PHY 180: Mid-term test

No calculators. 100 pts total. Time limit: 90 minutes

Numerical answers that are within 10% of the correct answer will receive full credit.
You may assume that g = 10 m/s^2.

1. *(20 pts.)* Two objects with mass 2 kg each collide with each other. Observed from an inertial frame, their velocities before the collision are $\vec{u}_1 = 5\,\hat{i}$ m/s and $\vec{u}_2 = 5\,\hat{j}$ m/s. The first object has velocity $\vec{v}_1 = 5\,\hat{i}$ m/s - 5 $\hat{j}$ m/s after the collision.

   (a) Determine the velocity of the second object after the collision.

   (b) Is the collision elastic? If not, calculate the amount of energy lost/gained during the collision.

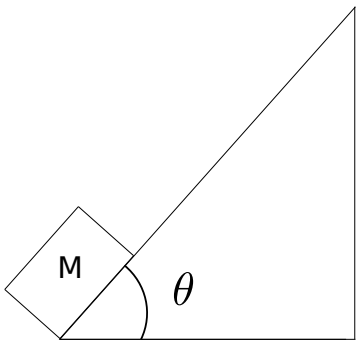
2. *(20 pts.)* The potential energy for a particle of mass m moving along the x-axis is $V(x) = \frac{1}{2}Ax^2 - \frac{1}{4}Bx^4$.

   (a) What are the SI units for the quantities A and B?

   (b) Construct a quantity with the dimensions of *time*, and another quantity with the dimensions of *length*, using the dimension-ful parameters in this problem.

   (c) Locate all the points at which the force on the particle is zero.

3. *(30 pts.)* A block of mass m = 1 kg is placed on a wedge inclined at θ = 45°. The block is launched up the slope with speed u = 1 m/s. Assume that the wedge is fixed and that it is big enough that the block stays on it throughout.



   (a) How long does the block take to return to its launch point, if friction is assumed to be negligible?

   (b) If friction cannot be neglected, and the block returns to its launch point with speed v = 0.3 m/s, calculate the work done on the block by the friction force.

4. *(30 pts.)* An projectile of mass m = 10 kg is launched with initial velocity $\vec{u} = 10\,\hat{i}\ \mathrm{m/s} + 10\,\hat{\mathrm{j}}\ \mathrm{m/s}$. The gravitational field points along $-\hat{j}$.

   At the highest point of its trajectory, the projectile explodes into two identical pieces. One of the pieces (fragment A) acquires extra momentum $\Delta\vec{p}_A$ = 50 kg m/s $\hat{i}$ due to the explosion.

   (Call the other piece fragment B.)

   (a) Calculate the distance along the x-axis between the launch point and the explosion point.

   (b) Calculate the extra momentum acquired by fragment B due to the explosion.

   (c) Calculate the distance from the launch point to the landing point for fragment A and fragment B.