Physics C2801 Professor Christ
Midterm Examination (Practice) 10/19/2012

Answer each of the following **three (3)** questions.

Please give a complete description of your method of solution since *partial credit* will be given.

1. Short problems:

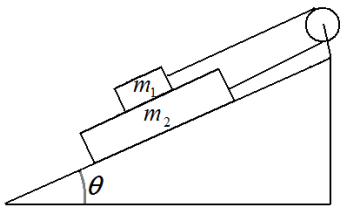
   (a) A cork is fixed to the bottom, inside an upright, freely-falling bucket filled with water. If the cork is released at $t = 0$, find the distance between the cork and the bottom of the bucket as a function of time. [9 points]

   (b) At what rate is work done by a 50Kg boy walking up a down escalator at such a rate that he stays in the same place? Assume the escalator stairs move downward with a speed of 10 cm/sec at an inclination of 30° from the horizontal. [9 points]

   (c) Neglecting the influence of visual stimulae, what causes a person traveling in a car to become motion sick: The car's velocity? The car's acceleration? or Changes in the car's acceleration? Explain your reasoning. [8 points]

   (d) A child is riding in a school bus holding a helium-filled balloon floating above her head and tethered to a string. If the bus driver suddenly brakes, does the balloon move toward the rear or the front of the bus? Explain. [8 points]

2. A block of mass m_1 slides on top of a block of mass m_2 which, in turn, slides on an inclined plane making an angle of θ with the horizontal. They are joined by a massless rope passing over a pulley as shown on the right. Each sliding surface experiences a frictional force with coefficient of friction μ. With what acceleration does m_2 slide down the inclined surface? (Assume that m_2 is sufficiently large compared to m_1 that m_2 does slide downward.) [33 points]



3. Sand falls at a constant rate λ (in units of mass per unit time) from a raised hopper, located at the position $x = 0$, onto railroad tracks. A flatcar of length L and mass M_0 moves without friction on those tracks with initial velocity v_0. At $t = 0$ the front edge of the car passes under the hopper so the sand begins to fall on the flatcar. At the time $t = T$ the flatcar passes beyond the hopper and the falling sand. Consider $0 \leq t \leq T$.

   (a) What is the total mass, $M(t)$, of the moving car and sand? [4 points]

   (b) Determines the car's velocity $v(t)$ at the time t. [12 points]

   (c) What is the position of the front edge of the car, $x(t)$? [12 points]

   (d) Find the time T in terms of L, M, v_0, and λ. [5 points]