PHYS-3203 Homework 6 Due 9 Mar 2022

This homework is due to `https://uwcloud.uwinnipeg.ca/s/QGK3eGfDRgND6sC` by 10:59PM on the due date. Your file(s) must be in PDF format; they may be black-and-white scans or photographs of hardcopies (all converted to PDF), PDF prepared by LaTeX, or PDF prepared with a word processor *using an equation editor.*
Note that I cannot give an extension on this assignment due to the midterm test.

1. **Exploding Cannonball** *inspired by a problem by Barton (and other texts)*

   A cannonball is launched in an arc with velocity $\vec{u}$. At the top of its trajectory, a chemical charge in it explodes into two parts of masses m_1 and m_2 that separate in the horizontal direction only. The explosion releases energy E, which essentially all goes into the kinetic energy of the cannonball pieces. Show that they are separated by a distance $(u_y/g)\sqrt{2E(m_1+m_2)/m_1m_2}$ when they land, where u_y is the initial vertical component of the velocity.

2. **Sun, Earth, and Moon**

   The earth (mass $M_\oplus$) and moon (mass m) orbit each other at a distance a with period T. The earth-moon center of mass orbits the sun (mass $M_\odot$) at a distance b and period $13T$. You may treat all orbits as circular and use $m \ll M_\oplus \ll M_\odot$.

   (a) What is the total angular momentum in the rest frame of the center of mass of all three objects?

   (b) What is the total kinetic energy in the rest frame of the center of mass of all three objects?

3. **Chain Sliding Off a Table**

   A chain of linear mass density μ and length L lies stretched out linearly on a table with one end hanging over the end. The chain slides off the table frictionlessly, and gravity pulls on the part of the chain hanging off the table. The length of the chain hanging off the table is x, and the chain slides off the table at speed $\dot{x}$.

   (a) What is the vertical center of mass position of the chain, assuming the table is at vertical position $y = 0$?

   (b) What are the kinetic and potential energies of the chain?

   (c) If the chain is initially at rest when $x = 0$ (ie, when it is just starting to slide off the table), use energy conservation to find the speed when $x = L$ (when it has just slide entirely off the table).