

44. (a) The proper lifetime Δt_0 is $2.20\ \mu\text{s}$, and the lifetime measured by clocks in the laboratory (through which the muon is moving at high speed) is $\Delta t = 6.90\ \mu\text{s}$. We use Eq. 38-7 to solve for the speed:

$$v = c \sqrt{1 - \left(\frac{\Delta t_0}{\Delta t} \right)^2} = 0.9478c$$

or $v = 2.84 \times 10^8\ \text{m/s}$.

- (b) From the answer to part (a), we find $\gamma = 3.136$. Thus, with $m_\mu c^2 = 207m_e c^2 = 105.8\ \text{MeV}$ (see Table 38-3), Eq. 38-49 yields

$$K = m_\mu c^2 (\gamma - 1) = 226\ \text{MeV} .$$

- (c) We write $m_\mu c = 105.8\ \text{MeV}/c$ and apply Eq. 38-38:

$$p = \gamma m_\mu v = \gamma m_\mu c \beta = (3.136)(105.8\ \text{MeV}/c)(0.9478) = 314\ \text{MeV}/c$$

which can also be expressed in SI units ($p = 1.7 \times 10^{-19}\ \text{kg}\cdot\text{m/s}$).