Physics 101 Fall 2009 Lab 7: Collisions!

Goal:

Collisions occur when two or more objects crash into one each other. More specifically, a collision is an interaction between two or more objects in which a relatively strong force acts between the objects for a relatively short time. Keeping this in mind, let's put to use what we have learned in class about collisions and see how well we can describe our world quantatively.

Background:

The momentum of an object, $\vec{\mathbf{p}}$, is its mass times velocity, or $\vec{\mathbf{p}} = m\vec{\mathbf{v}}$. In general, the momentum of an object is a vector (because the velocity of an object is a vector). For this lab we will be working in one dimension so that we only have to worry about distinguishing left from right with the appropriate sign. If there are several objects, the total momentum of all objects is the sum of their individual momenta.

The law of conservation of momentum tells us that the total momentum of the colliding objects before the collision is the same after the collision. The total momentum after the collision is just distributed differently.

Question: What is assumed when stating that the total momentum of the system of colliding objects does not change before and after the collision?

Question: How is the conservation of momentum expressed in terms of an equation for a two object collision?

Collisions that conserve momentum *and* kinetic energy are called elastic collisions.

Questions: What is the expression for kinetic energy in terms of an object's mass and speed? How is the conservation of kinetic energy expressed for a two object elastic collision? How does an elastic collision compare with an inelastic one?

Materials:

Track, two carts, motion detectors, Iron bar, Logger Pro, scale

Activity 1: Elastic collisions

(1) Weigh the two carts and record their masses. Keep track of which cart is which.

(2) Place the two carts on the track and practice gently colliding the two carts together. Make sure that the carts *do not* stick together. If they do because of the velcro, change the orientation of one of the cars.

(3) Open the Logger Pro Collisions file. Ask your TA if you cannot find it. After you have done that, there should be two graphs on your computer screen. The top graph measures the displacement of both carts—one color for each cart—as a function of time. The bottom graph measures the velocity of both carts—again, one color for each cart—as a function of time.

(4) Before starting, zero both motion sensors by clicking on the *Zero sensors* button.

(5) Now collect data while moving the carts individually to figure out which color for the two graphs corresponds to which cart and take note of it. Keep in mind that the origin of the displacement for each cart is set to zero. Come up with a way to look at the displacement versus time graph to determine where the collision occurs. Write it down.

(6) Now place each car near their respective ends of the track and set them in motion towards each other. Click on *collect* to begin taking data.

(7) What do the two graphs look like? Sketch both. Be sure to identify on each graph (i) the

region before the collision (ii) the region during the collision (iii) the region after the collision.

(8) Using the "x=" button on Logger Pro, determine velocity of each cart before the collision and after the collision and check if the total momentum of the two-cart system is conserved before and after the collision. Show your work. Is momentum conserved within 10 percent accuracy? If not, why?

(9) Is kinetic energy conserved within 10 percent accuracy? If not, why?

Activity 2: Inelastic collisions

(1) Weigh each cart and record their masses. Keep track of which cart is which.

(2) Orient the carts so that when they collide, they stick together.

(3) Open the Logger Pro Inelastic file. Ask your TA if you cannot find it. After you have done that, there should be two graphs on your computer screen. The top graph measures the displacement of one cart as a function of time. The bottom graph measures the velocity of that same cart as a function of time. Note that there is only one working detector. Determine which one it is.

(4) Before starting, zero the working motion sensor by clicking on the *Zero sensors* button.

(5) Place one car near the end of the track with the working motion detector. Then place the other cart near the middle of the track. Set the cart at the end of the track in motion towards the

stationary cart. Click on *collect* to begin taking data. Because there is only one working motion detector, there can be only one "object" moving at one time.

(6) What do the two graphs look like? Sketch both. Identify on each graph (i) the region before the collision (ii) the region during the collision (iii) the region after the collision.

(7) Using the "x=" button on Logger Pro, determine the velocity of each cart before the collision and after the collision and check if the total momentum of the two-cart system is conserved before and after the collision. Show your work. Is momentum conserved within 10 percent accuracy? If not, why?

(8) Is kinetic energy conserved within 10 percent accuracy? If not, why?