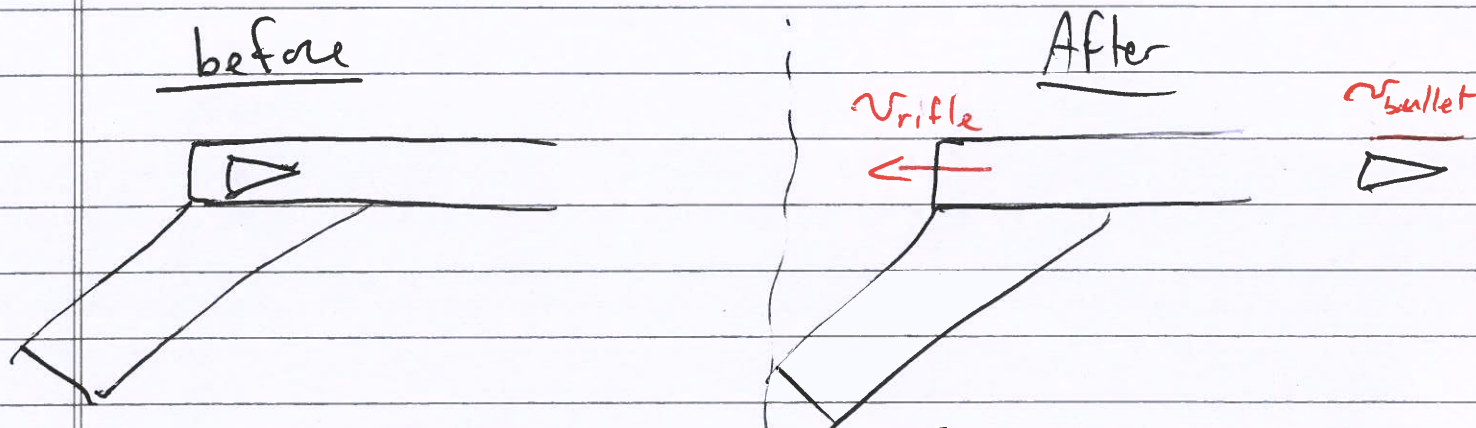


Wednesday, February 5, 2025

#1

Example: Momentum conservation: rifle recoil



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

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

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

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

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

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

Initial Momentum: $p = mv$

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

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

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

Final Momentum: $P_{total, i} = P_{total, f} = 0$ by conservation of momentum

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

$$P_{rifle, f} = ? \text{, but } \overbrace{P_{bullet, f} + P_{rifle, f}}^{P_{total, f}} = 0 \Rightarrow P_{rifle, f} = -P_{bullet, f}$$

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

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