JEE Main 2021 | Gravitation

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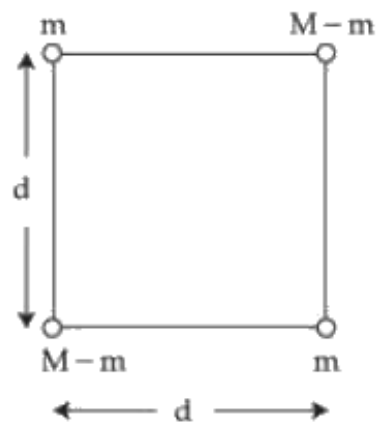
Question 1

(Integer type question) 2021

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 M/m for which, the gravitational potential energy of the system becomes maximum is $x:1$. The value of x is .....



Question 2

(Integer type question) 2021

The radius in kilometer to which the present radius of earth ($R = 6400\ km$) to be compressed so that the escape velocity is increased 10 times is .....

Question 3

(Only one correct answer) 2021

A mass of $50\ kg$ is placed at the center of a uniform spherical shell of mass $100\ kg$ and radius $50\ m$. If the gravitational potential at a point, $25\ m$ from the center is $V\ kg/m$. The value of V is:

- (a) $+2\ G$
- (b) $-20\ G$
- (c) $-4\ G$
- (d) $-60\ G$

Question 4

(Only one correct answer) 2021

The masses and radii of the earth and moon are $(M_1,\ R_1)$ and $(M_2,\ R_2)$ respectively. Their centers 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 :

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

(b) $v = \sqrt{\frac{4G(M_1 + M_2)}{r}}$

(c) $v = \frac{\sqrt{2G}(M_1 + M_2)}{r}$

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

Question 5

(Only one correct answer) 2021

If R_E be the radius of Earth, then the ratio between the acceleration due to gravity at a depth $'r'$ below and a height $'r'$ above the earth surface is : (Given : $r < R_E$)

(a) $1 + \frac{r}{R_E} - \frac{r^2}{R_E^2} - \frac{r^3}{R_E^3}$

(b) $1 + \frac{r}{R_E} - \frac{r^2}{R_E^2} + \frac{r^3}{R_E^3}$

(c) $1 - \frac{r}{R_E} - \frac{r^2}{R_E^2} - \frac{r^3}{R_E^3}$

(d) $1 + \frac{r}{R_E} + \frac{r^2}{R_E^2} + \frac{r^3}{R_E^3}$

Question 6

(Only one correct answer) 2021

Match List-I with List-II

List-I List-II

(a) $10\ km$ height over earth's surface (i) Thermosphere

(b) $70\ km$ height over earth's surface (ii) Mesosphere

(c) $180\ km$ height over earth's surface (iii) Stratosphere

(d) $270\ km$ height over earth's surface (iv) Troposphere

(a) (a)-(iii), (b)-(ii), (c)-(i), (d)-(iv)

(b) (a)-(ii), (b)-(i), (c)-(iv), (d)-(i)

(c) (a)-(iv), (b)-(iii), (c)-(ii), (d)-(i)

(d) (a)-(i), (b)-(iv), (c)-(iii), (d)-(ii)

Question 7

(Only one correct answer) 2021

The angular momentum of a planet of mass M moving around the sun in an elliptical orbit is The

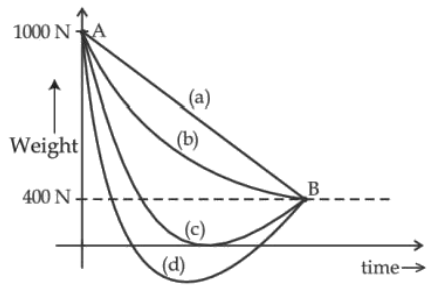
magnitude of the areal velocity of the planet is

- (a) $\frac{L}{M}$
- (b) $\frac{4L}{M}$
- (c) $\frac{L}{2M}$
- (d) $\frac{2L}{M}$

Question 8

(Only one correct answer) 2021

A person whose mass is $100\ kg$ travels from Earth to Mars in a spaceship. Neglect all other objects in sky and take acceleration due to gravity on the surface of the Earth and Mars as $10\ m/s^2$ and $4\ m/s^2$ respectively. Identify from the below figures, the curve that fits best for the weight of the passenger as a function of time.



- (a) (c)
- (b) (d)
- (c) (b)
- (d) (a)

Question 9

(Only one correct answer) 2021

Consider a binary star system of star A and star B with masses m_A and m_B revolving in a circular orbit of radii r_A and r_B, respectively. If T_A and T_B are the time period of star A and star B, respectively, then ;

- (a) $T_A = T_B$
- (b) $T_A > T_B$ (If $r_A > r_B$)
- (c) $\frac{T_A}{T_B} = \left(\frac{r_A}{r_B}\right)^{\frac{3}{2}}$
- (d) $T_A > T_B$ (If $m_A > m_B$)

Question 10

(Only one correct answer) 2021

The minimum and maximum distances of a planet revolving around the Sun are x_1 and x_2. If the minimum speed of the planet on its trajectory is v_0 then its maximum speed will be:

- (a) $\frac{v_0 x_2^2}{x_2^2}$
- (b) $\frac{v_0 x_2}{x_1}$
- (c) $\frac{v_0 x_1}{x_2}$
- (d) $\frac{v_0 x_1^2}{x_2^2}$

Question 11

(Integer type question) 2021

The initial velocity v_i required to project a body vertically upward from the surface of the earth to reach a height of $10R$, where R is the radius of the earth, may be described in terms of escape velocity v_e such that $v_i = \sqrt{\frac{x}{y}} \times v_e$. The value of x will be .....

Question 12

(Only one correct answer) 2021

Consider a planet in some solar system which has a mass double the mass of earth and density equal to the average density of earth. If the weight of an object on earth is W, the weight of the same object on that planet will be:

- (a) $2W$
- (b) $\sqrt{2}W$
- (c) W
- (d) $2^{\frac{1}{3}}W$

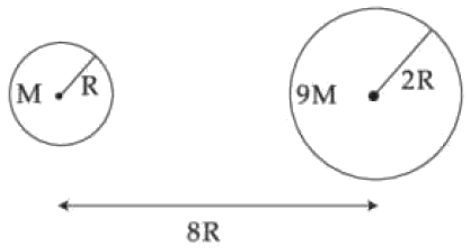
Question 13

(Integer type question) 2021

Suppose two planets (spherical in shape) of radii R and $2R$, but mass M and $9M$ respectively have a center to center separation $8R$ as shown in the figure. A satellite of mass $'m'$ is projected from the surface of the planet of mass $'M'$ directly towards the center of the second planet. The minimum speed $'v'$ required for the satellite to reach the surface of the second planet is $\sqrt{\frac{a}{7}\frac{GM}{R}}$ then the

value of $'a'$ is .....

[Given : the two planets are fixed in their position]



Question 14

(Only one correct answer) 2021

A particle is moving with uniform speed along the circumference of a circle of radius R under the action of a central fictitious force F which is inversely proportional to R^3, its time period of revolution will be given by :

- (a) $T \propto R^{\frac{4}{3}}$
- (b) $T \propto R^{\frac{3}{2}}$
- (c) $T \propto R^{\frac{5}{2}}$
- (d) $T \propto R^2$

Question 15

(Only one correct answer) 2021

Two identical particles of mass $1\ kg$ each go round a circle of radius R, under the action of their mutual gravitational attraction. The angular speed of each particle is :

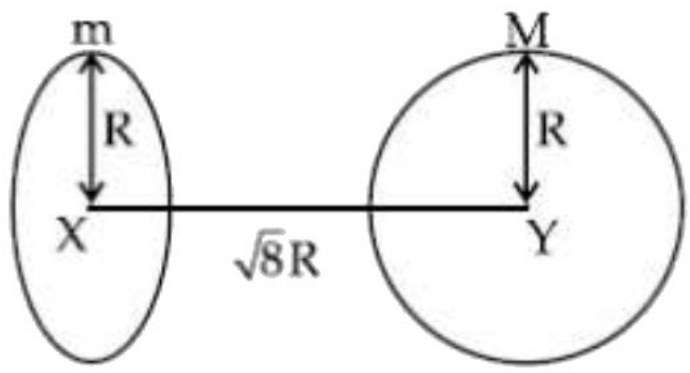
- (a) $\frac{1}{2R}\sqrt{\frac{1}{G}}$
- (b) $\sqrt{\frac{2G}{R^3}}$
- (c) $\frac{1}{2}\sqrt{\frac{G}{R^3}}$
- (d) $\sqrt{\frac{G}{2R^3}}$

Question 16

(Only one correct answer) 2021

Find the gravitational force of attraction between the ring and sphere as shown in the diagram, where the plane of the ring is perpendicular to the line joining the centers. If $\sqrt{8}R$ is the distance

between the centers of a ring (of mass $'m'$) and a sphere (mass $'M'$) where both have equal radius $'R'$.



- (a) $\frac{1}{3\sqrt{8}} \cdot \frac{GMm}{R^2}$
- (b) $\frac{2\sqrt{2}}{3} \cdot \frac{GMm}{R^2}$
- (c) $\frac{\sqrt{8}}{9} \cdot \frac{GMm}{R}$
- (d) $\frac{\sqrt{8}}{27} \cdot \frac{GMm}{R^2}$

Question 17

(Only one correct answer) 2021

The planet Mars has two moons, if one of them has a period 7 hours, 30 minutes and an orbital radius of $9.0 \times 10^3\ km$. Find the mass of Mars. (Given $\frac{4\pi^2}{G} = 6 \times 10^{11}\ N^{-1}\ m^{-2}\ kg^2$)

- (a) $7.02 \times 10^{25}\ kg$
- (b) $2.25 \times 10^{21}\ kg$
- (c) $5.96 \times 10^{19}\ kg$
- (d) $6.00 \times 10^{23}\ kg$

Question 18

(Integer type question) 2021

In one wants to remove all the mass of the earth to infinity in order to break it up completely. The amount of energy that needs to be supplied will be $\frac{x}{5}\frac{GM^2}{R}$ where x is ..... (Round off to the Nearest Integer) (M is mass of earth, R is the radius of earth, G is the gravitational constant)

Question 19

(Only one correct answer) 2021

Two stars of masses m and $2m$ at a distance d rotate about their common center of mass in free space. The period of revolution is :

(a) $\frac{1}{2\pi}\sqrt{\frac{d^3}{3Gm}}$

(b) $2\pi\sqrt{\frac{d^3}{3Gm}}$

(c) $\frac{1}{2\pi}\sqrt{\frac{3Gm}{d^3}}$

(d) $2\pi\sqrt{\frac{3Gm}{d^3}}$

Question 20

(Only one correct answer) 2021

Four identical particles of equal masses $1\ kg$ 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 :

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

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

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

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

Question 21

(Only one correct answer) 2021

If the angular velocity of earth's spin is increased such that the bodies at the equator start floating the duration of the day would be approximately : [Take $g = 10\ ms^{-2}$, the radius of earth. $R = 6400 \times 10^3\ m$, Take $\pi = 3.14$]

(a) 1200 minutes

(b) does not change

(c) 60 minutes

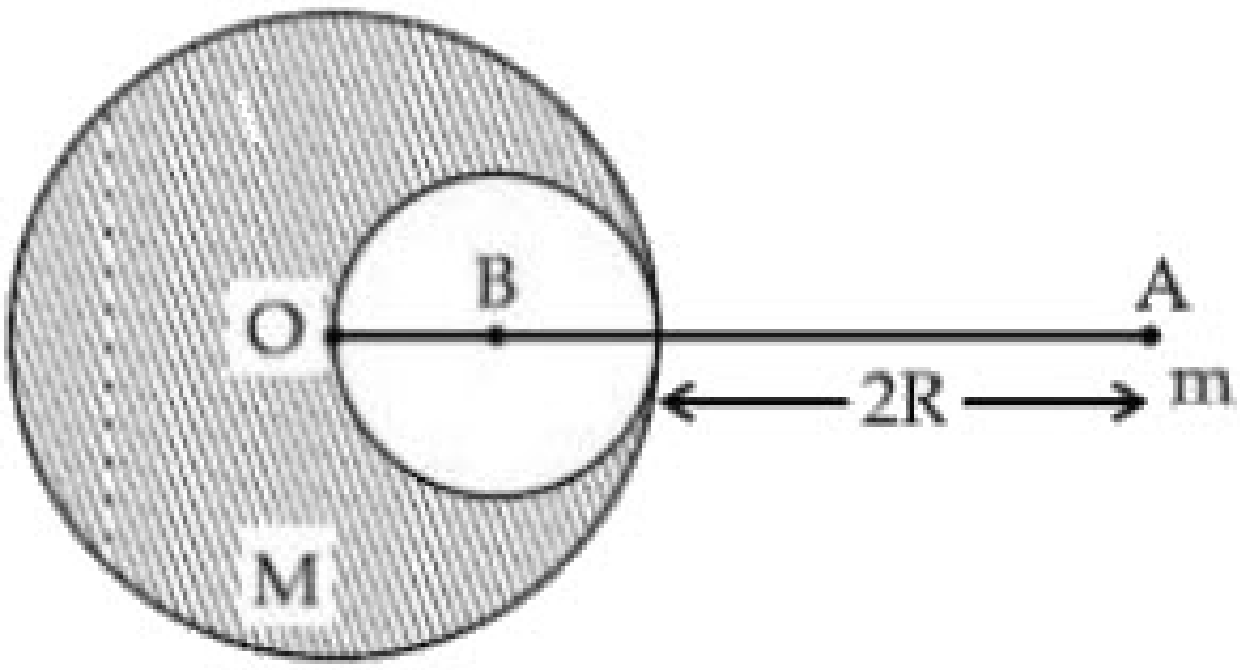
(d) 84 minutes

Question 22

(Only one correct answer) 2021

A solid sphere of radius R gravitationally attracts a particle placed at $3R$ from its center 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 :



(a) $41 : 50$

(b) $50 : 41$

(c) $36 : 25$

(d) $25 : 36$

Question 23

(Only one correct answer) 2021

A satellite is launched into a circular orbit of radius R around earth, while a second satellite is launched into a circular orbit of radius $1.02R$. The percentage difference in the time periods of the two satellites is

(a) 1.5

(b) 0.7

(c) 3.0

(d) 2.0

Question 24

(Only one correct answer) 2021

Given below are two statement : one labelled as Assertion A and the other is labelled as Reason R.

Assertion A : The escape velocities of planet A and B are same. But A and B are of unequal mass.

Reason R : The product of their mass and radius must be same. $M_1 R_1 = M_2 R_2$.

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

(a) A is not correct but R is correct

(b) Both A and R are correct but R is NOT the correct explanation of A

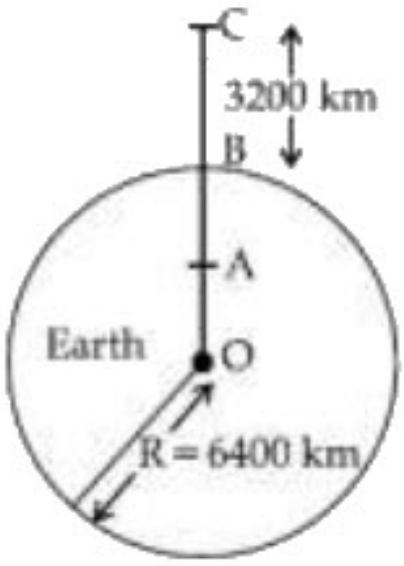
(c) A is correct but R is not correct

(d) Both A and R are correct and R is the correct explanation of A

Question 25

(Integer type question) 2021

In the reported figure of earth, the value of acceleration due to gravity is same at point A and C but it is smaller then that of its value at point B (surface of the earth). The value of $OA : AB$ will be $x : y$. The value of x is .....



Question 26

(Only one correct answer) 2021

The maximum and minimum distances of comet from the Sun are $1.6 \times 10^{12}\ m$ and $8.0 \times 10^{10}\ m$ respectively. If the speed of the comet at the nearest point is $6 \times 10^{4}\ ms^{-1}$, the speed at the farthest point is :

(a) $3.0 \times 10^{3}\ m/s$

(b) $4.5 \times 10^{3}\ m/s$

(c) $1.5 \times 10^{3}\ m/s$

(d) $6.0 \times 10^{3}\ m/s$

Question 27

(Only one correct answer) 2021

Inside a uniform spherical shell:

(a) The gravitation field is zero

(b) The gravitational potential is zero

(c) The gravitational field is same everywhere.

(d) the gravitational potential is same everywhere.

(e) all of the above

Choose the most appropriate answer from the options given below:

(a) (b), (c), and (d) only

(b) (e) only

(c) (a), (c) and (d) only

(d) (a), (b) and (c) only

Question 28

(Only one correct answer) 2021

The time period of a satellite in a circuit orbit of radius R is T. The period of another satellite in a circular orbit of radius $9R$ is :

(a) $12\ T$

(b) $3\ T$

(c) $27\ T$

(d) $9\ T$

Question 29

(Only one correct answer) 2021

A body weighs $49\ N$ on a spring balance at the north pole. What will be its weight recorded on the same weighing machine, if it is shifted to the equator ?

[Use $g = \dfrac{GM}{R^2} = 9.8\ ms^{-2}$ and radius of earth, $R = 6400\ km$]

(a) $48.83\ N$

(b) $49.83\ N$

(c) $49\ N$

(d) $49.17\ N$

Question 30

(Only one correct answer) 2021

A planet revolving in elliptical orbit has :

(A) a constant velocity of revolution.

(B) has the least velocity when it is nearest to the sun.

(C) its areal velocity is directly proportional to its velocity.

(D) areal velocity is inversely proportional to its velocity.

(E) to follow a trajectory such that the areal velocity is constant.

Choose the correct answer from the options given below :

(a) E only

(b) A only

(c) C only

(d) D only

Question 31

(Only one correct answer) 2021

A geostationary satellite is orbiting around an arbitrary planet $'P'$ at a height of $11R$ above the surface of $'P'$, R being the radius of $'P'$. The time period of another satellite in house at a height of $2R$ from the surface of $'P'$ is ..... $'P'$ has the time period of 24 hours.

(a) 3

(b) 5

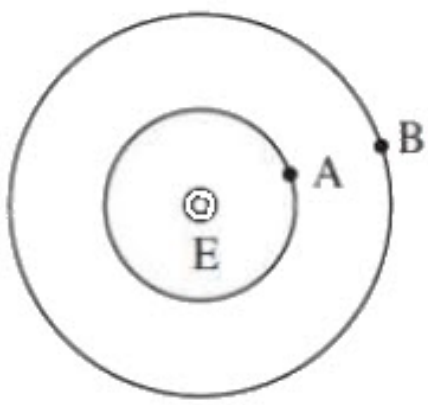
(c) $\frac{6}{\sqrt{2}}$

(d) $6\sqrt{2}$

Question 32

(Only one correct answer) 2021

Two satellites A and B of masses $200\ kg$ and $400\ kg$ are revolving round the earth at height of $600\ km$ and $1600\ km$ respectively. If T_A and T_B are the time periods of A and B respectively then the value of $T_B - T_A$:



Given : radius of earth $= 6400\ km$, mass of earth $= 6 \times 10^{24}\ kg$

(a) $3.33 \times 10^2\ s$

(b) $4.214 \times 10^3\ s$

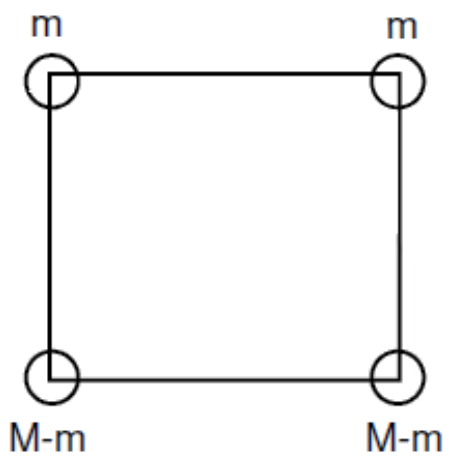
(c) $4.24 \times 10^2\ s$

(d) $1.33 \times 10^3\ s$

Answer 1

Solution:

$$U = \frac{Gm^2}{a} + \frac{G(M-m)^2}{a} + \frac{2Gm(M-m)}{a} + \frac{2Gm(M-m)}{\sqrt{2}a}$$



For maxima or minima of potential energy $\frac{dU}{dm} = 0$

$$\frac{dU}{dm} = \frac{G}{a}(2m - 2(M-m) + (M-2m)2 + \sqrt{2}(M-2m))$$
$$(4m - 4m - 2\sqrt{2}m) + (-2M + 2M + \sqrt{2}M) = 0\,;$$
$$\sqrt{2}M = 2\sqrt{2}m\,;$$
$$\frac{M}{m} = 2$$

Answer 2

Solution:

Escape velocity $= \sqrt{\frac{2GM}{R}}$

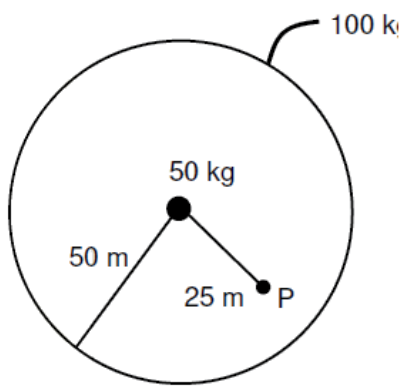
As mass remains same

$$\frac{V_e'}{V_e} = \sqrt{\frac{R_e}{R_e'}}$$
$$\implies \quad \frac{10V_e}{V_e} = \sqrt{\frac{6400}{R_e'}}$$
$$\implies \quad R_e' = 64\ km$$

Answer 3

Correct answers is C

Solution:

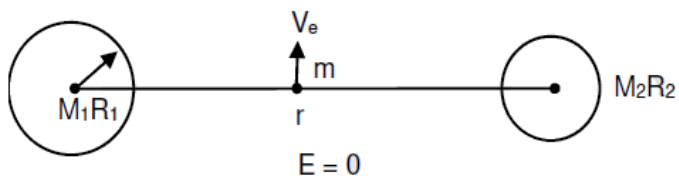


$$V_p = -\frac{(100)}{50} - \frac{(50)}{25}$$
$$V_p = -4\ G$$

Answer 4

Correct answers is B

Solution:



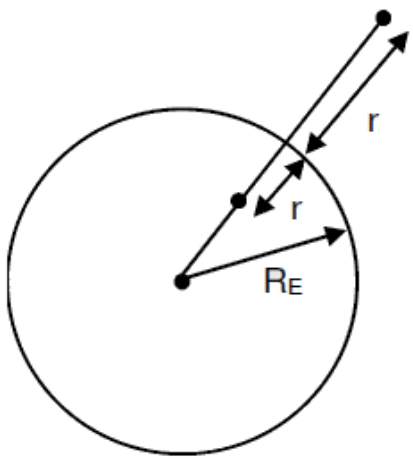
$$-\left(\frac{GM_1}{r/2}+\frac{GM_2}{r/2}\right)m+\frac{1}{2}mv_e^2=0$$

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

Answer 5

Correct answers is A

Solution:



$$\frac{g_h}{g_d}=\frac{\frac{GM}{(R_E+r)^2}}{\frac{GM}{R_E^3}(R_E-r)}$$

$$=\frac{R_E^3}{(R_E+r)^2(R_E-r)}$$

$$\frac{G_d}{g_h}=\frac{(R_E+r)^2(R_E-r)}{R_E^3}$$

$$=\frac{R_E^3-R_Er^2+rR_E^2-r^3}{R_E^3}$$

$$=1-\frac{r^2}{R_E^2}+\frac{r}{R_E}-\left(\frac{r}{R_E}\right)^3$$

Answer 6

Correct answers is C

Solution:

Correct option is (c).

Answer 7

Correct answers is C

Solution:

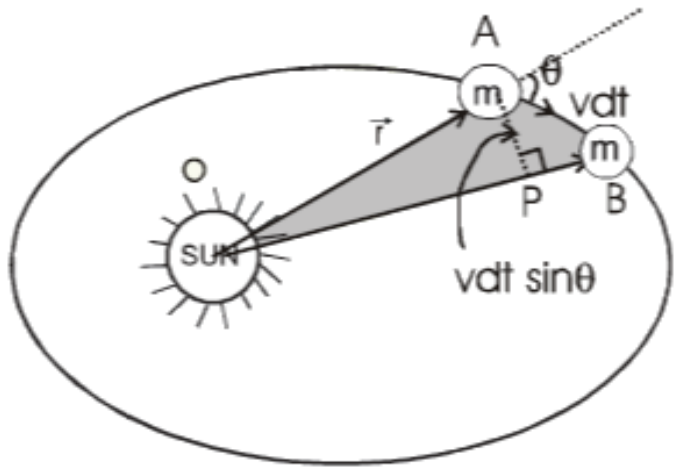
A real velocity $=\dfrac{L}{2m}$

Suppose a planet is revolving around the sun and at any instant its velocity is v, and angle between radius vector ($\overrightarrow{r}$) and velocity ($\overrightarrow{v}$). In dt time, it moves by a distance vdt, during this dt time, area swept by the radius vector will be OAB which can be assumed to be a triangle

$dA = 1/2$ (Base) (Perpendicular height)
$dA = 1/2(r)(vdt\sin\theta)$

So rate of area swept $\dfrac{dA}{dt} = \dfrac{1}{2}vr\sin\theta$

We can write $\dfrac{dA}{dt} = \dfrac{1}{2}\dfrac{mvr\sin\theta}{m}$



where $mvr\sin\theta =$ angular momentum of the planet about the sun, which remains conserved (constant)

$$\Longrightarrow \quad \frac{dA}{dt} = \text{Areal velocity} = \frac{L_{\text{planet/sun}}}{2m} = \frac{L}{2m}$$

Answer 8

Correct answers is A

Solution:

$\overrightarrow{g}$ (at any point) $= \overrightarrow{g}_{\text{Earth}} + \overrightarrow{g}_{\text{mars}}$. Since distance is large so $|\overrightarrow{g}| = |\overrightarrow{g}_E| = 10$. As we move away from earth, It decrease to zero at a point where $|\overrightarrow{g}_E| = |\overrightarrow{g}_M| = 0$ Then it increase to $|\overrightarrow{g}| = |\overrightarrow{g}_M| = 4$ at mars surface.

Answer 9

Correct answers is A

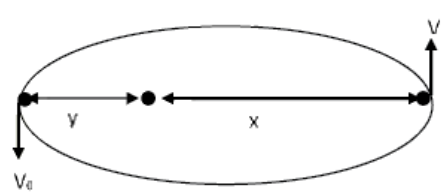
Solution:

Both the planets will move due to mutual gravitational interaction, thus will have same angular velocity. This will result in same time period.

Answer 10

Correct answers is B

Solution:



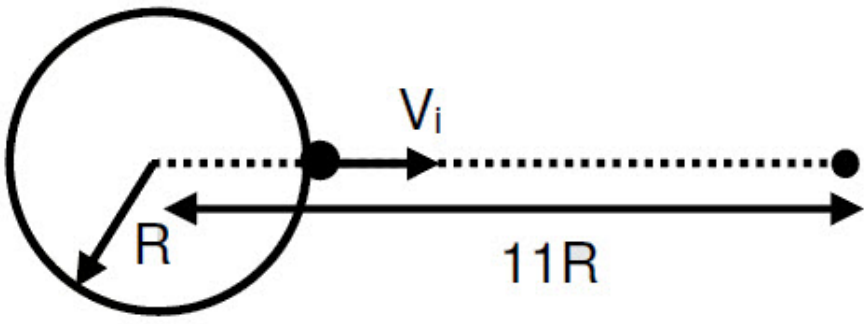
By angular momentum conservation

$mv_0x_2 = mvx_1$

$v = \dfrac{v_0x_2}{x_1}$

Answer 11

Solution:



$$\frac{1}{2}mv_i^2 - \frac{GMm}{R} = \frac{-GMm}{11R}$$

$$v_i^2 = \left(2 - \frac{2}{11}\right)\frac{GM}{R}$$

$$v_i = \sqrt{\frac{20}{11}\frac{GM}{R}} = \sqrt{\frac{10}{11}}v_e$$

Thus, $x = 10, \quad y = 11$

Answer 12

Correct answers is D

Solution:

$2M_E = M_P$

$2\rho \times \frac{4}{3}\pi R_E^3 = \rho \times \frac{4}{3}\pi R_P^3$ (same density)

$R_P = 2^{1/3}R_E$

$g_P = \frac{GM_P}{R_P^2}$ (acceleration due to gravity)

$g_E = \frac{G2M_E}{(2^{1/3}R_E)^2} = \frac{G2M_E}{2^{2/3}R_E^2}$

$g_P = 2^{1/3}g_E$

Weight on planet $= 2^{1/3}$ weight on earth

$W_P = 2^{1/3}W$

Answer 13

Solution:

Let at a distance $'X'$ from planet $'A'$, the net gravitational field becomes zero

$\frac{GM}{X^2} = \frac{G \times 9M}{(8R - X)^2}$

$(3X)^2 = (8R - X)^2$

$X = 2R$

Now, Particle should be projected such that it covers a minimum distance of $'2R'$. Thus

$$\frac{1}{2}mv^2 - \frac{GMm}{R} - \frac{G(9M)m}{7R}$$

$$= -\frac{GMm}{2R} - \frac{G(9M)m}{6R}$$

$$\frac{1}{2}v^2 = \frac{2}{7}\frac{GM}{R}$$
$$\implies v = \sqrt{\frac{4}{7}\frac{GM}{R}}$$

Answer 14

Correct answers is D

Solution:

$$F = \frac{mv^2}{R}$$
$$\frac{K}{R^3} = \frac{mv^2}{R}\ ; \quad \frac{K}{R^2 m} = v^2\ ; \quad v = \frac{1}{R}\sqrt{\frac{K}{m}}$$
$$T = \frac{2\pi R}{v} = \frac{2\pi R}{\frac{1}{R}\sqrt{\frac{K}{m}}} \propto R^2$$
$$T \propto R^2$$

Answer 15

Correct answers is C

Solution:

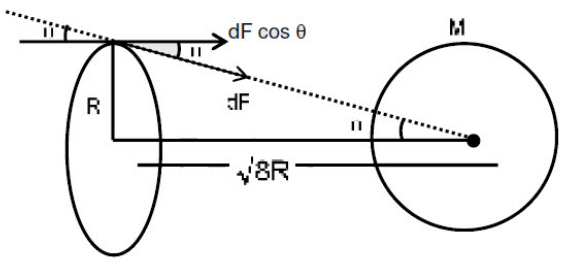
$$\frac{Gm^2}{4R^2} = m\omega^2 R$$
$$\omega = \sqrt{\frac{Gm}{4R^3}};$$
$$\omega = \frac{1}{2}\sqrt{\frac{G}{R^3}}, \text{Given } m = 1\ kg$$

Answer 16

Correct answers is D

Solution:

$$\tan\theta = \frac{1}{\sqrt{8}}$$



$$F = \int dF\cos\theta = \cos\theta\int dF$$
$$= \frac{\sqrt{8}}{3}\left[\int(dm)\frac{GM}{(3R)^2}\right]$$
$$= \frac{\sqrt{8}GM}{27R^2}\int dm = \frac{\sqrt{8}}{27}\frac{GMm}{R^2}$$

Alternate solution:

$$F = ME = M\frac{Gmx}{(R^2+x^2)^{3/2}}$$
$$= \frac{M \times Gm\sqrt{8}R}{(R^2+8R^2)^{3/2}} = \frac{\sqrt{8}}{27}\frac{GMm}{R^2}$$

Answer 17

Correct answers is D

Solution:

$$m\omega^2 R = \frac{GmM}{R^2}$$
$$\omega^2 = \frac{GM}{R^3}$$
$$T = \frac{2\pi}{\omega} = \frac{2\pi}{\sqrt{\frac{GM}{R^3}}};$$
$$\frac{GM}{R^3} = \frac{4\pi^2}{T^2}$$
$$M = \frac{4\pi^2 R^3}{GT^2}$$
$$= \frac{6\times 10^{11} \times (9\times 10^6)^3}{(7\times 3600 + 30\times 60)^2}$$
$$= 6\times 10^{23}\ kg$$

Answer 18

Solution:

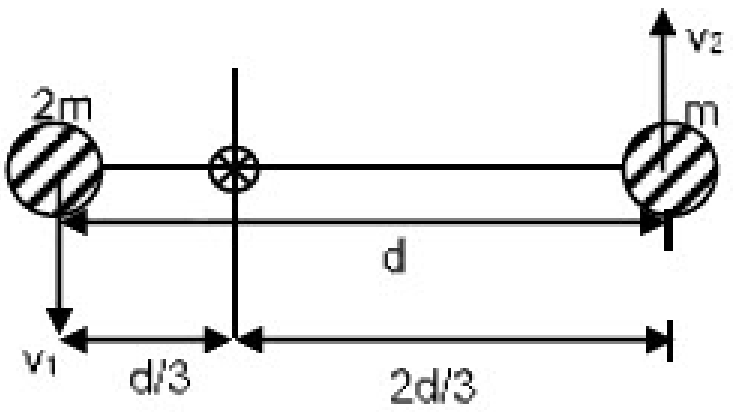
Self energy of earth $= -\frac{3}{5}\frac{GM^2}{R}$

Energy required to break earth into pieces = - self energy $= -\frac{3}{5}\frac{GM^2}{R}$

Answer 19

Correct answers is B

Solution:



For mass $'m'$

$$F = \frac{G \times 2m^2}{d^2} = \frac{m2d}{3}\omega^2$$

$$\omega = \sqrt{\frac{3Gm}{d^3}}$$

$$T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{d^3}{3Gm}}$$

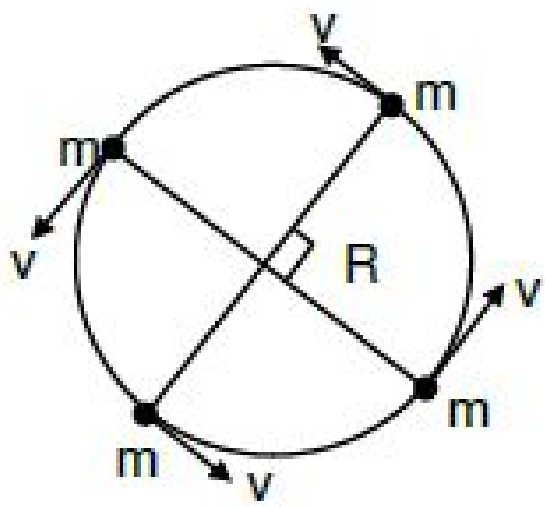
Answer 20

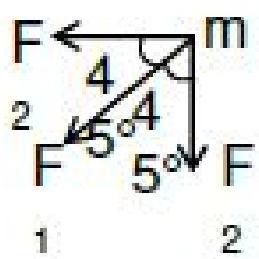
Correct answers is C

Solution:

$$F_{\text{net}} = F_1 + \sqrt{F_2} = \frac{mv^2}{R}$$

$$F_1 = \frac{Gmm}{4R^2} \qquad F_2 = \frac{Gmm}{2R^2}$$





$$\frac{mv^2}{R} = \frac{Gmm}{4R^2} + \frac{\sqrt{2}}{2}\frac{Gmm}{R^2}\ ;$$

$$V = \sqrt{\frac{(2\sqrt{2}+1)}{4}\frac{Gm}{R}}$$

$$V = \frac{\sqrt{(2\sqrt{2}+1)G}}{2}\ (\text{given } m = 1\ kg,\ R = 1\ m)$$

Answer 21

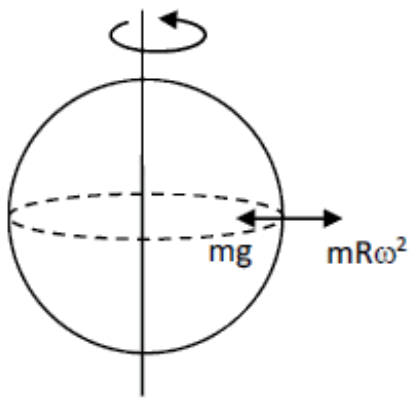
Correct answers is D

Solution:

For weightlessness, $N = 0$

$$mg = mR\omega^2$$

$$\omega = \sqrt{\frac{g}{R}}$$



Time period, $T = 2\pi\sqrt{\frac{R}{g}}$

$R = 6400\ km,\ g = 9.8\ m/s^2$

$T = 84$ minutes

Answer 22

Correct answers is B

Solution:

$$F_1 = \frac{GmM}{9R^2}$$

$$F_2 = F_1 - \frac{G\frac{M}{8}m}{\left(\frac{5}{2}R\right)^2}$$

$$F_2 = \frac{GMm}{R^2}\left(\frac{1}{9} - \frac{1}{50}\right) \implies \frac{41}{9 \times 50}\frac{GMm}{R^2}$$

$$\frac{F_1}{F_2} = \frac{50}{41}$$

Answer 23

Correct answers is C

Solution:

As $T \propto R^{3/2}$

$T_1 = kR^{3/2}$

$$\frac{\Delta T}{T} = \frac{3}{2} \times \frac{\Delta R}{R} = 3\ \%$$

Answer 24

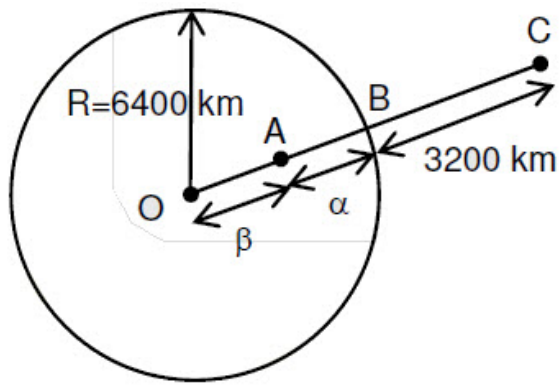
Correct answers is C

Solution:

$$V_E = \sqrt{\frac{2GM}{R}} \implies \frac{M_1}{R_1} = \frac{M_2}{R_2}$$

Answer 25

Solution:



$$E_A = E_B$$

$$\frac{GM}{(6400+3200)^2} = \frac{GM}{(6400)^3}\beta$$

$$\beta = \frac{8}{9} \times 3200$$

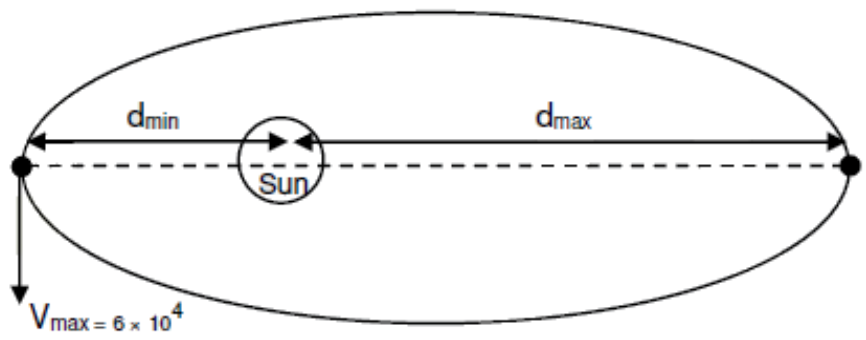
$$\alpha = R - \beta = 6400 - \frac{8}{9} \times 3200$$

$$\alpha = \frac{10}{9} \times 3200\ ; \quad \frac{\alpha}{\beta} = \frac{10}{8} = \frac{5}{4}$$

Answer 26

Correct answers is A

Solution:



$$L = mv_1r_1 = mv_2r_2$$

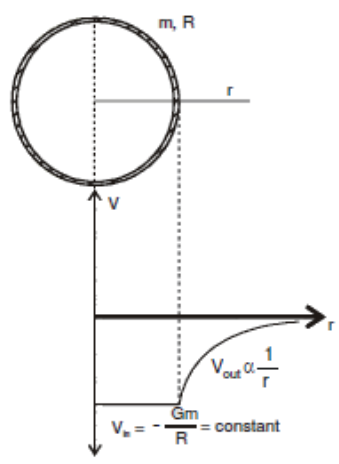
$$v_2 = \frac{v_1r_1}{r_2} = v_1 \times \frac{8 \times 10^{10}}{160 \times 10^{10}} = \frac{6 \times 10^4}{20} = 3000\ m/s.$$

Answer 27

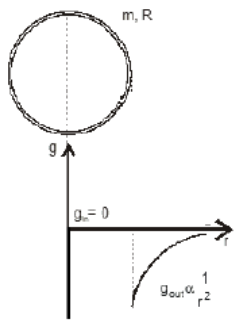
Correct answers is C

Solution:

Gravitational potential due to uniform spherical shell



Gravitational field due to uniform spherical shell



Answer 28

Correct answers is C

Solution:

$$T \propto R^{3/2}$$

$$\frac{T_2}{T_1} = \left(\frac{R_2}{R_1}\right)^{3/2} = (9)^{3/2}$$

$$T_2 = 27\,T$$

Answer 29

Correct answers is A

Solution:

$$mg_{\text{pole}} = 49$$

$$m = \frac{49}{9.8} = \frac{49}{88} \times 10 = 5\ kg$$

$$g_{\text{equa}} = g - R\omega^2$$

$$= 9.8 - (6400 \times 10^3)(7.27)(10^{-5})$$

$$\omega = \frac{2\pi}{T} = \frac{2 \times 3.14}{24 \times 60 \times 60} = 7.27 \times 10^{-5}$$

$$= 9.8 - 0.034 = 9.766$$

$$W = 5 \times 9.766 = 48.83\ N$$

Answer 30

Correct answers is A

Solution:

$$\text{Areal velocity} = \frac{L}{2m} = \text{constant}$$

Answer 31

Correct answers is A

Solution:

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

$$\left(\frac{T_{S_1}}{T_{S_2}}\right)^2 = \left(\frac{r_{S_1}}{r_{S_2}}\right)^3$$

$$\left(\frac{T_{S_1}}{24}\right)^2 = \left(\frac{3R}{12R}\right)^3$$

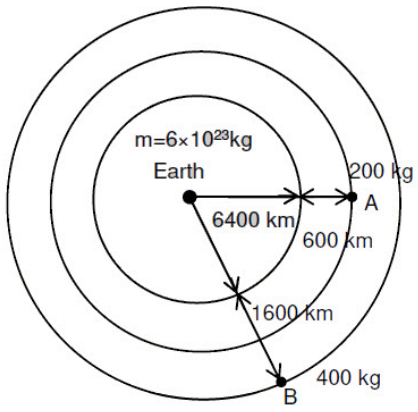
$$T_{S_1}^2 = \frac{1}{4^3} \times (24)^2 = \frac{24 \times 24}{4 \times 4 \times 4} = 9$$

$$T_{S_1} = 3\ hrs$$

Answer 32

Correct answers is D

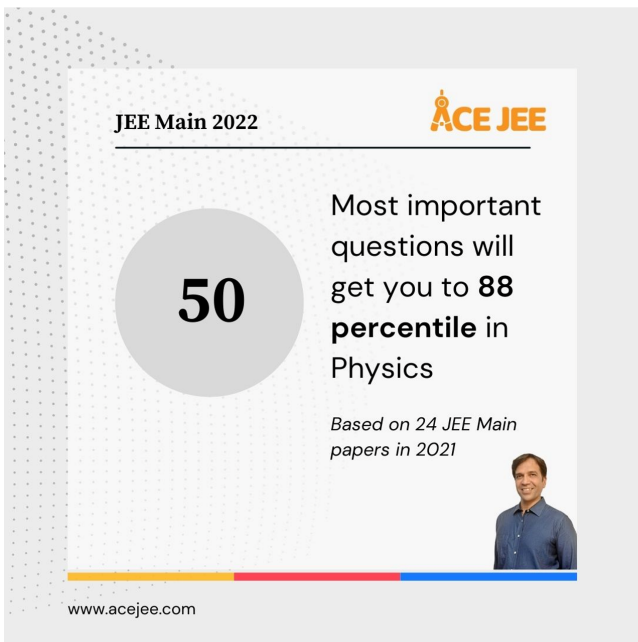
Solution:

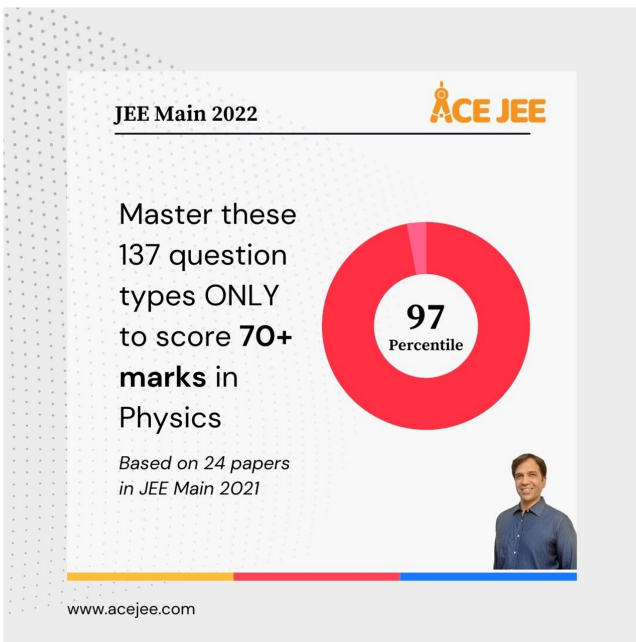


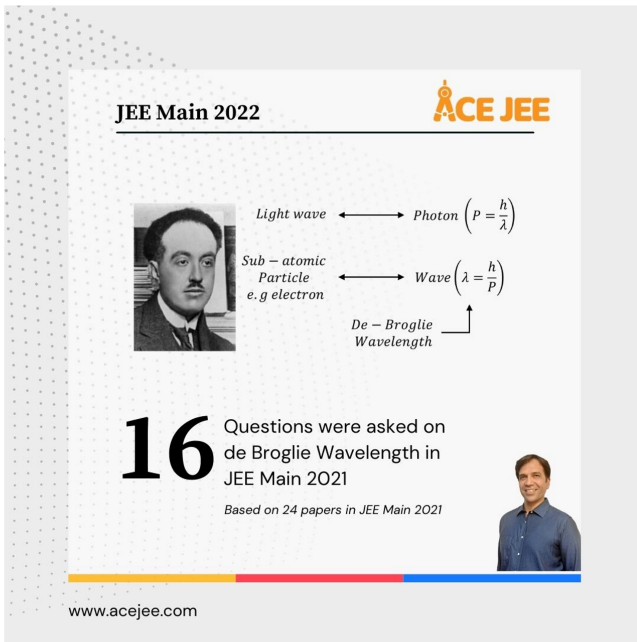
$$T = \frac{2\pi(R)^{3/2}}{\sqrt{GM}}$$

Thus, $T_B - T_A = \frac{2\pi}{\sqrt{GM}}\left((8000 \times 10^3)^{3/2} - (7000 \times 10^3)^{3/2}\right)$

$= 1.287 \times 10^3$ sec







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