

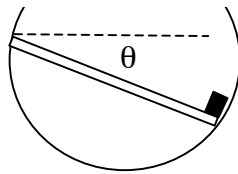
PHYSICS 180

Problem Set # 9

due: December 1, 2006

"Imagination is more important than knowledge"
.....anon.

1. A plank of mass M and length $R\sqrt{3}$ lies in a frictionless circular trough of radius R as shown. At one end of the plank is a mass $0.5M$. Determine the angle θ the plank makes with the horizontal when it is in equilibrium.



2. A true "syncom" satellite rotates synchronously with the Earth: it always remains in a fixed position, above a point P on the surface of the Earth. Can P have any latitude? What restrictions, if any exist? What is the distance from the Earth's centre for a satellite of mass 100 kg ?
3. Show that for a point mass m moving in a gravitational field of a planet of mass M ($\gg m$) $\vec{p} \times \vec{L} - Gm^2M\hat{r}$ is a constant where \vec{L} is the angular momentum of the point mass about the center of the planet and \vec{p} is its linear momentum.
4. The space shuttle is in a circular orbit above the Earth at an altitude of 250 km. It fires its rockets in a backward direction so as to go into a new orbit. If it increases its speed by 5% what will be the maximum distance of the shuttle above the Earth in its new orbit? What will its minimum distance be?

(for practice only)

1. Santa Claus is able to park his sleigh on snow-covered roofs whose slope is as much as 30° . What is the coefficient of static friction between the snow and his sleigh?
2. If Santa leaves the North Pole with 5 kg of toys for every household in North America estimate the power of the reindeers if they can accelerate to 100 km/hr in 10 s. If Santa consumes the glass of milk and two cookies left out for him in each household in North America, estimate the mass the reindeers are pulling on the return trip to the North Pole.
3. Your little brother in his excitement on Christmas morning leans against the Christmas tree causing it to tip over. Estimate the difference in time for the tree top to hit the floor and your mother to scream.
4. Discuss how Santa used time dilation and length contraction effects in order to deliver all his toys between 10 PM and 5AM.