PHYSICS

BOOKS - BHARATI BHAWAN PHYSICS (HINGLISH)

GRAVITATION

Examples

1. Calculate the mass of the sun , given that the sistance between the sum and the earth is 1.5×10^{-11} m and G = 6.66×10^{-11} SI units and taken a year = 365 days .

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2. Calculate the speed of projection necessary to send a body right out of the filed of the earth's grvivtational attraction.

$G = 6.63 \times 10^{-11}$ "newton $metre^2$" Kg^2

Mass of the earth = 5.97×10^{24}

Radius of the earth = $6.37 \times 10^6 m$.

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3. A body is projected vertically upwards from the surface of the earth with an initial velocity v. Show that the it wall go up to a height h given by $h = v^2 R / \left(2gRv^2\right)$ and hence deduce the expression for escape velocity .

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4. Calculate the acceleration due to gravity on the earth from the following data

$G = 6.6 \times 10^{-11} Nm^2 Kgm^{-3}$

Mean density of the earth =$5 \times 10^{-3} kgm$

Radius of the earth =$6.4 \times 10^6 m$.

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5. Calculat the binding energy of the - sum system . Mass of the earth $= 6 \times 10^{24}$ kg , mass of the sun =2×10^{30} kg, distance between the earth and the sun =1.5×10^{11} and gravitational constant = $6.6 \times 10^{-11}\ Nm^2 kg^2$

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6. Calculate the pressure the pressure caused by gravitational compressions inside the earth , at a distance r from its centre . Take M as the mass of the earth of the earth and R as its radius .

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7. A space-ship is stationed on Mars. How much energy must be expended on the spaceship to rocket it out of the solar system ? Mass of the spaceship $= 1000kg$, Mass of the sun $= 2 \times 10^{30}kg$. Mass of the Mars $= 6.4 \times 10^{23}kg$, Radius of Mars $= 3395km$. Radius of the orbit Mars $= 2.28 \times 10^{11}m, G = 6.67 \times 10^{-11}Nm^2kg^{-2}$.

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Exercise

1. Calculate the acceleration due to gravity on the earth 's surface , given that gravitational constant $G = 6.7 \times 10^{-11}$ SL unit , radius of he earth = $6.4 \times 10^{6} m$ and mean density of earth = $5.5 \times 10^{3} kgm^{-3}$.

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2. With what velocity would a shell have to be projected horizontally so that it might describle a circular orbit round the earth ? Acceleration due to gravity = $9.81 ms^{-2}$ and radius of the earth = $6.4 \times 10^{6} m$.

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3. With what velocity must a body be projected vertically upwards from the surface of the earth in orer that it may never return to the earth ? ($G = 6.6610^{-11}$ SI units , mean density of the earth = $5.525 \times 10^3\ kgm^{-3}$, radius of the earth = 6.38×10^6m.)

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4. Compare the minimum velocity with which a particle must be projected vertically upwards from the surfaces of the earth in order that it may never return to the earth with that which is needed to make it escape from the earth ' s gravitational field .

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5. Calculate the mass and mean density of the earth from the following data :

Gravitational constant	(G)	$= 6.6 \times 10^{-11} Nm^2 kg^{-2}$
Radius of the earth	(R)	$= 6.37 \times 10^6 m$
Acceleration due to gravity	(g)	$= 9.8 ms^{-2}$

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6. How many hours would make a day if the earth were rotating at such a high speed that the weight of a body on the equator were zero

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7. The mass of Mars is one - tenth that of the earth and its diameter is only half that of the earth . Compare the values of

g on their surface .

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8. Calculate the escape speed of an atmospheric particle which is 1000 km above the earth's surface . (Radius of the = 6400 km nd acceleration due to gravity $=9.8ms^{-2}$

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9. Two masses, 800 kg and 600 kg, are at a distance 0.25 m apart. Compute the magnitude of the intensity of the gravitational field at a point distant 0.20 m from the 800 kg mass and 0.15 m from the 600 kg mass.

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10. A man can jump vertically to a height of $1.5m$ on the earth. Calculate the radius of a planet of the same mean density as that of the earth from whose gravitational field he could escape by jumping. Radius of earth is $6.41 \times 10^5 m$.

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11. A body weights 20 kg on the surface of the earth . What will be its its weight when it is at a height equal to (i) the radius of the earth ,(ii) dobble the radius of the earth ?

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12. Find the self gravitationl potential of (a) a thin unifrom spherical shell of radius R snd mass M, (b) a solid sphere of

the same radius and mass .

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13. A projectile is fired vertically from the earth's surface with an initial speed of $10km/s$. Neglecting air drag, how high above the surface of earth will it go?

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14. A short , straight and frictinless tunnel is bored through the centre of the earth and a body is realesed from the surface into the tunnel . Show that the motion of the body in the tunnell will be simple harmoic and hence calculate the taken by the body to travel from one end of the tunnel to the

other (Radius of the earth = $6.38 \times 10^6 m$ and acceleration due to gravity at the surface = $9.81 ms^2$

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15. Two particle of mass m and M are initially at rest at inifinte distance . Find their relative velocity of approch due to grvitational atraction when d is their separation at any instant . [Hint : From the principle of conservation of energy $\frac{GmM}{d} = \frac{1}{2}mv_1^2 + \frac{1}{2}v_2^2.$. From the principle of conservationl of momentum , $mv_1 - Mv_2 = 0$. Relative velocity of approch =$V_1 + V_2$]

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16. Three identical particles each of mass "m" are arranged at the corners of an equiliteral triangle of side "L". If they are to be in equilibrium, the speed with which they must revolve under the influence of one another's gravity in a circular orbit circumscribing the triangle is

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17. An iron ball o fradius 1 m and density $8000kgm^{-3}$ is placed in water . A bubble of radius 1 cm at a distance 1.5 m from the centre of the ball . Will there be a force of attraction or repulsion between them and what will be the magnitude of this force ? (Neglect the mass of air and take $G = 6.67 \times 10^{-11}$.)

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18. A particles is fired vertically from the surface of the earth with a velocity Kv_e , where u_e is the escape velcocity ans $K < 1$. Neglecting air resistance , calcualte the heightto which it will rise from the surface of the earth .(R= radius of the earth).

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19. Calculate the pressure caused by gravitational copmression at the centre of the earth . Express the result in terms of standard atmospheric pressure .Mass of the earth = 6.0×10^{24} kg , radius of the earth =6.4×10^6 m and g (at the surface of the earth) $= 9.8ms^{-2}$. 1 standard atmospheric pressure = $10^5 Nm^{-2}$.

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20. A planet of mass moves alng an ellipes around the sun so that its maximum distance from the sum are equal to r_1 and r_2 respectively . Find the angular momenture L of this planet relative to the centre of the sun.

[Hint :L Rember that at the maximum and minimum distance velocity is perpendicular to tthe position vectors of the planet . Apply the princples of conservation of angula r momenture and energy .]

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21. In a double star, two stars (one of mass m and the other of mass $2m$) distance d apart rotate about their common centre

of mass., Deduce an expressioin for the period of revolution. Show that te ratio of their angular momenta about the centre of mass is the same as the ratio of their kinetic energies.

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22. Two satellites A and B of equal mass move in the equatorial plane of the earth, close to earth's surface. Satellite A moves in the same direction as the of the rotation of the earth while satellite B moves in the opposite direction. Calclate the ratio of the kinetic energy of B of that of A in the reference frame fixed to the earth $\left(g = 9.8ms^{-2}\right.$ and radius of the earth $\left. = 6.37 \times 10^{6}km\right)$

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23. Three masses ,100kg 200kg and 500 kg are placed at the vetices of an equilateral triangle with sides 10 m they are rearranged by an agent on the verticws of a bigger triangle of siders 15 m and with the same in -centre Calcualte the work dine by the agent.

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24. Two satellites of the earth move in the sme plane with radii a and b,b being slghtly gerater than a. what is the minimum intants when they are on the same line thourth the centre of the earth (i) when they move in the same direction , (ii) in oppsite direction?

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25. A body is projected horizontally near the surface of the earth with $\sqrt{1.5}$ times the orbital velocity .Calculate the maximum heght up which it will rise above the surface of the earth.

[Hint : when the velocity of projection exceeds the orbital velocity the path taken is an ellipse At the highest point the radius vector and velocity are right angles Conserve angular momentum and energy.]

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26. Calculate the distance from the surface of the earth at which the acceleration due to gravity is the same below and above the surface of the earth.

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27. Find the gravitatinal force of between a point mass m placed at a disance x on the prolongation of a thin rod of mass M andlength l from near end .

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28. An artificial satellite (mass m) of a planet (mass M) revolves in a circular orbit whose radius is n times the radius R of the planet in the process of motion the satellite experiences a slight resistance due to cosmic dust. Assuming the force of resistance on satellite to depend on velocity as $F = av^2$ where 'a' is a constant caculate how long the satellite will stay in the space before it falls on to the planet's surface.

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29. Calcualte the third cosmic veocity i.e the velocity relative to the Earth 'a surface to drive a body out of the Solar system in terms m_e (mass of the earth) ,M_s (mass of the sun) R (radius of the Earth),and d(the earth sun distance)

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