EXERCISE-1

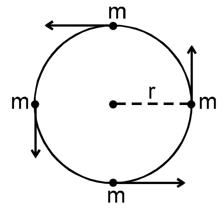
* MARK IS MORE THAN ONE CORRECT QUESTIONS.

SECTION : (A) UNIVERSAL LAW OF GRAVITATION

A 1. If we ignore the presence of the sun, then there exists a point on the line joining the earth and the moon where gravitational force is zero. The point is located from the moon at a distance of (Given that earth is 81 times heavier than moon and the separation between earth and moon 4×10^8 m) :

(A) 8×10^7 m (B) 4×10^6 m (C) 4×10^7 m (D) 8×10^6 m

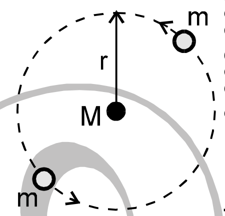
A 2. Four similar particles of mass ma are orbiting in a circle of radius r in the same direction because of their mutual gravitational attractive force. Velocity of a particle is given by



(A) $\left[\frac{Gm}{r}\left(\frac{1+2\sqrt{2}}{4}\right)\right]^{\frac{1}{2}}$ (B) $\sqrt[3]{\frac{Gm}{r}}$

(C) $\sqrt{\frac{Gm}{r}\left(1+2\sqrt{2}\right)}$ (D) $\left[\frac{1}{2}\frac{Gm}{r}\left(\frac{1+\sqrt{2}}{2}\right)\right]^{\frac{1}{2}}$

A 3. A certain triple-star system consists of two stars, each of mass ‘ m ‘ revolving about a central star of mass M in the same circular orbit of radius ‘ r ‘. The two stars are always at opposite ends of a diameter of the circular orbit. An expression for the period of revolution of the stars is :

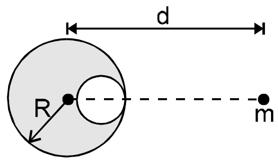


(A) $\frac{4\pi r^{3/2}}{G(M+m)}$ (B) $\frac{4\pi r^{3/2}}{\sqrt{G(4M+m)}}$ (C) $\frac{4\pi r^{3/2}}{\sqrt{G(M+m)}}$ (D) $\frac{4\pi r^{3/2}}{G(4M+m)}$

A 4. An experiment using the Cavendish balance to measure the gravitational constant G found that a mass of 0.800 kg attracts another sphere of mass 4.00×10^{-3} kg with a force of 1.30×10^{-10} N when the distance between the centres of the spheres is 0.0400 m. The acceleration due to gravity at the earth’s surface is 9.80 m/s^2 and the radius of the earth is 6380 km. The mass of the earth from these data is (approximately) –

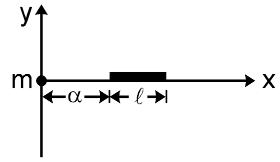
(A) 8×10^{24} kg (B) 8×10^{23} kg (C) 6×10^{23} kg (D) 6×10^{24} kg

A 5 . A spherical hollow cavity is made in a lead sphere of radius R, such that its surface touches the outside surface of the lead sphere and passes through its centre. The mass of the sphere before hollowing was M. With what gravitational force will the hollowed-out lead sphere attract a small sphere of mass ‘ m ‘, which lies at a distance d from the centre of the lead sphere on the straight line connecting the centres of the spheres and that of the hollow, if d = 2R :



(A) $\frac{7GMm}{18R^2}$ (B) $\frac{7GMm}{36R^2}$ (C) $\frac{7GMm}{9R^2}$ (D) $\frac{7GMm}{72R^2}$

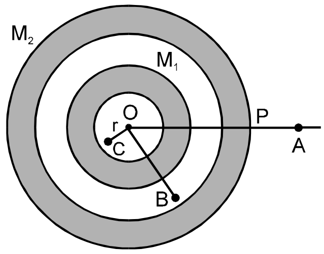
A 6. A straight rod of length ℓ extends from $x = \alpha$ to $x = \ell + \alpha$. If the mass per unit length is $(a + bx^2)$. The gravitational force it exerts on a point mass m placed at x = 0 is given by



(A) $Gm\left(a\left(\frac{1}{\alpha}-\frac{1}{\alpha+\ell}\right)+b\ell\right)$ (B) $\frac{Gm(a+bx^2)}{\ell^2}$

(C) $Gm\left(\alpha\left(\frac{1}{a}-\frac{1}{a+\ell}\right)+b\ell\right)$ (D) $Gm\left(a\left(\frac{1}{\alpha+\ell}-\frac{1}{\alpha}\right)+b\ell\right)$

A 7. Two concentric shells of uniform density of mass M_1 and M_2 are situated as shown in the figure. The forces experienced by a particle of mass m when placed at positions A, B and C respectively are (given OA = p, OB = q and OC = r)



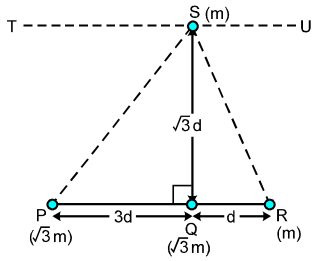
(A) zero, $G\dfrac{M_1m}{q^2}$ and $G\dfrac{(M_1+m_2)m}{p^2}$

(B) $G\dfrac{(M_1+M_2)m}{p^2}$, $G\dfrac{(M_1+M_2)m}{q^2}$ and $G\dfrac{M_1m}{r^2}$

(C) $G\dfrac{M_1m}{q^2}$, $\dfrac{G(M_1+M_2)m}{p^2}$, $G\dfrac{M_1m}{q^2}$ and zero

(D) $\dfrac{G(M_1+M_2)m}{p^2}$, $G\dfrac{M_1m}{q^2}$ and zero

A 8. Three particles P, Q and R are placed as per given figure. Masses of P, Q and R are $\sqrt{3}$ m, $\sqrt{3}$ m and m respectively. The gravitational force on a fourth particle 'S' of mass m is equal to



(A) $\dfrac{\sqrt{3}\,GM^2}{2d^2}$ in ST direction only

(B) $\dfrac{\sqrt{3}\,Gm^2}{2d^2}$ in SQ direction and $\dfrac{\sqrt{3}\,Gm^2}{2d^2}$ in SU direction

(C) $\dfrac{\sqrt{3}\,Gm^2}{2d^2}$ in SQ direction only

(D) $\dfrac{\sqrt{3}\,Gm^2}{2d^2}$ in SQ direction and $\dfrac{\sqrt{3}\,Gm^2}{2d^2}$ in ST direction

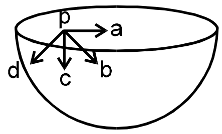
A 9. No two bodies on the earth move towards each other inspite of the force of gravitational attraction between them. Explain why?

A 10. Do the force of friction, and other contact forces arise due to gravitational attraction? If not, what is the origin of these forces?

A 11. Solid spheres of same material and same radius 'r' are touching each other. If the density is 'ρ' then find out gravitational force between them.

SECTION : (B) GRAVITATIONAL FIELD AND POTENTIAL

B 1. Figure show a hemispherical shell. The direction of gravitational field intensity at point P will be along:

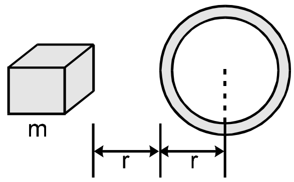


(A) a (B) b (C) c (D) d

B 2. Let gravitation field in a space be given as E = – (k/r). If the reference point is at d_i where potential is V_i then relation for potential is :

(A) $V = k\log\dfrac{1}{V_i} + 0$ (B) $V = k\log\dfrac{r}{d_i} + V_i$ (C) $V = \log\dfrac{r}{d_i} + kV_i$ (D) $V = \log\dfrac{r}{d_i} + \dfrac{V_i}{k}$

B 3. A block of mass m is lying at a distance r from a spherical shell of mass m and radius r. Then

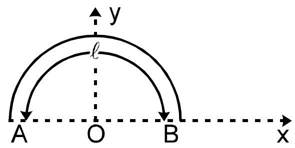


(A) only gravitational field inside the shell is zero
(B) gravitational field and gravitational potential both are zero inside the shell
(C) gravitational potential as well as gravitational field inside the shell are not zero
(D) can't be ascertained.

B 4. Gravitational field at the centre of a semicircle formed by a thin wire AB of mass m and length ℓ is :

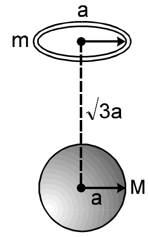
(A) $\dfrac{Gm}{\ell^2}$ along +x axis (B) $\dfrac{Gm}{\pi\ell^2}$ along +y axis

(C) $\frac{2\pi Gm}{\ell^2}$ along + x axis (D) $\frac{2\pi Gm}{\ell^2}$ along + y axis



B 5. A uniform ring of mass m is lying at a distance $\sqrt{3}$ a from the centre of a sphere of mass M just over the sphere where a is the small radius of the ring as well as that of the sphere. Then gravitational force exerted is :

(A) $\frac{GMm}{8a^2}$ (B) $\frac{GMm}{3a^2}$ (C) $\sqrt{3}\frac{GMm}{a^2}$ (D) $\sqrt{3}\frac{GMm}{8a^2}$



B 6. In a spherical region, the density varies inversely with the distance from the centre. Gravitational field at a distance r from the centre is :

(A) proportional to r (B) proportional to $\frac{1}{r}$ (C) proportional to r^2 (D) same everywhere

B 7. In above problem, the gravitational potential is -

(A) proportional to r (B) proportional to $\frac{1}{r}$ (C) proportional to r^2 (D) same every where.

B 8.* Inside a uniform spherical shell :
(A) The gravitation potential is zero (B) The gravitational field is zero
(C) The gravitational potential is same everywhere (D) The gravitational field is same everywhere.

B 9. Is it possible to shield a body from gravitational effects?

B 10. Two bodies of masses 100 kg and 10000 kg are at a distance 1 m apart. At which point on the line joining them will the gravitational field-intensity be zero ?

B 11. The weight of a person on the earth is 480 N. The gravitational field on the surface of the moon is $\frac{1}{6}$ times that of the gravitational field on the surface of earth.

(a) What will be the weight of the person on the moon

(b) If the person can jump 2 meter high on the earth how much high can he jump on the moon

(c) What is the mass of the person on the earth? On the moon? (g on earth = 10 N kg^{-1})

B 12. If the gravitational field on the surface of the moon is $\frac{1}{6}^{th}$ of the gravitational field on the surface of the earth. The radius of the moon is $\frac{1}{4}^{th}$ of the radius earth, find out the ratio of the masses of the moon and earth.

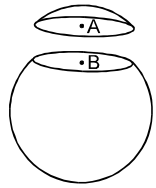
B 13. The gravitational field in a region is given by $\vec{E} = (3\hat{i} - 4\hat{j})$ N/kg. Find out the work done (in joule) in displacing a particle by 1 m along the line 4y = 3x + 9.

B 14. The gravitational potential in a region is given by V = (20x + 40y) J/kg. Find out the gravitational field (in newton / kg) at a point having co-ordinate (2, 4).

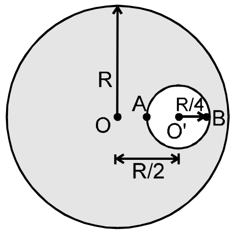
B 15. Radius of the earth, 6.4×10^6 m and the mean density is 5.5×10^3 kg/m^3. Find out the gravitational potential at the earth's surface.

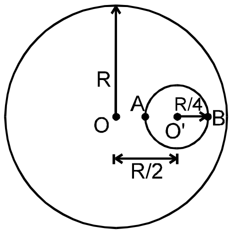
B 16. A ring of radius R = 8m is made of a highly dense-material. Mass of the ring is $m_R = 2.7 \times 10^9$ kg distributed uniformly over its circumference. A particle of mass (dense) $m_p = 3 \times 10^8$ kg is placed on the axis of the ring at a distance x_0 = 6m from the centre. Neglect all other forces except gravitational interaction. Determine :
(a) closest distance of their approach (from centre).
(b) displacement of ring by this moment.
(c) speed of the particle at this instant.

B 17. A thin spherical shell having uniform density is cut in two parts by a plane and kept separated as shown in figure. The point A is the centre of the plane section of the first part and B is the centre of the plane section of the second part. Show that the gravitational feld at A due to the first part is equal in magnitude to the gravitational field at B due to the second part.



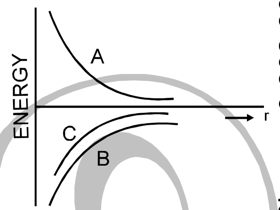
B 18. In a solid sphere of radius 'R' and density 'ρ' there is a spherical cavity of radius R/4 as shown in figure. A particle of mass 'm' is released from rest from point 'B' (inside the cavity). Find out -
(a) The position where this particle strikes the cavity.
(b) Velocity of the particle at this instant.





SECTION : (C) GRAVITATIONAL POTENTIAL ENERGY AND SELF ENERGY

C 1. The figure shows the variation of energy with the orbit radius of a body in circular planetary motion. Find the correct statement about the curves A, B and C



(A) A shows the kinetic energy, B the total energy and C the potential energy of the system
(B) C shows the total energy, B the kinetic energy and A the potential anergy of the system
(C) C and A are kinetic and potential energies respectively and B is the total energy of the system
(D) A and B are the kinetic and potential energies and C is the total energy of the system.

C 2. A body starts from rest at a point, distance R_0 from the centre of the earth of mass M, radius R. The velocity acquired by the body when it reaches the surface of the earth will be

(A) $GM\left(\frac{1}{R}-\frac{1}{R_0}\right)$ (B) $2\,GM\left(\frac{1}{R}-\frac{1}{R_0}\right)$ (C) $\sqrt{2GM\left(\frac{1}{R}-\frac{1}{R_0}\right)}$ (D) $2GM\sqrt{\left(\frac{1}{R}-\frac{1}{R_0}\right)}$

C 3. A point P lies on the axis of a fixed ring of mass M and radius R, at a distance 2R from its centre O. A small particle starts from P and reaches O under gravitational attraction only. Its speed at O will be

(A) zero (B) $\sqrt{\frac{2GM}{R}}$ (C) $\sqrt{\frac{2GM}{R}(\sqrt{5}-1)}$ (D) $\sqrt{\frac{2GM}{R}(1-\frac{1}{\sqrt{5}})}$

C 4. If M_e be the mass of the earth and M_m the mass of the moon ($M_e = 81\ M_m$), the potential energy of a body of mass m in the gravitational field of the earth and moon which is at a distance R from the centre of the earth and a distance r from the centre of the moon, is

(A) $-Gm\ M_m\left(\frac{81}{R}+\frac{1}{r}\right)$ (B) $-Gm_e\left(\frac{81}{r}+\frac{1}{R}\right)$ (C) $-Gm\ M_m\left(\frac{R}{81}+r\right)\cdot\frac{1}{R^2}$ (D) $Gm\ M_m\left(\frac{81}{R}-\frac{1}{r}\right)$

C 5. Three equal masses each of mass'm' are placed at the three-corners of an equilateral triangle of side 'a'.
(a) If a fourth particle of equal mass is placed at the centre of triangle, then net force acting on it, is equal to :

(A) $\frac{Gm^2}{a^2}$ (B) $\frac{4Gm^2}{3a^2}$ (C) $\frac{3Gm^2}{a^2}$ (D) zero

(b) In above problem, if fourth particle is at the mid-point of a side, then net force acting on it, is equal to:

(A) $\frac{Gm^2}{a^2}$ (B) $\frac{4Gm^2}{3a^2}$ (C) $\frac{3Gm^2}{a^2}$ (D) zero

(c) If above given three particles system of equilateral triangle side a is to be changed to side of 2a, then work done on the system is equal to :

(A) $\frac{3Gm^2}{a}$ (B) $\frac{3Gm^2}{2a}$ (C) $\frac{4Gm^2}{3a}$ (D) $\frac{Gm^2}{a}$

(d) In the above given three particle system, if two particles are kept fixed and third particle is released. Then speed of the particle when it reaches to the mid-point of the side connecting other two masses:

(A) $\sqrt{\frac{2Gm}{a}}$ (B) $2\sqrt{\frac{Gm}{a}}$ (C) $\sqrt{\frac{Gm}{a}}$ (D) $\sqrt{\frac{Gm}{2a}}$

C 6*. In case of an orbiting satellite if the radius of orbit is decreased :
(A) its KE decreases (B) its PE decreases
(C) its ME decreases (D) its speed decreases

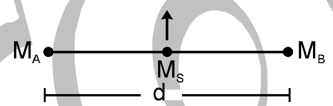
C 7. A satellite is in a circular orbit of radius 'r'. Another satellite is in a circular orbit of radius 4r. How do you compare their orbital velocities and time periods

C 8. Does a planet revolving around sun in an elliptical orbit have a constant (i) linear speed (ii) angular momentum about the sun (iii) kinetic energy (iv) potential energy and (v) total energy throughout its orbit ?

C 9. A mass M is split into two parts, m & M – m, which are then separated by a certain distance. What ratio of m/M gives the least gravitational potential energy for the system.

C 10. Two earth satellites A and B each of equal mass are to be launched in to circular orbits about earth's centre. Satellite 'A' is to orbit at an allitude of 6400 km and B at 19200 km. The radius of the earth is 6400 km. Determine-
(a) the ratio of the potential energy
(b) the ratio of kinetic energy
(c) which one has the greater total energy

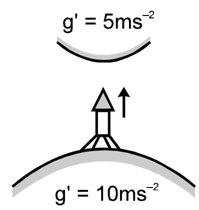
C 11. Two objects A and B are fixed at a distance d from each other. If the mass of A is M_A and that of B is M_B, then find out the velocity of a satellite of mass M_S projected from the mid point of two planets to infinity.

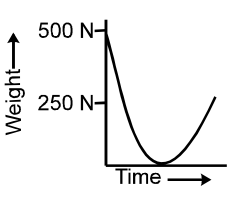


SECTION : (D) THE EARTH AND OTHER PLANETS GRAVITY

D 1. Suppose a tunnel could be dug through the earth from one side to the other along a diameter and particle of mass M is, dropped into it. If all frictional forces are neglected, the particle will
(A) enter from one side and come out from the other with a velocity greater than that at the centre
(B) stop at the centre of the earth as earth attracts all bodies towards its centre
(C) undergo simple harmonic motion and never stop
(D) take a spiral path in the tunnel till it comes out from the other end

D 2. If acceleration due to gravity is 10 ms^{-2} then let acceleration due to gravitational force at another planet of our solar system be 5 ms^{-2}. An astronaut weighing 50 kg on earth goes to this planet in a spaceship with a constant velocity. The change in the weight of the astronaut with time of flight is roughly given by



(A)


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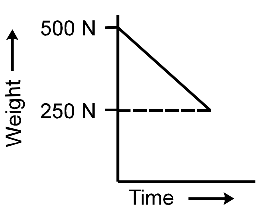

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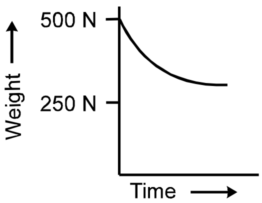
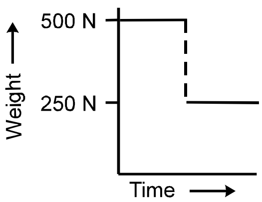


(D)


D 3*. In case of earth :
(A) field is zero, both at centre and infinity
(B) potential is zero, both at centre and infinity
(C) potential is same, both at centre and infinity but not zero

(D) potential is minimum at the centre

D 4. A body is going from the earth to the moon. How does its weight changes as it goes from the earth to the moon? Will there be any change in its mass?

D 5. How will the value of apparent acceleration due to gravity be affected if the earth begins to rotate about its own axis at a speed greater than its present speed?

D 6. If the earth suddenly contracts to half of its radius, what would be the length of day.

D 7. The acceleration due to gravity at a height (1/20) th the radius of the earth above earth's surface is 9 m/s^2. Find out its approsimate value at a point at an equal distance below the surface of the earth.

SECTION : (E) KEPLER'S LAW SATELLITES, ORBITAL SPEED AND ESCAPE SPEED

E 1. The angular velocity of a geostationary satellite in radian per hour is-

(A) $\frac{\pi}{6}$ (B) $\frac{\pi}{24}$ (C) $\frac{\pi}{12}$ (D) $\frac{\pi}{18}$

E 2. Choose the correct statement from among the following

(A) A planet moves in an elliptical orbit with the centre of mass located at the intersection of major and minor axes of the ellipse

(B) The position vector for a planet, no matter from where it is measured, sweeps out equal area in equal time intervals

(C) The time period of a planet is directly proportional to the cube root of the semimajor axis

(D) The ratio of the square of the time period to the cube of the semimajor axis is approximately the same for all planets.

E 3. An artificial satellite of the earth releases a package. If air resistance is neglected the point where the package will hit (with respect to the position at the time of release) will be

(A) ahead (B) exactly below

(C) behind (D) it will never reach the earth

E 4. A projectile is fired from the surface of earth of radius R with a velocity kv_e where v_e is the escape velocity and k < 1. Neglecting air resistance, the maximum height of rise from centre of earth is

(A) $\frac{R}{k^2+1}$ (B) k^2 R (C) $\frac{R}{1-k^2}$ (D) kR

E 5*. Which of the following statements are correct about a planet rotating around the sun in an elliptic orbit:

(A) its mechanical energy is constant (B) its angular momentum about the sun is constant

(C) its areal velocity about the sun is constant (D) its time period is proportional to r^3

E 6*. 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) $m^{-1/2}$

E 7*. 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

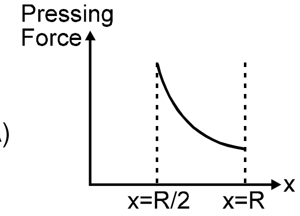
(A) 1.5 hours

(B) 1.6 hours if it is rotating from west to east

(C) 24/17 hours if it is rotating from east to west

(D) 24/17 hours if it is rotating from west to east

E 8*. 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)


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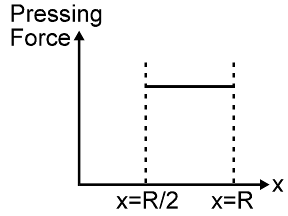
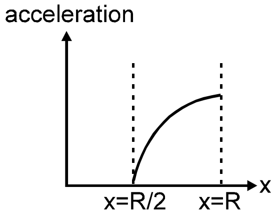
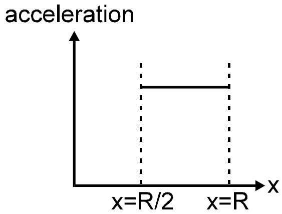


(C) 

(D) 

E 9. A person in an artificial satellite of the earth feels weightlessness. But a person on the moon has weight though the moon is also a satellite of the earth. Why?

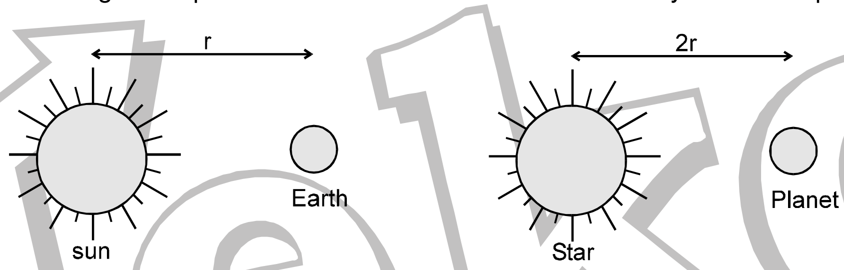
E 10. A satellite of mass m is orbitting in a circular orbit of radius 'r'. Find the angular momentum with respect to the centre of the orbit in terms of the mass of the earth M.

E 11. The radius of planet is R_1 and a satellite revolves round it in a circle of radius R_2. The time period of revolution is T. Find the acceleration due to the gravitation of the planet at its surface.

E 12. A space craft of mass ' m ' describes a circular orbit of radius r_1 around the earth. Find the additional energy ΔE which must be imparted to the spacecraft to transfer it to a circular orbit of larger radius r_2. (M is mass of the earth)

E 13. A satellite is established in a circular orbit of radius r and another in a circular orbit of radius 1.01 r. How much percentage the time period of second-satellite will be larger than the first satellite nearly.

E 14. Let a star be much brigheter than our sun but its mass is same as that of sun. If our earth has average life span of a man as 70 years. The earth like planet of this star system having double the distance from our star. Find the average life span of the man on earth in terms of the year of that planet.



EXERCISE-2

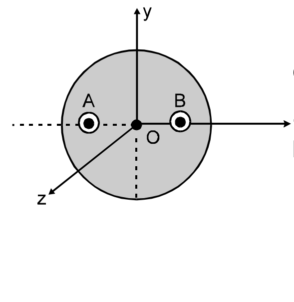
1. Imagine a light planet revolving around a very massive star in a circular orbit of radius R with a period of revolution T. If the gravitational force of attraction between the planet and the star is proportional to $R^{-5/2}$ then

(A) T^2 is proportional to R^3 (B) T^2 is proportional to $R^{7/2}$
(C) T^2 is proportional to $R^{3/2}$ (D) T^2 is proportiona to $R^{3.75}$

2. 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 the figure. **[IIT – 1993]**

(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 field at the point A(–2, 0, 0) is zero.
(D) The gravitational field at points A, O and B is zero.

3. In the above question :
[IIT – 1993]



(A) The gravitational potential is different at different points of circle $y^2 + z^2 = 36$
(B) The gravitational potential is different at all points of circle $y^2 + z^2 = 4$
(C) The gravitational potential is same at all points of circle $y^2 + z^2 = 36$ and the potential is same at all points of circle $y^2 + z^2 = 4$
(D) Nothing can be said about potetnial with the given data.

4. The magnitudes of the gravitational field at distances r_1 and r_2 from the centre of a uniform sphere of radius R and mass M are F_1 and F_2 respectively, then :
[JEE - 94]

(A) $\frac{F_1}{F_2} = \frac{r_1}{r_2}$ if $r_1 < R$ & $r_2 < R$ (B) $\frac{F_1}{F_2} = \frac{r_2^2}{r_1^2}$ if $r_1 > R$ & $r_2 > R$
(C) $\frac{F_1}{F_2} = \frac{r_1}{r_2}$ if $r_1 > R$ & $r_2 > R$ (D) $\frac{F_1}{F_2} = \frac{r_1^2}{r_2^2}$ if $r_1 < R$ & $r_2 < R$

5. A satellite is launched into a circular orbit of radius R around the earth A. Second satellite is launched into an orbit of radius 1.01 R. The period of the second satellite is larger than the first one by approximately : **[JEE - 95,2]**
(A) 0.7 % (B) 1.0 % (C) 1.5 % (D) 3.0 %

6. Two particle are projected vertically upwards with the same velocity on two different planets with accelerations due to gravities g_1 and g_2 respectively. If they fall back to their initial points of projection after lapse of times t_1 and t_2 respectively, then **[REE - 95]**
(A) $t_1 t_2 = g_1 g_2$ (B) $t_1 g_1 = t_2 g_2$ (C) $t_1 g_2 = t_2 g_1$ (D) $t_1^2 + t_2^2 = g_1 + g_2$

7. If the distance between the earth and the sun were half its present value, the number of days in a year would have been : **[JEE - 96,2]**
(A) 64.5 (B) 129 (C) 182.5 (D) 730

8. Distance between the centres of two stars is 10 a. The masses of these stars are M & 16 M & their radii a & 2 a respectively. A body of mass ' m ' is fired straight from the surface of the larger star towards 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 & a. **[JEE - 96, 5]**

9. If the radius of the earth be increased by a factor of 5, by what factor its density be changed to keep the value of g the same ? **[REE - 96]**
(A) 1/25 (B) 1/5 (C) $1/\sqrt{5}$ (D) 5

10. An artificial satellite moving in a circular orbit around the earth has a total (kinetic + potential) energy Eº. Its potential energy is : **[JEE - 97, 2]**
(A) – Eº (B) 1.5 Eº (C) 2 Eº (D) Eº

11. The ratio of Earth's orbital angular momentum (about the sun) to its mass is, 4.4×10^{15} m²/s. The area enclosed by earth's orbit is approximately _______ m². **[JEE - 97, 3]**

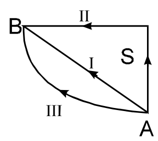
12. Two particles, each of mass M, move around in a circle o radius R under the action of their mutual gravitational attraction. The speed of each particle is **[REE - 97]**
(A) $\sqrt{\frac{GM}{R}}$ (B) $\sqrt{\frac{GM}{2R}}$ (C) $\sqrt{\frac{GM}{4R}}$ (D) $\sqrt{\frac{2GM}{R}}$

13. At what distance R, from the center of the earth, does the acceleration due to gravity becomes one half of the value that it has on the surface of the earth? (R_e is the earth's radius) **[REE - 97]**
(A) $R = \sqrt{2}\, R_e$ (B) $R = \sqrt{3}\, R_e$ (D) $R = 2R_e$ (D) $R = \sqrt{5}\, R_e$

14. A satellite of mass 100 kg is placed initially in a temporary orbit 800 km above the surface of earth. The satellite is to be placed now in a permanent orbit at 2000 km above the surface of earth. Find the amount of work done to move the satellite from the temporary to permanent orbit. The radius of the earth is 6400 km. **[REE - 99]**

15. A simple pendulum has a time period T_1 when on the earth's surface, and T_2 when taken to a height R above the earth's surface, where R is the radius of the earth. The value of T_2/T_1 is: **[JEE - 01, 1]**
(A) 1 (B) $\sqrt{2}$ (C) 4 (D) 2

16. A particle of mass m is taken through the gravitational field produced by a source S, from A to B, along the three paths as shown in figure. If the work done along the paths as shown in the figure. If the work done along the paths I, II and III is W_I, W_{II} and W_{III} respectively, then



(A) $W_I = W_{II} = W_{III}$ (B) $W_{II} > W_{III} = W_{II}$
(C) $W_{III} = W_{II} > W_I$ (D) $W_I > W_{II} > W_{III}$ **[JEE Scr. - 2003]**

17. 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. **[JEE 2006, 3/164]**
(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) $T_A = T_B$

ANSWER

EXERCISE 1

SECTION : (A)

A 1. C **A 2.** A **A 3.** B

A 4. D **A 5 .** B **A 6.** A

A 7. D **A 8.** C

A 9. Gravitational attraction is a weak force, can not over come friction.

A 10. No, Electromagnetic interection between the charges.

A 11. $\frac{4}{9}\pi^2\rho^2 Gr^4$

SECTION : (B)

B 1. C **B 2.** B **B 3.** C

B 4. D **B 5.** D **B 6.** D

B 7. A **B 8.*** BCD **B 9.** No.

B 10. 1/11 m from 100 kg and between them

B 11. **(a)** The weight will be $\frac{1}{6}^{th}$ of the weight on earth. Thus it is 80 N.

(b) Due to lesser gravitational field, at moon, lesser will be retardation (1/6th). Thus it will jump 12 m high on moon.

(c) W = Mg, 480 = m_{earth} × 10, m_{earth} = 48 kg It will be same on moon as weight and gravitational field both reduce to 1/6th W = Mg, 480 = m_{earth} × 10, m_{earth} = 48 kg

B 12. 1/96 **B 13.** zero **B 14.** $-20\hat{i} - 40\hat{j}$

B 15. $V = -\frac{GM}{r} = \frac{-G\frac{4}{3}\pi r^3\rho}{r}$

$= -\frac{4}{3}\pi G\rho r^2$

Putting r = 6.4×10^6 m
$\rho = 5.5 \times 10^3$ kg/m^3 ,
V = -6.3×10^7 J/kg^{-1}

B 16. (a) zero ; (b) 0.6 m; (c) 9cm/s

B 18. (a) Since force is always acting towards centre of solid sphere. Hence it will strike at 'A'.

(b) $v = \sqrt{\frac{2\pi G\rho R^2}{3}}$

SECTION : (C)

C 1. D **C 2.** C **C 3.** D

C 4. A

C 5. **(a)** D **(b)** B **(c)** BD

(d) B

C 6*. BC

C 7. $V = \sqrt{\frac{GM}{r}}$ and $\sqrt{\frac{GM}{4r}}$, 2 : 1, $T_r : T_{4r}$ = 1 : 8

C 8. (i) No, (ii) Yes, (iii) No, (iv) No, (v) Yes,

C 9. 1/2

C 10. (a) $\frac{U_A}{U_B} = \frac{25600}{12800} = 2$ (b) $\frac{K_A}{K_B} = \frac{m_A}{m_B}\frac{r_B}{r_A} = 2$

(c) B is having more energy.

C 11. $2\sqrt{\frac{G(M_A + M_B)}{d}}$

SECTION : (D)

D 1. C **D 2.** A **D 3*.** AD

D 4. First decreases then increases, No.

D 5. Apparent gravitational acceleration gets de creased everywhere except pole.

D 6. 6 hrs **D 7.** 9.5 m/s^2

SECTION : (E)

E 1. C **E 2.** D **E 3.** D

E 4. C **E 5*.** ABC **E 6*.** AD

E 7*. BC **E 8*.** BC

E 9. Due to moon's gravity

E 10. $(GMm^2r)^{1/2}$.

E 11. $\frac{4\pi^2 R_2^3}{T^2 R_1^2}$ **E 12.** $\Delta E = \frac{GMm(r_2 - r_1)}{2r_1 r_2}$

E 13. 1.5% **E 14.** 25 Planet years.

EXERCISE 2

1. B **2.** A **3.** C

4. AB **5.** C **6.** B

7. B **8.** $v_{min} = 1.5\sqrt{\frac{5GM}{a}}$

9. B **10.** C

11. 6.93×10^{22} m^2 **12.** C

13. A **14.** 4.06×10^8 J

15. D **16.** A **17.** D