CH 10.II: COLLISIONS

1. A car of mass 1850 kg is traveling at 28 m/s in a direction that is 35° north of east. (Let east be the positive-x direction, and let north be the positive-y direction.) A second car of mass 2200 kg is traveling at 32 m/s in a direction that is 12° east of south. (Draw good pictures to get these velocity directions right!) The two cars collide in a maximally inelastic collision. The coefficient of friction between the car tires and the road surface is 0.378.

(a) How far and in what direction do the coupled cars slide after the collision?

(b) What percent of the initial kinetic energy is lost in the collision?
Before:

\[ m_1, v_1 \cos \theta_1 + m_2 v_2 \sin \theta_2 = M v_f \cos \theta_f \]

\[ \Rightarrow v_f \cos \theta_f = \frac{m_1 v_1 \cos \theta_1 + m_2 v_2 \sin \theta_2}{M} = 14.1 \text{ m/s} \] (A)

\[ M, v_1 \sin \theta_1 - m_2 v_2 \cos \theta_2 = -M v_f \sin \theta_f \]

\[ \Rightarrow v_f \sin \theta_f = \frac{m_2 v_2 \cos \theta_2 - m_1 v_1 \sin \theta_1}{M} = 9.67 \text{ m/s} \] (B)

\[ \frac{B}{A} : \quad \frac{v_f \sin \theta_f}{v_f \cos \theta_f} = \tan \theta_f = 0.686 \quad \Rightarrow \theta_f = 34.4^\circ \] (C) (South of East)

\[ A : \quad v_f = \frac{14.1 \text{ m/s}}{\cos \theta_f} = 17.1 \text{ m/s} \]

After collision:

\[ F \cdot D \cdot \theta \quad \text{steps}\]

\[ W_f = -K_i = -\frac{1}{2} M v_f^2 = -5.92 \times 10^5 \text{ J} \]

Part: \[ W_f = \int F_f \cdot dl = \int F \cdot dl \cos (180^\circ) = -F_f D \]

Thus: \[ W_f = -\mu Mg \cdot D \quad \Rightarrow \quad D = \frac{W_f}{(-\mu Mg)} = 39.4 \text{ m} \]

(b) Find \% kinetic loss:

\[ K_{\text{before}} = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 = 1.85 \times 10^6 \text{ J} \]

\[ K_{\text{after}} = 5.92 \times 10^5 \text{ J} \quad \text{(from part a)} \]

Thus: \[ \% \text{ kinetic loss} = \frac{K_{\text{before}} - K_{\text{after}}}{K_{\text{before}}} \times 100 \% = 16.8 \% \]