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Time : 50 Mins | **Gravitation Important Questions With Answers NEET Physics 2023 1** | **Marks : 185**

1. A satellite in force free space sweeps stationary interplanetary dust at a rate dM/dt=o.v where M is the mass and v is the velocity of the satellite and 0. is a constant. What is the deceleration of the satellite?
   a) $-\alpha v^2$ b) $-\alpha v^2/2M$ **c) $-\alpha v^2/M$** d) $-2\alpha v^2/M$

   Solution : -
   In case of variable mass, force
   F = (dM/dt) x v
   dM/dt=av
   So putting this in above expression:
   F=av^2
   So, retardation
   - F/M=- av^2/M
2. A satellite is launched in a direction parallel to the surface of earth from a height 390 km with a speed 30.3 Mm hr^{-1}. Speed of the satellite as it reaches its maximum altitude of 3770 km, is:
   a) 22.02 Mm hr^{-1} b) 22.20 Mm hr^{-1} **c) 20.22 Mm hr^{-1}** d) 22.82 Mm hr^{-1}

   Solution : -
   Let v be its velocity at its maximum altitude. From the law of conservation of angular momentum, we get: $mv_0r_0 = mv_1r_1$
   i.e., $v_1 = \frac{v_0 r_0}{r_1}$
   $= \frac{(30.3)(390+6400)\times 10^3}{(3770+6400)\times 10^3}$
3. If a planet of given density were made larger (keeping its density unchanged) its force of attraction for an object on its surface would increase because of increased mass of the planet but would decrease because of larger separation between the centre of the planet and its surface. Which effect would dominate?
   a) Increase in mass **b) Increase in radius** c) Both affect the attraction equally d) None of the above
4. Kepler's third law states that square of period of revolution (T) of a planet around the sun, is proportional to third power of average distance r between sun and planet i . e. $T_2 = K\mu^3$ where R⁻ is conistant. If the masses of sun and planet are M and m respectively then as per Newton's law of gravitation force of attraction between them is $\frac{GMm}{r^2}$, here G is gravitational constant. The relation between G and K is described as _____
   a) $GMK = 4\pi^2$ b) K=G c) $K = \frac{1}{G}$ d) $GK = 4\pi^2$

   Solution : -

Orbital speed, $V_{orb} = \sqrt{\frac{GM}{r}}$

Time period $T = \frac{2\pi r}{v_{\text{orb}}} = \frac{2\pi r}{\sqrt{GM}}\sqrt{r}$

Squaring both sides, we have,

$$T^2 = \left(\frac{2\pi r\sqrt{r}}{\sqrt{GM}}\right)^2 = \frac{4\pi^2}{GM} \cdot r^3$$

$$\Rightarrow \frac{T^2}{r^3} = \frac{4\pi^2}{GM} = K$$

$$\Rightarrow GMK = 4\pi^2$$

5. The condition for a uniform spherical mass mofradius r to be a black hole is: (G = gravitational constant and g = acceleration due to gravity)

   a) $(2Gm/r)^{1/2} \le c$ b) $(2gm/r)^{1/2} = c$ **c) $(2Gm/r)^{1/2} \ge c$** d) $(gm/r)^{1/2} \ge c$

   Solution : -

   The criterion for a star to be black hole is:

   $$\frac{GM}{c^2 r} \ge \frac{1}{2}$$

   or $\sqrt{\frac{2Gm}{r}} \ge c.$

6. A satellite of mass m is orbiting the earth (of radius R) at a height h from its surface. The total energy of the satellite in terms of got the value of acceleration due to gravity at the earth's surface, is

   a) $mg_oR^2/2(R+h)$ **b) $-mg_oR^2/2(R+h)$** c) $2mg_oR^2/(R+h)$ d) $-2\,mg_oR^2/(R+h)$

   Solution : -

   Total mechanical energy of satellite is given by

   E = -GMm/2r

   Here, r = R + h

   And, $GM = g_oR^2$

   So, $E = -\,mg_oR^2/2(R+h)$

7. The density of a newly discovered planet is twice that of earth. The acceleration due to gravity at the surface of the planet is equal to that at the surface of the earth. If the radius of the earth is R, the radius of the planet would be____

   a) 1/2 R b) 2R c) 4R d) 1/4 R

   Solution : -

   $g = \frac{GM}{R^2}$. Also, $M = d \times \frac{4}{3}\pi R^3$

   $\therefore g = G\frac{4}{3}d\pi R.$

   At the surface of planet, $g_p = \frac{4}{3}(G)(2d)\pi R,$

   At the surface of the earth $g_e = \frac{4}{3}Gd\pi R$

   $\therefore g_e = g_p \Rightarrow dR = 2dR' \Rightarrow R' = \frac{R}{2} = \frac{1}{2}R$

8. (A) One does not experience gravitational force in daily life due to objects of same size.

   (R) Value of gravitational constant is very small.

   a) If both assertion and reason are true and reason is the correct explanation of assertion.

   b) If both assertion and reason are true but reason is not the correct explanation of assertion

c) If assertion is true but reason is false. d) If both assertion and reason are false.
e) If assertion is false but reason is true.

9. A body weighs 250 N on the surface of the earth. How much will it weigh half way down to the centre of the earth?

   a) 125 N b) 150 N c) 175 N d) 250 N

   Solution : -

   Let m be mass of a body.
   ∴ Weight of the body on the surface of the earth is
   W= mg= 250 N
   Acceleration due to gravity at a depth d below thae surface of the earth is

   $g'=g\left(1-\frac{d}{R_E}\right)$

   Weight of the body at depth d is

   $W'=mg'=mg\left(1-\frac{d}{R_E}\right)$

   Here $d=\frac{R_E}{2}$

   ∴ $W'=mg\left(1-\frac{R_E/2}{R_E}\right)=\frac{mg}{2}=\frac{W}{2}=\frac{250N}{2}=125$ N

10. A satellite is placed in a circular orbit around the earth at such a height that it always remains stationary with respect to the earth's surface. In such a case, its height (in km) from the earth's surface is:

    a) 32000 **b) 36000** c) 6400 d) 4800

11. To put in the orbit, the satellite should be fired as a projectile with:

    a) escape velocity b) twice the escape velocity c) thrice the escape velocity **d) none of these**

12. Orbit velocity of an object of mass m is proportional to:

    a) m^0 b) m c) m^2 d) $\frac{1}{m}$

    Solution : -

    Orbital velocity is independent of mass.

13. A satellite is orbiting around the earth with a period T. If the earth suddenly shrinks to half its radius without change in mass, the period of revolution of the satellite will be:

    a) $\frac{T}{2}$ **b) T** c) 2T d) $\frac{T}{\sqrt{2}}$

    Solution : -

    $T=2\pi[\frac{(R_e+h)^3}{GM_e}]^{1/2}$

    When the earth shrinks to half its radius, the radius of the orbit of satellite still remains the same, i.e., $(R_e + h)$. Hence, time period will remain the same.

14. You are given 32 identical balls all of equal weight except 1 which is heavier than the others. You are given a beam balance but no weight box. What is the minimum number of weighings required to identify the balls of different weight?

    a) 3 b) 4 **c) 5** d) 6

Solution : -

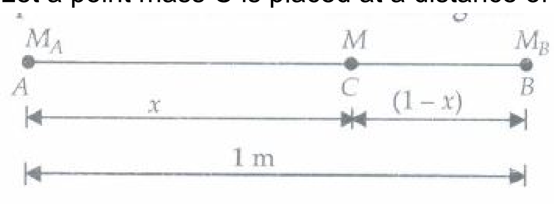
Divide the balls into two lots of 16 each. Put them in two pans and identify the lot containing heavier ball. Then divide this identified lot into two lots of 8 each and proceed as before. You will require weighings with 16, 8, 4, 2 and 1 balls in each pan.

15. Two point masses A and B having masses in the ratio 4 : 3 are separated by a distance of 1 m. When another point mass C of mass M is placed in between A and B, the force between A and C is $\left(\frac{1}{3}\right)^{rd}$ of the force between Band C. Then the distance of C from A is:

a) $\left(\frac{2}{3}\right)m$ b) $\left(\frac{1}{3}\right)m$ c) $\left(\frac{1}{4}\right)m$ d) $\left(\frac{2}{7}\right)m$

Solution : -

Let a point mass C is placed at a distance of x m from the point mass A as shown in the figure.



Here, $\left(\frac{M_A}{M_B}\right) = \frac{4}{3}$

Force between A and C is

$$F_{AC} = \frac{GMM_A}{x^2} \qquad \text{..........(i)}$$

Force between B and C is

$$F_{BC} = \frac{GMM_B}{(1-x)^2} \qquad \text{...........(ii)}$$

According to given problem

$$F_{AC} = \frac{1}{3}F_{BC}$$

$$\therefore \frac{GM_AM}{x^2} = \left(\frac{GM_BM}{(1-x)^2}\right) \qquad \text{(Using(i) and (ii))}$$

$$\frac{M_A}{x^2} = \frac{M_B}{3(1-x)^2} \text{ or } \frac{M_A}{M_B} = \frac{x^2}{3(1-x)^2}$$

$$\frac{4}{3} = \frac{x^2}{3(1-x)^2} \text{ or } 4 = \frac{x^2}{(1-x)^2}$$

or $2 = \frac{x}{1-x}$ or 2 - 2x = x

3x = 2 or $x = \frac{2}{3}m$

16. A body is thrown upward from the earth surface with velocity 5 m/s and from a planet surface with velocity 3 m/s. Both follow the same path. What is the projectile acceleration due to gravity on the planet?
a) 2 m/s^2 b) 3.5 m/s^2 c) 4 m/s^2 d) 5 m/s^2

17. In some region, the gravitational field is zero. The gravitational potential in this region:
a) must be variable **b) must be constant** c) cannot be zero d) must be zero

18. Two satellites S and S' revolve around the earth at distances 3R and 6R from the centre of the earth. Their periods of revolution will be in the ratio:
a) 1 : 2 b) 2 : 1 **c) 1 : $2^{1.5}$** d) 1 : $2^{0.67}$

19. In motion of an object under the gravitational influence of another object. Which of the following quantities is not conserved?
a) Angular momentum b) Mass of an object c) Total mechanical energy **d) Linear momentum**

Solution : -
Linear momentum is not conserved.

20. If g is acceleration due to gravity on the earth's surface, the gain in the potential energy of an object of mass m raised from the surface of the earth to a height equal to the radius R of the earth is:
a) $\frac{1}{2}mgR$ b) 2mgR c) mgR d) $\frac{1}{4}mgR$

Solution : -
At a distance x, from the centre of the earth, gravitational force,

$F = \frac{GMm}{x^2}dx$

$dW = Fdx = \frac{GMm}{x^2}dx$

$W = \int_R^{R+h}\frac{GMm}{x^2}dx = GMm[\frac{1}{R} - \frac{1}{R+h}]$

$= gR^2m[\frac{1}{R} - \frac{1}{R+h}]...(i)$

∴ Gain in potential energy

$= gR^2m[\frac{1}{R} - \frac{1}{2}] = \frac{mgR}{2}.$

21. If the radius of the earth's orbit around the sun is R and the time period of revolution of the earth around the sun is T. The mass of the sun is:
a) $\frac{GT^3}{4\pi^2R^2}$ **b) $\frac{4\pi^2R^2}{GT^2}$** c) $\sqrt{\frac{4\pi^2R^3}{GT^2}}$ d) $[\frac{4\pi^2R^3}{GT^2}]^{1/3}$

Solution : -

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

or $R^2\omega^2 = \frac{GM}{R} or R^2\frac{4\pi^2}{T^2} = GM$

∴ M = mass of the sun = $\frac{4\pi^2R^2}{GT^2}$.

22. The ratio of earth's orbital angular momentum (about the sun) to its mass is 4.4 x 10^{15} m^2/s. The area enclosed by earth's orbit approximately is (in m^2)
a) 6.94 x 10^{22} b) 6.94 x 10^{23} c) 7.94 x 10^{22} d) 7.94 x 10^{23}

Solution : -

Let L = Angular momentum of earth about sun.
M = Mass of earth

$\therefore$ By Kepler's law, $\frac{dA}{dt} = \frac{L}{2M}$ or $\frac{L}{2M}$ or $dA = \frac{L}{2M}dt$

The earth completes its orbital journey in 365 days.

$\therefore$ Area $A = \frac{L}{2M} \times T = \frac{1}{2}\left(\frac{L}{M}\right)T$, where T= 365 days.

or $A = \frac{\left(4.4 \times 10^{15}\right) \times 365 \times 24 \times 60 \times 60}{2} m^2$

or Area = 6.94 x $10^{22} m^2$

$\therefore$ Area enclosed by earth's orbit = 6.94 x $10^{22} m^2$

23. If the earth were to suddenly contract to $\frac{1}{n}$th of its present radius without any change in its mass, the duration of the new day will be nearly:

a) $\boldsymbol{\frac{24}{n^2}hr}$ b) 24 n hr c) $\frac{24}{n}hr$ d) 24 n^2 hr

Solution : -

According to law of conservation of angular momemntum,

$l_1\omega_1 = l_2\omega_2$

$\frac{2}{5}MR^2(\frac{2\pi}{T_1}) = \frac{2}{5}M(\frac{R}{n})^2\frac{2\pi}{T_2}$

$T_2 = \frac{T_1}{n^2} = \frac{24}{n^2}hr(\because T_1 = 24$ times)

24. infinite number of masses, each 1 kg are placed along the x-axis at x = ± 1 In, ± 2 In, ± 4 In, ± 8m, ± 16 m . 1 •••
The magnitude of the resultant gravitational potential in terms of gravitational constant Gat the origin (x = 0) is

a) G/2 b) G c) 2G **d) 4G** e) 8G

Solution : -

Gravitational potential,

$V = GM(\frac{1}{r_1} + \frac{1}{r_2} + \frac{1}{r_3} + ...)$

$= G \times 1(\frac{1}{1} + \frac{1}{2} + \frac{1}{4} + \frac{1}{8} + \frac{1}{16} + ...)$

=$G(\frac{1}{1-1/2})(\because sumofGP = \frac{a}{1-r})$

=2G.

25. LANDSAT series of satellite move in near polar orbits at an altitude of

a) 3600 km b) 3000 km **c) 918 km** d) 512 km

26. If the earth is supposed to be a sphere of radius R, g 300 is the value of acceleration due to gravity at latitude of 30° and g at the equator, the value of g - g 30^0 is:

a) (1/4) ω^2R **b) (3/4) $\boldsymbol{\omega^2}$R** c) ω^2R d) (1/2) ω^2R

Solution : -

Acceleration due to gravity at latitude λ is given by:

g' = g - Rω^2 $\cos^2 \lambda$

At 30° g^{30o} = g - R$\omega^2$$\cos^2$ 30°

$= g - \frac{3}{4}R\omega^2$

or g - g^{30o} =$\frac{3}{4}\omega^2 R$.

27. Two bodies of masses m_1, and m_2 are initially at rest at infinite distance apart. They are then allowed to move towards each other under mutual gravitational attraction. Their relative velocity of approach at a separation distance r between them is:

a) $[2G\frac{(m_1-m_2)}{r}]^{1/2}$ b) $[\frac{2G}{r}(m_1-m_2)]^{1/2}$ c) $[\frac{r}{2G(m_1-m_2)}]^{1/2}$ d) $[\frac{2G}{r}(m_1 m_2)]^{1/2}$

Solution : -

Apply the principle of conservation of momentum and conservation of energy.

Let velocities of these masses at r distance from each other be V_1 and V_2 respectively.

By conservation of momentum,

$m_1U_1 - m_2v_2 = 0$

or $m_1 U_1 = m_2v_2$...(i)

By conservation of energy,

Change in PE = change in KE

$$\frac{Gm_1m_2}{r} = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$$

$$\frac{m_1^2v_1^2}{m_1} + \frac{m_2^2v_2^2}{m_2} = \frac{2Gm_1m_2}{r} \text{...(ii)}$$

On solving eqn. (i) and eqn. (ii),

$$v_1 = \sqrt{\frac{2Gm_2^2}{r(m_1+m_2)}}$$

and $v_2 = \sqrt{\frac{2Gm_1^2}{r(m_1+m_2)}}$

$$\therefore V_{app.} = |v_1| + |v_2| = \sqrt{\frac{2G}{r}(m_1+m_2)}$$

28. The gravitational field intensity at a point 10,000 km from the centre of the earth is 4.8 N kg $^{-1}$, The gravitational potential at that point is :

a) -4.8 x 10^7 J kg^{-1} b) -2.4 x 10^7 J kg^{-1} c) -4.8 x 10^6 J kg^{-1} d) -3.6 x 10^6 J kg^{-1}

Solution : -

Gravitational field intensity, E = $\frac{GM}{R^2}$

Gravitational potential, V = $\frac{GM}{R}$

$$\therefore \frac{V}{E} = -R$$

or V = -ER = -4.8 x 10,000 x 10^3

= -4.8 x 10^7 J kg^{-1}

29. Assertion: A man sitting in a closed cabin which is falling freely does not experience any gravity.

Reason: Inertial and gravitational mass are equivalent.

a) If both assertion and reason are true and reason is the correct explanation of assertion

b) If both assertion and reason are true but reason is not the correct explanation of assertion

c) If assertion is true but reason is false d) If both assertion and reason are false

Solution : -

Both man and the lift are falling freely with acceleration equal to the acceleration due to gravity. The relative acceleration of the man with respect to the cabin is zero.

30. If g = acceleration due to gravity and V be gravitational potential at a distance r from the centre of the earth (where r > R), then what is the relation between g and V ?

a) g = V/r **b) g =-dV /dr** c) $g = d^2 V/ dr^2$ d) $g = - V^2 /r^2$

31. Average distance of the earth from the sun is L_1 If one year of the earth = D days, one year of another planet whose average distance from the sun is L_2 will be

a) $D\left(\frac{L_2}{L_1}\right)^{1/2}$ days **b) $D\left(\frac{L_2}{L_1}\right)^{3/2}$ days** c) $D\left(\frac{L_2}{L_1}\right)^{2/3}$ days d) $D\left(\frac{L_2}{L_1}\right)$ days

Solution : -

According to Kepler's third law,

$T^2 \propto r^3$ or $T \propto r^{3/2}$

$\therefore \frac{D'}{D} = \left(\frac{L_2}{L_1}\right)^{3/2}$ or $D' = D\left(\frac{L_2}{L_1}\right)^{3/2}$ days

32. The earth moves around the Sun in an elliptical orbit as shown in figure. The ratio OA/OB = x. The A ratio of the speed of the earth at B to that at A is nearly

a) $\sqrt{x}$ **b) x** c) $x\sqrt{x}$ d) x^2

Solution : -

Applying conservation of angular momentum at position A and B

$mv_A \times OA = mv_B \times OB$

Hence, $\frac{v_B}{v_A} = \frac{OA}{OB} = x$

33. The two planets have radii r_1 and r_2 and their densities ρ_1 and ρ_2 respectively. The ratio of acceleration due to gravity on them will be:

a) $r_1\rho_1 : r_2\rho_2$ b) $r_1\rho_1^2 : r_2\rho_2^2$ c) $r_1^2\rho_1 : r_2^2\rho_2$ d) $r_1\rho_2 : r_2\rho_1$

Solution : -

$$g = \frac{GM}{r^2} = G.\frac{4}{3}\frac{\pi r^3 \rho}{r^2}$$

$$= G.\frac{4}{3}\pi r \rho$$

$$\therefore \frac{g_1}{g_2} = \frac{r_1\rho_1}{r_2\rho_2}.$$

34. The gravitational potential due to the earth at infinite distance from it is zero. Let the gravitational potential at a point P be -5 J/kg . Suppose, we arbitrarily assume the gravitational potential at infinity to be + 10 J/kg , then the gravitational potential at P will be:

a) -5 J/Kg **b) + 5 J/Kg** c) -15 J/Kg d) + 15 J/Kg

Solution : -

According to the problem, as the potential at ∞∞ increases by +10 J/kg, hence potential will increase by the same amount everywhere (Potential gradient will remain constant). Hence, potential at point P = 10 - 5 = +5 J/kg.

35. The mass of the earth is 6×10^{24} kg and that of the moon is 7.4×10^{22} kg. The potential energy of the system is -7.79×10^{28} J. The mean distance between the earth and moon is

($G = 6.67 \times 10^{-11}$ N $m^2 kg^{-2}$)

a) 3.8×10^8 m b) 3.37×10^6 m c) 7.60×10^4 m d) 1.9×10^2 m

Solution : -

Here, Potential energy of system,

U = - 7.79 x 10^{28} J

Mass of the earth, M_E = 6 x 10^{24} kg

Mass of the moon, M_M = 7.4 x 10^{22} kg

The potential energy of the earth-moon system is

U=$-\frac{GM_EM_M}{r}$

where r is the mean distance between earth and moon

∴ r=$-\frac{GM_EM_M}{r} = \frac{6.67\times10^{-11}\times6\times10^{24}\times7.4\times10^{22}}{-7.79\times10^{28}}$

=3.8 x 10^8 m

36. If the radius of the earth's orbit is made one-fourth, the duration of a year will become:

a) 8 times b) 4 times **c) $\frac{1}{8}$ time** d) $\frac{1}{4}$ time

37. The eccentricity of the earth's orbit is 0.0167. The ratio of its maximum speed in its orbit to its minimum speed is:

a) 2.507 **b) 1.0339** c) 8.324 d) 1.000

Solution : -

Eccentricity,$e = \frac{r_{max.}-r_{min}}{r_{max.}+r_{min.}} = 0.0167$

therefore, $\frac{r_{max.}}{r_{min.}} = \frac{1+e}{1-e} = \frac{1+0.0167}{1-0.0167}$

As angular momentum remains constant, hence,

$r_{max.}\times v_{min.} = r_{min.}\times v_{max.}$

$\therefore \frac{v_{max.}}{v_{min.}} = \frac{r_{max.}}{r_{min.}} = \frac{1+0.0167}{1-0.0167} = 1.0339.$

38. If there were a smaller gravitational effect, which of the following forces do you think would alter in some respect :

a) Viscous forces **b) As it depends on the weight of the body** c) Electrostatic force

d) None of the above

Solution : -

If gravitational effect is less, the weight of body gets altered due to Archimedes uplift.

39. The escape velocity from the surface of the earth is (where R_E is the radius of the earth)

a) $\sqrt{2gR_E}$ b) $\sqrt{gR_E}$ c) $2\sqrt{gR_E}$ d) $\sqrt{3gR_E}$

Solution : -

The escape velocity from the surface of the earth is

$v_e=\sqrt{\frac{2GM_E}{R_E}} = \sqrt{2gR_E}\ \left(\because g = \frac{GM_E}{R_E^2}\right)$

40. The distances of two planets from the sun are 10^{13} and 10^{12} m respectively. The ratio of time periods of these two planets is_____

a) $\frac{1}{\sqrt{10}}$ b) 100 **c) $10\sqrt{10}$** d) $\sqrt{10}$

Solution : -

According to Kepler's third law (or law of periods) the square of the time taken to complete the orbit (time period T) is proportional to the cube of the semi-major axis (r) of the elliptical orbit.

i.e., $T^2 \mu r^3$

Here, $r_1 = 10^{13}$ m, $r_2 = 10^{12}$ m

$$\therefore \frac{T_1^2}{T_2^2} = \frac{r_1^3}{r_2^3} = \frac{\left(10^{13}\right)^3}{\left(10^{12}\right)^3}$$

or $\frac{T_1^2}{T_2^2} = \frac{10^{39}}{10^{36}} = 10^3$

or $\frac{T_1}{T_2} = 10\sqrt{10}$

41. A satellite of the sun is in circular orbit around the sun, midway between the sun and the earth. Then:
a) the period of the satellite is nearly 129 days
b) the speed of the satellite equals the escape velocity of the earth
c) the acceleration of the satellite is four times the acceleration of the earth
d) the period of the satellite is nearly 229 days

42. The orbital velocity at a height h above the surface of the earth is 90% of that near the surface of the earth. If the escape velocity at the surface of the earth be v, then its value at the height h will be:
a) 0.99 v **b) 0.90 v** c) 0.81 v d) 0.11 v

43. The force on a 1 kg mass on the earth of radius R is 10 N. Then, the force on a satellite revolving around the earth in the mean orbit of radius 3RI2 will be: (mass of satellite is 100 kg)
a) 4.44 x 10^2 N b) 6. 66 x 10^2 N c) 500 N d) 3.33 x 10^2 N

44. A cosmonaut is orbiting the earth in a space-craft at an altitude h = 630 km with a speed of 8 km/s. If the radius of the earth is 6400 km, the acceleration ofthe cosmonaut is:
a) 9.10 m/s^2 b) 9.80 m/s^2 c) 10.0 m/s^2 d) 9.88 m/s^2

45. The acceleration due to gravity at a height 1 km above the earth is the same as at a depth d below the surface of earth. Then______
a) $d = \frac{1}{2}$ km b) $d = 1$ km c) $d = \frac{3}{2}$ km **d) $d = 2$ km**

Solution : -

g_h= Due to gravity acceleration at height h above earth's surface

$$= g\left(\frac{R}{R+h}\right)^2$$

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

g_d = Acceleration at depth d below earth's surface

$$= g\left(1 - \frac{d}{R}\right)$$

as we have, when $h = 1$ km, $g_a = g_h$

$$\text{or } g\left(1 - \frac{d}{\mathrm{R}}\right) = g\left(1 - \frac{2h}{\mathrm{R}}\right)$$

$\Rightarrow d = 2h$

or $d = 2$ km

46. The moon has a mass of $\frac{1}{81}$ that of the earth and a radius of $\frac{1}{4}$ that of the earth. The escape speed from the surface of the earth is 11.2 km/s. The escape speed from the surface of the moon is:

a) 1.25 Km/s **b) 2.49 Km/s** c) 3.7 Km/s d) 5.6 Km/s

Solution : -

On the earth,

The escape speed is, $V_e = \sqrt{\frac{2GM_e}{R_e}}$

On the moon,

The escape speed is, $V_m = \sqrt{\frac{2GM_m}{R_m}}$

$$\therefore \frac{v_m}{v_e} = \sqrt{(\frac{M_m}{M_m}) \times (\frac{R_e}{R_m})}$$

$$= \sqrt{(\frac{1}{81}) \times (\frac{4}{1})} = \frac{2}{9}$$

$$v_m = \frac{2}{9} \times v_e = \frac{2}{9} \times 11.2 \text{ kms}^{-1} = 2.49 \text{ kms}^{-1}.$$

47. (A) A spherically symmetric shell produces no gravitational field anywhere.

(R) The field due to various mass elements cancels out, everywhere for a spherically symmetric shell.

a) If both assertion and reason are true and reason is the correct explanation of assertion.

b) If both assertion and reason are true but reason is not the correct explanation of assertion

c) If assertion is true but reason is false. **d) If both assertion and reason are false.**

e) If assertion is false but reason is true.

48. The period of the satellite of the earth orbiting very near to the surface of the earth is T_o. What is the period of the geostationary satellite in terms of T_o?

a) $\frac{T_0}{\sqrt{7}}$ b) $\sqrt{7}T_0$ c) $7T_0$ **d)** $\mathbf{7\sqrt{7}T_0}$

49. How much energy will be necessary for making a body of 500 kg escape from the earth? (g = 9.8 m/s^2, radius of the earth = 6.4 x 10^6 m)

a) About 9.8 x 10^6 J b) About 6.4 x 10^8 J **c) About 3.1 x 10^{10} J** d) About 27.4 x 10^{12} J

50. A body is projected upwards with a velocity of 4 x 11.2 km/s from the surface of the earth. What will be the velocity of the body when it escapes the gravitational pull of the earth?

a) 11.2 km/s b) 2 x 11.2 km/s c) 3 x 11.2 km/s **d) $\sqrt{15}$ × 11.2 km/s**

Solution : -

Initial KE = $\frac{1}{2}mv^2$

$= \frac{1}{2}m(4 \times 11.2)^2 = 16 \times \frac{1}{2}mv_e^2$

As $\frac{1}{2}mv_e^2$ energy is used up in coming out from the gravitational pull of the earth, so final KE should be 15 x $\frac{1}{2}mv_e^2$.

Hence, $\frac{1}{2}mv'^2 = 15 \times \frac{1}{2}mv_e^2$

$\therefore v'^2 = 15v_e^2$

or $v' = \sqrt{15}v_e = \sqrt{15} \times 11.2 km/s.$