Inelastic Collisions– Prelab Quiz

Answer these questions after reading the "Inelastic Collisions" assignment. Be sure to show all of your work so that partial credit can be given.

1. **[3 points]** A mass, m_2, is initially at rest. A mass, m_1, traveling with velocity, v_i, collides with m_2 in an inelastic collision. After the collision, the two masses stick together and move as one with velocity v_f.

   The fractional energy lost in a collision is given by:

   $$F = \frac{|K_i - K_f|}{K_i} \tag{0.1}$$

   Where K_i and K_f are the initial and final kinetic energy of the system respectively.

   Using expressions for the initial and final kinetic energies and the conservation of momentum, demonstrate that the fractional energy loss can also be written as:

   $$F = \frac{m_2}{m_1 + m_2}. \tag{0.2}$$

2. **[2 points]** Equations 0.1 and 0.2 demonstrate two different ways of measuring the same quantity, fractional energy loss, F.

   We can call Equation 0.1 the *observed* fractional energy loss, F_{observed}, because we can calculate initial and final kinetic energies directly from the cart velocities that we can measure.

   We can call Equation 0.2 the *predicted* fractional energy loss, $F_{\text{predicted}}$, because it depends only on the masses of the two carts in the collision.

   One way to test the agreement between the *observed* quantity to the *prediction* is to plot one against another.

   Sketch a cartoon plot of F_{observed} vs. $F_{\text{predicted}}$ complete with a linear "fit". Assuming that your observations match the predictions of the theory well, what slope and intercept do you expect?

3. **[3 points]** Masses m_1 and m_2 are measured and their uncertainties estimated to be δm_1 and δm_2 respectively. Write an expression for the uncertainty in the the *predicted* fractional energy loss $F_{\text{predicted}}$ in terms of the measured quantities: m_1, m_2, δm_1, and δm_2.

4. **[2 points]** Suppose a student consistently observes $F_{\text{observed}} > F_{\text{predicted}}$ throughout their experiment.

   What trend do we expect to see in the plot described in Problem 2?

   Identify and describe a possible mechanism (systematic effect) that could explain this observation.