Problem 1. 1

Using both relativistic and non-relativistic kinematics, calculate the kinetic energy of a proton with β=0.001, 0.01, 0.1, 0.2 and 0.5. Estimate where you start seeing a significant (>5%) difference between the relativistic and non-relativistic energies.

Solution

When approaching this relativistically, we know that $E = \gamma mc^2$, $\gamma = \frac{1}{\sqrt{1-\beta^2}}$, and $E = T + mc^2$.

$$\begin{aligned} E &= T + mc^2 && (1) \\ T &= E - mc^2 && (2) \\ &= \gamma mc^2 - mc^2 && (3) \\ &= (\gamma - 1)mc^2 && (4) \end{aligned}$$

When considering this from a classical perspective, we know that:

$$\begin{aligned} T &= \frac{1}{2}mv^2 && (5) \\ &= \frac{1}{2}mc^2\frac{v^2}{c^2} && (6) \\ &= \frac{1}{2}\beta^2 mc^2 && (7) \end{aligned}$$

Problem 2. 2

Using relativistic kinematics, calculate the neutron threshold energy for: $\mathrm{n} + {}^{12}\mathrm{C} \longrightarrow \mathrm{n} + 3\,\alpha (\alpha = {}^{4}\mathrm{He})$

Solution

Got a little chemistry here. Glad I loaded that mchem package.