

54. Conservation of energy gives $Q = K_\alpha + K_n$, and conservation of linear momentum (due to the assumption of negligible initial velocities) gives $|p_\alpha| = |p_n|$. We can write the classical formula for kinetic energy in terms of momentum:

$$K = \frac{1}{2}mv^2 = \frac{p^2}{2m}$$

which implies that $K_n = (m_\alpha/m_n)K_\alpha$. Consequently, conservation of energy and momentum allows us to solve for kinetic energy of the alpha particle which results from the fusion:

$$K_\alpha = \frac{Q}{1 + \frac{m_\alpha}{m_n}} = \frac{17.59 \text{ MeV}}{1 + \frac{4.0015 \text{ u}}{1.008665 \text{ u}}} = 3.541 \text{ MeV}$$

where we have found the mass of the alpha particle by subtracting two electron masses from the ${}^4\text{He}$ mass (quoted several times in this and the previous chapter). Then, $K_n = Q - K_\alpha$ yields 14.05 MeV for the neutron kinetic energy.