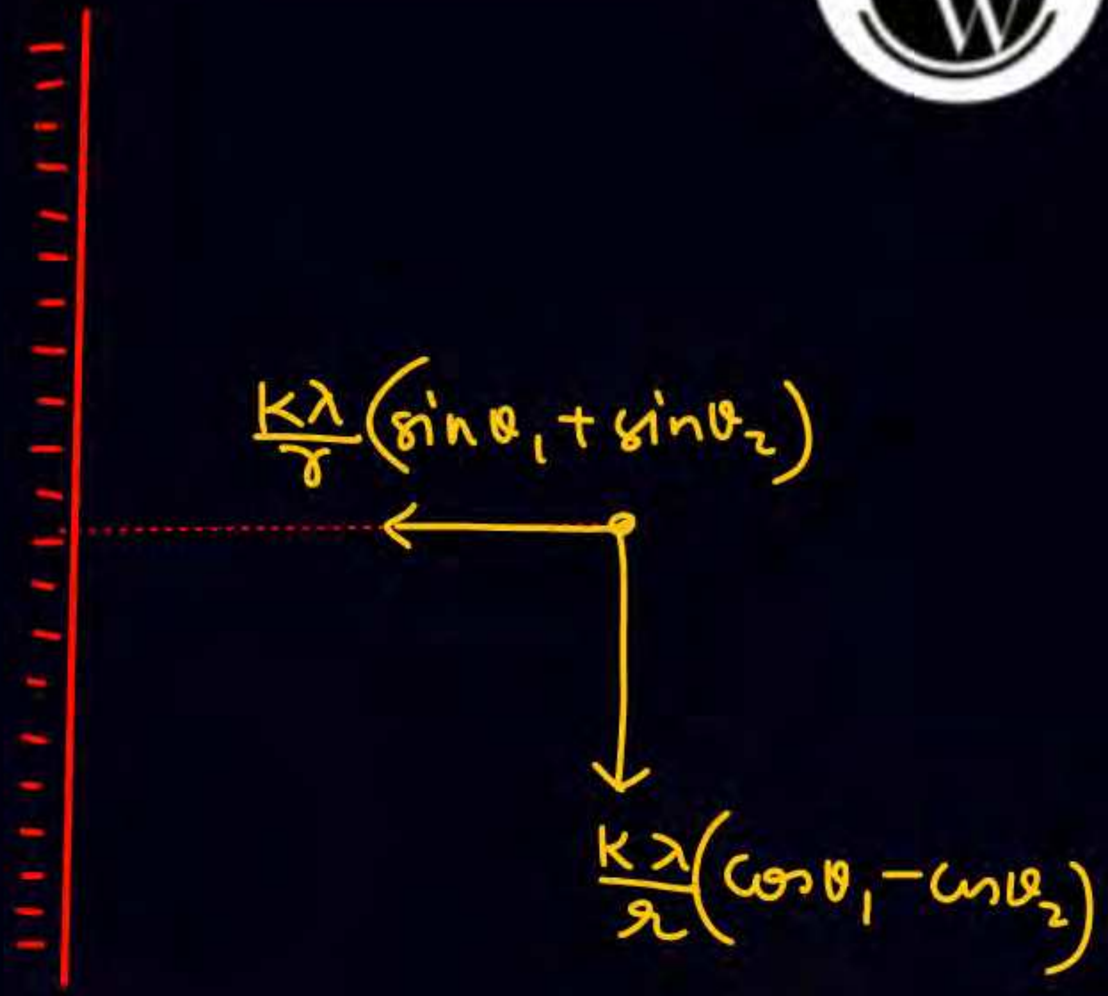
$$\theta = \frac{l}{R}$$

$$\lambda = \frac{m}{l} = \frac{m}{R\theta}$$

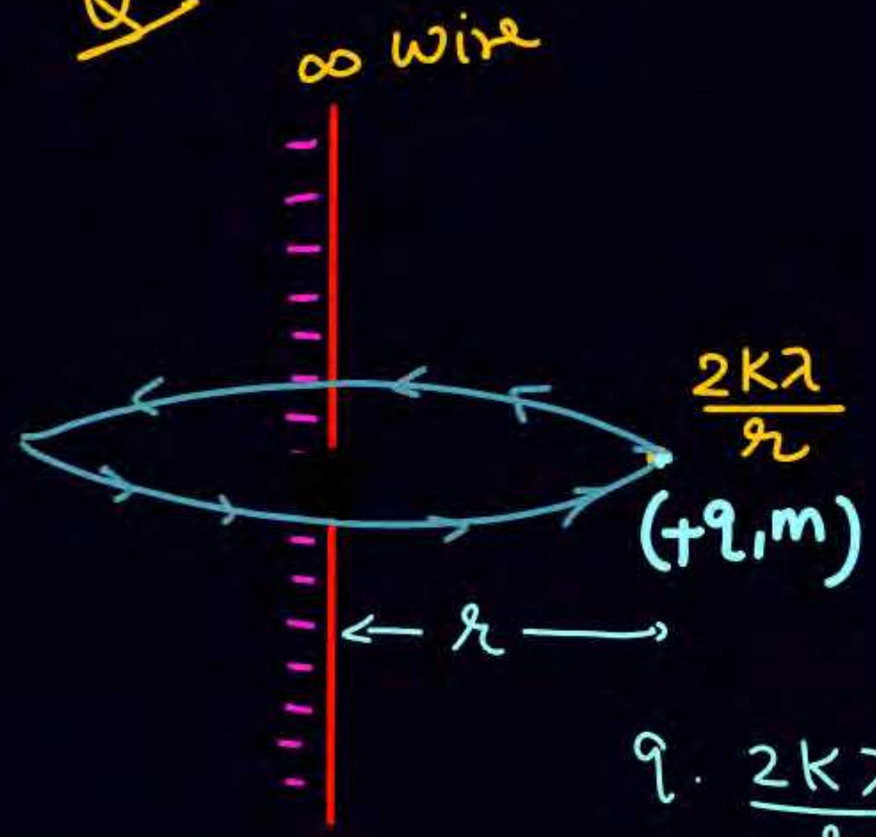
$$E_g = \frac{2G\lambda}{r}\sin\left(\frac{\theta}{2}\right)$$

#


$\frac{K\lambda}{r}(\cos\theta_1 - \cos\theta_2)$
$\frac{K\lambda}{r}(\sin\theta_1 + \sin\theta_2)$
r

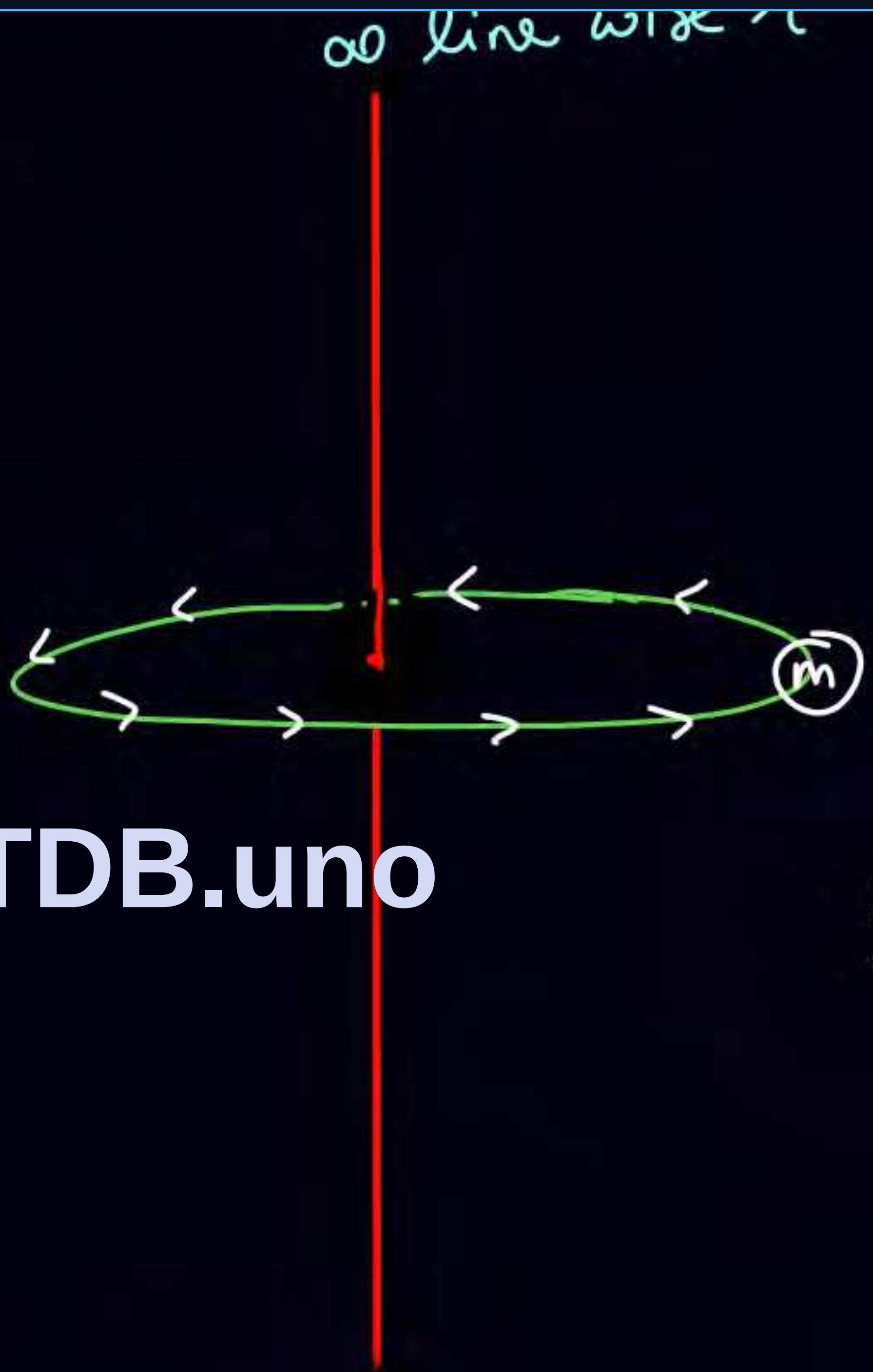

$\frac{K\lambda}{r}(\sin\theta_1 + \sin\theta_2)$
$\frac{K\lambda}{r}(\cos\theta_1 - \cos\theta_2)$

Q



$$q \cdot \frac{2k\lambda}{r} = \frac{mv^2}{r}$$

Q



$$\frac{2G\lambda}{r} m = \frac{mv^2}{r}$$

Question

Four particles each of mass M, move along a circle of radius R under the action of their mutual gravitational attraction as shown in figure. The speed of each particle is:

(JEE Main-2021)

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

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

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

(D) $\sqrt{\frac{GM}{R}}$

Ans : (B)

Question

On the x-axis and a distance x from the origin, the gravitational field due to a mass distribution is given by $\frac{Ax}{(x^2+a^2)^{3/2}}$ in the x-direction. The magnitude of gravitational potential on the x-axis at a distance x, taking its value to be zero at infinity, is:

(JEE Main-2020)

(A) $\frac{A}{(x^2+a^2)^{1/2}}$

(B) $\frac{A}{(x^2+a^2)^{3/2}}$

(C) $(x^2+a^2)^{3/2}$

(D) $(x^2+a^2)^{1/2}$

Ans : (A)

Question

Four identical particles of equal masses 1kg made to move along the circumference of a circle of radius 1 m under the action of their own mutual gravitational attraction. The speed of each particle will be : (JEE Main-2021)

(A) $\sqrt{\frac{G}{2}(1+2\sqrt{2})}$

(B) $\sqrt{G(1+2\sqrt{2})}$

(C) $\sqrt{\frac{G}{2}(2\sqrt{2}-1)}$

(D) $\sqrt{\frac{(1+2\sqrt{2})}{2}G}$

Ans : (D)

Question

A solid sphere of radius R gravitationally attracts a particle placed at 3R form its centre with a force F_1. Now a spherical cavity of radius $\left(\frac{R}{2}\right)$ is made in the sphere (as shown in figure) and the force becomes F_2. The value of $F_1 : F_2$ is:

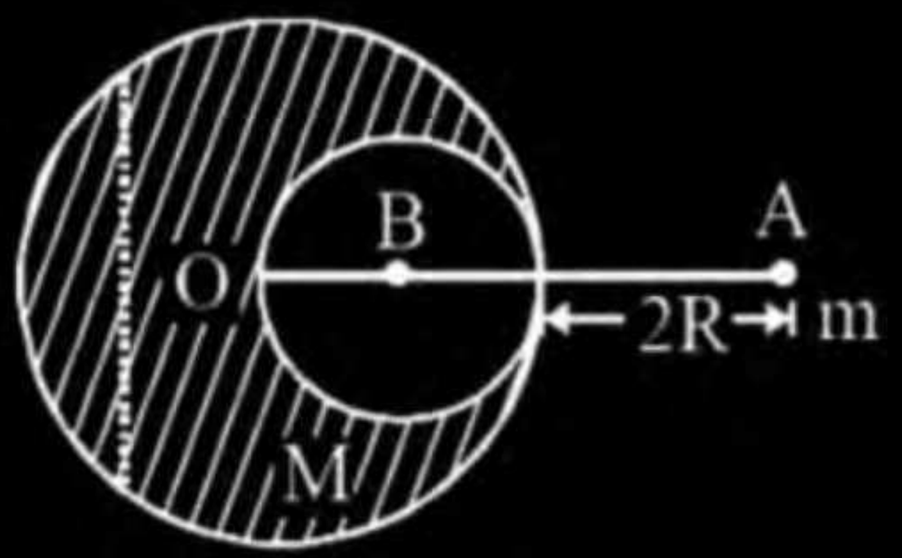
(JEE Main-2021)

(A) 25 : 36

(B) 36 : 25

(C) 50 : 41

(D) 41 : 50



Ans : (C)

Question

Inside a uniform spherical shell:
(a) the gravitational field is zero
(b) the gravitational potential is zero
(c) the gravitational field is same everywhere
(d) the gravitation potential is same everywhere
(e) all of the above
Choose the most appropriate answer from the options given below:

(JEE Main-2021)

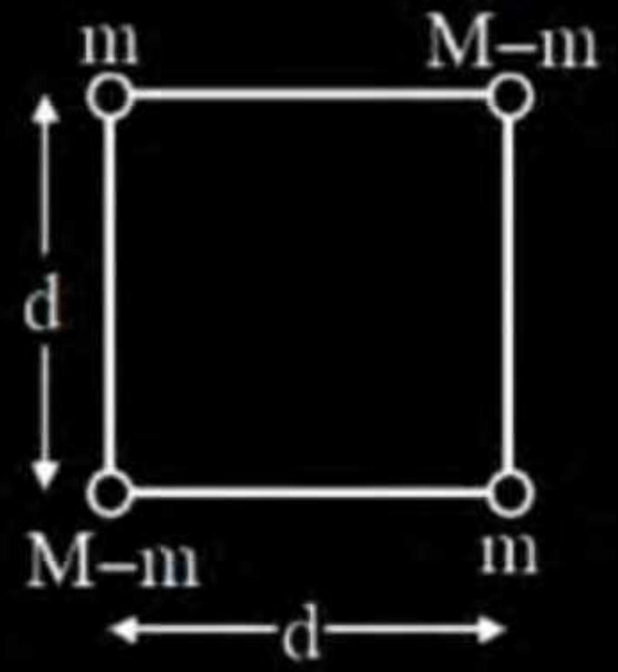
A. (a), (c) and (d) only
B. (e) only
C. (a), (b) and (c) only
D. (b), (c) and (d) only

Ans : (D)

Question

A body of mass (2M) splits into four masses $\{m, M - m, m, M - m\}$, which are rearranged to form a square as shown in the figure. The ratio of $\frac{M}{m}$ for which, the gravitational potential energy of the system becomes maximum is x : 1. The value of x is ....

(JEE Main-2021)



Ans : (2)

Question

The masses and radii of the earth and moon are (M_1, R_1) and (M_2, R_2) respectively. Their centres are at a distance 'r' apart. Find the minimum escape velocity for a particle of mass 'm' to be projected from the middle of these two masses:

(JEE Main-2021)

(A) $V = \frac{1}{2}\sqrt{\frac{4G(M_1 + M_2)}{r}}$

(B) $V = \sqrt{\frac{4G(M_1+M_2)}{r}}$

(C) $V = \frac{1}{2}\sqrt{\frac{2G(M_1 + M_2)}{r}}$

(D) $V = \frac{\sqrt{2G}(M_1 + M_2)}{r}$

Ans : (B)

Question

Four particles each of mass M, move along a circle of radius R under the action of their mutual gravitational attraction as shown in figure. The speed of each particle is:

(JEE Main-2021)

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

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

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

(D) $\sqrt{\frac{GM}{R}}$

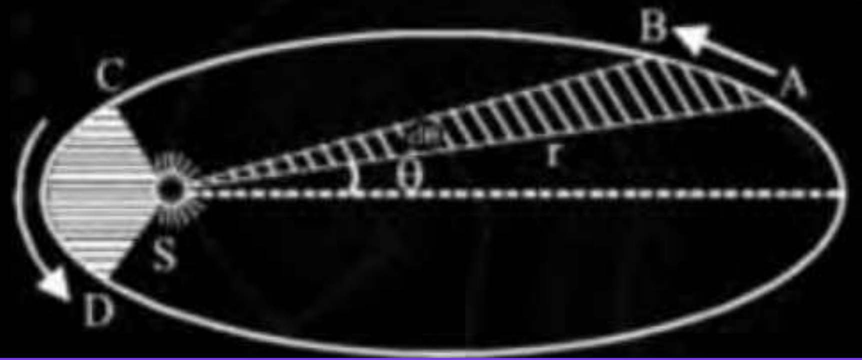
Ans : (B)

Kepler's Laws

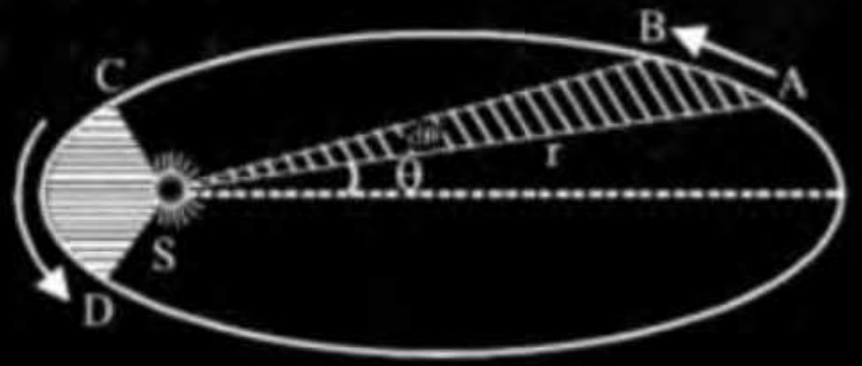
Kepler found important regularities in the motion of the planets. These regularities are known as 'Kepler's three laws of planetary motion'.

(a) First Law (Law of Orbits) : All planets move around the Sun in elliptical orbits, having the Sun at one focus of the orbit.

(b) Second Law (Law of Areas) : A line joining any planet to the Sun sweeps out equal areas in equal times, that is, the areal speed of the planet remains constant. According to the second law, when the planet is nearest the Sun, then its speed is maximum and when it is farthest from the Sun, then its speed is minimum. In figure if a planet moves from A to B in a given time–interval, and from C to D in the same time–interval, then the areas ASB and CSD will be equal



Kepler's Laws



$$\frac{dA}{dt} = \frac{J}{2m} \quad .....(iii)$$

Now, the areal speed dA/dt of the planet is constant, according to Kepler's second law. Therefore, according to eq. (iii), the angular momentum J of the planet is also constant, that is, the angular momentum of the planet is conserved. Thus, Kepler's second law is equivalent to conservation of angular momentum.

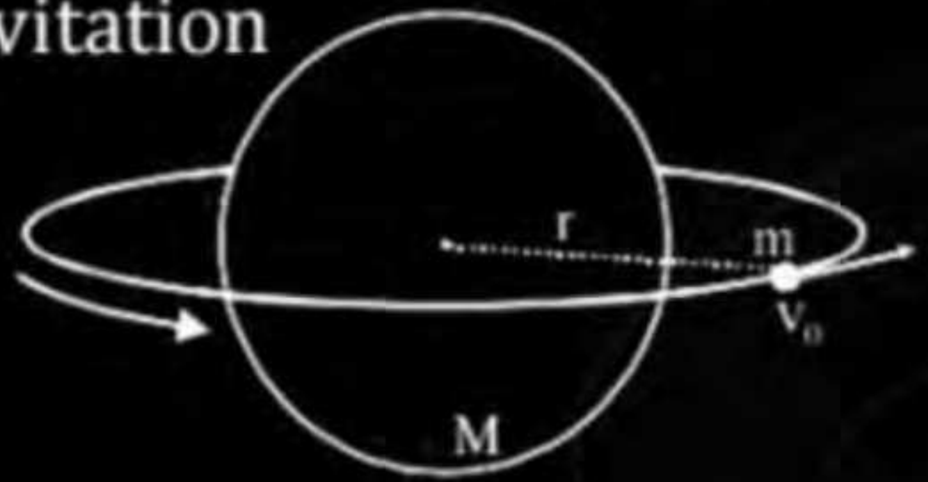
(c) Third Law : (Law of Periods) : The square of the period of revolution (time of one complete revolution) of any planet around the Sun is directly proportional to the cube of the semi–major axis of its elliptical orbit.

$T^2 \propto a^3$

So it is clear through this rule that the farthest planet from the Sun has largest period of revolution. The period of revolution of the closest planet Mercury is 88 days, while that of the farthest dwarf planet Pluto is 248 years.

- **Satellite motion:** A light body revolving round a heavier body due to gravitational attraction, is called satellite. Earth is a satellite of the Sun while Moon is satellite of Earth.

- **Orbital velocity (v_0) :** A satellite of mass m moving in an orbit of radius r with speed v_0 then required centripetal force is provided by gravitation



$$F_{cp} = F_g \Rightarrow \frac{mv_0^2}{r} = \frac{GMm}{r^2} \Rightarrow v_0 = \sqrt{\frac{GM}{r}} = \sqrt{\frac{GM}{(R_e+h)}}\ (r = R_e + h)$$

For a satellite very close to the Earth surface $h << R_e$ $\therefore r = R_e$

$$v_0 = \sqrt{\frac{GM}{R_e}} = \sqrt{gR_e} = 8\,km/s$$

- If a body is taken at some height from Earth and given horizontal velocity of magnitude 8 km/sec then the body becomes satellite of Earth.
- v_o depends upon : Mass of planet, Radius of circular orbit of satellite, g (at planet), Density of planet

➢ Essential Condition's for Satellite Motion

- Centre of satellite's orbit coincide with centre of Earth.
- Plane of orbit of satellite is passing through centre of Earth.

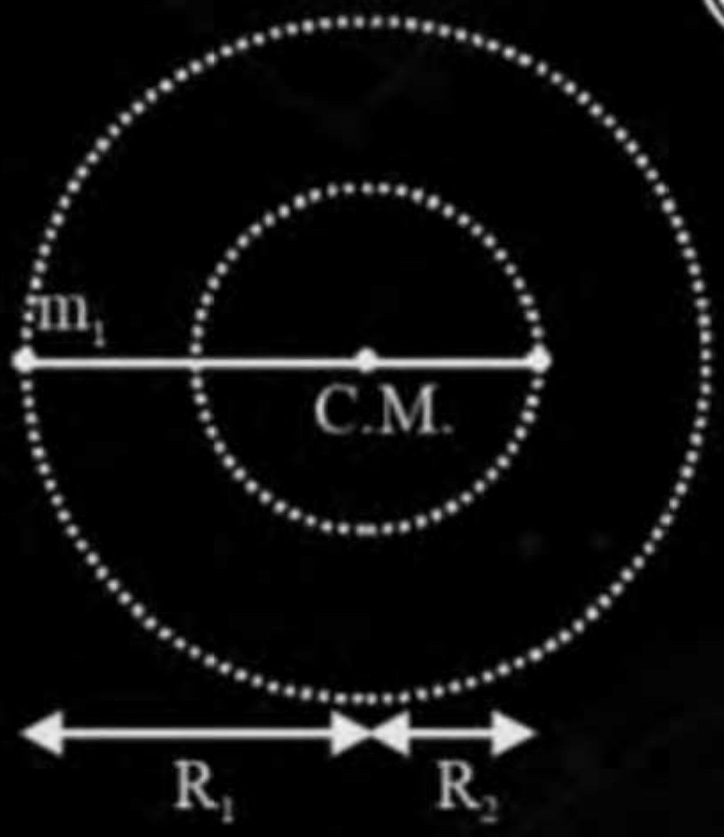
➢ Special Points about Geo–Stationary Satellite

- All three essential conditions for satellite motion should be followed.
- It rotates in equatorial plane.
- Its height from Earth surface is 36000 km. (~6Re)
- Its angular velocity and time period should be same as that of Earth.
- Its rotating direction should be same as that of Earth (West to East).
- Its orbit is called parking orbit and its orbital velocity is 3.1 km./sec.
- Maximum latitude at which message can be recieved by geostationary satellite is

$$\theta = \cos^{-1}\left(\frac{R_e}{R_e + h}\right)$$

Binary star system:

Figure shows two particles moving due to mutually attractive gravitational force about center of mass. Since there is no external force CM of system remains fixed and time period of revolution must be same. Both bodies have comparable mass and both are moving in circular orbit centre of mass as shown in diagram

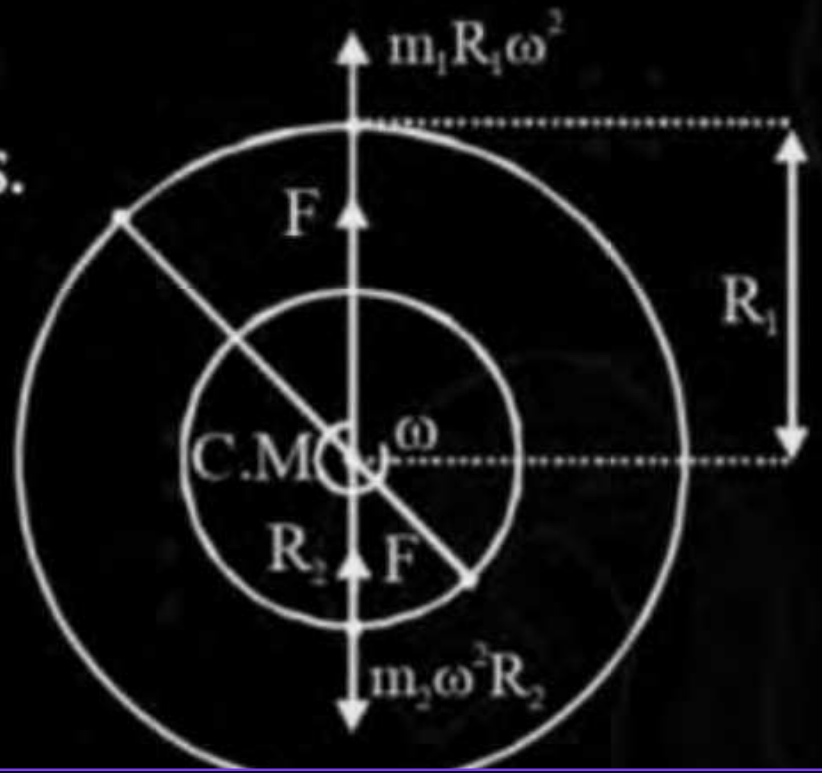


$$\omega = \sqrt{\frac{G(m_1+m_2)}{R^3}}$$

Angular momentum of the system about centre of mass.

$$L = \left(\frac{m_1 m_2}{m_1+m_2}\right) R^2 \omega$$

$$\text{Kinetic energy} = \frac{1}{2}\left(\frac{m_1 m_2}{m_1+m_2}\right) R^2 \omega^2$$



Motion of a ball in a tunnel through the earth :

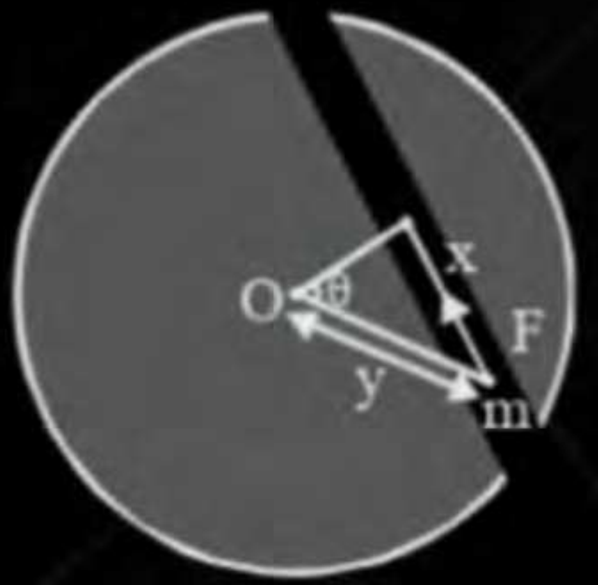
- Case I : If the tunnel is along a diameter and the ball is released from the suface. The ball executes SHM.

so that $T = 2\pi\sqrt{\frac{R^3}{GM}}$; $T = 2\pi\sqrt{\left(\frac{R}{g}\right)}$

Which is same as that of a simple pendulum of infinite length and is equal to 84.6 minute.

(A)

- Case II : If the tunnel is along a chord and ball is released from the surface. The motion is SHM with he same time period.



(B)

QUESTION

The time period of a satellite revolving around earth in a given orbit is increased to three times its previous value, then approximate new time period of the satellite will be:

(JEE Main-2022)

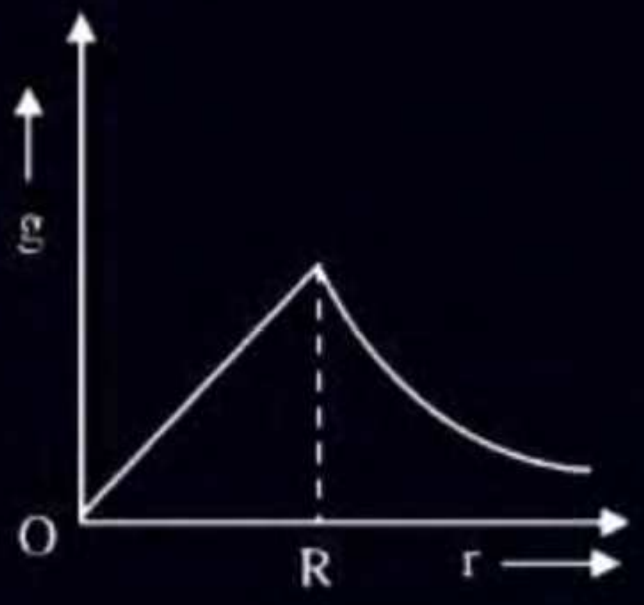
1. 40 hours
2. 36 hours
3. 30 hours
4. 25 hours

Ans : (2)

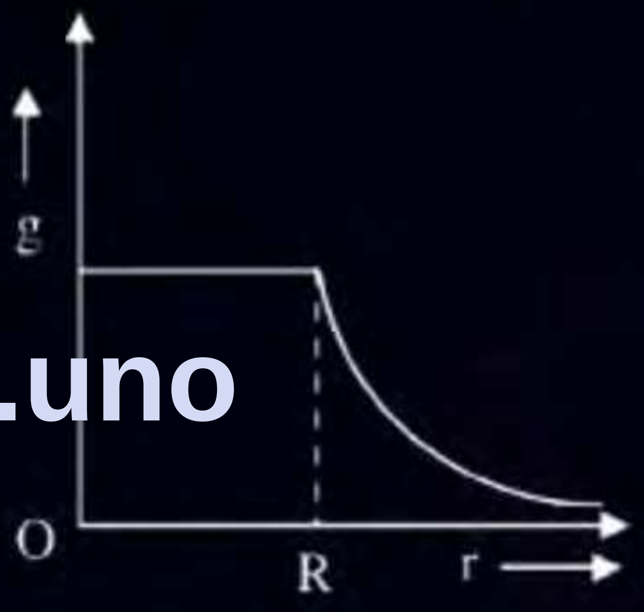
QUESTION

The variation of acceleration due to gravity (g) with distance (r) from the center of the earth is correctly represented by: (given R = radius of earth). **(JEE Main-2022)**

(1)

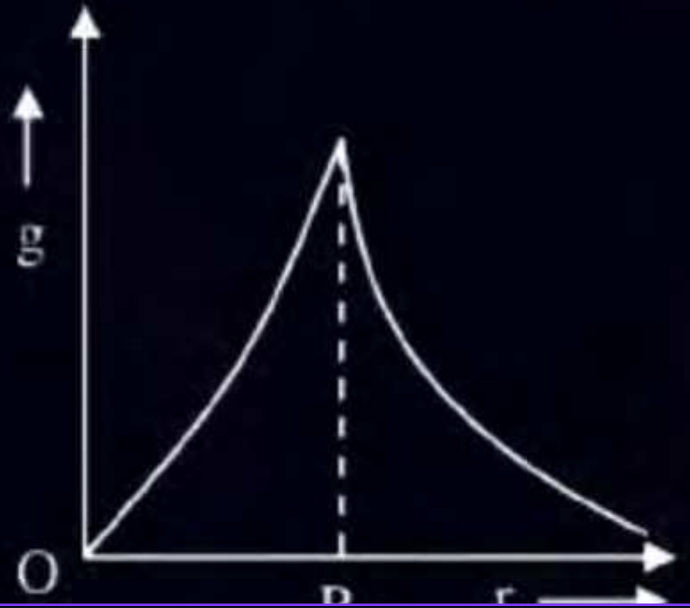


(2)



(3)

(4)



Ans : (1)

QUESTION

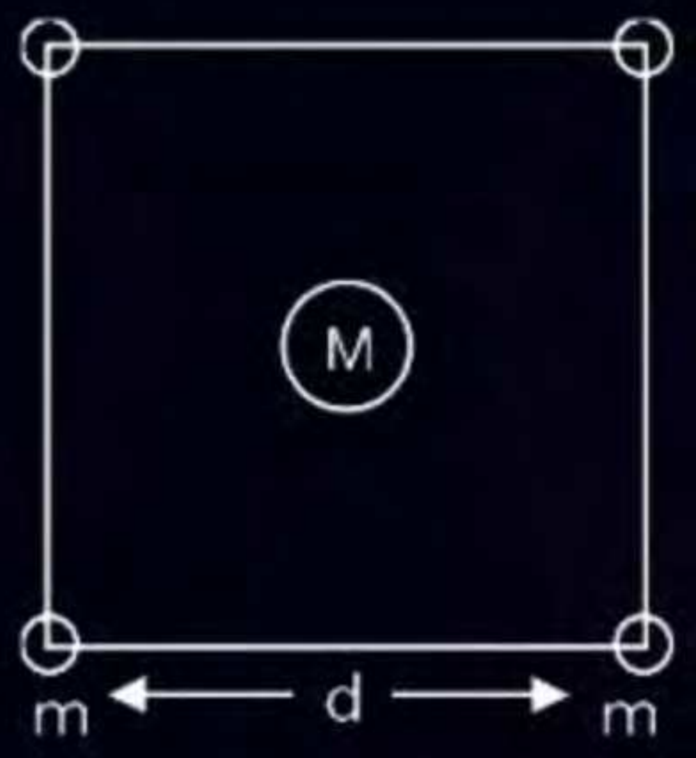
Four spheres each of mass m from a square of side d (as shown in figure). A fifth sphere of mass M is situated at the centre of square. The total gravitational potential energy of the system is: (JEE Main-2022)

(1) $-\frac{Gm}{d}[(4+\sqrt{2})m+4\sqrt{2}M]$

(2) $-\frac{Gm}{d}[(4+\sqrt{2})m+4\sqrt{2}m]$

(3) $-\frac{Gm}{d}[3m^2+4\sqrt{2}M]$

(4) $-\frac{Gm}{d}[6m^2+4\sqrt{2}M]$



Ans : (1)

QUESTION

Two objects of equal masses placed at certain distance from each other attracts each other with a force of F. If one-third mass of one object is transferred to the other object, then the new force will be: (JEE Main-2022)

(1) $\frac{2}{9}F$

(2) $\frac{16}{9}F$

(3) $\frac{8}{9}F$

(4) F

Ans : (3)

QUESTION

The escape velocity of a body on a planet 'A' is 12 kms^{-1}. The escape velocity of the body on another planet 'B', whose density is four times and radius is half of the planet 'A', us: (JEE Main-2022)

1. 12 kms^{-1}
2. 24 kms^{-1}
3. 36 kms^{-1}
4. 6 kms^{-1}

Ans : (1)

QUESTION

The weight of a body at the surface of earth is 18 N. The weight of the body at an altitude of 3200 km above the earth's surface is:
(given, radius of earth $R_e = 6400$ km). (24 January 2023 - Shift 1)

1. 9.8 N
2. 4.9 N
3. 19.6 N
4. 8 N

Ans : (4)

QUESTION

A body of mass is taken from earth surface to the height h equal to twice the radius of earth (R_e), the increase in potential energy will be: (g = acceleration due to gravity on the surface of Earth) (25 January 2023 - Shift 2)

(1) $3\,mgR_e$

(2) $\frac{1}{3}mgR_e$

(3) $\frac{2}{3}mgR_e$

(4) $\frac{1}{2}mgR_e$

Ans : (3)

QUESTION

Two particles of equal mass 'm' move in a circle of radius 'r' under the action of their mutual gravitational attraction. The speed of each particle will be:

(29 January 2023 - Shift 1)

1. $\sqrt{\frac{GM}{2r}}$
2. $\sqrt{\frac{4GM}{r}}$
3. $\sqrt{\frac{GM}{r}}$
4. $\sqrt{\frac{GM}{4r}}$

Ans : (4)

QUESTION

The time period of a satellite of earth is 24 hours. If the separation between the earth and the satellite is decreased to one fourth of the previous value, then its new time period will become. (29 January 2023 - Shift 2)

1. 4 hours
2. 6 hours
3. 12 hours
4. 3 hours

Ans : (4)

QUESTION

Spherical insulating ball and a spherical metallic ball of same size and mass are dropped from the same height. Choose the correct statement out of the following {Assume negligible air friction}. **(31 January 2023 - Shift 1)**

1. Time taken by them to reach the earth's surface will be independent of the properties of their materials
2. Insulating ball will reach the earth's surface earlier than the metal ball
3. Both will reach the earth's surface simultaneously
4. Metal ball will reach the earth's surface earlier than the insulating ball.

Ans : (2)

QUESTION

If earth has a mass nine times and radius twice to the of a planet P. Then $\frac{v_e}{3}\sqrt{x}$ ms^{-1} will be the minimum velocity required by a rocket to pull out of gravitational force of P, where v_e is escape velocity on earth. The value of x is.

(01 February 2023 - Shift 1)

1. 2
2. 3
3. 18
4. 1

Ans : (1)

QUESTION

Given below are two statements:

Statement-I: Acceleration due to gravity is different at different places on the surface of earth.

Statement-II: Acceleration due to gravity increases as we go down below the earth's surface.

In the light of the above statements, choose the correct answer from the options given below. **(01 February 2023 - Shift 1)**

1. Both Statement I and Statement II are true
2. Both Statement I and Statement II are false
3. Statement I is true but Statement II is false
4. Statement I is false but Statement II is true

Ans : (3)

QUESTION

The escape velocities of two planets A and B are in the ratio 1 : 2. If the ratio of their radii respectively is 1 : 3, then the ratio of acceleration due to gravity of planet A to the acceleration of gravity of planet B will be: (01 February 2023 - Shift 2)

(1) $\frac{4}{3}$

(2) $\frac{3}{2}$

(3) $\frac{2}{3}$

(4) $\frac{3}{4}$

Ans : (4)

QUESTION

For a body projected at an angle with the horizontal from the ground, choose the correct statement. (01 February 2023 - Shift 2)

1. Gravitational potential energy is maximum at the highest point.
2. The horizontal component of velocity is zero at highest point.
3. The vertical component of momentum is maximum at the highest point.
4. The kinetic energy (K.E.) is zero at the highest point of projectile motion.

Ans : (1)

QUESTION

A planet has double the mass of the earth. Its average density is equal to that of the earth. An object weighing W on earth will weigh on that planet:

(06 April 2023 - Shift 1)

(1) $2^{\frac{1}{4}}$ W

(2) $2^{\frac{1}{3}}$ W

(3) 2 W

(4) $2^{\frac{2}{3}}$ W

Ans : (2)

QUESTION

Choose the incorrect statement from the following: (06 April 2023 - Shift 2)

1. The speed of satellite in a given circular orbit remains constant
2. For a planet revolving around the sun in an elliptical orbit, the total energy of the planet remains constant
3. The linear speed of a planet revolving around the sun remains constant
4. When a body falls towards earth, the displacement of earth towards the body is negligible

Ans : (3)

QUESTION

The weight of a body on the surface of the earth is 100 N. The gravitational force on it when taken at a height, from the surface of earth, equal to one-fourth the radius of the earth is: (06 April 2023 - Shift 2)

(1) 64 N

(2) 25 N

(3) 50 N

(4) 100 N

Ans : (1)

QUESTION

The weight of a body on the earth is 400 N. Then weight of the body when taken to a depth half of the radius of the earth will be: (08 April 2023 - Shift 1)

1. 200 N
2. Zero
3. 100 N
4. 300 N

Ans : (1)

QUESTION

Given below are two statements:

Statement I: If E be the total energy of a satellite moving around the earth, then its potential energy will be $\frac{E}{2}$.

Statement II: The kinetic energy of a satellite revolving in an orbit is equal to the half the magnitude of total energy E.

In the light of the above statements, choose the most appropriate answer from the options given below. **(08 April 2023 - Shift 1)**

1. Statement I is correct but Statement II is incorrect
2. Statement I is incorrect but Statement II is correct
3. Both Statement I and Statement II are correct
4. Both Statement I and Statement II are incorrect

Ans : (4)

QUESTION

The acceleration due to gravity at height h above the earth if $h \ll R$ (Radius of earth) is given by:

(08 April 2023 - Shift 2)

(1) $g' = g\left(1 - \frac{h^2}{2R^2}\right)$

(2) $g' = g\left(1 - \frac{h}{2R}\right)$

(3) $g' = g\left(1 - \frac{2h}{R}\right)$

(4) $g' = g\left(1 - \frac{2h^2}{R^2}\right)$

Ans : (3)

QUESTION

Two satellites of masses m and 3 m revolve around the earth in circular orbits of radii r & 3r respectively. The ratio of orbital speeds of the satellites respectively is.

(10 April 2023 - Shift 1)

(1) $\sqrt{3}:1$

(2) $3:1$

(3) $9:1$

(4) $1:1$

Ans : (1)

QUESTION

If the earth suddenly shrinks to $\frac{1}{64}$th of its original volume with its mass remaining the same, the period of rotation of earth becomes $\frac{24}{x}$h. The value of x is ______.

(10 April 2023 - Shift 1)

$L \longrightarrow$ Const

$I\omega \longrightarrow$ Const

$I_1 \omega_1 = I_2 \omega_2$

Ans : (16)

QUESTION

Assuming the earth to be a sphere of uniform mass density, the weight of a body at a depth $d = \frac{R}{2}$ from the surface of earth, if its weight on the surface of earth is 200 N, will be: (Given R = radius of earth). (10 April 2023 - Shift 1)

(1) 300 N

(2) 100 N

(3) 400 N

(4) 500 N

Ans : (2)

QUESTION

Given below are two statements:

Statement I: Rotation of the earth shows effect on the value of acceleration due to gravity (g).

Statement II: The effect of rotation of the earth on the value of g at the equator is minimum and that at the pole is maximum.

In the light of the above statements, choose the correct answer from the options given below:

(10 April 2023 - Shift 2)

1. Statement I is false but statement II is true
2. Both Statement I and Statement II are true
3. Both Statement I and Statement II are false
4. Statement I is true but statement II is false

Ans : (4)

QUESTION

The time period of a satellite, revolving above earth's surface at a height equal to R will be (Given $g = \pi^2\ m\ s^{-2}$, R = radius of earth): (10 April 2023 - Shift 2)

1. $\sqrt{2R}$
2. $\sqrt{8R}$
3. $\sqrt{32R}$
4. $\sqrt{4R}$

Ans : (3)

QUESTION

The radii of two planets A and B are R and 4R and their densities are ρ and $\frac{\rho}{3}$ respectively. The ratio of acceleration due to gravity at their surfaces $(g_A : g_B)$ will be.

(11 April 2023 - Shift 1)

(1) 4 : 3

(2) 1 : 16

(3) 3 : 16

(4) 3 : 4

Ans : (4)

QUESTION

The ratio of escape velocity of a planet to the escape velocity of earth will be:
Given: Mass of the planet is 16 times mass of earth and radius of the planet is 4 times the radius of earth. (12 April 2023 - Shift 1)

1. $4:1$
2. $1:4$
3. $1:\sqrt{2}$
4. $2:1$

Ans : (4)

QUESTION

Two satellites A and B move round the earth in the same orbit. The mass of A is twice the mass of B. The quantity which is same for the two satellites will be:

(12 April 2023 - Shift 1)

1. Speed
2. Kinetic energy
3. Total energy
4. Potential energy

Ans : (1)

QUESTION

A planet having mass 9 M_e and radius 4 R_e, where M_e and R_e are mass and radius of earth respectively, has escape velocity in km s^{-1} given by:
(Given escape velocity on earth $V_e = 11.2 \times 10^3$ m s^{-1}). **(13 April 2023 - Shift 1)**

1. 67.2
2. 16.8
3. 11.2
4. 33.6

Ans : (2)

QUESTION

Given below are two statements:

Statement I: For a planet, if the ratio of mass of the planet to its radius increase, the escape velocity from the planet also increase.

Statement II: Escape velocity is independent of the radius of the planet.

In the light of above statements, choose the most appropriate answer from the options given below. (13 April 2023 - Shift 2)

1. Statement I is incorrect but Statement II is correct
2. Statement I is correct but statement II is incorrect
3. Both Statement I and Statement II are incorrect
4. Both Statement I and Statement II are correct

Ans : (2)

QUESTION

Two planets A and B of radii R and 1.5 R have densities ρ and $\frac{\rho}{2}$ respectively. The ratio of acceleration due to gravity at the surface of B to A is: **(13 April 2023 - Shift 2)**

1. 2 : 3
2. 2 : 1
3. 3 : 4
4. 4 : 3

Ans : (3)

QUESTION

Two identical particles each of mass m go round a circle of radius a under the action of their mutual gravitational attraction. The angular speed of each particle will be:

(15 April 2023 - Shift 1)

1. $\sqrt{\frac{Gm}{a^3}}$
2. $\sqrt{\frac{Gm}{8a^3}}$
3. $\sqrt{\frac{Gm}{4a^3}}$
4. $\sqrt{\frac{Gm}{2a^3}}$

Ans : (3)

QUESTION

The acceleration due to gravity on the surface of earth is g. If the diameter of earth reduces to half of its original value and mass remains constant, then acceleration due to gravity on the surface of earth would be: (27 Jan 2024 - Shift 1)

(1) g/4

(2) 2 g

(3) g/2

(4) 4 g

Ans : (4)

QUESTION

A planet takes 200 days to complete one revolution around the Sun. If the distance of the planet from Sun is reduced to one fourth of the original distance, how many days will it take to complete one revolution? (29 Jan 2024 - Shift 2)

1. 25
2. 50
3. 100
4. 20

Ans : (1)

QUESTION

The gravitational potential at a point above the surface of earth is -5.12×10^7 J/kg and the acceleration due to gravity at that point is 6.4 m/s^2. Assume that the mean radius of earth to be 6400 km. The height of this point above the earth's surface is:

(30 Jan 2024 - Shift 1)

1. 1600 km
2. 540 km
3. 1200 km
4. 1000 km

Ans : (1)

QUESTION

Escape velocity of a body from earth is 11.2 km/s. If the radius of a planet be one-third the radius of earth and mass be one-sixth that of earth, the escape velocity from the plate is: (30 Jan 2024 - Shift 2)

1. 11.2 km/s
2. 8.4 km/s
3. 4.2 km/s
4. 7.9 km/s

Ans : (4)

QUESTION

Four identical particles of mass m are kept at the four corners of a square. If the gravitational force exerted on one of the masses by the other masses is $\left(\frac{2\sqrt{2}+1}{32}\right)\frac{Gm^2}{L^2}$, the length of the sides of the square is:

(31 Jan 2024 - Shift 1)

(1) L/2

(2) 4L

(3) 3L

(4) 2L

Ans : (2)

QUESTION

The mass of the moon is 1/144 times the mass of a planet and its diameter 1/16 times the diameter of a planet. If the escape velocity on the planet is v, the escape velocity on the moon will be: (31 Jan 2024 - Shift 2)

1. v/3
2. v/4
3. v/12
4. v/6

Ans : (1)

QUESTION

A metal wire of uniform mass density having length L and mass M is bent to form a semicircular arc and a particle of mass m is placed at the centre of the arc. The gravitational force on the particle by the wire is: (04 Apr. 2024 - Shift 1)

(1) $\frac{GmM\pi^2}{L^2}$

(2) $\frac{GMm\pi}{2L^2}$

(3) 0

(4) $\frac{2GmM\pi}{L^2}$

Ans : (4)

QUESTION

A 90 kg body placed at 2R distance from surface of earth experiences gravitational pull of:

(R = Radius of earth, $g = 10\ ms^{-2}$) (04 Apr. 2024 - Shift 2)

1. 100 N
2. 300 N
3. 225 N
4. 120 N

Ans : (1)

QUESTION

Match List I with List II: **(05 Apr. 2024 - Shift 1)**

(where a = radius of planet orbit,
r = radius of planet, M = mass of Sun,
m = mass of planet).
Choose the correct answer from the options given below:

List-I		List-II	
(A)	Kinetic energy of planet	(I)	$-GMm/a$
(B)	Gravitation potential energy of sun-planet system	(II)	$GMm/2a$
(C)	Total mechanical energy of planet	(III)	Gm/r
(D)	Escape energy at the surface of planet of unit mass object	(IV)	$-GMm/2a$

1. (A)-(III), (B)-(IV), (C)-(I), (D)-(II)
2. (A)-(II), (B)-(I), (C)-(IV), (D)-(III)
3. (A)-(I), (B)-(II), (C)-(III), (D)-(IV)
4. (A)-(I), (B)-(IV), (C)-(II), (D)-(III)

Ans : (2)

QUESTION

A satellite revolving around a planet in stationary orbit has time period 6 hours. The mass of planet is one-fourth the mass of earth. The radius orbit of planet is:
(Given = Radius of geo-stationary orbit for earth is 4.2×10^4 km) **(05 Apr. 2024 - Shift 2)**

1. 1.4×10^4 km
2. 1.05×10^4 km
3. 8.4×10^4 km
4. 1.68×10^5 km

Ans : (2)

QUESTION

To project a body of mass m from earth's surface to infinity, the required kinetic energy is (assume, the radius of earth is R_E, g = acceleration due to gravity on the surface of earth): (06 Apr. 2024 - Shift 1)

(1) $2\ mgR_E$

(2) $4\ mgR_E$

(3) mgR_E

(4) $1/2\ mgR_E$

Ans : (3)

QUESTION

Two planets A and B having masses m_1 and m_2 move around the sun in circular orbits of r_1 and r_2 radii respectively. If angular momentum of A is L and that of B is 3 L, the ratio of time period $\left(\frac{T_A}{T_B}\right)$ is:

(08 Apr. 2024 - Shift 1)

(1) $\left(\frac{r_2}{r_1}\right)^{\frac{3}{2}}$

(2) $\frac{1}{27}\left(\frac{m_2}{m_1}\right)^3$

(3) $27\left(\frac{m_1}{m_2}\right)^3$

(4) $\left(\frac{r_1}{r_2}\right)^3$

Ans : (2)

QUESTION

Two satellite A and B go round a planet in circular orbits having radii 4R and R respectively. If the speed of A is $3v$, the speed of B will be: (08 Apr. 2024 - Shift 2)

(1) $3v$

(2) $6v$

(3) $\frac{4}{3}v$

(4) $12v$

Ans : (2)

QUESTION

A satellite of 10^3 kg mass is revolving in circular orbit of radius 2R. If $\frac{10^4 R}{6}$ J energy is supplied to the satellite, it would revolve in a new circular orbit of radius.
(use $g = 10 \text{ m/s}^2$, R = radius of earth) (09 Apr. 2024 - Shift 2)

(1) 2.5 R

(2) 3 R

(3) 4 R

(4) 6 R

Ans : (4)

Question

m

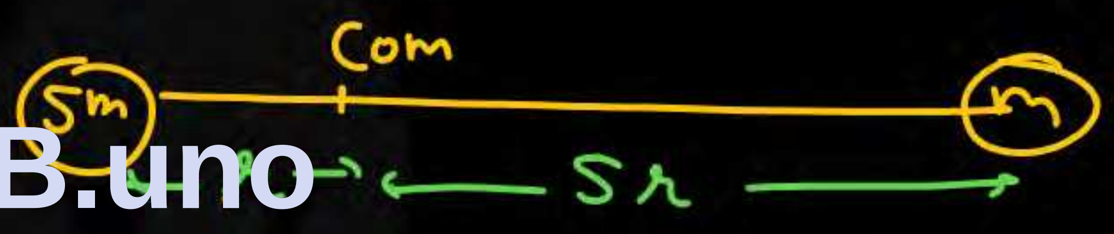
5m

A binary star consists of two stars A (mass $2.2M_s$) and B (mass $11M_s$), where M_s is the mass of the sun. They are separated by distance d and are rotating about their centre of mass, which is stationary. The ratio of the total angular momentum of the binary star to the angular momentum of star B about the centre of mass is :-

[IIT-JEE 2010]

$$L = mr^2\omega = I\omega$$

$$\frac{L_1}{L_2} = \frac{m_1}{m_2}\cdot\left(\frac{r_1}{r_2}\right)^2\cdot\frac{\omega_1}{\omega_2}$$

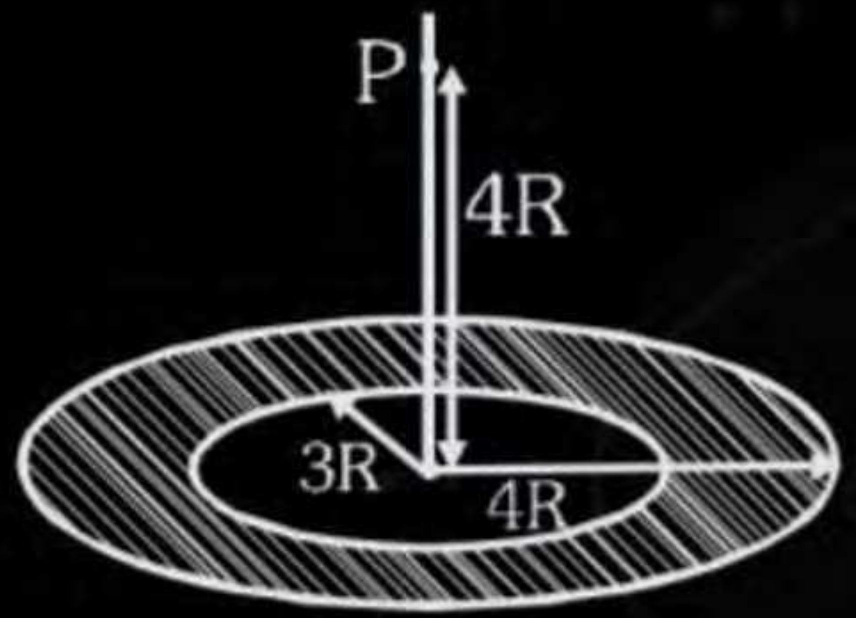


Ans : (6)

Question

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

[IIT-JEE 2010]



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

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

(C) $\frac{GM}{4R}$

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

Ans : (A)

Home Work

- Qus are attached.


THANK
YOU