Physics 15a – Spring 2006 – Section 4 Handout (Mar 6-7) **Wissner-Gross**

Readings

(1) Hooke's law, (2) Conservation of energy, (3) Frictional force, (4) Potential energy, (5) Kinetic energy

Review

1. Remember: Work $W = \int_{x_i}^{x_f} \vec{F} \cdot d\vec{x}$ so you only need to consider the force along the direction of motion.
2. Hooke's law: F = -k|x| opposite displacement; PE = $1/2*k*|x|^2$
3. Conservation of energy: P.E. + K.E. is constant
4. A taught string remains taught as long as the inward radial force does not exceed the required centripetal force. (What happens otherwise?) Remember that the tension an "ideal string" exerts on an object always pulls and never pushes!
5. Total momentum in a given direction is conserved if there is no net external force in that direction.
6. REMEMBER TO ANSWER QUESTION #11 FOR EXTRA POINTS!!!! ☺

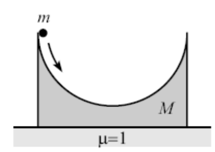
Exercises

Easy

1. A particle moves toward $x = 0$ under the influence of a potential $V(x) = -A|x|^n$, where A > 0 and n > 0. The particle has barely enough energy to reach x = 0. For what values of n will it reach $x = 0$ in a finite time?
2. A small ball rests on top of a fixed frictionless sphere. The ball is given a tiny kick and slides downward. At what point does it lose contact with the sphere?
3. A variable force ***F*** is maintained tangent to a frictionless semicircular surface. By slowly varying the force, a block with weight w is moved, and the spring to which it is attached is stretched from the rightmost side of the semicircle to angle θ with the horizontal. The spring has negligible mass and force constant k. The end of the spring moves in an arc of radius a. Calculate the work done by the force ***F***.

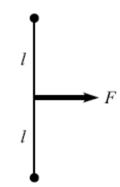
Medium

4. A frictionless cylindrical pipe with radius r is positioned with its axis parallel to the ground, at height h. What is the minimum initial speed at which a ball must be thrown (from ground level) in order to make it over the pipe? Consider two cases: (a) the ball is allowed to touch the pipe, and (b) the ball is not allowed to touch the pipe.
5. A hemispherical bowl of mass M rests on a table. The inside surface of the bowl is frictionless, while the coefficient of friction between the bottom of the bowl and the table is $\mu = 1$. A particle of mass m is released from rest at the top of the bowl and slides down into it (see figure). What is the largest valu e of m/M for which the bowl will never slide on the table?



Hard

6. A massless string of length $2l$ connects two hockey pucks that lie on frictionless ice. A constant horizontal force F is applied to the midpoint of the string, perpendicular to it (see right figure). How much kinetic energy is lost when the pucks collide, assuming they stick together?



7. A bead, under the influence of gravity, slides along a frictionless wire whose height is given by the function $y(x)$. Assume that at position $(x,y) = (0,0)$, the wire is vertical and the bead passes this point with a given speed downward. What should the shape of the wire be (that is, what is y as a function of x) so that the vertical speed remains v_0 at all times?