Q.1 A body is projected up with a velocity equal to $\frac{3}{4}$th of the escape velocity from the surface of the earth. The height it reaches from the centre of the earth is : (Radius of the earth = R) :

(A) $\frac{10R}{9}$ (B) $\frac{16R}{7}$

(C) $\frac{9R}{8}$ (D) $\frac{10R}{3}$

[B]

Sol. $v = \frac{3}{4} v_e$

K.E. = $\frac{1}{2} mv^2 = \frac{1}{2} m \left(\frac{3}{4} v_e\right)^2$

$= \frac{9}{32} mv_e^2$

$= \frac{9}{32} m \left(\frac{2GM}{R}\right)$

K.E = $\frac{9}{16} \frac{GMm}{R}$

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

Total energy = K.E. + P.E. = $-\frac{7}{16} \frac{GMm}{R}$

Let the height above the surface of earth be h; then P.E. = $-\frac{GMm}{h}$

Total energy = P.E. above earth's surface

$-\frac{7}{16} \frac{GMm}{R} = -\frac{GMm}{h}$

$\therefore \quad h = \frac{16R}{7}$

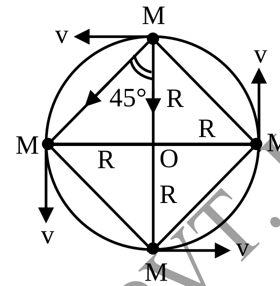
Q.2 Four particles of equal mass M move along a circle of radius R under the action of their mutual gravitational attraction. The speed of each particle is -

(A) $\frac{GM}{R}$ (B) $\sqrt{\left[2\sqrt{2}\,\frac{GM}{R}\right]}$

(C) $\sqrt{\left[\frac{GM}{R}(2\sqrt{2}+1)\right]}$ (D) $\sqrt{\left[\frac{GM}{R}\left(\frac{2\sqrt{2}+1}{4}\right)\right]}$

[D]

Sol. Gravitational force on each due to other three particles provides the necessary centripetal force.



$\therefore \sqrt{2}\,\frac{GM^2}{(\sqrt{2}R)^2}\cos 45° + \frac{GM^2}{(2R)^2} = \frac{Mv^2}{R}$

Simplifying it, we get

$v = \sqrt{\frac{GM}{R}\left(\frac{2\sqrt{2}+1}{4}\right)}$

Q. 3 The gravitational field in a region is 10 N/kg $(\hat{i}-\hat{j})$. Then the work done by gravitational force to shift slowly a particle of mass 1kg from point (1m, 1m) to a point (2m, –2m) is -

(A) 10 J (B) –10J (C) –40J (D) + 40 J

Sol. **[D]**

$W_g = \vec{F}_g . \Delta\vec{S} = 10\,(\hat{i}-\hat{j}).(\hat{i}-3\,\hat{j})$

$= 10 + 30 = 40$ J

Q.4 Two bodies of masses m_1 and m_2 are initially at rest placed infinite distance apart. They are then allowed to move towards each other under mutual gravitational attraction. Their relative velocity when they are r distance apart is –

(A) $\sqrt{\frac{2G(m_1+m_2)}{r}}$ (B) $\sqrt{\frac{2G\,m_1 m_2}{(m_1+m_2)r}}$

(C) $\sqrt{\frac{G(m_1+m_2)}{r}}$ (D) $\sqrt{\frac{G\,m_1 m_2}{(m_1+m_2)r}}$

Sol. **[A]**

$m_1v_1 - m_2v_2 = 0$ by conservation of momentum

$\frac{1}{2} m_1v_1^2 + \frac{1}{2} m_2v_2^2 - \frac{G\,m_1 m_2}{r} = 0$

(by conservation of energy)

Also, $v_{rel.} = v_1 + v_2$

Q. 5 A projectile is fired vertically upwards from the surface of the earth with a velocity kv_e, where v_e is the escape velocity and $k < 1$. If R is the radius of the earth, the maximum height to which it will rise measured from the centre of earth will be - (Neglect air resistance)

(A) $\frac{1-k^2}{R}$ (B) $\frac{R}{1-k^2}$

(C) $R(1-k^2)$ (D) $\frac{R}{1+k^2}$ **[B]**

Sol. Vertically upwards then let r is the maximum height so from conservation of energy

$$\frac{1}{2}\ m\ (kv_e)^2 + \left\{-\frac{GM_eM}{R}\right\} = 0 + \left\{-\frac{GM_eM}{r}\right\}$$

$$\Rightarrow -GM_eM/r = \frac{1}{2}\ m\ \left(k^2\left(2\frac{GM_e}{R}\right)\right\} - \frac{GM_eM}{R}$$

$$= -(1-k^2)\ \frac{GM_eM}{R} \Rightarrow r = \frac{R}{1-k^2}$$

Q. 6 A man weight W on the surface of the earth. What is his weight at a height equal to R ?

(A) W (B) $\frac{W}{2}$ (C) $\frac{W}{4}$ (D) $\frac{W}{8}$

[C]

Sol. $\frac{W_h}{W} = \frac{mg_h}{mg}$

$= \frac{g_h}{g}$

$= \frac{R^2}{(R+R)^2}$

$W_h = \frac{W}{4}$

Q. 7 If the distance between the earth and the sun becomes half its present value, the number of days in a year would have been -

(A) 64.5 (B) 129

(C) 182.5 (D) 730 **[B]**

Sol. $T = \left[\frac{1}{2}\right]^{\frac{3}{2}} \times 365$ days

$= \frac{1}{2\sqrt{2}} \times 365$ days

$= \frac{182.5}{\sqrt{2}} \times \frac{\sqrt{2}}{\sqrt{2}}$ days

$= 91.25 \times 1.414$ days

$= 129$ days

Q. 8 A particle is kept at rest at a distance R (Earth's radius) above the earth's surface. The minimum speed with which it should be projected so that it does not return is :

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

(C) $\sqrt{\frac{GM}{R}}$ (D) $\sqrt{\frac{2GM}{R}}$ **[C]**

Sol. using conservation of energy

$-\frac{GMm}{2R} + \frac{1}{2}\ mv^2 = 0$

or $mv^2 = \frac{GMm}{R}$

or $v = \sqrt{\frac{GM}{R}}$

Q. 9 Acceleration due to gravity at earth's surface is $10\ ms^{-2}$. The value of acceleration due to gravity at the surface of a planet of mass $\frac{1}{5}$th and radius $\frac{1}{2}$ of the earth is -

(A) $4\ ms^{-2}$ (B) $6\ ms^{-2}$

(C) $8\ ms^{-2}$ (D) $12\ ms^{-2}$ **[C]**

Sol. $g_p = \frac{GM_p}{R_p^2}$

$= G \times \frac{1}{5} \times Me \times \frac{4}{R_e^2}$

$= \frac{4}{5}\ g = 8\ ms^{-2}$

Q. 10 With what angular velocity the earth should spin in order that a body lying at 45° latitude may become weightless ?

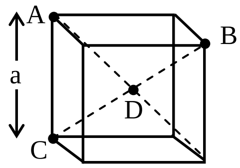
(A) $\sqrt{\frac{g}{R}}$ (B) $\sqrt{\frac{2g}{R}}$

(C) $2\sqrt{\frac{g}{R}}$ (D) None of these **[B]**

Sol. $0 = g - R\omega^2 \cos^2 45°$

$$\frac{R\omega^2}{2} = g \text{ or } \omega = \sqrt{\frac{2g}{R}}$$

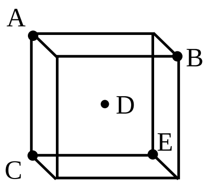
Q. 11 Four identical masses m each are kept at points A, B, C & D shown in figure. Gravitational force on mass at point D (body centre) is -



(A) $\frac{3Gm^2}{a^2}$ (B) $\frac{12Gm^2}{a^2}$

(C) $\frac{4Gm^2}{a^2}$ (D) $\frac{4Gm^2}{3a^2}$ **[D]**

Sol.



Let us put identical mass at E.
Due to symmetry net force on mass at 'D' is equal to zero.
$\therefore$ Required force = Force due to mass placed at E

$$= \frac{Gm^2}{\left(\sqrt{3}a/2\right)^2} = \frac{4\ Gm^2}{3a^2}$$

Q. 12 The total energy of a satellite is -

(A) Always positive

(B) Always negative

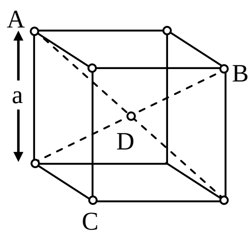
(C) Always zero

(D) +ve or –ve depending upon radius of orbit.

[B]

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

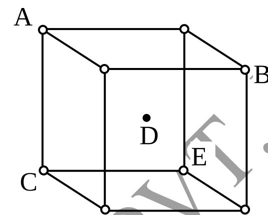
Q.13 Four identical masses m each are kept at points A, B, C & D shown in figure. Gravitational force on mass at point D (body centre) is -



(A) $\frac{3\ Gm^2}{a^2}$ (B) $\frac{12\ Gm^2}{a^2}$

(C) $\frac{4\ Gm^2}{a^2}$ (D) $\frac{4\ Gm^2}{3a^2}$ **[D]**

Sol. Let us put identical mass at E.
Due to symmetry net force on mass at 'D' is equal to zero.



$\therefore$ Required force=Force due to mass placed at E

$$= \frac{Gm^2}{(\sqrt{3}a/2)^2} = \frac{4Gm^2}{3a^2}$$

Q.14 There is a concentric hole of radius R in a solid sphere of radius 2R. Mass of remaining portion is M, then the gravitational potential at centre is

(A) $\frac{-5GM}{7R}$ (B) $\frac{-7GM}{14R}$

(C) $\frac{-3GM}{7R}$ (D) $\frac{-9\ GM}{14R}$ **[D]**

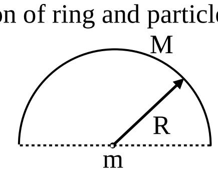
Sol. Potential at centre due to a solid sphere of radius r and mass m is

$$v = -\frac{3Gm}{2r}$$

Here required potential

$$= \begin{bmatrix} \text{Potential due to} \\ \text{sphere of radius } 2R \end{bmatrix} - \begin{bmatrix} \text{Potential due to} \\ \text{sphere of radius } R \end{bmatrix}$$

Q.15 A particle of mass m is placed on the centre of a fixed uniform semi-circular ring of radius R and mass M as shown. Then work required to displace the particle slowly from centre of ring to infinity is : (Assume only gravitational interaction of ring and particle)



(A) $\frac{GMm}{R}$ (B) $-\frac{GMm}{R}$

(C) $\frac{GMm}{\pi R}$ (D) $-\frac{GMm}{\pi R}$ **[A]**

Sol. $U_i = -\frac{GMm}{R}$ and $U_f = 0$

$\therefore\ W = \Delta U = \dfrac{GMm}{R}$

Q.16 A spherical hole is made in a solid sphere of radius R. The mass of the sphere before hollowing was M. The gravitational field at the centre of the hole due to the remaining mass is –

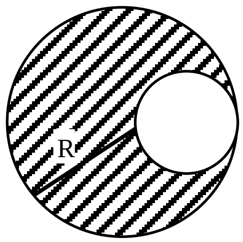


Fig.

(A) zero (B) $\dfrac{GM}{8R^2}$

(C) $\dfrac{GM}{2R^2}$ (D) $\dfrac{GM}{R^2}$ **[C]**

Sol. By the principle of superposition of fields

$\vec{E} = \vec{E}_1 + \vec{E}_2$

Here, $\vec{E}$ = net field at the centre of hole due to entire mass

$\vec{E}_1$ = field due to remaining mass

and $\vec{E}_2$ = field due to mass in hole = 0

$\therefore\ \vec{E}_1 = \vec{E} = \left(\dfrac{GM}{R^3}\right).r$

where $r = \dfrac{R}{2}$

$\therefore\ \vec{E} = \dfrac{GM}{2R^2}$

Q.17 The gravitational field due to a mass distribution is $E = \dfrac{A}{x^2}$ in x-direction. Here, A is a constant. Taking the gravitational potential to be zero at infinity, potential at **x** is –

(A) $\dfrac{2A}{x}$ (B) $\dfrac{2A}{x^3}$

(C) $\dfrac{A}{x}$ (D) $\dfrac{A}{2x^2}$ **[C]**

Sol. $V(x) = -\int_{\infty}^{x} E\,dx = -\int_{\infty}^{x} \dfrac{A}{x^2}\,dx = \dfrac{A}{x}$

Q.18 A body is projected from the surface of earth with a velocity 2 v_e where v_e is the escape velocity. The velocity of the body when it escapes the gravitational field of the earth is -

(A) $\sqrt{2}\ v_e$ (B) $\sqrt{3}\ v_e$

(C) $\sqrt{7}\ v_e$ (D) $\sqrt{11}\ v_e$

Sol. **[B]**

$v = v_e\sqrt{n^2 - 1}$ or $v = v_e\sqrt{2^2 - 1}$, $v = v_e\sqrt{3}$

Q.19 Two bodies of masses 10 kg and 100 kg are separated by a distance of 2m. The gravitational potential at the mid-point of the line joining the two bodies is :

(A) -7.3×10^{-7} J/kg (B) -7.3×10^{-8} J/kg

(C) -7.3×10^{-9} J/kg (D) -7.3×10^{-6} J/kg

[C]

Sol. Gravitational potential

$= -\dfrac{G\times10}{1} - \dfrac{G\times100}{1} = -110\ G$

$= -110 \times 6.67 \times 10^{-11}\ J\ kg^{-1}$

$= -7.3 \times 10^{-9}$ J/kg

Q.20 For the earth escape velocity is 11.2 km/s. What will be the escape velocity of that planet whose mass and radius are four times those of earth ?

(A) 11.2 km/s (B) 44.8 km/s

(C) 2.8 km/s (D) 0.7 km/s

Sol. **[A]** $v_e = \sqrt{\dfrac{2GM_e}{R_e}}$ and $v_p = \sqrt{\dfrac{2GM_p}{R_p}}$

$\dfrac{v_p}{v_e} = \sqrt{\dfrac{M_p}{M_e}.\dfrac{R_e}{R_p}} = \sqrt{4\times\dfrac{1}{4}} = 1$

or $v_p = v_e = 11.2$ km/s

Q.21 The weight of an object in the coal mine, sea level, at the top of the mountain are W_1, W_2 and W_3 respectively, then-

(A) $W_1 < W_2 > W_3$ (B) $W_1 = W_2 = W_3$

(C) $W_1 < W_2 < W_3$ (D) $W_1 > W_2 > W_3$

[A]

Q.22 The height above surface of earth where the value of gravitational acceleration is one fourth of that at surface, will be-

(A) $R_e/4$ (B) $R_e/2$

(C) $3R_e/4$ (D) R_e **[D]**

Q.23 The magnitude 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 $r_1 < R$ and $r_2 < R$

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

(C) $\frac{F_1}{F_2} = \frac{r_1}{r_2}$ if $r_1 > R$ and $r_2 > R$

(D) $\frac{F_1}{F_2} = \frac{r_1^2}{r_2^2}$ if $r_1 < R$ and $r_2 < R$ **[A]**

Q.24 The diameters of two planets are in ratio 4 : 1. Their mean densities have ratio 1 : 2. The ratio of 'g' on the planets will be-

(A) 1 : 2 (B) 1 : 4

(C) 2 : 1 (D) 4 : 1 **[C]**

Q.25 If the earth suddenly stops rotating, the value of g at any place will -

(A) remain same

(B) decrease

(C) increase

(D) none of these **[C]**

Q.26 If two bodies of mass M and m are revolving around the centre of mass of the system in circular orbits of radii R and r respectively due to mutual interaction. Which of the following formulae is applicable ?

(A) $\frac{GMm}{(R+r)^2} = m\omega^2 r$ (B) $\frac{GMm}{R^2} = m\omega^2 r$

(C) $\frac{GMm}{r^2} = m\omega^2 R$ (D) $\frac{GMm}{R^2 + r^2} = m\omega^2 r$

[A]

Q.27 The earth's radius is R and acceleration due to gravity at its surface is g. If a body of mass m is sent to a height of R/4 from the earth's surface, the minimum speed with which the body must be thrown to reach a height of R/4 above the surface of the earth is -

(A) $\sqrt{\frac{2gR}{5}}$ (B) $\sqrt{\frac{gR}{3}}$

(C) $\sqrt{gR}$ (D) $\sqrt{2gR}$

Sol. **[A]** $\frac{1}{2}mv^2 = \Delta U = \frac{1}{5}mgR$

$v = \sqrt{\frac{2gR}{5}}$

Q.28 A body of mass m rises to height h = R/5 from the earth's surface, where R is earth's radius. If g is acceleration due to gravity at earth's surface, the increase in potential energy is -

(A) $\frac{5}{6}$ mg/h (B) $\frac{1}{6}$ mgh

(C) $\frac{3}{5}$ mgh (D) $\frac{6}{7}$ mgh **[B]**

Q.29 The distance of Neptune and Saturn from the Sun are nearly 10^{13} m and 10^{12} m respectively. Their periodic times will be in the ratio -

(A) 10 (B) 100

(C) $10\sqrt{10}$ (D) 1000 **[C]**

Sol. $\frac{T_n^2}{T_s^2} = \frac{R_n^3}{R_s^3}$

$\frac{T_n}{T_s} = \left[\frac{10^{13}}{10^{12}}\right]^{3/2}$

$= \left(\sqrt{10}\right)^3 = 10\sqrt{10}$

Q.30 The time period of a satellite of Earth is 5 hours. If the separation between the Earth and the satellite is increased to 4 times the previous value, the new time period will become -

(A) 40 hours (B) 20 hours

(C) 10 hours (D) 80 hours **[A]**

Sol. $T^2 \propto r^3$; $T'^2 \propto (4r)^3$ or $T^2/T'^2 = 64$

or $T'/T = 8$

or $T' = 8 \times 5h = 40$ h

Q.31 A person brings a mass of 1kg from infinity to a point A. Initially the mass was at rest but it moves at a speed of 2m/s as it reaches A. The work done by the person on the mass is –3J. The potential at A is-

(A) –3J/kg (B) –2 J/kg

(C) –5 J/kg (D) none of these

[C]

Q.32 A planet is moving in an elliptical orbit. If T, V, E and L are respectively its kinetic energy, potential energy, total energy and magnitude of angular momentum, then which of the following statements is true ?

(A) T is conserved

(B) V is always positive

(C) E is always negative

(D) L is conserved but the direction of vector $\vec{L}$ will continuously change **[C]**

Q.33 Which statement is not true for artificial geostationary satellite ?

(A) It revolves round the earth in equatorial plane

(B) It revolves round the earth with in great circle

(C) It revolves round the earth with time period of 24 hours

(D) It revolves round the earth with a velocity of 8 kilometer/second **[D]**

Q.34 One satellite is revolving round the earth in an elliptical orbit. Its speed will-

(A) be same at all the points of orbit

(B) be maximum at the point farthest from the earth

(C) be maximum at the point nearest from the earth

(D) depend on mass of satellite **[C]**

Q.35 The orbital velocity of an artificial satellite in a circular orbit just above the earth's surface is v. For a satellite orbiting at an altitude of half of the earth's radius, the orbital velocity is-

(A) $\frac{3}{2}$ v (B) $\sqrt{\frac{3}{2}}$ v

(C) $\sqrt{\frac{2}{3}}$ v (D) $\frac{2}{3}$ v **[C]**

Q.36 The escape velocity from a planet is V. If its mass and radius becomes four and two times respectively, then the escape velocity will become -

(A) V (B) 2V

(C) 0.5V (D) $\sqrt{2}$ V **[D]**

Q.37 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 planet and star is proportional to $R^{-5/2}$, then T^2 is proportional to-

(A) R^3

(B) $R^{7/2}$

(C) $R^{5/2}$

(D) $R^{3/2}$ **[B]**

Q.38 A planet of mass m is moving in an elliptical path about the sun. Its maximum and minimum distances from the sun are r_1 and r_2 respectively. If M_s is the mass of sun then the angular momentum of this planet about the centre of sun will be -

(A) $\sqrt{\frac{2GM_s}{(r_1 + r_2)}}$

(B) $2GM_s m \sqrt{\frac{r_1 r_2}{(r_1 + r_2)}}$

(C) $m\sqrt{\frac{2GM_s r_1 r_2}{(r_1 + r_2)}}$

(D) $\sqrt{\frac{2GM_s m(r_1 + r_2)}{r_1 r_2}}$ **[C]**

Q.39 Two artificial satellites whose masses are m_1 and m_2 are moving in circular orbits of radii r_1 and r_2 respectively if $r_1 > r_2$ then which of the following statements is true about the speeds v_1 and v_2 of the satellites ?

(A) $v_1 = v_2$ (B) $v_1 > v_2$

(C) $v_1 < v_2$ (D) $\frac{v_1}{r_1} = \frac{v_2}{r_2}$

[C]

Q.40 A body is projected from the surface of earth with a velocity $2v_e$ where v_e is the escape velocity. The velocity of the body when it escapes the gravitational field of the earth is :

(A) $\sqrt{2}v_e$ (B) $\sqrt{3}\,v_e$

(C) $\sqrt{7}\,v_e$ (D) $\sqrt{11}\,v_e$ **[B]**

Sol. $v = \sqrt{n^2 - 1}\ v_e$

or $v = \sqrt{2^2 - 1}\ v_e$

$v = \sqrt{3}\ v_e$

Q.41 The radius of earth is 6.4×10^6m and acceleration due to gravity at earth's surface is 9.8 m/s^2. The temperature required by the Oxygen molecules to escape from the earth's surface is- (universal gas constant R = 8.3 joule/mole - K)

(A) 1.59×10^5K (B) 15.9×10^5 K

(C) 159×10^5K (D) 0.159×10^4 K

[A]

Q.42 A satellite is revolving around earth in a circular orbit. The radius of orbit is half of the radius of the orbit of moon. Satellite will complete one revolution in -

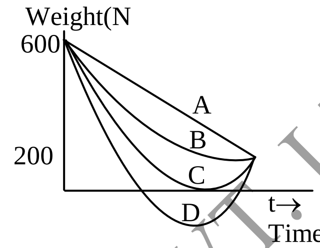
(A) $2^{-3/2}$ lunar month

(B) $2^{-2/3}$ lunar month

(C) $2^{3/2}$ lunar month

(D) $2^{2/3}$ lunar month **[A]**

Q.43 Imagine the acceleration due to gravity on earth is 10m/s^2 and on mars is 4 m/s^2. A traveller of mass 60kg goes from earth to mars by a rocket moving with constant velocity. If effect of other planets is assumed to be negligible, which one of the following graphs shown the variation of weight of traveller with time –



(A) A (B) B

(C) C (D) D **[C]**

Q.44 The velocity with which a projectile must be fired so that it escapes Earth's gravitation does not depend on -

(A) mass of the earth

(B) mass of the projectile

(C) radius of the projectile's orbit

(D) gravitational constant **[B]**

Sol. $v = \sqrt{\frac{2GM}{R}}$, v does not depends mass of the projectile.

Q.45 The escape velocity from the earth is about 11 km/s. The escape velocity from a planet having twice the radius and the same mean density as the earth is -

(A) 22 km/s (B) 11 km/s

(C) 5.5 km/s (D) 15.5 km/s **[A]**

Sol. $v = \sqrt{\frac{2GM}{R}} = \sqrt{2G\frac{4}{3}\pi R^2 d}$

$v \propto R\sqrt{d}$

$v = 2v_0$

Q.46 The kinetic energy needed to project a body of mass m from the earth's surface to infinity is -

(A) $\frac{1}{4}$ mg R (B) $\frac{1}{2}$ mg R

(C) mg R (D) 2mg R. **[C]**

Sol. $E_R - \dfrac{GMm}{R} = 0$

or $E_R = \dfrac{GMm}{R}$

or $E_R = \dfrac{gR^2m}{R}$

or $E_R = mgR$

Q.47 A body is projected up with a velocity equal to (3/4)th of the escape velocity from the surface of the earth. The height it reaches is-
(Radius of earth = R)

(A) $\dfrac{10R}{9}$ (B) $\dfrac{9}{7}R$ (C) $\dfrac{9}{8}R$ (D) $\dfrac{10R}{3}$

Sol. **[B]** Escape velocity for the earth is

$v_e = \sqrt{\dfrac{2GM}{R}}$

Given the velocity projection of the body

$= v = \dfrac{3}{4}v_e = \dfrac{3}{4}\sqrt{\dfrac{2GM}{R}}$

Total energy on the earth
= Total enery at maximum height h

$\dfrac{1}{2}mv^2 + \left(-\dfrac{GMm}{R}\right) = 0 + \left(-\dfrac{GMm}{R+h}\right)$

$\dfrac{1}{2}m \cdot \dfrac{9}{16} \cdot \dfrac{2GM}{R} - \dfrac{GMm}{R} = -\dfrac{GMm}{R+h}$

$\dfrac{9}{16} - 1 = -\dfrac{R}{R+h}$ or $-\dfrac{R}{R+h} = \dfrac{-7}{16}$

$7R + 7h = 16R$

$7h = 9R \Rightarrow h = \dfrac{9}{7}R$

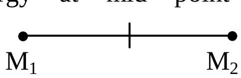
Q.48 The masses and radii of Earth and Moon are M_1, R_1 and M_2, R_2 respectively. Their centre are at a distance d apart. The minimum speed with which a particle of mass m should be projected from a point mid-way between the two centres so as to escape to infinity is :

(A) $\sqrt{\dfrac{2G(M_1+M_2)}{d}}$ (B) $\sqrt{\dfrac{G(M_1+M_2)}{2d}}$

(C) $2\sqrt{\dfrac{G(M_1-M_2)}{2d}}$ (D) $2\sqrt{\dfrac{G(M_1+M_2)}{d}}$

Sol. **[D]**
Total potential energy at mid point is

$\left[-\dfrac{GM_1m}{d/2} - \dfrac{GM_2m}{d/2}\right]$



or $-\dfrac{2G}{d}(M_1 + M_2)m$

If v is required escape velocity, the

$\dfrac{1}{2}mv^2 = \dfrac{2G}{d}(M_1 + M_2)m$

$v = 2\sqrt{\dfrac{G(M_1+M_2)}{d}}$

Q.49 A body of mass m and radius r falls on earth from a great height. If M is mass and R is the radius of earth while $r = \dfrac{R}{100}$ then the acceleration of the body when it hits the earth is : (acceleration due to gravity at earth surface is g)

(A) g (B) 0.98 g

(C) $\dfrac{g}{0.98}$ (D) 9.8 g **[B]**

Sol. $a = \dfrac{GM}{x^2} = \dfrac{GM}{(R+r)^2} = \dfrac{GM}{\left(R+\dfrac{R}{100}\right)^2}$

$= \dfrac{GM}{\left(\dfrac{101}{100}\right)^2 R^2} = 0.98\ g$

Q.50 The increase in gravitational potential energy of an object of mass m raised from the surface of earth to a height equal to radius R of earth is :

(A) mgR (B) $\dfrac{mgR}{2}$

(C) $\dfrac{mgR}{3}$ (D) $\dfrac{mgR}{4}$ **[B]**

Sol. Increase in potential energy

$= -\dfrac{GmM}{2R} - \left(-\dfrac{GmM}{R}\right)$

$= \dfrac{GmM}{2R} = \dfrac{GM}{R^2} \times \dfrac{mR}{2}$

$= g \times \dfrac{1}{2}\ mR = \dfrac{1}{2}\ mgR$

$U = \dfrac{-GMm}{R} + \dfrac{GMm}{4R} = \dfrac{-3GMm}{4R}$