37.25. **Model:** Use the relativistic expression for the total energy.
Solve: **(a)** The energy of the proton is

$$E = \gamma_p mc^2 = \frac{1}{\sqrt{1 - v^2/c^2}} mc^2 = \frac{1}{\sqrt{1 - (0.99)^2}} mc^2 = (7.089)\left(1.67 \times 10^{-27}\ \text{kg}\right)\left(3.0 \times 10^8\ \text{m/s}\right)^2$$

$$= 1.065 \times 10^{-9}\ \text{J} \times \frac{1\ \text{eV}}{1.6 \times 10^{-19}\ \text{J}} = 6.66 \times 10^9 \text{eV} = 6.66\ \text{GeV}$$

(b) Likewise, the energy of the electron is

$$E = \frac{1}{\sqrt{1 - (0.99)^2}}\left(9.11 \times 10^{-31}\ \text{kg}\right)\left(3.0 \times 10^8\ \text{m/s}\right)^2 = 5.812 \times 10^{-13}\ \text{J} \times \frac{1\ \text{eV}}{1.6 \times 10^{-19}\ \text{J}} = 3.63 \times 10^6\ \text{eV} = 3.63\ \text{MeV}$$

Assess: The total energy E for the proton is larger than that for the electron by the factor $m_{\text{proton}}/m_{\text{electron}} = 1833$.