PHYSICS

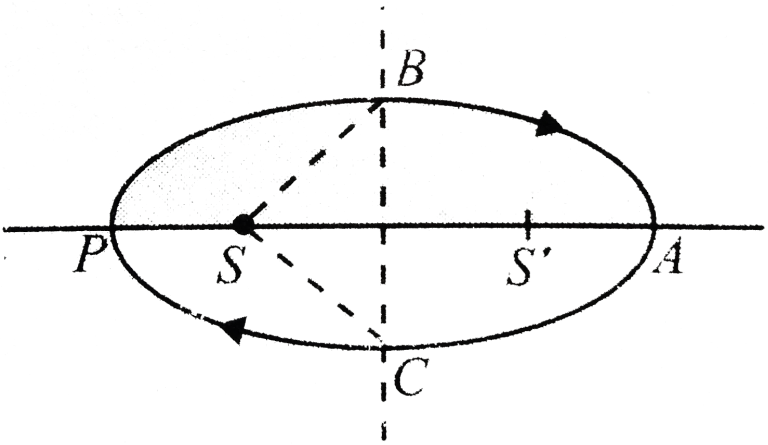
NCERT - NCERT PHYSICS(ENGLISH)

GRAVITATION

Solved Example

1. Let the speed of the planet at the perihelion P in figure be v_P and the Sun planet distance SP be r_P. Relater r_P, v_P to the corresponding quantities at the aphelion (r_A, v_A). Will the planet take equal times to

transverse BAC and CPB?



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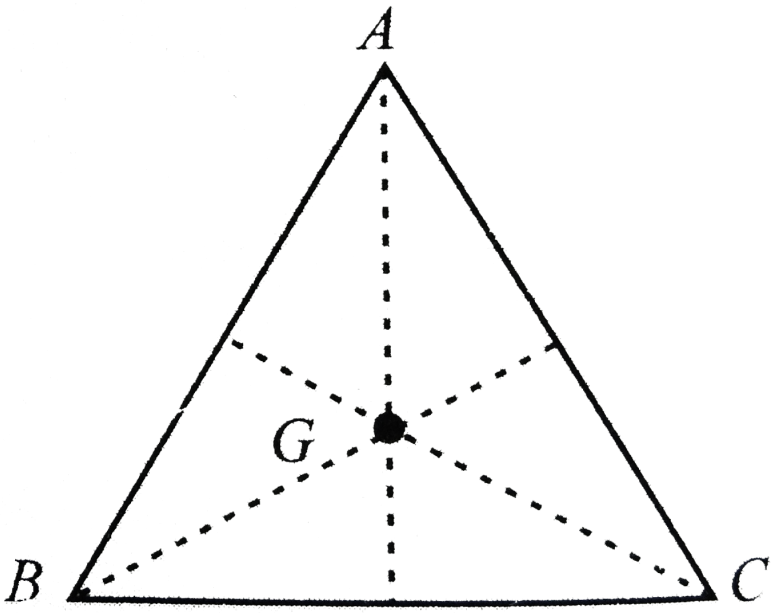
2. Three equal masses of mkg each are fixed at the vertices of an equilateral triangle ABC.

a. What is the force acting on a mass $2m$ placed at the centroid G of the triangle?

b. What is the force if the mass at the vertex A is

doubled? Take $AG = BG = CG = 1m$



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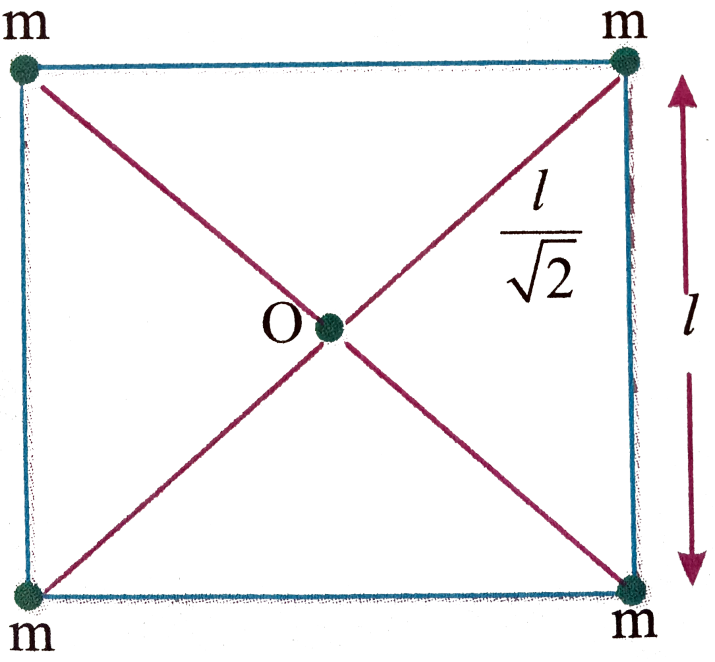
3. Find the gravitational potential energy of a system of four particles, each of mass m placed at the verticles of a square of side l. Also obtain the gravitaitonal potential

at centre of the square.



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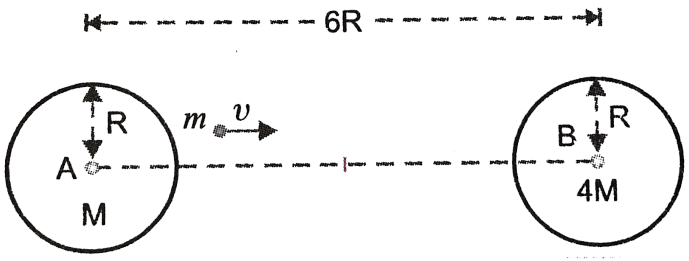
4. Two uniform soild spheres of equal radii R but mass M and $4M$ have a centre to centre separation $6R$, as shows in Fig. (a) The two spheres are held fixed. A projectile of mass$m$ is projected from the surface of the

sphere of mass M directly towards the centre of teh second. Obtain an expression for the minimum speed v of the projectile so that it reaches the surface of second sphere.



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5. The planet Mars has two moons. Phobos and Delmos (i) phobos has period 7 hours, 39 minutes and an orbital radius of $9.4 \times 10^3 km$. Calculate the mass of Mars. (ii)

Assume that Earth and mars move in a circular orbit around the sun, with the martian orbit being 1.52 times the orbital radius of the Earth. What is the length of the martian year in days? $\left(G = 6.67 \times 10^{-11} Nm^2 kg^{-2}\right)$

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6. You are given the following data : $g = 9.81 ms^{-2}$, radius of earth $= 6.37 \times 10^6 m$ the distance the Moon from the earth $= 3.84 \times 10^8 m$ and the time period of the Moon's revolution $= 27.3 days$. Obtain the mass of the earth in two different ways. $G = 6.67 \times 10^{-11} Nm^2 kg^2$.

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7. Given that $T^2 = kR^3$, express the constant k of the above relation in days and kilometres. Given, $k = 10^{-13} s^2 m^{-3}$. The Moon is at a distance of $3.84 \times 10^5 km$ from the earth. Obtain its time period of revolution in days.

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8. A $400kg$ satellite is in a circular orbit of radius $2R_E$ around the Earth. How much energy is required to transfer it to a circular orbit of radius $4R_E$? What are the changes in the kinetic and potential energies?

Given $g = 9.81 m^{-2}$, $R_E = 6.37 \times 10^6 m$.

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Exercise

1. Answer the following: (a) You can shield a charge from electrical forces by putting it inside a hollow conductor. Can you shield a body from the gravitational influence of nearby matter by putting it inside a hollow sphere or by some other means? (b) An astronaut inside a small spaceship orbiting around the Earth cannot detect gravity. If the space station orbiting around the Earth has a large size, can he hope to detect gravity? (c) If you compare the gravitational force on the Earth due to the Sun to that due to the Moon, you would find that the Sun's pull is greater than the Moon's pull. (You can check

this yourself using the data available in the succeeding exercises). However, the tidal effect of the Moon's pull is greater than the tidal effect of Sun. Why?

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2. Choose the correct alternative

(a)Acceleration due to gravity increase/decrease with increasing altitude.

(b) Acceleration due to gravity increase/decrease with increasing depth (assume the earth to be a sphere of uniform density).

(c) Acceleration due to gravity is independent of mass of the earth/mass of the body.

(d) The formula $-GMm\left(\frac{1}{r_2}-\frac{1}{r_1}\right)$ is more/less

accurate than the formula $mg(r_2 - r_1)$ for the difference of potential energy between two points r_2 and r_1 distance away from the centre of earth.

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3. Suppose there existed a planet that went around the sun twice as fast as the earth. What would by its orbital size?

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4. One of the satellite of jupiter, has an orbital period of 1.769 days and the radius of the orbit is $4.22 \times 10^8 m$.

Show that mass of jupiter is about one thousandth times that of the mass of the sun. (Take 1 year $= 365.15$ mean solar day).

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5. Let us consider that our galaxy consists of 2.5×10^{11} stars each of one solar mass. How long will this star at a distance of $50,000$ light year from the galastic entre take to complete one revolution? Take the diameter of the Milky way to be $10^5 ly$. $G = 6.67 \times 10^{-11} Nm^2 Kg^{-2}$. $\left(1ly = 9.46 \times 10^{15} m\right)$

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6. Choose the correct alternative :

(a) If the zero of the potential energy is at infinity, the total energy of an orbiting satellite is negative of its kinetic/potential energy.

(b) The energy required to rocket an orbiting satellite out of Earth's gravitational influence is more/less than the energy required to project a sationary object at the same height (as the satellite) out of Earth's influence.

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7. Does the escape speed of a body from the earth depend on (a) the mass of the body. (b) the location from where it is projected. © the direction of projection,

(d) the height of the location from where the body is launched?

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8. A comet orbits the Sun in a highly elliptical orbit. Does the comet have a constant (a) linear speed (b) angular speed (c) angular momentum (d) kinetic energy (e) potential energy (f) total energy throughout its orbit? Neglect any mass loss of the comet when it comes very close to the Sun.

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9. Which of the following symptoms is likely to afflict an astronaut in space (a) swollen feet, (b) swollen face, (c) headache, (d) orientational problem.

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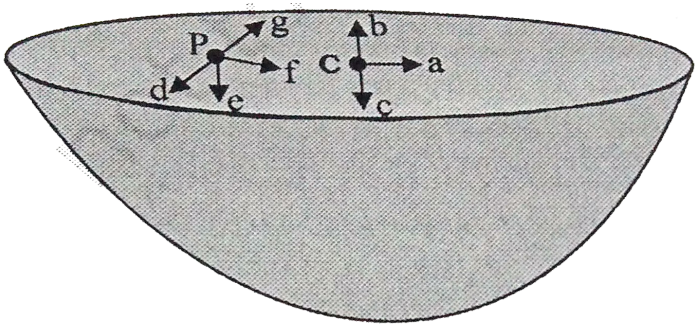
10. In the following two exercises, choose the correct answer from among the given ones: The gravitational intensity at the centre of a hemispherical shell of uniform mass density has the direction indicated by the arrow (see Fig.) (i) a, (ii) b, (iii) c, (iv) 0. For the above problem, the direction of the gravitational intensity at an arbitrary point P is indicated by the arrow (i) d, (ii), e,

(iii) f (iv) g.



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11. For the above problem, the direction of the gravitational intensity at an arbitrary point P is indicated by the arrow (i) d, (ii), e, (iii) f (iv) g.

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12. A rocket is fired from the earth towards the sun. At what distance from the earth's centre is the gravbitaional force on the rocket zero? Mass of the sun $= 2 \times 10^{30} kg$, mass of the earth $= 6 \times 10^{24} kg$. Neglect the effect of other planets etc. (orbital radius= $1.5 \times 10^{11} m$).

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13. The mean orbital radius of the Earth around the Sun is $1.5 \times 10^{8} km$. Estimate the mass of the Sun.

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14. A Saturn year is 29.5 times that earth year. How far is the Saturn from the sun if the earth is 1.50×10^8 km away from the sun ?

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15. A body weighs 63 N on the surface of the earth. What is the gravitational force on it due to the earth at a height equal to half the radius of the earth ?

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16. Assuming the earth to be a sphere of uniform mass density, how much would a body weigh half way down to

the centre of the earth if it weighd 250 N on the surface ?

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17. A rocket is fired vertically with a speed of 5 kms^{-1} from the earth's surface. How far from the earth does the rocket go before returning to the earth ? Mass of earth=6.0×10^{24}kg, mean radius of the earth =6.4×10^{6} m, G=$6.67 \times 10^{-11} Nm^2 Kg^{-2}$.

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18. The escape speed of a projectile on the earth's surface is 11.2 km s^{-1}. A body is projected out with thrice this speed. What is the speed of the body far away from the earth? Ignore the presence of the sun and other planets.

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19. A satellite orbits the earth at a height of 400 km, above the surface. How much energy must be expended to rocket the satellite out of the earth's gravitational influence ? Mass of the satellite=200 kg, mass of the earth=6.0×10^{24}kg, radius of the earth=$6.4 \times 10(6)$m, G= $6.67 \times 10^{-11} Nm^2 Kg^{-2}$.

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20. Two starts each of one solar mass $\left(= 2 \times 10^{30} kg \right)$ are approaching each other for a head on collision. When they are a distance 10^9km. their speeds are negligible. What is the speed with which they collide? The radius of each star is 10^4km. Assume the stars to remain undistorted until they collide. (Use the known value of G).

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21. Two heavy sphere each of mass $100kg$ and radius $0.10m$ are placed $1.0m$ apart on a horizontal table. What

is the gravitational field and potential at the mid point of the line joining the centres of the sphere? Is an object placed at that point in equilibrium? If so, is the equilbrium stable or unstable.

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22. A geostationary satellite orbits the Earth at a height of nearly $36,000km$ from the surface of earth. What is the potential due to earth's gravity at the site of this satllite ? (Take the potential energy at infinity to be zero). Mass of the Earth $= 6.0 \times 10^{24}kg$, radius $= 6400km, G = 6.67 \times 10^{-11}Nm^2/kg^2.$

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23. A star 2.5 times the mass of the sun and collapsed to a size of 12km rotates with a speed of 1.2 rev. per second. (Extremely compact stars of this kind are known as neutron stars. Certain stellar object called pulsars belong to this category). Will an neutron stars. Certainstellar objects called pulsars belong to this category). will an object placed on its equator remain stuck to its surface due to gravity? (mass of the sun $= 2 \times 10^{40} kg$).

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24. A spaceship is stationed on mars. How much energy must be expended on the spaceship to launch it out of

this kind are known as neutron stars. Certain steller objects called pulsars belong to this categor). Will an object placed on its equator remain stuck to its surface due to gravity? (mass of the sun $= 2 \times 10^{30} kg$).

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25. A rocket is fired fired vertically from the surface of Mars with a speed of 2 Kms^{-1}. If $20\,\%$ of its initial energy is lost due to martain atmospheric resistance, how far will the rocket go from the surface of Mars before returning to it ? Mass of Mars=6.4×10^{23}Kg, radius of Mars=3395 Km, G=$6.67 \times 10^{-11} Nm^2 Kg^{-2}$.

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