PHYS-3203 Homework 10 Due 3 April 2023

This homework is due to `https://uwcloud.uwinnipeg.ca/s/NwC99SeB7qHz9Ky` 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*.

1. **Neutrino Recoil**

   When a muon-neutrino and an electron collide, the neutrino and electron can transform into an electron-neutrino and a muon. For reference, the electron and muon have masses m_e and m_μ respectively with $m_\mu > m_e$, and you may approximate both types of neutrino as being massless.

   (a) If the electron is initially at rest, what is the minimum initial neutrino energy required for this process to occur?

   (b) Suppose the electron is initially at rest and the final electron-neutrino moves off at an angle θ from the initial direction of motion of the muon-neutrino. If the initial muon-neutrino energy is E, find the energy of the electron-neutrino.

2. **Relativistic Newton's Cradle**

   A particle of type B smashes into a particle of type C, turning into one particle of type A and one of type D, with masses $m_A < m_B < m_C < m_D$. Suppose that the C particle is intially at rest and the D particle is produced also at rest. What is the initial energy of the B particle?