SPECIAL RELATIVITY HOMEWORK – WEEK 3

Exercise 1. *A neutron in isolation is unstable, with a half-life of several minutes. It eventually decays into a proton, an electron and an anti-neutrino – a process known as β-decay. You can look up the masses of the neutron, the proton and the electron. The mass of the anti-neutrino is negligible (and unknown; and ill-defined; long story). In the rest frame of the original neutron, what is the maximal energy of the outgoing anti-neutrino?*

In the lecture, I slightly messed up the definition of Mandelstam variables. Here, we'll introduce the correct one and play with it. For incoming 4-momenta p_1^μ, p_2^μ and outgoing 4-momenta $p_1'^\mu, p_2'^\mu$, the Mandelstam variables are defined as:

$$s = -(p_1 + p_2)^2 \ ; \quad t = -(p_1' - p_1)^2 \ ; \quad u = -(p_2' - p_1)^2 \ . \tag{1}$$

Exercise 2. *Understand why these are equivalent to:*

$$s = -(p_1' + p_2')^2 \ ; \quad t = -(p_2' - p_2)^2 \ ; \quad u = -(p_1' - p_2)^2 \tag{2}$$

Then, express $s + t + u$ in terms of the particles' masses m_1, m_2.