PHYSICS

BOOKS - CP SINGH PHYSICS (HINGLISH)

GRAVITATION

Example

1. A mass M is broken into two parts of masses m_1 and m_2. How are m_1 and m_2 related so

that force of gravitational attraction between the two parts is maximum?

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2. Three uniform spheres each having a mass M and radius a are kept in such a way that each touches the other two. Find the magnitude of the gravitational force on any of the spheres due to the other two.

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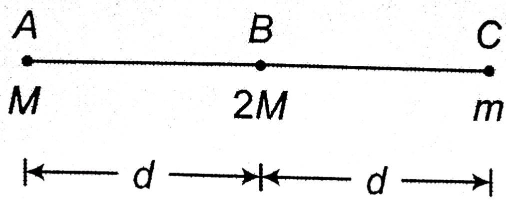
3. Consider the situation as shown in the following diagrams. Find net gravitational force on the particle of mass m.


A
B
C
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2M
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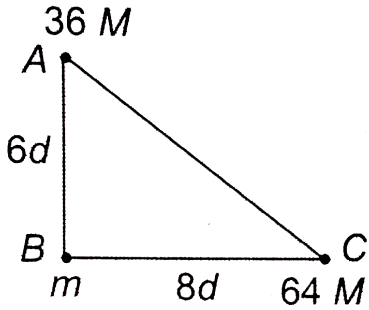
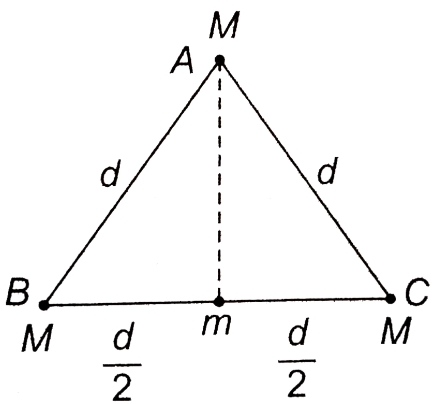

36 M
A
6d
B
C
m
8d
64 M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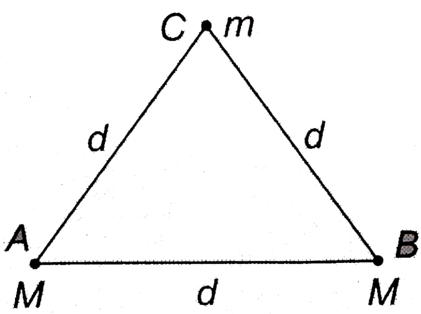
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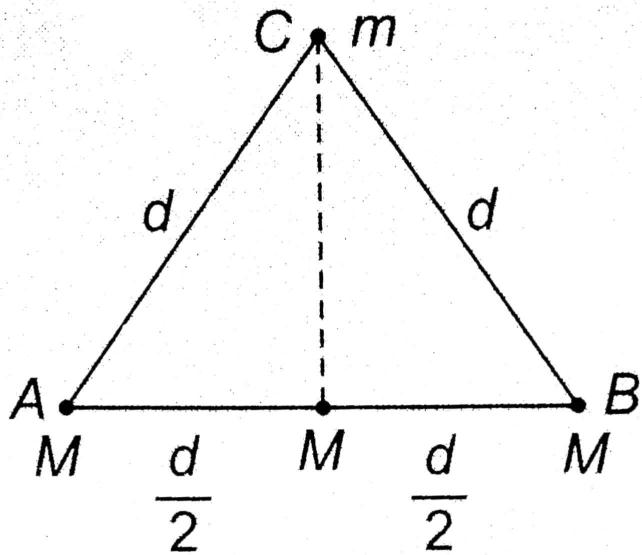
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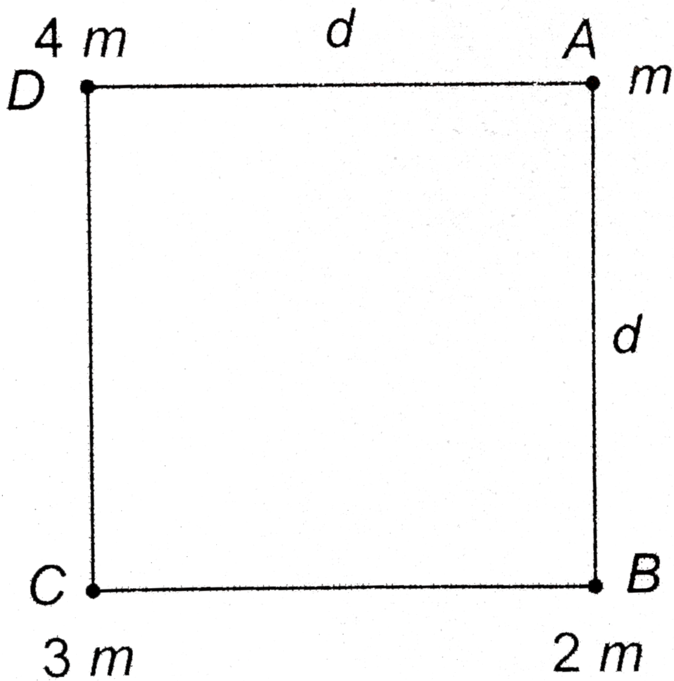
4 m
D
d
A
m
d
C
B
3 m
2 m

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4. For particles of equal masses M that move along a circle of radius R under the action of their mutual gravitational attraction. Find the speed of each particle.

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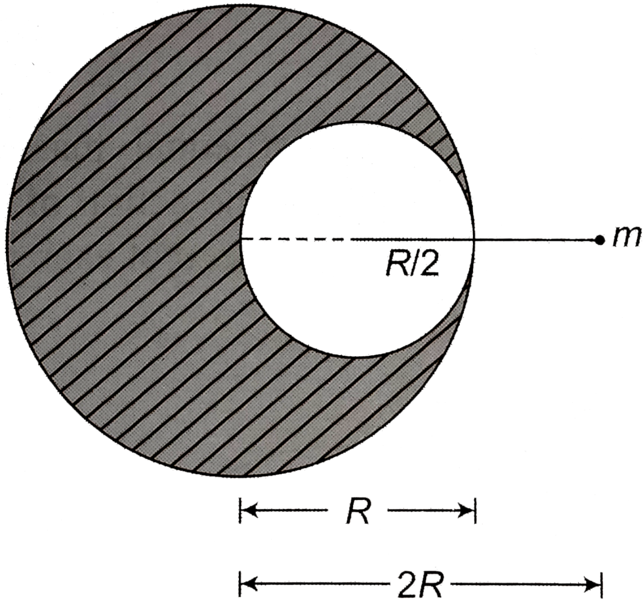
5. From a solid sphere of mass M and radius R, a solid sphere of radius $R/2$ is removed as shown. Find gravitational force on mass m as shown



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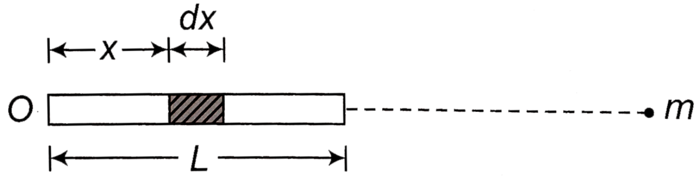
6. (a) A uniform rod of mass M and length L is placed at distance L from a point mass m as shown. Find force on m



(b) A semiconductor wire has a length L and mass M. A particle of mass m is placed at the centre of the circle. find the gravitational attraction on the particle due to the wire.

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7. (a) Find the acceleration due to gravity in a mine of depth $640km$ if the value at the surface is $9.800m/s^2$. The radius of the earth is

$6400km$

(b) Find the height over the earth's surface at which the weight of a body becomes half of its value at the surface.

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8. (a) At what rate should the earth so that the apparent g at the equator becomes zero? What will be the length of the day in this situation?

(b) A body stretches a spring by a particular length at the earth's surface at equator. At what height above the south pole will it stertch the same spring by the same length? Assume the earth to be spherical.

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9. A simple pendulum has a time period T_0 at north pole. Find time period at equator. Accunt for earth's rotation only.

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10. Two particles of masses $9M$ and $16M$ are placed at separtion d. At what distance from $9M$, gravitational field is zero.

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11. The distance between earth and moon is about $3.8 \times 10^5 km$. At what point or points will the gravitational field strength of earth-moon system be zero? Given mass of earth is 81 times the moon's mass.

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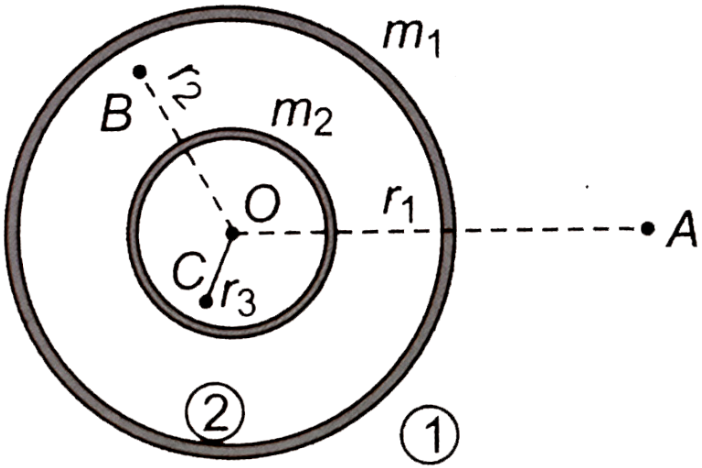
12. Two concentric shells of mass m_1 and m_2 are situated as shown. Find the force on a particle of mass m when the particles is located at $(a) r = r_1$, $(b) r = r_2$, $(c) r = r_3$. The distance r is measured from the centre of the shell.



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13. a solid sphere of mass m and radius r is placed inside a hollow thin spherical shell of mass M and radius R as shown in figure. A particle of mass m is placed on the line joining the two centers as a distance x from the point of contact of the sphere and the shell. Find the magnitude of the resultant gravitational force on this particle due to the sphere and the shell if

$a). r < x < 2r, b). 2r < x < 2R \text{ and } c). x > 2R$

.

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14. A uniform metal sphere of radius a and mass M is surrounded by a thin uniform spherical shell of equal mass and radius 4a. The centre of the shell falls on the surface of the inner sphere. Find the gravitational field at the points P_1 and P_2 shown in the figure

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15. A uniform ring of mas m and radius a is placed directly above a uniform sphere of mass M and of equal radius. The centre of the ring is at a distance $\sqrt{3}$ a from the centre of the sphere. Find the gravitational force exerted by the sphere on the ring.

16. A point mass m is a distance x from the centre of mass M and radius R on its axis. Find the gravitational force between the two. What will this force be if $x > > R$ and $x < < R$? For what value of x is the force maximum?

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17. (a) A tunnel is dug along a diameter of the earth. Find the force on the a particle of mass m placed in the tunnel at a distance x from the centre.

(b) 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. Find the force exerted by the wall on a particle of mass m when it is at a distance x from the centre of the tunnel.

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18. A fixed sphere of radius R and uniform density ρ has a spherical cavity of radius $R/2$ such that the surface of the cavity passes through the centre of the sphere. A particle of mass m is located at the centre (A) of the velocity. Calculated

(a) The gravitational field at A.

(b) The velocity with which the particle strikes the centre O of the sphere. (Neglect earth's gravity)

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19. The density inside a solid sphere of radius a is given by $\rho = \rho_0\left(1 - \frac{r}{a}\right)$, where ρ_0 is the density at the surface and r denotes the distance from the centre. Find the gravitational field due to this sphere at a distance $2a$ from its centre.

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20. (a) If gravitational field is given by $\vec{E} = -2x\hat{i} - 3y^2\hat{j}$. If gravitational potential is zero at $(0, 0)$, find potential at $(1, 2)$

(b) If gravitational potential is $V = x^2Y$, find gravitational field at $(1, 2)$.

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21. In a certain region of space gravitational field is given by $I = -(k/r)$. Taking the reference point to be at $r = r_0$, with gravitational potential $V = V_0$, find the gravitational potential at distance r.

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22. The gravitational field in a region is given by $\overrightarrow{E} = (5Nkg^{-1})\overrightarrow{i} + (12nk^{-1})\overrightarrow{j}$. . a.find the magnitude of the gravitational force acting on a particle of mass 2 kg placed at the origin. B. Find the potential at the points (12m,0) and (0,5m) if the potential at the origin is taken to be zero. C. Find the change in gravitational potential energy if a particle of mass 2 kg is taken from the origin to the point (12m,5m). d. Find the change in potential energy if the particle is taken from $(12m, 0) \rightarrow (0, 5, m)$.

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23. The gravitational potential in a region is given by $V = 20Nkg^{-1}(x + y)$. A. Show that the equation is dimensionally correct B. Find the gravitational field at the point (x, y) Leave your answer in terms of the unit vector $\overrightarrow{i}, \overrightarrow{j}, \overrightarrow{k}$. C. Calculate the magnitude of the gravitational force on a particle of mass 500 g placed at the origin.

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24. The gravitational field in a region is given by $E = \left(2\overrightarrow{i} + \overrightarrow{j}\right) Nkg^{-1}$ show that no work is done by the gravitational field when particle is move on the line $3y + 2x = 5$.

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25. The gravitational field in a region is given by $\overrightarrow{E} = (10Nkg^{-1})\left(\overrightarrow{i} + \overrightarrow{j}\right)$. Find the work done by an external agent to slowly shift a particle of mass 2 kg from the point (0,0) to a point (5m,4m)`

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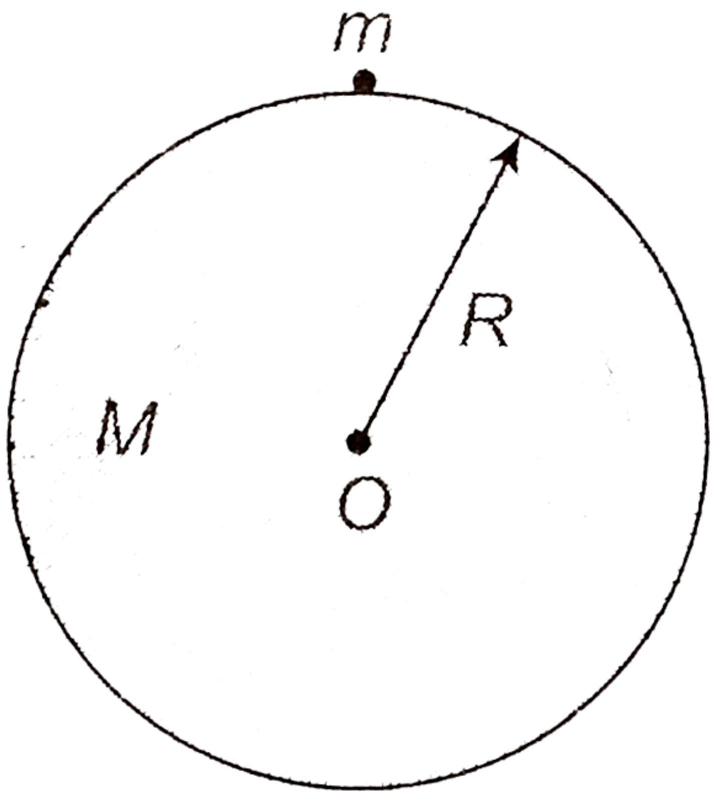
26. (a) Three particles of mass m each are placed at the three corners of an equilateral triangle of side a. Find the work which should be done on this system to increases the sides of the triangle to $2a$,



(b)

Find work done in sending m to infinity.

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27. A particle is fired vertically upward with a speed v_0. Find

(a) Speed at distance $2R_e$ from centre of earth.

(b) Calculated maximum height attained by particle.

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28. Two masses m_1 and m_2 at an infinite distance from each other are initially at rest, start interacting gravitationally. Find their velocity of approach when they are at a distance r apart.

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29. Two points mass m and $2m$ are kept at a distance a. Find the speed of particles and their relative velocity of approach when separation becomes $a/2$.

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30. A body is projected vartically upwards from the bottom of a crater of moon of depth $\frac{R}{100}$ where R is the radius of moon with a velocity equal to the escape velocity on the surface of moon. Calculate maximum height attained by the body formt eh surface of the moon.

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31. A body is projected vertically upward from the surface of earth with a velocity sufficient to carry it to initially. Calculate the time taken by it to reach height h.

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32. Three particles, each of the mass m are situated at the vertices of an equilateral triangle of side a. The only forces acting on the particles are their mutual gravitational forces. It is desired that each particle moves in a circle while maintaining the original mutual separation a. Find the initial velocity that should be given to each particle and also the time period of the circular motion.

$$\left(F = \frac{Gm_1m_2}{r^2}\right)$$

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

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34. What will be acceleration due to gravity on the surface of the moon if its radius were $(1/4)^{th}$ the radius of earth and its mass $(1/80)^{th}$ the mass of earth? What will be the escape velocity on the surface of moon if it is $11.2 km/s$ on the surface of the earth? (given that $g = 9.8 m/s^2$)

35. The masses and radii of the Earth and the Moon are M_1, R_1 and M_2, R_2 respectively. Their centres are at a distance d apart. The minimum speed with which a particel of mass m should be projected from a point midway between the two centres so as to escape to infinity is ....

36. A rocket is fired with a speed $v = 2\sqrt{gR}$ near the earth's surface and directed upwards.

(a) Show that it will escape from the earth.

(b) Show that in interstellar space its speed is $v = \sqrt{2gR}$.

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37. A planet of mass m revolves in elliptical orbit around the sun of mass M so that its maximum and minimum distance from the sun equal to r_a and r_p respectively. Find the angular momentum of this planet relative to the sun.

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38. 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 proportational to $R^{-5/2}$, then

(a) T^2 is proportional to R^2

(b) T^2 is proportional to $R^{7/2}$

(c) T^2 is proportional to $R^{3/3}$

(d) T^2 is proportional to $R^{3.75}$.

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39. As satellite of mass 1000 kg is supposed to orbit the earth at a height of 2000 km above the earth\'s surface. Find a). its speed in the orbit b). its kinetic energy. c). The potential energy of the earth satelilte system and d). its time period. Mass of the earth $= 6 \times 10^{24} kg$.

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40. A spaceship is launched into a circular orbit close to the earth's surface . What additional velocity has now to be imparted to the spaceship in the orbit to overcome the gravitational pull. Radius of earth $= 6400km$, $g = 9.8m/s^2$.

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41. 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 onto the earth, find the speed with which it hits the surface of the earth.

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42. Two satellites S_1 and S_2 resolve round a planet in coplaner circular orbit in the same sense. Their period of revolution are 1 hour and 8 hour respectively. The radius of the orbit of S_1 is $10^4 km$. When S_2 is closest to S_1, find

(a) The speed of S_2 relative to S_1,

(b) The angular speed of S_2 actually observed by an astronaut is S_1

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43. A cord of length $64m$ is used to connected a $100kg$ astronaut to spaceship whose mass is much larger than that of the astronuat. 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 $6400 km$.

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44. In a double star, two stars one of mass m_1 and another of mass m_2, with a separation d, rotate about their common centre of mass. Find

(a) an expression for their time period of revolution.

(b) the ratio of their kinetic energies.

(c) the ratio of their angular momenta about the centre of mass.

(d) the total angular momentum of the system.

(e) the kinetic energy of the system.

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Exercise

1. Two identical copper spheres of radius R are in contact with each other. If the gravitational attraction between them is F, find the relation between F and R.

A. R^2

B. R^{-2}

C. R^4

D. R^{-4}

Answer: C

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2. Two sphere of masses m and M are situated in air and the gravitational force between them is F. The space around the masses in now filled with a liquid of specific gravity 3. The gravitational force will now be

A. F

B. $F/3$

C. $F/9$

D. $3F$

Answer: A

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3. Two particles of equal mass $'m'$ go around a circle of radius R under the action of their mutual gravitaitonal attraction. The speed of each particle with respect to their centre of a mass is -

A. $v = \frac{1}{2R}\sqrt{\frac{1}{Gm}}$

B. $v = \sqrt{\frac{Gm}{2R}}$

C. $v = \frac{1}{2}\sqrt{\frac{Gm}{R}}$

D. $v = \sqrt{\frac{4Gm}{R}}$

Answer: C

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

A. $\frac{2}{3}m$

B. $\frac{1}{3}m$

C. $\frac{1}{4}m$

D. $\frac{2}{7}m$

Answer: A

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5. If R is the radius of the earth and g the acceleration due to gravity on the earth's surface, the mean density of the earth is

A. $4\pi G / 3gR$

B. $3\pi R / 4gG$

C. $3g / 4\pi RG$

D. $\pi RG / 12G$

Answer: C

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6. Mass remaining constant, the radius of the earth shrinks by 1%. The acceleration due to gravity on the earth's surface would

A. decreases by 2%

B. remain unchanged

C. increases by 2%

D. increases by 1%

Answer: C

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7. Two planets have the same average density but their radii are R_1 and R_2. If acceleration due to gravity on these planets be g_1 and g_2 respectively, then

A. $\frac{g_1}{g_2} = \frac{R_1}{R_2}$

B. $\frac{g_1}{g_2} = \frac{R_2}{R_1}$

C. $\frac{g_1}{g_2} = \frac{R_1^2}{R_2^2}$

D. $\frac{g_1}{g_2} = \frac{R_1^3}{R_2^3}$

Answer: A

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

A. $2R$

B. $4R$

C. $R/4$

D. $R/2$

Answer: D

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9. Acceleration due to gravity on moon is $1/6$ of the acceleration due to gravity on earth. If the ratio of densities of earth (ρ_e) and moon (ρ_m) is $\left(\frac{\rho_e}{\rho_m}\right) = \frac{5}{3}$ then radius of moon (R_m) in terms of R_e will be

A. $\frac{5}{18}R_e$

B. $\frac{1}{6}R_e$

C. $\frac{3}{18}R_e$

D. $\frac{1}{2\sqrt{3}}R_e$

Answer: A

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10. Consider a planet in some solar system which has a mass double the mass of the earth and density equal to the average density of the earth. An object weighing W on the earth will weigh

A. W

B. $2W$

C. $W/2$

D. $2^{1/3}W$ at the planet

Answer: D

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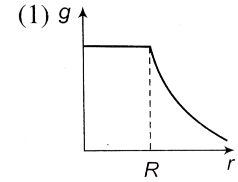
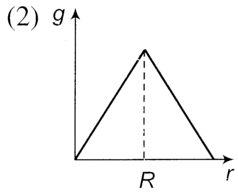
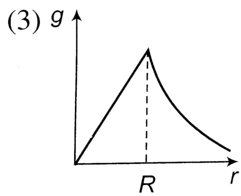
11. Which graph correctley presents the variation of acceleration due to gravity with the distance form the centre of the earth?

A. 

B. 

C. 

D. 

Answer: C

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12. Let the acceleration due to gravity be g_1 at a height h above the earth's surface g_2 at a depth d below the earth's surface. If $g_1 = g_2, h < < R$ and $d < < R$ then

A. $h = d$

B. $h = 2d$

C. $2h = d$

D. it is not possible for g_1 to be equal to g_2

Answer: C

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

A. $W_2 > W_1 > W_3$

B. $W_1 = W_2 = W_3$

C. $W_1 < W_2 < W_3$

D. $W_1 > W_2 > W_3$

Answer: A

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14. Suppose the earth increases its speed of rotation . At what new time period will the weight of a body on the equator becomes zero? Take $g = 10\frac{m}{s^2}$ and radius of the earth $R = 6400 km.$

A. $1/80 rad/s$

B. $1/400 rad/s$

C. $1/800 rad/s$

D. $1/1600 rad/s$

Answer: C

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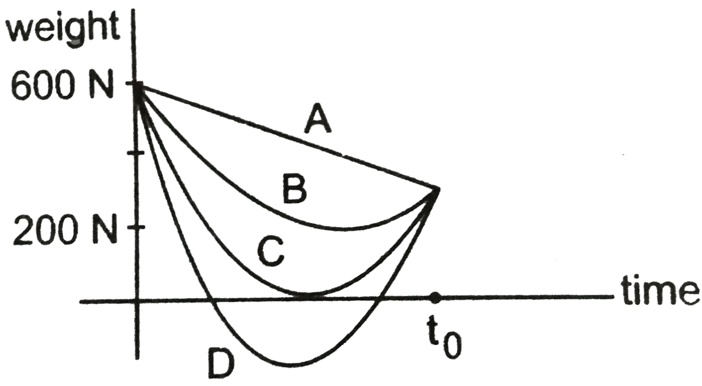
15. Suppose the acceleration due to gravity at earth's surface is $10ms^{-2}$ and at the surface of Mars it is $4.0ms^{-2}$. A passenger goes from the to the mars in a spaceship with a constant velocity. Neglect all other object in sky. Which part of figure best represent the weight (net gravitational force) of the passenger as a function of time?



A. A

B. B

C. C

D. D

Answer: C

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16. 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:

A. zero

B. $-\frac{4Gm}{r}$

C. $-\frac{6Gm}{r}$

D. $-\frac{9Gm}{r}$

Answer: D

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17. Four particles each of mass m are placed at the vertices of a square of side l. the potential at the centre of square is

A. $-\sqrt{32}\frac{GM}{L}$

B. $-\sqrt{64}\frac{GM}{L^2}$

C. zero

D. $\sqrt{32}\frac{GM}{L}$

Answer: A

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18. Infinite number of masses, each of $1kg$, are placed along the x-axis at $x = \pm 1m, \pm 2m, \pm 4m, \pm 8m, \pm 16m..$ The gravitational of the resultant gravitational potential in term of gravitaitonal constant G at the origin $(x = 0)$ is

A. $-G/2$

B. G

C. $-2G$

D. $-4G$

Answer: D

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19. A particle of mass M is placed at the centre of a uniform spherical shell of equal mass and radius a. Find the gravitational potential at a point P at a distance $\frac{a}{2}$ from the centre.

A. $\frac{4GM}{a}$

B. $\frac{GM}{a}$

C. $-\frac{2GM}{a}$

D. $-\frac{3GM}{a}$

Answer: D

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20. The magnitude 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. $\frac{F_1}{F_2} = \frac{r_1^2}{r_2^2}$ if $r_1 > R$ and $r_2 > R$

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

D. $\frac{F_1}{F_2} = \frac{r_2^2}{r_1^2}$ if $r_1 < R$ and $r_2 < R$

Answer: A

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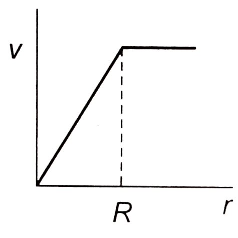
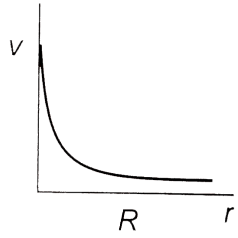
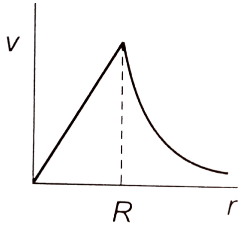
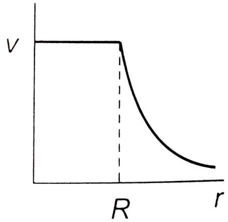
21. A spherically symmetric gravitational system of particles has a mass density $\rho = \begin{cases} \rho_0 & f\text{ or } \quad r < R \\ 0 & f\text{ or } \quad r > R \end{cases}$ whereρ_0 is a constant. A test mass can undergo circular motion under the influence of the gravitational field of particles. Its speed v as a function of distahce $r(0 < r < OO)$ form the centre of the system is represented by

A. 

B. 

C. 

D. 

Answer: C

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22. A planet is moving in an elliptic orbit. If T, V, E and L stand, respectively, for its kinetic energy, gravitational potential energy, total energy and angular momentum about the centre of force, then

A. T is conserved

B. V is always positive

C. E is always negative

D. magnitude of L is conserved but its direction changes continuously

Answer: C

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23. A satellite revolves around the earth in an elliptical orbit. Its speed is

A. same at all points on the orbit.

B. greatest when it farthest from the earth

C. greatest when it is closest to the earth

D. greatest neither when it is closest nor when it is farthest from the earth, but at some other point.

Answer: C

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24. For a planet moving and the sun in an elliptical orbit, which of the following quantities remain constant?

(i) The total energy of the 'sun plus planet' system

(ii) The angular momentum of the planet about the sun

(iii) The force of attraction between the two

(iv) The linear momentum of the planet

A. (i),(ii)

B. (ii),(iii)

C. (i),(iii)

D. (ii),(iv)

Answer: A

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25. Which of the following quantities remain constant in a planetary motion (consider elliptical orbits)as seen from the sun?

A. Speed

B. Angular speed

C. Kinetic energy

D. Angular momentum

Answer: D

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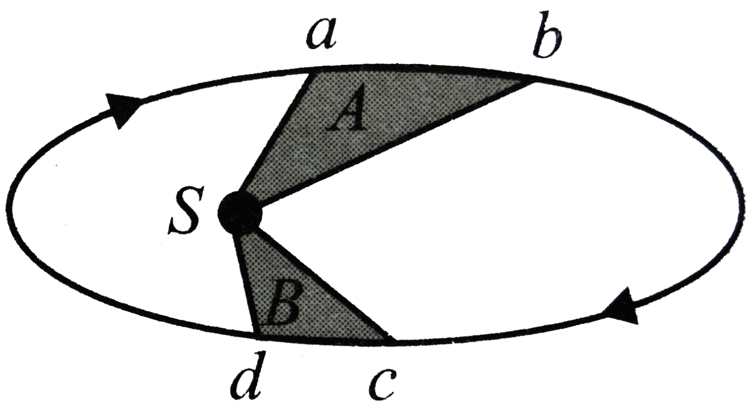
26. Figure shows the motion of a planet around the Sun S in an elliptical orbit with the Sun at the focus. The shaded areas A and B are also shown in the figure which can be assumed to be equal. If t_1 and t_2 represent the time taken for the planet to move from a to b and c to d, respectively then



A. $t_1 < t_2$

B. $t_1 = t_2$

C. $t_1 > t_2$

D. Insufficient information to deduce the relation between t_1 and t_2.

Answer: B

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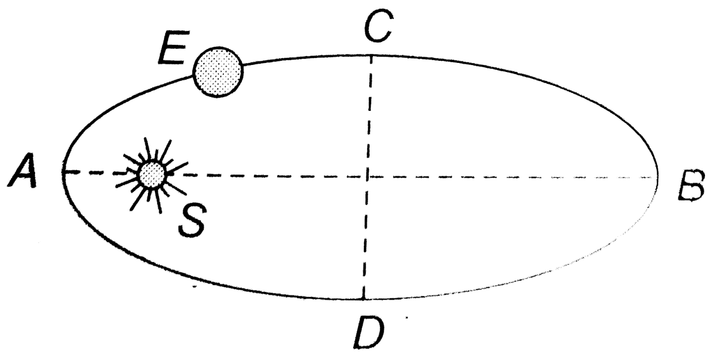
27. The earth E moves in an elliptical orbit with the sun S at one of the foci as shown in figure.

Its speed of motion will be maximum at the point



A. C

B. A

C. B

D. D

Answer: B

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28. The largest and the shortest distance of the earth from the sun are r_1 and r_2, its distance from the sun when it is at the perpendicular to the major axis of the orbit drawn from the sun

A. $\dfrac{r_1+r_2}{4}$

B. $\dfrac{r_1r_2}{r_1+r_2}$

C. $\dfrac{2r_1r_2}{r_1+r_2}$

D. $\dfrac{r_1r_2}{3}$

Answer: C

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29. A plenet moving along an elliptical orbit is closest to the sun at a distance r_1 and farthest away at a distance of r_2. If v_1 and v_2 are the linear velocities at these points respectively, then the ratio $\frac{v_1}{v_2}$ is

A. $\frac{r_1}{r_2}$

B. $\left(\frac{r_1}{r_2}\right)^2$

C. $\frac{r_2}{r_1}$

D. $\left(\frac{r_2}{r_1}\right)^2$

Answer: C

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30. If the distance between the earth and the sun were half its present value, the number of days in a year would have been

A. 64.5

B. 129

C. 182.5

D. 730

Answer: B

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31. The mean radius of the earth's orbit of mercury is $6 \times 10^{10} m$. The mercury will revolve around the sun in nearly

A. $\sqrt{\frac{2}{5}}$ years

B. 215 years

C. $\left(\frac{2}{5}\right)^{2}$ years

D. $\left(\frac{2}{4}\right)^{3/2}$ years

Answer: D

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32. The radius of the earth R and acceleration due to gravity at its surface is g. If a body of mass m is sent to a height of $R/4$ from the earth's surface, the potential energy increases by

A. $\frac{mgR}{3}$

B. $\frac{mgR}{4}$

C. $\frac{mgR}{5}$

D. $\frac{mgR}{16}$

Answer: C

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33. In the previous problem, the minimum speed with which the body must be thrown from the surface of the earth so as to reach a height of $R/4$ is

A. $\sqrt{\frac{gR}{2}}$

B. $\sqrt{gR}$

C. $\sqrt{\frac{gR}{5}}$

D. $\sqrt{\frac{2gR}{5}}$

Answer: D

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34. If the acceleration due to gravity at the surface of the earth is g, the work done in slowly lifting a body of mass m from the earth's surface to a height R equal to the radius of the earth is

A. $mgR/2$

B. $2mgR$

C. mgR

D. $mgR/4$

Answer: A

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35. A small mass m is moved slowly from the surface of the earth to a height h above the surface. The work done (by an external agent) in doing this is

A. (i),(ii)

B. (ii),(iii)

C. (i),(iii),(iv)

D. all

Answer: B

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36. A particle is projected vertically upwards with a velocity $\sqrt{gR}$, where R denotes the radius of the earth and g the acceleration due to gravity on the surface of the earth. Then the maximum height ascended by the particle is

A. $\frac{R}{2}$

B. R

C. $2R$

D. $\frac{5R}{4}$

Answer: B

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37. A projectile is projectile with velocity kv_e in vertically upward direction from the ground into the space (v_e is escape velocity and $k < 1$). If air resistance is considered to be negligible then the maximum height from the centre of earth to which it can go, will be : (R=raduis of earth)

A. $\frac{R}{k^2+1}$

B. $\frac{R}{k^2-1}$

C. $\frac{R}{1-k^2}$

D. $\frac{R}{k+1}$

Answer: C

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38. An asteroid of mass m is approaching earth, initially at a distance $10R_E$ with speed v_i. It hits earth with a speed v_f (R_E and M_E are radius and mass of earth),. Then

A. $v_f^2 = v_i^2 + \frac{2Gm}{M_e R}\left(1 - \frac{1}{10}\right)$

B. $v_f^2 = v_i^2 + \frac{2Gm_e}{R_e}\left(1 + \frac{1}{10}\right)$

C. $v_f^2 = v_i^2 + \frac{2Gm_e}{R_e}\left(1 - \frac{1}{10}\right)$

D. $v_f^2 = v_i^2 + \frac{2Gm}{R_e}\left(1 - \frac{1}{10}\right)$

Answer: C

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39. The gravitational force between two objects is proportional to $1/R$ (and not as $1/R^2$) where R is separation between them, then a particle in circular orbit under such a force would have its orbital speed v proportional to

A. $1/R^2$

B. R^0

C. R^1

D. $1/R$

Answer: B

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40. Suppose the gravitational force varies inversely as the nth power of distance. Then the time period of a planet in circular orbit of radius 'R' around the sun will be proportional to

A. $R^{\left(\frac{n+1}{2}\right)}$

B. $R^{\left(\frac{n-1}{2}\right)}$

C. R^{n}

D. $R^{\left(\frac{n-2}{2}\right)}$

Answer: A

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41. The distance of two satellites from the surface of the earth R and $7R$. There time periods of rotation are in the ratio

A. $1:7$

B. $1:8$

C. $1:49$

D. $1:7^{3/2}$

Answer: B

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42. A satellite is launched into a circular orbit of radius R around the earth. While a second is lunched into an orbit of radius $1.01R$ The period of the second satellite is longer than the first one by approximately:

A. 0.5%

B. 1.0%

C. 1.5%

D. 3.0%

Answer: C

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43. Two small satellies move in a circular orbits around the earth, at disatnce r and $(r+dr)$ from the centre of the earth. Their time periods of rotation ate T and $T+dT(\Delta r < < r, \Delta T < < T)$. Then

A. $\Delta T = \frac{3}{2} T \frac{\Delta r}{r}$

B. $\Delta T = \frac{3}{2} T \frac{\Delta r}{r}$

C. $\Delta T = \frac{2}{3} T \frac{\Delta r}{r}$

D. $\Delta T = T \frac{\Delta r}{r}$

Answer: B

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44. The period of a satellite moving in a circular orbit near the surface of a planet is independent of

A. radius of the planet

B. mass of the planet

C. mass of the satellite

D. none of the above

Answer: C

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45. The mean radius of the earth is R, its angular speed on its own axis is ω and the acceleration due to gravity at earth's surface is

g. The cube of the radius of the orbit of a geo-stationary satellite will be

A. $R^2 g / \omega$

B. $R^2 \omega^2 / g$

C. $R^2 g / \omega^2$

D. $R^2 g / \omega^2$

Answer: D

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46. Two satellites of earth S_1 and S_2 are moving in the same orbit. The mass of S_1 is four times the mass of S_2. Which one of the following statements is true?

A. The time period of S_1 is four times that of S_2

B. The potential energies of earth and satellite in the two casses are equal

C. S_1 and S_2 are moving with the same speed

D. The kinetic energies of the two satellite are equal

Answer: C

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47. If a satellite orbits as close to the earth's surface as possible,

A. (i),(ii)

B. (i),(ii),(iii)

C. (i),(ii),(iv)

D. (ii),(iv)

Answer: B

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48. In a satellite if the time of revolution is T, then kinetic energy is proportional to

A. $\frac{1}{T}$

B. $\frac{1}{T^2}$

C. $\frac{1}{T^3}$

D. $T^{2/3}$

Answer: B

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49. To an astronaut is a spcaceship, the sky appears

A. black

B. white

C. green

D. blue

Answer: A

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50. A person sitting in a chair in a satellite feels weightless because

A. the earth does not attract the objects in a satellite

B. the normal force by the chair on the person balances the earth's attraction

C. the normal force is zero

D. the person in satellite is not acceleration

Answer: C

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51. An astronaut orbiting the earth in a circular orbit $120 km$ above the surface of earth, gently drops a spoon out of space-ship. The spoon will

A. fall vertically down to the earth

B. move towards the moon

C. will move along with spaceship

D. will move in an irregular way then fall down to earh

Answer: C

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52. A geostationary satellite should be launched such that it moves from

A. north to south in the polar plane

B. south to north in the polar plane

C. east to west in the equatorial plane

D. west to east in the equatorial plane

Answer: D

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53. for a satellite to be geostationary, which of the following are essential conditions?

(i) It must always be stationed above the equator.

(ii) It must rotates from west to east.

(iii) It must be about $36,000 km$ above the earth

(iv) Its orbit must be circular and not elliptical.

A. (i),(ii)

B. (ii),(iii)

C. (i),(ii),(iv)

D. All

Answer: B

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54. For a satellite to orbit around the earth, which of the following must be true?

A. (i),(ii)

B. (ii),(iii)

C. (i),(iv)

D. (ii),(iv)

Answer: C

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55. The additional kinetic energy to be provided to a satellite of mass m revolving around a planet of mass M, to transfer it forms a circular orbit of radius R_1 to another of radius $R_2 (R_2 > R_1)$ is

A. $GmM\left(\frac{1}{R_1^2}-\frac{1}{R_2^2}\right)$

B. $GmM\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

C. $2GmM\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

D. $\frac{1}{2}GmM\left(\frac{1}{R_1}-\frac{1}{R_2}\right)$

Answer: D

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56. 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 equtor at some time, it will be above P again after time ....

A. (ii),(iv)

B. (ii),(iii)

C. (i),(iii)

D. (i),(iv)

Answer: A

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57. A satellite orbits around the earth in a circular orbit with a speed v and orbital radius r. If it loses some energy, then v and r changes as

A. d will increases, v will increases

B. d will increases, v will decreases

C. d will decreases, v will decreases

D. d will decreases, v will increases

Answer: D

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58. 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.

A. The acceleration of S is 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 remains constant

C. The total mechanical energy of S varies periodically with time

D. The linear momentum of S remains constant in magnitude

Answer: A

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59. The escape Velocity from the earth is $11.2Km/s$. The escape Velocity from a planet having twice the radius and the same mean density as the earth, is :

A. $22km/s$

B. $11km/s$

C. $5.5km/s$

D. $15.5km/s$

Answer: A

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60. The kinetic energy needed to project a body of mass m from the eath surface (radus R) to infinity is

A. $mgR/2$

B. $2mgR$

C. mgR

D. $mgR/4$

Answer: C

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61. A body is orbiting very close to the earth surface kinetic energy K.E. The energy required to completely escape from it is

A. $\sqrt{2}K.\ E$

B. $2K.\ E.$

C. $K.\ E.\ \sqrt{2}$

D. None of these

Answer: B

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62. The escape velocity of a body from earth's surface is v_e. The escape velocity of the same body from a height equal to $7R$ from earth's surface will be

A. $v_e / \sqrt{2}$

B. $v_e / 2$

C. $v_e / 2\sqrt{2}$

D. $v_e / 4$

Answer: C

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63. The escape velocity for a body projected vertically upwards from the surface of earth is 11km/s. If the body is projected at an angle of 45° with the vertical, the escape velocity will be

A. $11/\sqrt{2}km/s$

B. $11\sqrt{2}km/s$

C. $22km/s$

D. $11km/s$

Answer: D

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64. The mass of a spaceship is 1000kg. It is to be launched from the earth's surface out into free space. The value of g and R (radius of earth) are $10\frac{m}{s^2}$ and 6400 km respectively. The required energy for this work will be:

A. $6.4 \times 10^{11} J$

B. $6.4 \times 10^{8} J$

C. $6.4 \times 10^{9} J$

D. $6.4 \times 10^{10} J$

Answer: D

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65. There are two planets. The ratio of radius of two planets is k but ratio of acceleration due to gravity of both planets is g. What will be the ratio of their escape velocity ?

A. $k_1 k_2$

B. $\sqrt{k_1 k_2}$

C. $\sqrt{\frac{K_1}{k_2}}$

D. $\sqrt{\frac{K_2}{k_1}}$

Answer: B

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66. There is no atomosphere on moon because

A. it is close to the earth

B. it revolves round the earth

C. the escape velocity of the gas molecules is less than their rms velocity on the moon

D. the escape velocity of the gas molecules is more than their rms velocity on the moon.

Answer: C

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67. A projectile is launched from the surface of earth with a velocity less than the escape velocity. Its total mechanical energy is

A. positive

B. negative

C. zero

D. may be positive or negative depending upon its initial velocity

Answer: B

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68. The ratio of the K.E. required to the given to the satellite to escape earth's gravitational field to the K.E. required to be given so that the satellite moves in a circular orbit just above earth atmosphere is

A. $\sqrt{2}$

B. 2

C. $2\sqrt{2}$

D. 4

Answer: B

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69. The escape velocity for a planet is v_e. A particle is projected from its surface with a speed v. For this particle to move as a satellite around the planet.

A. $\frac{v_e}{2} < v < v_e$

B. $\frac{v_e}{\sqrt{2}} < v < v_e$

C. $v_e < v < \sqrt{2}v_e$

D. $\frac{v_e}{\sqrt{2}} < v < \frac{v_e}{2}$

Answer: B

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70. A particle of mass 'm' is projected from the surface of earth with velocity $v = 2v_e$, where v_e is the value of escape velocity from the surface of earth . Find velocity of the particle on reaching to interstellar space (at infinity) in terms of v_e.

A. v_{es}

B. $3v_{es}$

C. $\sqrt{3}v_{es}$

D. $\sqrt{5}v_{es}$

Answer: A

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71. The earth is assumed to be a sphere of raduis R. A plateform is arranged at a height R from the surface of the fv_e, where v_e is its escape velocity form the surface of the earth.

The value of f is

A. $1/3$

B. $1/2$

C. $\sqrt{2}$

D. $1/\sqrt{2}$

Answer: C

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72. A satellite is moving with a constant speed 'V' in a circular orbit about the earth. An object of mass 'm' is ejected from the satellite such that it just escapes form the gravitational pull of the earth. At the tme of its ejection, the kinetic energy of the object is

A. $\frac{1}{2}mV^2$

B. mV^2

C. $\frac{3}{2}mV^2$

D. $2mV^2$

Answer: B

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73. An object is weighted at the North Pole by a beam balance and a spring balance, giving readings of W_B and W_S respectively. It is again weighed in the same manner at the equator, giving readings of W'_B and W'_S respectively. Assume that the acceleration due to gravity is the same everywhere and that the balance are quite sensitive, Choose the wrong option

A. $W_B = W_S$

B. $W'_B = W'_S$

C. $W_B = W'_B$

D. $W'_S < W_S$

Answer: B

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74. Let ω be the angular velocity of the earth's rotation about its axis. Assume that the acceleration due to gravity on the earth's surface has the same value at the equator and the poles. An object weighed by a spring balance gives the same reading at the equator as at a height h above the poles $(h < < R)$. The value of h is

A. $\omega^2 R^2 / g$

B. $\omega^2 R^2 / 2g$

C. $2\omega^2 R^2 / g$

D. $\sqrt{Rg} / \omega$

Answer: B

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75. Let ω be the angular velocity of the earth's rotation about its axis. Assume that the acceleration due to gravity on the earth's surface has the same value at the equator and the poles. An object weighed at the equator gives the same reading as a reading taken at a depth d below earth's surface at a pole $(d < < R)$. the value of d is-

A. $\omega^2 R^2 / g$

B. $\omega^2 R^2 / 2g$

C. $2\omega^2 R^2 / g$

D. $\sqrt{Rg} / \omega$

Answer: A

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

A. $\left[2G\frac{(m_1 - m_2)}{r}\right]^{1/2}$

B. $\left[\frac{2G}{r}(m_1 - m_2)\right]^{1/2}$

C. $\left[\frac{r}{2G(m_1 m_2)}\right]^{1/2}$

D. $\left[\frac{2G}{r}m_1 m_2\right]^{1/2}$

Answer: B

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77. 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. (i),(iii)

B. (i),(iv)

C. (ii),(iii)

D. (ii),(iv)

Answer: B

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78. Three point masses are at the corners of an equilateral traingle of side r. Their separations do not change when the system rotates about the centre of the triangle. For this, the time period of rotation must be proportional to

A. (i),(ii)

B. (ii),(iii)

C. (i),(iii)

D. (i),(iv)

Answer: D

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

A. $\sqrt{\frac{2GM}{a}}$

B. $\sqrt{\frac{2GM}{a}\left(1-\frac{1}{\sqrt{2}}\right)}$

C. $\sqrt{\frac{2GM}{a}(\sqrt{2}-1)}$

D. zero

Answer: B

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80. 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

A. v_e

B. $1.5v_e$

C. $\sqrt{1.5}v_e$

D. $2v_e$

Answer: C

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81. 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 form rest at a height $H < < R$ above the earth's surface, and reaches 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. $\sqrt{4H / 3g}$

Answer: C

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82. In the previous questions, if the mass of the body is half the mass of the earth, and all other data remain the same, then t is equal to

A. $\sqrt{2H/g}$

B. $\sqrt{H/g}$

C. $\sqrt{2H/3g}$

D. $\sqrt{4H/3g}$

Answer: D

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83. A binary star system consists of two stars A and B which have time period T_A and $T_B, radius R_B a$ and mass M_a and M_B. Then

A. $\frac{T_A}{T_B} = \left(\frac{r_A}{r_B}\right)^{3/2}$

B. $T_A > T_B$(if $r_A > r_B$)

C. $T_A > T_B$ (if $m_A > m_B$)

D. $T_A = T_B$

Answer: D

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84. The escape velocity for a planet is v_e. A tunnel is dug along a diameter of the planet and a small body is dropped into it at the surface. When the body reaches the centre of the planet, its speed will be

A. v_e

B. $\frac{v_e}{\sqrt{2}}$

C. $\frac{v_e}{2}$

D. zero

Answer: B

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85. A train A runs from east to west and another train B of the same maas runs from west to east at the same speed along the equator. A presses the track with a force F_1 and B presses the track with a force F.

A. A

B. B

C. They will exert equal fore

D. The mass and the speed of each train must be known to reach a conclusion.

Answer: A

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86. The condition for a uniform spherical mass m of a radius r to be a black hole is [G =gravitational constant and g=acceleration due to gravity]

A. $(2Gm/r)^{1/2} \leq c$

B. $(2Gm/r)^{1/2} = c$

C. $(2Gm/r)^{1/2} \geq c$

D. $(Gm/r)^{1/2} \geq c$

Answer: C

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