

2.7 a) $200 \text{ GeV}/A$

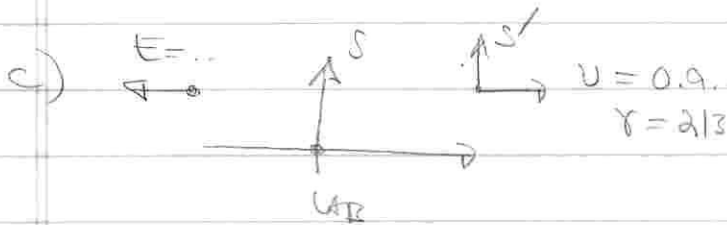
$$\sim 200 \text{ GeV} = \gamma m_p c^2 = \gamma 0.938 \text{ GeV}$$

$$\sim \gamma = 213 = \frac{1}{\sqrt{1 - (\frac{v}{c})^2}}$$

$$1 - (\frac{v}{c})^2 = \frac{1}{213^2} \quad \sim \frac{v}{c} = \sqrt{1 - \frac{1}{213^2}} = 0.999988$$

b) $E = \sqrt{p^2 c^2 + m^2 c^4} \approx pc$

$$P = E/c = 197 \times 200 \text{ GeV}/c = 3.94 \times 10^4 \text{ GeV}/c$$



$$E' = \gamma (E - v p) \approx \gamma (E - v \frac{E}{c})$$

$$\approx \gamma E (1 - \frac{v}{c}) = \gamma E (1 + |\frac{v}{c}|)$$

$$\approx 2\gamma E \approx 2 \times 213 \times 197 \times 200 \text{ GeV}$$

$$\approx 1.6 \times 10^7 \text{ GeV}$$