EXERCISE–01

CHECK YOUR GRASP [OBJECTIVE QUESTIONS]

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) $\frac{4}{3}\frac{GMm}{R^2}$

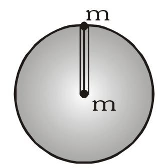
12. A body attains a height equal to the radius of the Earth when projected from Earth' surface. The velocity of the body with which it was projected is :–

(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

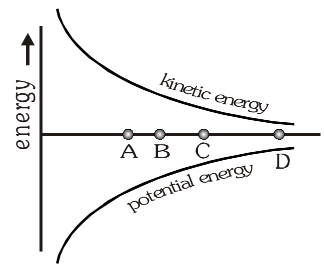
(C) Ratio of potential energy of both 4

(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

CHECK YOUR GRASP	ANSWER KEY	EXERCISE -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															

EXERCISE–02

BRAIN TEASERS [MCQs]

MCQs with one correct answer

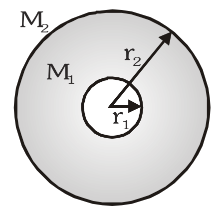
1. One projectile after deviating from its path starts moving round the Earth in a circular path of radius equal to nine times the radius of Earth R. Its time period will be :–

(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) $V_0 + k \log\left(\frac{r_0}{r}\right)$

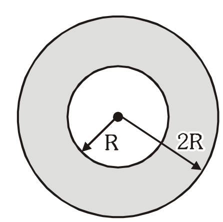
5. The potential energy of a body of mass m is U = ax + by the magnitude of acceleration of the body will be :–

(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 :–

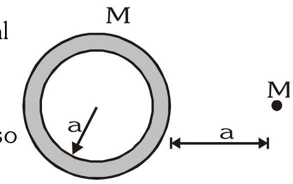
(A) The gravitational field inside a spherical cavity, within a spherical planet must be non zero and uniform

(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

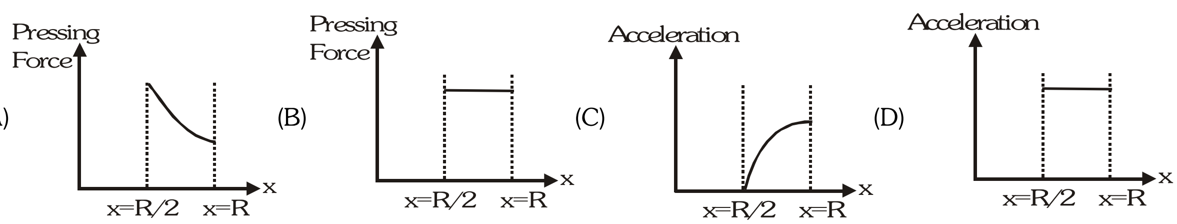
11. Three particles are projected vertically upward from a point on the surface of the Earth with velocities $\sqrt{2gR/3}$, $\sqrt{gR}$, $\sqrt{4gR/3}$ respectively where R is the radius of the Earth and g is the acceleration due to gravity on the surface of the Earth. The maximum heights attained are 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

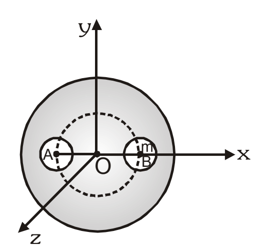
14. A cavity of radius R/2 is made inside a solid sphere of radius R. The centre of the cavity is located at a distance R/2 from the centre of the sphere. The gravitational force on a particle of mass 'm' at a distance R/2 from the centre of the sphere on the joining both the centres of sphere and cavity 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 :



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 $r_2 < R$

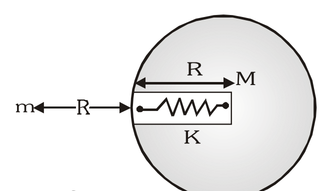
19. Mark the correct statement/s :-

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

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

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) $\dfrac{1}{\sqrt{2}-1}$

BRAIN TEASERS **ANSWER KEY** EXERCISE -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				

EXERCISE–03 MISCELLANEOUS TYPE QUESTIONS

True/False

1. Gravitational force is a conservative and central force.
2. For bounded system, potential energy must be negative.
3. Two air bubbles in water attract each other.

Fill in the blanks

1. The escape velocity for a planet is v_e. A particle starts from rest at a large distance from the planet, reaches the planet only under gravitational attraction, and passes through a smooth tunnel through its centre. Its speed at the centre of the planet will be ....
2. An exploratory rocket of mass m is in orbit about the Sun of mass M_s at a radius $\frac{R_{Es}}{10}$ (R_{Es} = distance of Sun from Earth). To exit from this orbit, it fires its engine over a short period of time. This quickly doubles the velocity of rocket while its mass reduces to half due to fuel consumption. Immediately after firing the engine, the kinetic energy of the rocket is ....
3. Two point masses each of mass m separated by a large distance are attracted towards each other due to gravitational interaction . If they start from rest then speed of each mass when they are separated by distance r is ....
4. The numerical value of the angular velocity of rotation of the Earth should be .... rad/s in order to make the effective acceleration due to gravity at equator equal to zero.
5. According to Kepler's second law, the radius vector to a planet from the Sun sweeps out equal areas in equal intervals of time. This law is consequence of the conservation of ....
6. The ratio of Earth's orbital angular momentum (about the Sun) to its mass is 4.4 10^{15} m^2/s. The area enclosed by Earth's orbit approximately .... m^2.
7. A particle is projected vertically upwards from the surface of Earth (radius R) with a kinetic energy equal to half of the minimum value needed for it to escape. The height to which it rises above the surface of Earth is ....

Match the Column

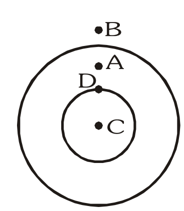
1. A satellite is in a circular equatorial orbit of radius 7000 km around the Earth. If it is transferred to a circular orbit of double the radius

	Column I		Column II
(A)	Angular momentum	(p)	Increases
(B)	Area of Earth covered by satellite signal	(q)	Decreases
(C)	Potential energy	(r)	Becomes double
(D)	Kinetic energy	(s)	Becomes half

2. In elliptical orbit of a planet, as the planet moves from apogee position to perigee position,

	Column–I		Column–II
(A)	Speed of planet	(p)	Remains same
(B)	Distance of planet from centre of Sun	(q)	Decreases
(C)	Potential energy	(r)	Increases
(D)	Angular momentum about centre of Sun	(s)	Can not say

3. Two concentric spherical shells are as shown in figure. :



	Column–I		Column–II
(A)	Potential at A	(p)	greater than B
(B)	Gravitational field at A	(q)	less than B
(C)	As one moves from C to D	(r)	potential remains constant
(D)	As one moves from D to A	(s)	gravitational field decreases
		(t)	None

4.

	Column–I		Column–II
(A)	Kinetic energy of a particle in gravitational field is increasing	(p)	work done by gravitational force should be positive
(B)	Potential energy of a particle in gravitational field is increasing	(q)	work done by external force should be non zero
(C)	Mechanical energy of a particle in gravitational field is increasing	(r)	work done by gravitational force should be negative
		(s)	can not say anything

ASSERTION & REASON TYPE QUESTIONS

These questions contains, Statement 1 (assertion) and Statement 2 (reason).

1. **Statement – 1** : Two satellites A & B are in the same orbit around the Earth, B being behind A. B cannot overtake A by increasing its speed.

and

Statement – 2 : It will then go into a different orbit.

(A) Statement–1 is True, Statement–2 is True ; Statement–2 is a correct explanation for Statement–1
(B) Statement–1 is True, Statement–2 is True ; Statement–2 is not a correct explanation for Statement–1
(C) Statement–1 is True, Statement–2 is False.
(D) Statement–1 is False, Statement–2 is True.

2. **Statement – 1** : The acceleration of a particle near the Earth surface differs slightly from the gravitational acceleration $a_g = GM/R^2$.

and

Statement – 2 : The Earth is not a uniform sphere and because the Earth rotates.

(A) Statement–1 is True, Statement–2 is True ; Statement–2 is a correct explanation for Statement–1
(B) Statement–1 is True, Statement–2 is True ; Statement–2 is not a correct explanation for Statement–1
(C) Statement–1 is True, Statement–2 is False.
(D) Statement–1 is False, Statement–2 is True.

3. **Statement – 1** : Kepler's law of areas is equivalent to the law of conservation of angular momentum.

and

Statement – 2 : Areal velocity $\frac{dA}{dt} = \frac{L}{2m}$ = constant

(A) Statement–1 is True, Statement–2 is True ; Statement–2 is a correct explanation for Statement–1
(B) Statement–1 is True, Statement–2 is True ; Statement–2 is not a correct explanation for Statement–1
(C) Statement–1 is True, Statement–2 is False.
(D) Statement–1 is False, Statement–2 is True.

4. **Statement – 1** : A satellite is moving in a circular orbit of the Earth. If the gravitational pull suddenly disappears, then it moves with the same speed tangential to the original orbit.

and

Statement – 2 : The orbital speed of a satellite increases with the increase in radius of the orbit.

(A) Statement–1 is True, Statement–2 is True ; Statement–2 is a correct explanation for Statement–1
(B) Statement–1 is True, Statement–2 is True ; Statement–2 is not a correct explanation for Statement–1
(C) Statement–1 is True, Statement–2 is False.
(D) Statement–1 is False, Statement–2 is True.

5. **Statement – 1** : A person feels weightlessness in an artificial satellite of the Earth. However a person on the Moon (natural satellite) feels his weight.

and

Statement – 2 : Artificial satellite is a freely falling body and on the Moon surface, the weight is mainly due to Moon's gravitational attraction.

(A) Statement–1 is True, Statement–2 is True ; Statement–2 is a correct explanation for Statement–1
(B) Statement–1 is True, Statement–2 is True ; Statement–2 is not a correct explanation for Statement–1
(C) Statement–1 is True, Statement–2 is False.
(D) Statement–1 is False, Statement–2 is True.

6. **Statement – 1** : Moon cannot be used as a satellite for communication.

and

Statement – 2 : Moon doesn't move in the equatorial plane of the Earth.

(A) Statement–1 is True, Statement–2 is True ; Statement–2 is a correct explanation for Statement–1
(B) Statement–1 is True, Statement–2 is True ; Statement–2 is not a correct explanation for Statement–1
(C) Statement–1 is True, Statement–2 is False.
(D) Statement–1 is False, Statement–2 is True.

7. **Statement – 1** : Moon has no atmosphere.

and

Statement – 2 : Due to less gravity Moon is unable to retain its atmosphere.

(A) Statement–1 is True, Statement–2 is True ; Statement–2 is a correct explanation for Statement–1
(B) Statement–1 is True, Statement–2 is True ; Statement–2 is not a correct explanation for Statement–1
(C) Statement–1 is True, Statement–2 is False.
(D) Statement–1 is False, Statement–2 is True.

8. **Statement – 1** : Pendulum clock stops working on the spaceship.

and

Statement – 2 : Pendulum of the pendulum clock falls down on the spaceship.

(A) Statement–1 is True, Statement–2 is True ; Statement–2 is a correct explanation for Statement–1
(B) Statement–1 is True, Statement–2 is True ; Statement–2 is not a correct explanation for Statement–1
(C) Statement–1 is True, Statement–2 is False.
(D) Statement–1 is False, Statement–2 is True.

9. **Statement – 1** : Escape velocity is independent of the angle of projection.

and

Statement – 2 : Escape velocity for vertical projection from the surface of Earth is $\sqrt{\frac{2GM}{R}}$.

(A) Statement–1 is True, Statement–2 is True ; Statement–2 is a correct explanation for Statement–1
(B) Statement–1 is True, Statement–2 is True ; Statement–2 is not a correct explanation for Statement–1
(C) Statement–1 is True, Statement–2 is False.
(D) Statement–1 is False, Statement–2 is True.

10. **Statement – 1** : The plane of the orbit of an artificial satellite must contain the centre of the Earth.

and

Statement – 2 : For an artificial satellite, the necessary centripetal force is provided by gravity.

(A) Statement–1 is True, Statement–2 is True ; Statement–2 is a correct explanation for Statement–1
(B) Statement–1 is True, Statement–2 is True ; Statement–2 is not a correct explanation for Statement–1
(C) Statement–1 is True, Statement–2 is False.
(D) Statement–1 is False, Statement–2 is True.

11. **Statement – 1** : When a planet approaches the point which is farthest from the Sun, its orbital speed decreases.

and

Statement – 2 : Work done on the planet by the gravitational force exerted by the Sun is negative.

(A) Statement–1 is True, Statement–2 is True ; Statement–2 is a correct explanation for Statement–1

(B) Statement–1 is True, Statement–2 is True ; Statement–2 is not a correct explanation for Statement–1

(C) Statement–1 is True, Statement–2 is False.

(D) Statement–1 is False, Statement–2 is True.

COMPREHENSION TYPE QUESTIONS

Comprehension # 1

When a particle is projected from the surface of Earth, its mechanical energy and angular momentum about centre of Earth at all time are constant.

1. A particle of mass m is projected from the surface of Earth with velocity v_0 at angle θ with horizontal. Suppose h be the maximum height of particle from surface of Earth and v its speed at that point then v is :–

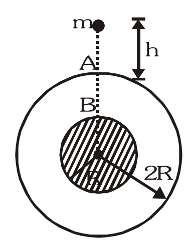
(A) $v_0 \cos\theta$ (B) $> v_0 \cos\theta$ (C) $< v_0 \cos\theta$ (D) Zero

2. Maximum height h of the particle is :–

(A) $= \dfrac{v_0^2 \sin^2\theta}{2g}$ (B) $> \dfrac{v_0^2 \sin^2\theta}{2g}$ (C) $< \dfrac{v_0^2 \sin^2\theta}{2g}$

(D) Can be greater than or less than $\dfrac{v_0^2 \sin^2\theta}{2g}$

Comprehension # 2



A solid sphere of mass M and radius R is surrounded by a spherical shell of same mass M and radius 2R as shown. A small particle of mass m is released from rest from a height h (<<R) above the shell. There is a hole in the shell.

1. In what time will it enter the hole at A :–

(A) $2\dfrac{\sqrt{hR^2}}{GM}$ (B) $\sqrt{\dfrac{2hR^2}{GM}}$ (C) $\sqrt{\dfrac{hR^2}{GM}}$ (D) None of these

2. What time will it take to move from A to B ?

(A) $= \dfrac{R^2}{\sqrt{GMh}}$ (B) $> \dfrac{R^2}{\sqrt{GMh}}$ (C) $< \dfrac{R^2}{\sqrt{GMh}}$ (D) None of these

3. With what approximate speed will it collide at B ?

(A) $\sqrt{\dfrac{2GM}{R}}$ (B) $\sqrt{\dfrac{GM}{2R}}$ (C) $\sqrt{\dfrac{3GM}{2R}}$ (D) $\sqrt{\dfrac{GM}{R}}$

Comprehension # 3

Two stars bound together by gravity orbit each other because of their mutual attraction. Such a pair of stars is referred to as a binary star system. One type of binary system is that of a black hole and a companion star. The black hole is a star that has collapsed on itself and is so missive that not even light rays can escape its gravitational pull. Therefore when describing the relative motion of a black hole and a companion star, the motion of the black hole can be assumed negligible compared to that of the companion.

The orbit of the companion star is either elliptical with the black hole at one of the foci or circular with the black hole at the centre. The gravitational potential energy is given by U = – GmM/r, where G is the universal gravitational constant, m is the mass of the companion star, M is the mass of the block hole, and r is the distance between the centre of the companion star and the centre of the black hole. Since the gravitational force is conservative, the companion star's total mechanical energy is a constant. Because of the periodic nature of the orbit, there is a simple relation between the average kinetic energy <K> of the companion star and its average potential energy <U>. In particular, <K> = <–U/2>.

Two special points along the orbit are single out by astronomers. Parigee is the point at which the companion star is closest to the black hole, and apogee is the point at which is the farthest from the black hole.

1. For circular orbits the potential energy of the companion star is constant throughout the orbit. If the radius of the orbit doubles, what is the new value of the velocity of the companion star ?

(A) It is 1/2 of the old value (B) It is $1/\sqrt{2}$ of the old value

(C) It is the same as old value (D) It is double the old value

2. Which of the following prevents the companion star from leaving its orbit and falling into the black hole ?

(A) The centripetal force (B) The gravitational force

MISCELLANEOUS TYPE QUESTION	ANSWER KEY			EXERCISE -3
• ***True / False***	1. T	2. F	3. T	
• ***Fill in the Blanks***	1. $\sqrt{1.5}v_e$	2. $\frac{10GM_s m}{R_{E_S}}$	3. $\sqrt{\frac{GM}{r}}$	4. 1.25 10^{-3}
	5. angular momentum	6. 6.94 10^{22}	7. h=R	
• ***Match the Column***	1. (A)p(B)p(C) p,s (D)q,s	2. (A) r (B) q (C) q (D) p		
	3. (A) q (B) t (C) r (D) s	4. (A) s (B) r (C) q		

• ***Assertion - Reason***

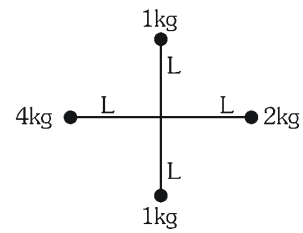
1	2	3	4	5	6	7	8
A	A	A	C	A	A	A	C
9	10	11					
B	A	C					

• ***Comprehension based***

Comprehension #1 :	1. C	2. B	
Comprehension #2 :	1. A	2. C	3. D
Comprehension #3:	1. B	2. D	

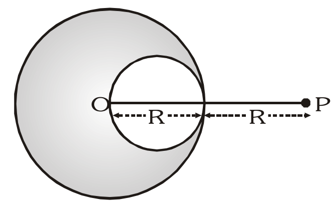
EXERCISE–04 [A] CONCEPTUAL SUBJECTIVE EXERCISE

1. In the given figure, L = 1 metre, if total gravitational force on 4 kg mass is $\vec{F}_1$ and on 2 kg mass is $\vec{F}_2$, then find out the ratio of $\frac{|\vec{F}_1|}{|\vec{F}_2|}$.



2. Two point–like objects, each with mass m, are connected by a massless rope of length ℓ. The objects are suspended vertically near the surface of Earth, so that one object is hanging below the other. Then the objects are released. Show that the tension in the rope is $T = \frac{GMm\ell}{R^3}$ where M is the mass of the Earth and R is its radius. [ℓ <<R]

3. A solid sphere of uniform density and radius R applies a gravitational force of attraction equal to F_1 on a particle placed at P, distance 2R from the centre of the sphere. A spherical cavity of radius R/2 is now made in the sphere as shown in figure. The sphere with cavity now applies a gravitational force F_2 on the same particle placed at P. Find the ratio of F_2/F_1 .



4. The gravitational field in a region is given by $\vec{E} = (3\hat{i} - 4\hat{j})$ N/kg. Find out the work done (in joule) in displacing a particle by 1 m, along the line 4y = 3x + 9 :

5. The Earth may be regarded as a spherically shaped uniform core of density ρ_1 and radius $\frac{R}{2}$ surrounded by a uniform shell of thickness $\frac{R}{2}$ and density ρ_2. Find the ratio of $\frac{\rho_1}{\rho_2}$ if the value of acceleration due to gravity is the same at surface as at depth $\frac{R}{2}$ from the surface.

6. A thin spherical shell of total mass M and radius R is held fixed. There is a small hole in the shell. A mass m is released from rest a distance R from the hole along a line that passes through the hole and also through the centre of the shell. This mass subsequently moves under the gravitational force of the shell. How long does the mass take to travel from the hole to the point diametrically opposite.

7. A particle of mass 1 kg is placed at a distance of 4 m from the centre and on the axis of a uniform ring of mass 5 kg and radius 3 m. Calculate the work done to increase the distance of the particle from 4 m to $3\sqrt{3}$ m.

8. Find the potential energy of a system of four particles placed at the vertices of a square of side ℓ. Also obtain the potential at the centre of the square.

9. Find the potential energy of a system of eight particles placed at the vertices of a cube of side L. Neglect the self energy of the particles.

10. Find the potential energy of the gravitational interaction of a point mass of mass m and a thin uniform rod of mass M and length ℓ , if they are located along a straight line such that the point mass is at a distance 'a' from one end. Also find the force of their interaction.

11. A body of mass m be projected vertically upward from the surface of the Earth so as to reach a height nR above the Earth's surface. Calculate :

(i) The increase in its potential energy (ii) The velocity with which the body must be projected

12. Two small dense stars rotate about their common centre of mass as a binary system with the period 1 year for each. One star is of double the mass of the other and the mass of the lighter one is $\frac{1}{3}$ of the mass of the Sun. Find the distance between the stars if distance between the Earth & the Sun is R.

13. A comet orbits the Sun in a highly elliptical orbit. Does the comet have a constant

(i) linear speed, (ii) angular speed, (iii) angular momentum, (iv) kinetic energy, (v) potential energy, (vi) total energy throughout its orbit ? Neglect any mass loss of the comet when it comes very close to the Sun.

14. An artificial satellite is moving in a circular orbit around the Earth with a speed equal to half the magnitude of escape velocity from the Earth.

(i) Determine the height of the satellite above the Earth's surface.

(ii) If the satellite is stopped suddenly in its orbit and allowed to fall freely on the Earth, find the speed with which it hits and surface of Earth. Given M = mass of Earth & R = Radius of Earth

CONCEPTUAL SUBJECTIVE EXERCISE — **ANSWER KEY** — EXERCISE-4(A)

1. $\sqrt{2}$

3. $\frac{7}{9}$

4. 0

5. $\frac{7}{3}$

6. $2\sqrt{\frac{R^3}{GM}}$

7. 1.11 10^{-11} Joule

8. $\frac{-5.41Gm^2}{\ell}$, $\frac{-4\sqrt{2}Gm}{\ell}$

9. $\frac{-4GM^2}{L}\left[3+\frac{3}{\sqrt{2}}+\frac{1}{\sqrt{3}}\right]$

10. $-\frac{GMm}{\ell}\log_e\left(1+\frac{\ell}{a}\right)$

11. (i) $\left[\frac{n}{n+1}\right]mgR$ (ii) $\sqrt{\left(\frac{n}{n+1}\right)2gR}$

12. R

13. All quantities vary over an orbit except angular momentum and total energy

14. (i) 6400 km (ii) 7.9 km/s

EXERCISE–04 [B] BRAIN STORMING SUBJECTIVE EXERCISE

1. A small satellite revolves around a heavy planet in a circular orbit. At certain point in its orbit a sharp impulse acts on it and instantaneously increases its kinetic energy to 'k' (<2) times without change in its direction of motion. Show that in its subsequent motion the ratio of its maximum and minimum distances from the planet is $\frac{k}{2-k}$, assuming the mass of the satellite is negligibly small as compared to that of the planet.

2. A satellite of mass m is in an elliptical orbit around the Earth of mass M (M>>m). The speed of the satellite at its nearest point to the Earth (perigee) is $\sqrt{\frac{6GM}{5R}}$ where R = its closest distance to the Earth. It is desired to transfer this satellite into a circular orbit around the Earth of radius equal its largest distance from the Earth. Find the increase in its speed to be imparted at the apogee (farthest point on the elliptical orbit).

3. A body is launched from the Earth's surface a angle $\alpha = 30^0$ to the horizontal at a speed $v_0 = \sqrt{\frac{1.5GM}{R}}$. Neglecting air resistance and Earth's rotation, find (i) the height to which the body will rise. (ii) The radius of curvature of trajectory at its top point.

4. Distance between the centres of two starts is 10a. The masses of these stars are M and 16M and their radii a and 2a respectively. A body of mass m is fired straight from the surface of the larger star towards the surface of the smaller star. What should be its minimum initial speed to reach the surface of the smaller star ? Obtain the expression in terms of G, M and a.

5. The minimum and maximum distances of a satellite from the centre of the Earth are 2R and 4R respectively, where R is the radius of Earth and M is the mass of the Earth. Find radius of curvature at the point of minimum distance.

6. A particle takes n seconds less and acquires a velocity u m/sec. higher at one place than at another place in falling through the same distance. Calculate the product of the acceleration due to gravity at these two places.

7. A satellite of mass M_s is orbiting the Earth in a circular orbit of radius R_s. It starts losing energy slowly at a constant rate C due to friction. If M_e and R_e denote the mass and radius of the Earth respectively, show that the satellite falls on the Earth in a limit time t given by $t = \frac{GM_S M_e}{2C}\left(\frac{1}{R_e} - \frac{1}{R_S}\right)$

8. A rocket starts vertically upwards with speed v_0. Show that its speed v at a height h is given by

$$v_0^2 - v^2 = \left[(2gh)\Big/\left(1+\frac{h}{R}\right)\right]$$

Where R is the radius of the Earth. Hence deduce the maximum height reached by a rocket fired with speed equal to 90% of escape velocity.

9. A cord of length 64 m is used to connect a 100 kg astronaut to spaceship whose mass is much larger than that of the astronaut. Estimate the value of the tension in the cord. Assume that the spaceship is orbiting near Earth surface. Assume that the spaceship and the astronaut fall on a straight line from the Earth centre. The radius of the Earth is 6400 km.

10. A remote sensing satellite is revolving in an orbit of radius x on the equator of Earth. Find the area on Earth surface in which satellite can not send message.

11. Calculate the distance from the surface of the Earth at which above and below the surface, acceleration due to gravity is the same.

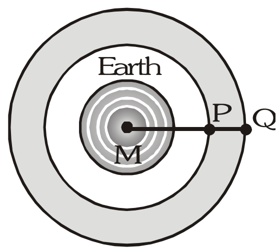
12. A body moving radially away from a planet of mass M, when at distance r from planet, explodes in such a way that two of its many fragments move in mutually perpendicular circular orbits around the planet. What will be

(i) Then velocity in circular orbits ?

(ii) Maximum distance between the two fragments before collision and

(iii) Magnitude of their relative velocity just before they collide ?

13. A satellite P is revolving around the Earth at a height h= radius of Earth (R) above equator. Another satellite Q is at a height 2h revolving in opposite direction. At an instant the two are at same vertical line passing through centre of sphere. Find the least time of after which again they are in this situation.



14. The fastest possible rate of rotation of a planet is that for which the gravitational force on material at the equator barely provides the centripetal force needed for the rotation. (Why?)

(i) Show then that the corresponding shortest period of rotation is given by $T = \sqrt{\frac{3\pi}{G\rho}}$ where ρ is the density of the planet, assumed to be homogeneous.

(ii) Evaluate the rotation period assuming a density of 3.0 gm/cm^3, typical of many planets, satellites, and asteroids. No such object is found to be spinning with a period shorter than found by this analysis.

15. In a particular double star system, two stars of mass $3.22 \quad 10^{30}$ kg each revolve about their common centre of mass, $1.12 \quad 10^{11}$ m away.

(i) Calculate their common period of revolution, in years.

(ii) Suppose that a meteoroid (small solid particle in space) passes through this centre of mass moving at right angles to the orbital plane of the stars. What must its speed be if it is to escape from the gravitational field of the double star?

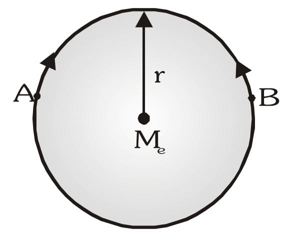
16. Assume that a tunnel is dug across the Earth (radius =R) passing through its centre. Find the time a particle takes to reach centre of Earth if it is projected into the tunnel from surface of Earth with speed needed for it to escape the gravitational field of Earth.

17. Ajay can throw a ball at a speed on Earth which can cross a river of width 10 m. Ajay reaches on an imaginary planet whose mean density is twice of the Earth. Find out the maximum possible radius of planet so that if Ajay throws the ball at same speed it may escape from planet. Given radius of Earth = $6.4 \quad 10^6$ m:

18. A particle takes a time t_1 to move down a straight tunnel from the surface of Earth to its centre. If gravity were to remain constant this time would be t_2. Calculate the ratio $\frac{t_1}{t_2}$

19. A satellite close to the Earth is in orbit above the equator with a period of rotation of 1.5 hours. If it is above a point P on the equator at some time, it will be above P again after time...........

20. Consider two satellites A and B of equal mass m, moving in the same circular orbit of radius r around the Earth E but in opposite sense of rotation and therefore on a collision course (see figure).



(i) In terms of G, M_e, m and r find the total mechanical energy $E_A + E_B$ of the two satellite plus Earth system before collision.

(ii) If the collision is completely inelastic so that wreckage remains as one piece of tangled material (mass =2m), find the total mechanical energy immediately after collision.

(iii) Describe the subsequent motion of the wreckage.

BRAIN STORMING SUBJECTIVE EXERCISE **ANSWER KEY** EXERCISE-4(B)

2. $\sqrt{\frac{GM}{R}}\left[\sqrt{\frac{2}{3}}-\sqrt{\frac{8}{15}}\right]$

3. (i) h= $\left(\frac{\sqrt{7}}{2}+1\right)R$, (ii) 1.13 R

4. $\frac{3}{2}\sqrt{\frac{5GM}{a}}$

5. $\frac{8R}{3}$

6. $\left(\frac{u}{n}\right)^2$

8. 4.26 R

9. 3 10^{-2}N

10. $\left[1-\frac{\sqrt{x^2-R^2}}{x}\right]4\pi R^2$

11. $\left(\frac{\sqrt{5}-1}{2}\right)R$

12. (i) $\sqrt{\frac{GM}{r}}$ (ii) $r\sqrt{2}$ (iii) $\sqrt{\frac{2GM}{r}}$

13. $\frac{2\pi R^{3/2}6\sqrt{6}}{\sqrt{GM}\left(2\sqrt{2}+3\sqrt{3}\right)}$

14. (ii) 1.9 h

15. (i) $T = 4\pi\sqrt{\frac{r^3}{Gm}}$ (ii) v= $\sqrt{\frac{4Gm}{r}}$, r= $\frac{d}{2}$

16. $T = \sin^{-1}\left(\frac{1}{\sqrt{3}}\right)\sqrt{\frac{R_e}{g}}$

17. 4 Km

18. $\frac{\pi}{2\sqrt{2}}$

19. 1.6 hours if it is rotating from west to east, $\frac{24}{17}$ hours if it is rotating east to west.

20. (i) $\frac{-GmM_e}{r}$, (ii) $-\frac{2GmM_e}{r}$ (iii) free fall

EXERCISE–05 (A) PREVIOUS YEAR QUESTIONS

1. If suddenly the gravitational force of attraction between earth and a satellite revolving around it becomes zero, then the satellite will- [AIEEE - 2002]
(1) continue to move in its orbit with same velocity
(2) move tangentially to the original orbit with same velocity
(3) become stationary in its orbit
(4) move towards the earth

2. The kinetic energy needed to project a body of mass m from the earth's surface (radius R) to infinity is- [AIEEE - 2002]
(1) $\frac{mgR}{2}$ (2) 2mgR (3) mgR (4) $\frac{mgR}{4}$

3. Energy required to move a body of mass m from an orbit of radius 2R to 3R is- [AIEEE - 2002]
(1) $GMm/12R^2$ (2) $GMm/3R^2$ (3) GMm/8R (4) GMm/6R

4. The time period of a satellite of earth is 5 hours. If the separation between the centre of earth and the satellite is increased to 4 times the previous value, the new time period will become- [AIEEE - 2003]
(1) 10 h (2) 80 h (3) 40 h (4) 20 h

5. Two spherical bodies of mass M and 5M and radii R and 2R respectively are released in free space with initial separation between their centres equal to 12 R. If they attract each other due to gravitational force only, then the distance covered by the smaller body just before collision is- [AIEEE - 2003]
(1) 2.5 R (2) 4.5 R (3) 7.5 R (4) 1.5 R

6. A satellite of mass m revolves around the earth of radius R at a height x from its surface. If g is the acceleration due to gravity on the surface of the earth, the orbital speed of the satellite is- [AIEEE - 2004]
(1) gx (2) $\frac{gR}{R-x}$ (3) $\frac{gR^2}{R+x}$ (4) $\left(\frac{gR^2}{R+x}\right)^{1/2}$

7. The time period of an earth satellite in circular orbit is independent of- [AIEEE - 2004]
(1) the mass of the satellite
(2) radius of its orbit
(3) both the mass and radius of the orbit
(4) neither the mass of the satellite nor the radius of its orbit

8. If g is the 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- [AIEEE - 2004]
(1) 2mgR (2) $\frac{1}{2}$ mgR (3) $\frac{1}{4}$ mgR (4) mgR

9. Suppose the gravitational force varies inversely as the n^{th} power of distance. Then the time period of a planet in circular orbit of radius R around the sun will be proportional to- [AIEEE - 2004]
(1) $R^{\left(\frac{n+1}{2}\right)}$ (2) $R^{\left(\frac{n-1}{2}\right)}$ (3) R^n (4) $R^{\left(\frac{n-2}{2}\right)}$

10. Average density of the earth- [AIEEE - 2005]
(1) does not depend on g (2) is a complex function of g
(3) is directly proportional to g (4) is inversely proportional to g

11. The change in the value of g at a height h above the surface of the earth is the same as at a depth d below the surface of earth. When both d and h are much smaller than the radius of earth, then which one of the following is correct ? [AIEEE-2005]
(1) $d = \frac{h}{2}$ (2) $d = \frac{3h}{2}$ (3) d = 2h (4) d = h

12. A particle of mass 10 g is kept on the surface of a uniform sphere of mass 100 kg and radius 10 cm. Find the work to be done against the gravitational force between them, to take the particle far away from the sphere (you may take $G = 6.67 \quad 10^{-11}\ Nm^2/kg^2$) **[AIEEE - 2005]**
(1) $13.34 \quad 10^{-10}$ J (2) $3.33 \quad 10^{-10}$ J (3) $6.67 \quad 10^{-9}$ J (4) $6.67 \quad 10^{-10}$ J

13. If g_E and g_M are the accelerations due to gravity on the surfaces of the earth and the moon respectively and if Millikan's oil drop experiment could be performed on the two surfaces, one will find the ratio $\dfrac{\text{electronic charge on the moon}}{\text{electronic charge on the earth}}$ to be- **[AIEEE - 2007]**
(1) 1 (2) zero (3) g_E/g_M (4) g_M/g_E

14. A planet in a distance solar system is 10 times more massive than the earth and its radius is 10 times smaller. Given that the escape velocity from the earth is 11 km s^{-1}, the escape velocity from the surface of the planet would be **[AIEEE - 2008]**
(1) 1.1 km s^{-1} (2) 11 km s^{-1} (3) 110 km s^{-1} (4) 0.11 km s^{-1}

15. This quqestion contains statement-1 and statement -2 of the four choices given after the statements, choose the one that best describes the two statements. **[AIEEE - 2008]**
Statement 1: For a mass M kept at the centre of a cube of side 'a', the flux of graviational field passing through its sides is 4π GM.
Statement 2 : If the direction of a field due to a point source is radial and its dependence on the distance 'r' from the source is given as $\dfrac{I}{r^2}$, its flux through a closed surface depends only on the strength of the source enclosed by the surface and not on the size or shape of the surface.
(1) Statement –1 is false, Statement –2 is true
(2) Statement–1 is true, Statement–2 is true; Statement–2 is a correct explanation for Statement–1
(3) Statement–1 is true, Statement–2 is true; Statement–2 is not a correct explanation for Statement–1
(4) Statement–1 is true, Statement–2 is false

16. The height at which the acceleration due to gravity becomes $\dfrac{g}{9}$ (where g = the acceleration due to gravity on the surface of the earth) in terms of R, the radius of the earth, is :- **[AIEEE - 2009]**
(1) $\dfrac{R}{2}$ (2) $\sqrt{2}R$ (3) 2R (4) $\dfrac{R}{\sqrt{2}}$

17. Two bodies of masses m and 4m are placed at a distance r. The gravitational potential at a point on the line joining them where the gravitational field is zero is :- **[AIEEE - 2011]**
(1) $-\dfrac{6Gm}{r}$ (2) $-\dfrac{9Gm}{r}$ (3) zero (4) $-\dfrac{4Gm}{r}$

18. Two particles of equal mass 'm' go around a circle of radius R under the action of their mutual gravitational attraction. The speed of each particle with respect to their centre of mass is:- **[AIEEE-2011]**
(1) $\sqrt{\dfrac{Gm}{R}}$ (2) $\sqrt{\dfrac{Gm}{4R}}$ (3) $\sqrt{\dfrac{Gm}{3R}}$ (4) $\sqrt{\dfrac{Gm}{2R}}$

19. The mass of a spaceship is 1000 kg. It is to be launched from the earth's surface out into free space. The value of 'g' and 'R' (radius of earth) are 10 m/s^2 and 6400 km respectively. The required energy for this work will be :- **[AIEEE-2012]**
(1) $6.4 \quad 10^{10}$ Joules (2) $6.4 \quad 10^{11}$ Joules (3) $6.4 \quad 10^{8}$ Joules (4) $6.4 \quad 10^{9}$ Joules

ANSWER-KEY

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Ans.	2	3	4	3	3	4	1	2	1	1	3	4	1	3	2	3	2	2	1

EXERCISE–05 (B)

PREVIOUS YEAR QUESTIONS

MCQs with one correct answer

1. A satellite S is moving in an elliptical orbit around the Earth. The mass of the satellite is very small compared to the mass of the Earth :– **[IIT-JEE 1998]**

(A) The acceleration of S always directed towards the centre of the Earth

(B) The angular momentum of S about the centre of the Earth changes in direction, but its magnitude remain constant

(C) The total mechanical energy of S varies periodically with time

(D) The linear momentum of S remains constant in magnitude

2. A geostationary satellite orbits around the Earth in a circular orbit of radius 36,000 km. Then, the time period of a spy satellite orbiting a few hundred km (600 km) above the Earth's surface (R_e= 6400 km) will approximately be :– **[IIT-JEE 2002]**

(A) $\frac{1}{2}$ h (B) 1h (C) 2h (D) 4h

3. A double star system consists of two stars A and B which have time period T_A and T_B. Radius R_A and R_B and mass M_A and M_B. Choose the correct option :– **[IIT-JEE 2006]**

(A) If $T_A > T_B$ then $R_A > R_B$ (B) If $T_A > T_B$ then $M_A > M_B$

(C) $\left(\frac{T_A}{T_B}\right)^2 = \left(\frac{R_A}{R_B}\right)^3$ (D) $T_A = T_B$

4. Two bodies, each of mass M, are kept fixed with a separation 2L. A particle of mass m is projected from the midpoint of the line joining their centres, perpendicular to the line. The gravitational constant is G. The correct statement(s) is (are) :- **[IIT-JEE 2013]**

(A) The minimum initial velocity of the mass m to escape the gravitational field of the two bodies is $4\sqrt{\frac{GM}{L}}$

(B) The minimum initial velocity of the mass m to escape the gravitational field of the two bodies is $2\sqrt{\frac{GM}{L}}$

(C) The minimum initial velocity of the mass m to escape the gravitational field of the two bodies is $\sqrt{\frac{2GM}{L}}$

(D) The energy of the mass m remains constant

Assertion-Reason

1. **Statement – 1** : An astronaut in an orbiting space station above the Earth experiences weightlessness.

and

Statement – 2 : An object moving around the Earth under the influence of Earth's gravitational force is in a state of 'free-fall'.

(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1

(B) Statement-1 is True, Statement-2 is True; Statement-2 is Not a correct explanation for Statement-1

(C) Statement-1 is True, Statement-2 is False **[IIT-JEE 2008]**

(D) Statement-1 is False, Statement-2 is True

Subjective Questions

1. There is a crater of depth $\frac{R}{100}$ on the surface of the Moon (radius R). A projectile is fired vertically upward from the crater with velocity, which is equal to the escape velocity v from the surface of the Moon. Find the maximum height attained by the projectile.

PREVIOUS YEARS QUESTIONS				EXERCISE -5(B)
• MCQ's One correct answers	1. A	2. C	3. D	4. B,D
• *Assertion - Reason Questions*	1. A			
• *Subjective Questions*	1. 99.5 R			