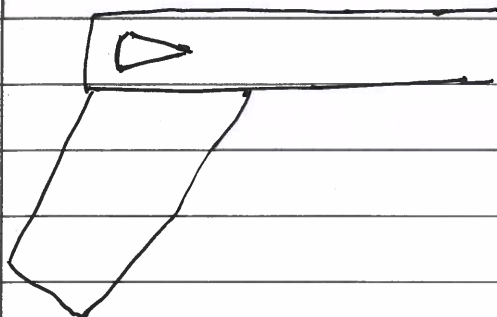


Wednesday, February 4, 2026

Example : Momentum conservation : rifle recoil

Before



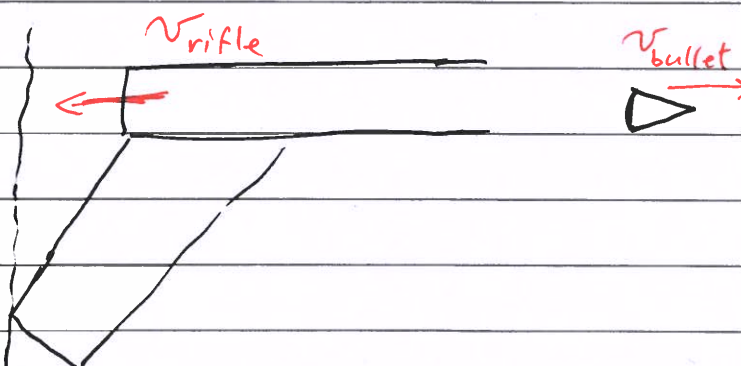
$$v_{\text{bullet}} = 0 \text{ m/s}$$

$$v_{\text{rifle}} = 0 \text{ m/s}$$

$$m_{\text{bullet}} = 10 \text{ g} = 0.01 \text{ kg}$$

$$m_{\text{rifle}} = 3 \text{ kg}$$

After



$$v_{\text{bullet}} = 1000 \text{ m/s}$$

$$v_{\text{rifle}} = v_{\text{recoil}} = ?$$

Initial Momentum : $p = mv$

$$p_{\text{bullet},i} = (0.01)(0) = 0 \text{ kg} \cdot \text{m/s}$$

$$p_{\text{rifle},i} = (3)(0) = 0 \text{ kg} \cdot \text{m/s}$$

$$\begin{aligned} \Rightarrow p_{\text{total},i} &= p_{\text{bullet},i} + p_{\text{rifle},i} \\ &= 0 \end{aligned}$$

Final Momentum : $\underbrace{P_{\text{total},i} = P_{\text{total},f} = 0}_{\text{Required by conservation of momentum}}$

$$P_{\text{bullet},f} = (0.01)(1000) = 10 \text{ kg} \cdot \text{m/s}$$

$$P_{\text{rifle},f} = ?, \text{ but } \underbrace{P_{\text{bullet},f} + P_{\text{rifle},f}}_{P_{\text{total},f}} = 0$$

$$\Rightarrow P_{\text{rifle},f} = -P_{\text{bullet},f}$$

$$\Rightarrow \underbrace{m_{\text{rifle}}}_{3 \text{ kg}} \cdot v_{\text{rifle},f} = -10 \text{ kg} \cdot \text{m/s}$$

$$\Rightarrow v_{\text{rifle},f} = \frac{-10}{3} = -3.33 \text{ m/s} = v_{\text{recoil}}$$