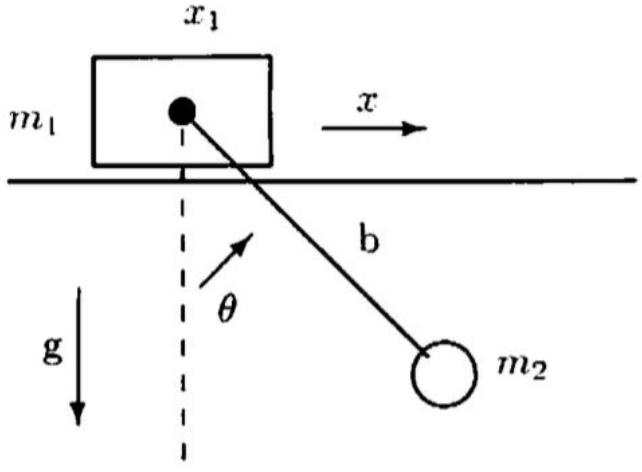
[3] (25 points) A rectangular block of mass m_1 rests on a horizontal surface under the influence of gravity g in the vertical y direction. This block is free to move (without friction) in the horizontal x direction. A pendulum with a support of length b (you may neglect the mass of the support) and mass m_2 is hung from the center of this block. The horizontal position of the block is x_1 and the pendulum makes an angle θ to the vertical (see figure at right). For each of the following, express your answer in terms of generalized coordinates x_1 and θ and their time derivatives.



a) What is the potential energy U of this system? You may ignore terms that do not vary with time.

b) What is the kinetic energy T of this system?

c) What is the Lagrangian L of this system?

d) What are Lagrange's equations of motion for this system in simplified form (i.e. leave your answer as one or more differential equations)?

e) Which component of momentum is conserved?