

$$1) \quad \vec{p} = (5, 3, 0, 0)$$

$$m^2 = \vec{p} \cdot \vec{p} = p_t^2 - (p_x^2 + p_y^2 + p_z^2)$$

$$= (25 - 9) \text{ kg}^2$$

$$m^2 = 16 \text{ kg}^2$$

$$\boxed{m = 4 \text{ kg}}$$

$$2) \quad \Delta v_0 = 0.5c \quad v > 0.92c$$

$$\Delta v_1 = 0.5c$$

$$v_1 = 0.5c = 0.5$$

$$v_2 = \frac{v_1 + \Delta v_0}{1 + \Delta v_0 v_1} = \frac{0.5 + 0.5}{1 + (0.5)(0.5)} = 0.8c$$

$$v_3 = \frac{v_2 + \Delta v_0}{1 + \Delta v_0 v_2} = \frac{0.8 + 0.5}{1 + (0.8)(0.5)} = 0.929c$$

$$v_4 = \frac{v_3 + \Delta v_0}{1 + \Delta v_0 v_3} = \frac{0.929 + 0.5}{1 + (0.929)(0.5)} = 0.976c$$

4 steps

3)

$$E_m = 2 \times 10^5 \frac{\text{V}}{\text{m}}$$

$$d = 4 \times 10^{-3} \text{ m}$$

$$I = S = \frac{E^2}{2\mu_0 c} = \frac{\left(2 \times 10^5 \frac{\text{V}}{\text{m}}\right)^2}{2 \left(1.26 \times 10^{-6} \frac{\text{T} \cdot \text{m}}{\text{A}}\right) (3 \times 10^8 \text{ m/s})}$$

$$S = 5.29 \times 10^7 \frac{\text{J}}{\text{s} \cdot \text{m}^2}$$

$$r = \frac{d}{2} = 2.0 \times 10^{-3} \text{ m}$$

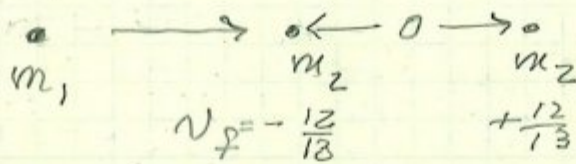
$$\phi = S \times \pi r^2$$

$$= 5.29 \times 10^7 \frac{\text{J}}{\text{s} \cdot \text{m}^2} \pi (2.0 \times 10^{-3} \text{ m})^2$$

$$\phi = 6.65 \times 10^2 \frac{\text{J}}{\text{s}}$$

$$B = \frac{E}{c} = \frac{2 \times 10^5 \text{ V/m}}{3 \times 10^8 \text{ m/s}} = 6.7 \times 10^{-4} \text{ T}$$

4)



$$m_2 = ?$$

$$\underline{p}_i = (m_1, 0, 0, 0) = \underline{p}_f = \left(\frac{m_2}{\sqrt{1-v_f^2}}, \frac{m_2 v}{\sqrt{1-v^2}}, 0, 0 \right) + \left(\frac{m_2}{\sqrt{1-v^2}}, -\frac{m_2 v}{\sqrt{1-v^2}}, 0, 0 \right)$$

$$\underline{m}_1^2 = \underline{p}_i \cdot \underline{p}_i = m_1^2$$

$$\underline{m}_f^2 = \underline{p}_f \cdot \underline{p}_f = \left(\frac{2m_2}{\sqrt{1-v^2/c^2}} \right)^2$$

$$m_1 = \frac{2m_2}{\sqrt{1-v^2/c^2}}$$

Conservation of 4-momentum

$$m_2 = \frac{m_1 \sqrt{1-v^2/c^2}}{2}$$

$$= \frac{2}{\sqrt{1-\left(\frac{12}{13}\right)^2}} m_1$$

$$m_2 = 0.192 m_1$$