Physics 1135: Homework for Recitation 11: Potential energy

1. In an amusement park ride, a car rolls on the frictionless track depicted in the figure. It starts from rest at height $H$ above the ground. Find the minimum value for $H$ necessary so that the car moves around the circular loop of radius $R$ without falling off. Treat the car as a point mass and express $H$ in terms of $R$.

2. A 2kg box is sliding along a horizontal table. The coefficient of kinetic friction between box and table is 0.3. Point P is 2m to the right of the origin O, as shown in the figure (top view of the table). Calculate the work done by friction on the box when it slides
   a) from O straight to point P.
   b) from O in a half-circle of radius 1m to point P.
   c) from O straight to point P then straight back to O.
   d) Based on the results of your calculation, is kinetic friction a conservative force or not?

3. A block of mass $M$ is pushed against a spring with unknown spring constant, compressing it a distance $L$. When the block is released from rest, it travels a distance $d$ on the rough horizontal surface and then up a rough incline (both surfaces have a coefficient of kinetic friction $\mu$ with the box). The incline makes an angle $\theta$ above the horizontal. When the block reaches height $H$ on the incline, its speed is $V$. Derive an expression for the force constant $k$ of the spring in terms of system parameters.

4. A block of mass $m$ is on a frictionless incline that makes an angle $\theta$ with the vertical. A light string attaches it to another block of mass $M$ that hangs over a massless, frictionless pulley. The blocks are released from rest. The block of mass $M$ falls onto a vertical spring of spring constant $k$ that was a distance $H$ below the block at release.
   a) Complete the diagram with all information necessary to solve part b) below.
   b) Derive an expression for the speed of the blocks when the spring has been compressed a distance $D$, in terms of system parameters.