Supplementary Problems for Topics I

1. A small block of mass $m$ is on a wedge as shown. The wedge is being accelerated to the left at rate $a$.
   
a. If there is no friction between the block and the wedge, for what value of $a$ will the system move with the block at rest relative to the wedge?

   Now suppose there is friction, but the coefficient of static friction, $\mu_s$, is not sufficient to keep the block from sliding if the wedge is at rest.
   
b. What is the minimum value of $a$ such that the block does not slide down the wedge?

c. What is the maximum value of $a$ such that the block does not slide up the wedge?

   Give answers in terms of $g$, $\mu_s$ and $\theta$.

2. A ball of mass $m$ is attached to a massless string of length $L$, which is attached to a ceiling as shown. The ball is pulled back until the string makes angle $\theta$ with the vertical, and it is released from rest. At the bottom of the swing, the string encounters a peg at distance $d$ below the ceiling. The upper part of the string stops moving, while the ball now rotates about the peg in a smaller circle than before.
   
a. Suppose the ball makes a complete circle about the peg. What is the minimum speed it must have at the top of that circle?

   b. At what minimum value of $\theta$ must the ball be released initially so that it makes a complete circle about the peg? [Take gravitational potential energy to be zero at the bottom of the swing.]

   c. Clearly $\theta$ cannot be greater than $90^\circ$. What is the smallest value of $d$ for which the ball can make a complete circle about the peg?