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Homework 3

1a)

$$show: \frac{v}{c} = \beta = sqrt(1 - \frac{1}{(1+\epsilon)^2})$$

$$m_o(1+\epsilon) = m = \frac{m_o}{sqrt(1-\beta^2)}$$

$$1 + \epsilon = \frac{1}{sqrt(1 - (sqrt\left(1 - \frac{1}{(1+\epsilon)^2}\right)^2)}$$

$$1 + \epsilon = \frac{1}{sqrt(1 - 1 - \frac{1}{(1+\epsilon)^2})}$$

$$1 + \epsilon = \frac{1}{sqrt(\frac{1}{(1+\epsilon)^2})}$$

$$1 + \epsilon = \frac{1}{\frac{1}{(1+\epsilon)}}$$

$$1 + \epsilon = 1 + \epsilon$$

Since these quantities are equal, the original statement is true.

b)

$$(1+\epsilon)^2 = 1 + 2\epsilon + \epsilon^2$$

$$Since\ \beta \ll 1, \qquad \epsilon \ll 1, \qquad \text{so } \epsilon^2 \sim 0.$$

$$\therefore (1+\epsilon)^2 = 1 + 2\epsilon$$

$$\therefore \beta = sqrt(1 - \frac{1}{1+2\epsilon})$$

$$If\ we\ factor\ out\ a\ factor\ of\ (1+2\epsilon)\ from\ the\ argument\ of\ the\ sqrt,$$

$$\beta = sqrt((1+2\epsilon) - 1)$$

$$\beta = sqrt(2\epsilon)$$

This is the quantity we were trying to get, so at low speeds, β is approximately sqrt(2ϵ)

2) Classical speed, 43.74e6 m/s

Relativistic speed, 43.39e6 m/s

Percent error, 0.79%

3) Kinetic Energy, 93.956 MeV

Relativistic speed, 124.893e6 m/s

4) Scattering Angle, 29.279 degrees

5) E max, 0.255 MeV

6) 10 eV wavelength, 3.878e-10 m

1000 eV wavelength, 3.878e-11 m

10e7 eV wavelength, 1.226e-13 m

7) Water wavelength, 9.229e-12 m

Cheese wavelength, 5.522e-34 m