大学物理第八次作业

9.3, 9.6, 9.13, 9.17, 9.19

9.3

(a)

已知 $l_0 = 200\ \mathrm{m}, \beta = 0.60, x' = -200\ \mathrm{m}$

$\because t = \gamma(t' + \dfrac{u}{c^2}x')$

$\therefore t' = -\dfrac{u}{c^2}x' = \dfrac{0.6 \times 200\ \mathrm{m}}{c} = 0.40\ \mu\mathrm{s}$

(b)

$\because x' = \gamma(x - ut)$

$\therefore t = -\dfrac{x'}{\gamma u} = 0.89\ \mu\mathrm{s}$

(c)

$\because x = \gamma(x' + ut')$

$\therefore t' = \dfrac{-x'}{u} = 1.1\ \mu\mathrm{s}$

9.6

$$\therefore \beta = \frac{\left(\dfrac{\lambda}{\lambda_0}\right)^2 - 1}{\left(\dfrac{\lambda}{\lambda_0}\right)^2 + 1} = 0.742$$

$$\therefore v = \sqrt{\frac{1-\beta}{1+\beta}}c = 2.23 \times 10^8\ \mathrm{m/s}$$

9.13

$$\because v_x' = \frac{v_x - u}{1 - v_x \dfrac{u}{c^2}}$$

$$\therefore v_x' = -u$$

$$v_y' = \frac{v_y}{\gamma} = 0.48c$$

$$\theta = \arctan \frac{0.48c}{0.80c} = 31^\circ$$

9.17

不妨假设原来 Σ 速度 v_0 方向向右, 且 π 介子方向向上, $E_k = \frac{1}{2} m_\Sigma v_0^2 = 250\ \mathrm{MeV}$

假设中子向下速度为 v_y, 向右速度为 $v_x = v_0$

由竖直动量守恒

$$\therefore m_\pi v_y' = m_n v_y$$

由能量守恒

$$\therefore \frac{1}{2} m_\Sigma v_0^2 + (m_\Sigma c^2 - m_\pi c^2 - m_n c^2) = \frac{1}{2} m_\pi v_y'^2 + \frac{1}{2} m_n v_y^2 + \frac{1}{2} m_n v_0^2$$

最终可解得结果, 且中子运动方向向右下方.

9.19

$$\because p^2 c^2 = E^2 - m_0^2 c^4 = E^2 \left(1 - \frac{m_0^2}{m^2}\right) = E^2 \left(1 - \frac{1}{\gamma^2}\right)$$

$$\therefore p = \frac{E}{c} \left(1 - \frac{1}{\gamma^2}\right)^{\frac{1}{2}} \approx \frac{E}{c} \left(1 - \frac{1}{2\gamma^2}\right)$$