Lab 8
Momentum & Kinetic Energy Lab Guidelines

Activity 1: Physics is Candy for the Mind

Two carts of mass $m_1$and m_2 roll on a track with initial velocity v_{1i} and v_{2i} respectively and undergo an elastic collision with each other. Show that the final expressions to calculate the final velocities v_{1f} and v_{2f} are;

$$v_{1f} = \frac{m_1 - m_2}{m_1 + m_2} v_{1i} + \frac{2m_2}{m_1 + m_2} v_{2i}$$

$$v_{2f} = \frac{2m_1}{m_1 + m_2} v_{1i} + \frac{m_2 - m_1}{m_1 + m_2} v_{2i}$$

Activity 2: Determine if momentum and kinetic energy are conserved in *elastic* collisions.

a. Start *DataStudio* and set up two "Phototgate" sensors with appropriate velocity displays. For the velocity displays use the digit window and select the velocity in gate Ch 1 for the left Phototgate. For the right Phototgate use another digit window and select the velocity in gate Ch 2. Double-click on the photogate icon in the set up box to access the Sensor Properties dialog box. Select the Constants tab and adjust the band spacing to read 0.1*m* (the default is 0.05*m*). Select the Measurements tab and check velocity only.

b. Adjust the height of the photogates above the dynamics track such that the 10*cm* bands on the picket fences pass through the photo detector when the picket fence rides the cart. Recall that friction is a dissipative force that drains a system's momentum and kinetic energy, and converts it to distortions, sound, heat, and even light. Adjust the level of your dynamics track in such a way that the speed of a given cart appears to remain constant as it passes through two photogates spaced 40*cm* to 50*cm* apart. This adjustment will allow you to use the force of gravity to compensate for small losses due to friction. This will work only so long as the carts travel <u>one way</u> down the track.

c. Keep in mind that a quantity is conserved in a collision if the amount of the quantity before the collision, X_1, equals the amount of that same quantity after the collision, X_2. That is, if $X_2 - X_1 = 0$, then X is conserved. To the extent of the difference, the quantity is not conserved.

d. Experiment: The equipment that you have is best for an elastic collision if you have two identical dynamics carts (PASCO ME-9454) that have between them four strong neodymium magnets arranged on their ends and put on the track in such a way that two carts repel each other when their ends are brought into proximity with one another. The magnets will keep the carts from actually contacting each other during a so-called "collision," so long as the collision isn't too violent. Also the collision process is easier to analyze if one of the cart is kept at rest between the two Photogates. Determine the velocity of the carts before and after the collision and record it on the worksheet. Then test to see if momentum and kinetic energy are conserved within reasonable experimental error.

Activity 3: Determine if momentum and kinetic energy are conserved in *inelastic* collisions.

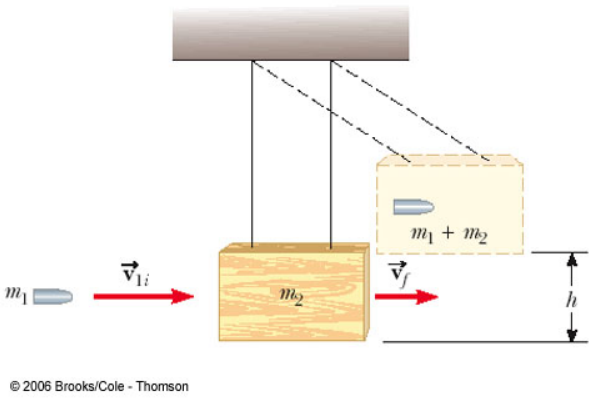
a. Experiment: The equipment that you have is best for an inelastic collision if you have dynamics carts that have no neodymium magnets on their ends and the carts can be made to stick together. Inelastic collisions in this lab will be represented by collisions between two dynamics carts that stick together – <u>though sticking together is not a requirement for inelastic collisions</u>. Place two "rounds" of tape on the contact ends of two colliding carts. When the carts collide, they should stick together. Also the collision process is easier to analyze if one of the cart is kept at rest between the two Photogates. Determine the velocity of the carts before and after the collision and record it on the worksheet. Then test to see if momentum and kinetic energy are conserved within reasonable experimental error.

Activity 4: Ballistic Pendulum

1. A bullet of mass m_1 is shot with speed v_i into a wooden block of mass m_2. Derive an expression that gives the initial velocity of the bullet v_i in terms of masses m_1, m_2, acceleration due to gravity g and the height h thru which the pendulum is raised.

2. Perform the experiment with the Ballistic pendulum equipment. Measure the relevant quantities and use the expression derived in 1) to determine the numerical value of the initial velocity v_i.

3. Perform an independent experiment with the Ballistic pendulum equipment to measure the initial velocity of the bullet. Hint you will not need the pendulum part so you can detach and remove it from the setup. Careful: shooting a bullet with the gun can damage other equipment or hurt someone. Take proper precaution to observe safety procedures.



Momentum & Kinetic Energy Work Sheet

Elastic Collision
Data
M_1 = M_2 =

V_{1i} = V_{2i} = V_{1f} = V_{2f} =

Conservation of Momentum

Conservation of Energy

In-Elastic Collision
Data
M_1 = M_2 =

V_{1i} = V_{2i} = V_{1f} = V_{2f} =

Conservation of Momentum

Conservation of Energy