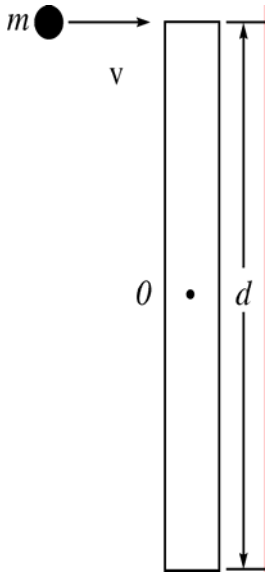
PHY180H1F TERM TEST II

MONDAY, NOVEMBER 21, 2005

Put your name, your tutorial number and your tutor's name on the examination booklet.

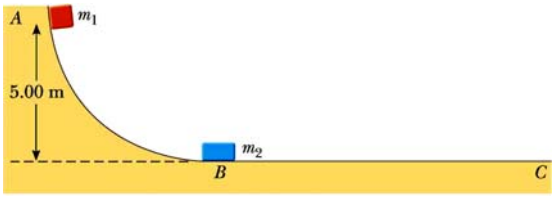
Answer all three questions. They are of equal value. Only aids are calculators, drawing instruments and a student supplied 8.5 x 11 inch aid sheet (both sides).



For this test the acceleration due to gravity is g = 9.80 ms^{-2}.

1) A projectile with a mass **m** = 0.50 kg moves to the right with a speed **v** = 2.0 m s^{-1}. The projectile strikes and sticks to the end of a long thin stationary rigid rod which has a mass of 5.0 kg and a length of **d** = 4.0 m. The rod is pivoted about a frictionless axle through its centre ***O***. (The moment of inertia of a long thin rod with the rotation axis through the centre is $\frac{1}{12}\mathbf{m}\,\mathbf{d}^2$.)
   a) What is the angular speed of the system right after the collision?
   b) How much energy is lost during the collision?

2) Two blocks are free to slide along the frictionless wooden track ABC shown in the diagram. The block of mass $\mathbf{m_1}$ = 5.00 kg is released from A. Protruding from its front end is the north pole of a strong magnet, repelling the north pole of an identical magnet embedded in the back end of the block of mass $\mathbf{m_2}$ = 10.0 kg, initially at rest. The collision is completely elastic. This is problem 20 from chapter 9).



   a) Calculate the maximum height $\mathbf{h_{max}}$ to which $\mathbf{m_1}$ rises after the elastic collision.
   b) In one sentence explain how the problem would change if Serway had said "frictionless aluminum track" instead of "frictionless wooden track". (Hint: Recall a class demonstration.)

3) You are able to observe a fictitious universe without changing it. In this universe there is an isolated system of two masses **m** and **M**. Physical quantities and units **are the same** in this universe as in ours except that the force of gravity is given by $\mathbf{F} = \mathbf{K}\,\mathbf{m}\,\mathbf{M}\,\mathbf{e}^{-\mathbf{r}}$ where **K** is a constant of proportionality and **r** is the distance, in meters, between the masses. The force of gravity is attractive and acts along the line joining **m** and **M**. (Since the exponent of **e** must be dimensionless there must be a constant with dimensions in the exponent but its magnitude is 1.)
   a) What are the units of **K**? (Show your work)
   b) $\mathbf{F} = \mathbf{F_1}$ when $\mathbf{r} = \mathbf{R_1}$ and the force decreases by a factor of 5 when **r** changes to $\mathbf{r} = 2\mathbf{R_1}$. Determine $\mathbf{R_1}$.
   c) Define the potential energy to be zero when the masses are infinitely apart. Showing all your work clearly, derive the potential energy for the system of **m** and **M**. (Placing **M** at the origin and using unit vectors may help you to keep track of signs.)
   d) If you have derived potential energy correctly, will the potential energy that you have derived have units of Joules in this universe? Answer with Yes or No. (Hint: Reread the question.)
   e) Justify your answer in (d) starting with your answer in (c) and using dimensional or unit analysis. Don't just quote an authority.