GRAVITATION -LEVEL 1

1. Three identical point masses, each of mass 1 kg lie in the x–y plane at points (0, 0) (0, 0.2m) and (0.2m,0). The gravitational force on the mass at the origin is :–

(A) $1.67 \times 10^{-11}\ (\tilde{i}+\tilde{j})N$ (B) $3.34 \times 10^{-10}\ (\tilde{i}+\tilde{j})N$ (C) $1.67 \times 10^{-9}\ (\tilde{i}+\tilde{j})N$ (D) $3.34 \times 10^{-10}\ (\tilde{i}-\tilde{j})N$

2. If the gravitational force were to vary inversely as m^{th} power of the distance, then the time period of a planet in circular orbit of radius r around the Sun will be proportional to

(A) $r^{-3m/2}$ (B) $r^{3m/2}$ (C) $r^{m+1/2}$ (D) $r^{(m+1)/2}$

3. If the distance between the centres of Earth and Moon is D and mass of Earth is 81 times that of Moon. At what distance from the centre of Earth gravitational field will be zero ?

(A) $\frac{D}{2}$ (B) $\frac{2D}{3}$ (C) $\frac{4D}{5}$ (D) $\frac{9D}{10}$

4. The radius of Earth is about 6400 km and that of mars is 3200 km. The mass of the Earth is 10 times the mass of mars. An object weight 200 N on the surface of Earth. Its weight on the surface of mars will be :–

(A) 80 N (B) 40 N (C) 20 N (D) 8 N

5. Weight of a body of mass m decreases by 1% when it is raised to height h above the Earth's surface. If the body is taken to a depth h in a mine, then its weight will :–

(A) decrease by 0.5% (B) decrease by 2% (C) increase by 0.5% (D) increase by 1%

6. Imagine a new planet having the same density as that of Earth but it is 3 times bigger than the Earth in size. If the acceleration due to gravity on the surface of Earth is g and that on the surface of the new planet is g', then

(A) g' = 3g (B) $g' = \frac{g}{9}$ (C) g' = 9g (D) g' = 27 g

7. An object weighs 10 N at the north pole of the Earth. In a geostationary satellite distance 7R from the centre of the Earth (of radius R), the true weight and the apparent weight are–

(A) 0 N, 0 N (B) 0.2 N, 0 (C) 0.2 N, 9.8 N (D) 0.2 N, 0.2 N

8. A stone drop from height 'h' reaches to Earth surface in1 sec. If the same stone taken to Moon and drop freely then it will reaches from the surface of the Moon in the time (The 'g' of Moon is 1/6 times of Earth):–

(A) $\sqrt{6}$ second (B) 9 second (C) $\sqrt{3}$ second (D) 6 second

9. The rotation of the Earth having radius R about its axis speeds upto a value such that a man at latitude angle 60^0 feels weightless. The duration of the day in such case will be

(A) $8\pi\sqrt{\frac{R}{g}}$ (B) $8\pi\sqrt{\frac{g}{R}}$ (C) $\pi\sqrt{\frac{R}{g}}$ (D) $4\pi\sqrt{\frac{g}{R}}$

10. A small body of superdense material, whose mass is twice the mass of the Earth but whose size is very small compared to the size of the Earth, starts from rest at a height H<<R above the Earth's surface, and reach the Earth's surface in time t. Then t is equal to

(A) $\sqrt{2H/g}$ (B) $\sqrt{H/g}$ (C) $\sqrt{2H/3g}$ (D) $\sqrt{4H/3g}$

11. A man of mass m starts falling towards a planet of mass M and radius R. As he reaches near to the surface, he realizes that he will pass through a small hole in the planet. As he enters the hole, he seen that the planet is really made of two pieces a spherical shell of negligible thickness of mass $\frac{2M}{3}$ and a point mass $\frac{M}{3}$ at the centre. Change in the force of gravity experienced by the man is :

(A) $\frac{2}{3}\frac{GMm}{R^2}$ (B) 0 (C) $\frac{1}{3}\frac{GMm}{R^2}$ (D) $\frac{4}{3}\frac{GMm}{R^2}$

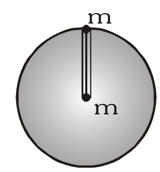
12. A body attains a height equal to the radius of the Earth when projected from Earth' surface. The velocity of the body with which it was projected is :–

(A) $\sqrt{\frac{GM_e}{R}}$ (B) $\sqrt{\frac{2GM_e}{R}}$ (C) $\sqrt{\frac{5}{4}\frac{GM_e}{R}}$ (D) $\sqrt{\frac{3GM_e}{R}}$

13. If the gravitational acceleration at surface of Earth is g, then increase in potential energy in lifting an object of mass m to a height equal to the radius R of Earth will be :–

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

14. Find the distance between centre of gravity and centre of mass of a two particle system attached to the ends of a light rod. Each particle has same mass. Length of the rod is R, where R is the radius of Earth



(A) R (B) R/2 (C) zero (D) R/4

15. The intensity of gravitational field at a point situated at a distance 8000 km from the centre of Earth is 6.0 newton /kg. The gravitational potential at that point in newton – meter/kg will be :–

(A) 6 (B) $4.8 \quad 10^7$ (C) $8 \quad 10^5$ (D) $4.8 \quad 10^2$

16. The gravitational field due to a mass distribution is $E = \frac{K}{x^3}$ in the x–direction. (K is a constant). Taking the gravitational potential to be zero at infinity, its value at the distance x is :–

(A) $\frac{K}{x}$ (B) $\frac{K}{2x}$ (C) $\frac{K}{x^2}$ (D) $\frac{K}{2x^2}$

17. Two bodies of masses m and M are placed at distance d apart. The gravitational potential (V) at the position where the gravitational field due to them is zero V is :–

(A) $V = -\frac{G}{d}(m+M)$ (B) $V = -\frac{G}{d}$ (C) $V = -\frac{GM}{d}$ (D) $V = -\frac{G}{d}(\sqrt{m}+\sqrt{M})^2$

18. Gravitation on Moon is $\frac{1}{6}$th of that on Earth. When a balloon filled with hydrogen is released on Moon then this

(A) will rise with an acceleration less then $\frac{g}{6}$ (B) will rise with acceleration $\frac{g}{6}$

(C) will fall down with an acceleration less than $\frac{5g}{6}$ (D) will fall down with acceleration $\frac{g}{6}$

19. Escape velocity of a body from the surface of Earth is 11.2 km/sec. from the Earth surface. If the mass of Earth becomes double of its present mass and radius becomes half of its present radius, then escape velocity will become

(A) 5.6 km/sec (B) 11.2 km/sec (C) 22.4 km/sec (D) 44.8km/sec

20. A body of mass m is situated at distance $4R_e$ above the Earth's surface, where R_e is the radius of Earth how much minimum energy be given to the body so that it may escape :–

(A) mgR_e (B) $2mgR_e$ (C) $\frac{mgR_e}{5}$ (D) $\frac{mgR_e}{16}$

21. The atmospheric pressure and height of barometer column is 10^5 P_a and 760mm respectively on the Earth surface. If the barometer is taken to the Moon then column height will be :–

(A) zero (B) 76 mm (C) 126.6 mm (D) 760 mm

22. Two identical satellites are at the heights R and 7R from the Earth's surface. Then which of the following statement is incorrect :– (r = radius of the Earth)

(A) Ratio of total energy of both is 5

(B) Ratio of kinetic energy of both is 4

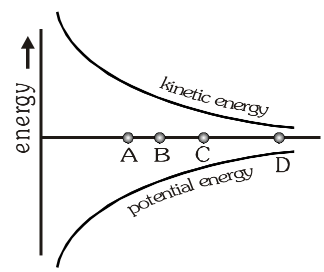
(C) Ratio of potential energy of both 4

(D) Ratio of total energy of both is 4 and ratio of magnitude of potential to kinetic energy is 2

23. A satellite is seen after each 8 hours over equator at a place on the Earth when its sense of rotation is opposite to the Earth. The time interval after which it can be seen at the same place when the sense of rotation of Earth & satellite is same will be:

(A) 8 hours (B) 12 hours (C) 24 hours (D) 6 hours

24. Potential energy and kinetic energy of a two particle system are shown by KE and PE. respectively in figure. This system is bound at :



(A) Only point A (B) Only point D

(C) Points A, B, and C (D) All points A, B, C and D

25. A hollow spherical shell is compressed to half its radius. the gravitational potential at the centre

(A) Increases (B) Decreases

(C) Remains same (D) During the compression increases then returns at the previous value

ANSWER KEY LEVEL-1

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Ans.	C	D	D	A	A	A	B	A	C	C	A	A	A	B	B	D	D	D	C	C
Que.	21	22	23	24	25															
Ans.	A	A	C	C	B															

GRAVITATION -LEVEL 2

MCQs with one correct answer

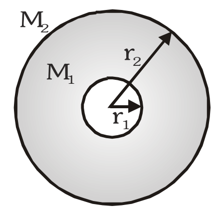
1. One projectile after deviating from its path starts moving round the Earth in a circular path of radius equal to nine times the radius of Earth R. Its time period will be :–

(A) $2\pi\sqrt{\frac{R}{g}}$ (B) $27 \times 2\pi\sqrt{\frac{R}{g}}$ (C) $\pi\sqrt{\frac{R}{g}}$ (D) $0.8 \times 3\pi\sqrt{\frac{R}{g}}$

2. Gravitational potential difference between surface of a planet and a point situated at a height of 20m above its surface is 2 joule/kg. If gravitational field is uniform, then the work done in taking a 5kg body of height 4 meter above surface will be :–

(A) 2J (B) 20J (C) 40J (D) 10J

3. Two concentric shells of masses M_1 and M_2 are having radii r_1 and r_2. Which of the following is the correct expression for the gravitational field at a distance r :–



(A) $\frac{G(M_1+M_2)}{r^2}$, for $r < r_1$ (B) $\frac{G(M_1+M_2)}{r^2}$, for $r < r_2$

(C) $\frac{GM_2}{r^2}$, for $r_1 < r < r_2$ (D) $\frac{GM_1}{r^2}$, for $r_1 < r < r_2$

4. In a certain region of space, the gravitational field is given by $-\frac{k}{r}$, where r is the distance and k is a constant. If the gravitational potential at $r = r_0$ be V_0, then what is the expression for the gravitational potential (V) :–

(A) $k \log\left(\frac{r}{r_0}\right)$ (B) $k \log\left(\frac{r_0}{r}\right)$ (C) $V_0 + k \log\left(\frac{r}{r_0}\right)$ (D) $V_0 + k \log\left(\frac{r_0}{r}\right)$

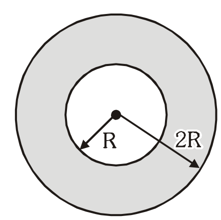
5. The potential energy of a body of mass m is U = ax + by the magnitude of acceleration of the body will be :–

(A) $\frac{ab}{m}$ (B) $\left(\frac{a+b}{m}\right)$ (C) $\frac{\sqrt{a^2+b^2}}{m}$ (D) $\frac{a^2+b^2}{m}$

6. Two metallic balls of mass m are suspended by two strings of length L. The distance between upper ends is ℓ. The angle at which the string will be inclined with vertical due to attraction, is (m<<M, where M is the mass of Earth):–

(A) $\tan^{-1}\frac{Gm}{g\ell^2}$ (B) $\tan^{-1}\frac{Gm}{gL^2}$ (C) $\tan^{-1}\frac{Gm}{g\ell}$ (D) $\tan^{-1}\frac{Gm}{gL}$

7. There is a concentric hole of radius R in a solid sphere of radius 2R. Mass of the remaining portion is M. What is the gravitational potential at centre ?



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

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

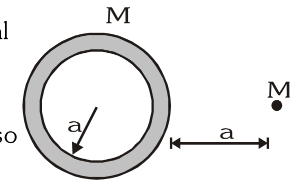
8. If there were a smaller gravitational effect, which of the following forces do you think would alter in some respect.

(A) Viscous force (B) Archimedes uplift (C) Electrostatic force (D) Magnetic force

9. Select the correct alternative :–

(A) The gravitational field inside a spherical cavity, within a spherical planet must be non zero and uniform
(B) When a body is projected horizontally at an appreciable large height above the Earth, with a velocity less than for a circular orbit, it will fall to the Earth along a parabolic path
(C) A body of zero total mechanical energy placed in a gravitational field will escape the field
(D) Earth's satellite must be in equatorial plane

10. A particle of mass M is at a distance a from surface of a thin spherical shell of equal mass and having radius a



(A) Gravitational field and potential both are zero at centre of the shell
(B) Gravitational field is zero not only inside the shell but at a point outside the shell also
(C) Inside the shell, gravitational field alone is zero
(D) Neither gravitational field nor gravitational potential is zero inside the shell

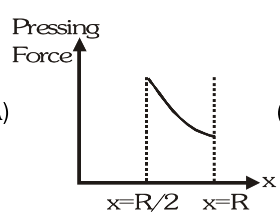
11. Three particles are projected vertically upward from a point on the surface of the Earth with velocities $\sqrt{2gR/3}$, $\sqrt{gR}$, $\sqrt{4gR/3}$ respectively where R is the radius of the Earth and g is the acceleration due to gravity on the surface of the Earth. The maximum heights attained are respectively h_1, h_2, h_3.
(A) $h_1 : h_2 = 2 : 3$ (B) $h_2 : h_3 = 3 : 4$ (C) $h_1 : h_3 = 1 : 4$ (D) $h_2 = R$

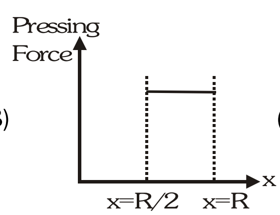
12. When a satellite in a circular orbit around the Earth enters the atmospheric region, it encounters small air resistance to its motion. Then
(A) Its kinetic energy increases (B) Its kinetic energy decreases
(C) Its angular momentum about the Earth decreases (D) Its period of revolution around the Earth increases

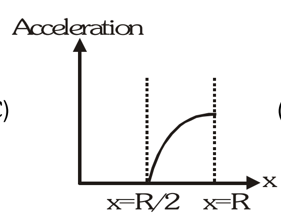
13. For a satellite to be geo–stationary, which of the following are essential conditions?
(A) It must always be stationed above the equator (B) It must be rotated from west to east
(C) It must be about 36000 km above the Earth (D) Its orbit must be circular, and not elliptical

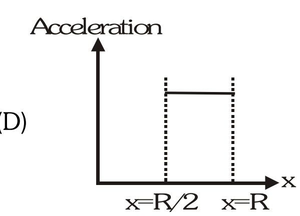
14. A cavity of radius R/2 is made inside a solid sphere of radius R. The centre of the cavity is located at a distance R/2 from the centre of the sphere. The gravitational force on a particle of mass 'm' at a distance R/2 from the centre of the sphere on the joining both the centres of sphere and cavity is (opposite to the centre of cavity). [Here $g = GM/R^2$, where M is the mass of the sphere]
(A) $\frac{mg}{2}$ (B) $\frac{3mg}{8}$ (C) $\frac{mg}{16}$ (D) None of these

15. A tunnel is dug along a chord of the Earth at a perpendicular distance R/2 from the Earth's centre. The wall of the tunnel may be assumed to be frictionless. A particle is released from one end of the tunnel. The pressing force by the particle on the wall, and the acceleration of the particle varies with x (distance of the particle from the centre) according to :

(A) 

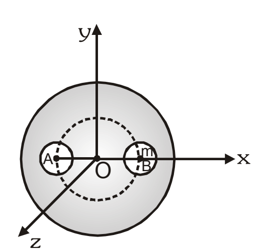
(B) 

(C) 

(D) 

16. A double star is a system of two stars of masses m and 2m, rotating about their centre of mass only under their mutual gravitational attraction. If r is the separation between these two stars then their time period of rotation about their centre of mass will be proportional to :
(A) $r^{3/2}$ (B) r (C) $m^{1/2}$ (D) $m^{-1/2}$

17. A solid sphere of uniform density and radius 4 units is located with its centre at the origin O of coordinates. Two spheres of equal radii 1 unit, with their centres at A (–2, 0, 0) and B (2, 0, 0) respectively, are taken out of the solid leaving behind spherical cavities as shown in figure. Then :–



(A) The gravitational field due to this object at the origin is zero
(B) The gravitational field at the point B (2, 0, 0) is zero
(C) The gravitational potential is the same at all points of circle $y^2+z^2=36$
(D) The gravitational potential is the same at all points on the circle $y^2+z^2=4$

18. The magnitudes of the gravitational field at distance 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) $\frac{F_1}{F_2}=\frac{r_2^2}{r_1^2}$ if $r_1 > R$ and $r_2 > R$
(C) $\frac{F_1}{F_2}=\frac{r_1^3}{r_2^3}$ 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 $r_2 < R$

19. Mark the correct statement/s :–

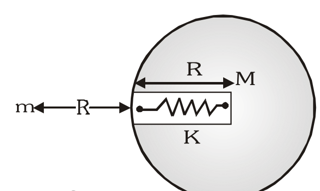
(A) Gravitational potential at curvature centre of a thin hemispherical shell of radius R and mass M is equal to $\frac{GM}{R}$
(B) Gravitational field strength at point lying on the axis of a thin, uniform circular ring of radius R and mass M is equal to $\frac{GMx}{\left(R^2+x^2\right)^{3/2}}$ where x is distance of that point from centre of the ring
(C) Newton's law of gravitation for gravitational force between two bodies is applicable only when bodies have spherically symmetric distribution of mass
(D) None of these

20. Gravitational potential at the centre of curvature of a hemispherical bowl of radius R and mass M is V :–
(A) Gravitational potential at the centre of curvature of a thin uniform wire of mass M, bent into a semicircle of radius R, is also equal to V
(B) In part (A) if the same wire is bent into a quarter of a circle then also the gravitational potential at the centre of curvature will be V
(C) In part (A) if the wire mass is non uniformly distributed along its length audit is bent into a semicircle of radius R, gravitational potential at the centre is V
(D) None of these

21. Suppose a smooth tunnel is dug along a straight line joining two points on the surface of the Earth and a particle is dropped from rest at its one end. Assume that mass of Earth is uniformly distributed over its volume. Then

(A) The particle will emerge from the other end with velocity $\sqrt{\frac{GM_e}{2R_e}}$ where M_e and R_e are Earth's mass and radius respectively
(B) The particle will come to rest at centre of the tunnel because at this position, particle is closest to Earth centre.
(C) Potential energy of the particle will be equal to zero at centre of tunnel if it is along tunnel's diameter
(D) Acceleration of the particle will be proportional to its distance from midpoint of the tunnel

22. A small ball of mass 'm' is released at a height 'R' above the Earth surface, as shown in the figure. If the maximum depth of the ball to which it goes is R/2 inside the Earth through a narrow grove before coming to rest momentarily. The grove, contain an ideal spring of spring constant K and natural length R, the value of K is (R is radius of Earth and M mass of Earth)



(A) $\frac{3GMm}{R^3}$ (B) $\frac{6GMm}{R^3}$ (C) $\frac{9GMm}{R^3}$ (D) $\frac{7GMm}{R^3}$

23. A particle of mass m is transferred from the centre of the base of a uniform solid hemisphere of mass M and radius R to infinity. The work performed in the process by the gravitational force exerted on the particle by the hemisphere is

(A) $\frac{GMm}{R}$ (B) $-\frac{1}{2}\frac{GMm}{R}$ (C) $-\frac{3}{2}\frac{GMm}{R}$ (D) $-\frac{3}{4}\frac{GMm}{R}$

24. Masses and radii of Earth and Moon are M_1, M_2 and R_1, R_2 respectively. The distance between their centre is 'd'. The minimum velocity given to mass 'M' from the mid point of line joining their centre so that it will escape :–

(A) $\sqrt{\frac{4G(M_1+M_2)}{d}}$ (B) $\sqrt{\frac{4G}{d}\frac{M_1M_2}{(M_1+M_2)}}$ (C) $\sqrt{\frac{2G}{d}\left(\frac{M_1+M_2}{M_1M_2}\right)}$ (D) $\sqrt{\frac{2G}{d}(M_1+M_2)}$

25. A planet is revolving around the Sun in an elliptical orbit. Its closest distance from the Sun is r_{min}. The farthest distance from the Sun is r_{max}. If the orbital angular velocity of the planet when it is nearest to the Sun is ω, then the orbital angular velocity at the point when it is at the farthest distance from the Sun is–

(A) $\left(\sqrt{\frac{r_{min}}{r_{max}}}\right)\omega$ (B) $\left(\sqrt{\frac{r_{max}}{r_{min}}}\right)\omega$ (C) $\left(\frac{r_{max}}{r_{min}}\right)^2\omega$ (D) $\left(\frac{r_{min}}{r_{max}}\right)^2\omega$

26. A satellite is in a circular orbit very close to the surface of a planet. At some point it is given an impulse along its direction of motion, causing its velocity to increase n times. It now goes into an elliptical orbit. The maximum possible value of n for this to occur is

(A) 2 (B) $\sqrt{2}$ (C) $\sqrt{2}+1$ (D) $\frac{1}{\sqrt{2}-1}$

ANSWER KEY — LEVEL-2

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	A	D	D	C	A	D	B	C	D	C,D	A,C	ABCD	B	B,C
Que.	16	17	18	19	20	21	22	23	24	25	26				
Ans.	A,D	A,C,D	A,B	B,C	A,C	D	D	C	A	D	B				