PHY131 Practicals Day 5 Student Guide

Summer 2009 – Best of luck on the test today!

Concepts of this week's Module

- Impulse-momentum Theorem
- Conservation of Momentum
- Introduction to Conservation of Energy

Mechanics Module 4, *Activity 1*

Setup:

- Make sure the Track is level.
- The Motion Sensor should be mounted on the end of the Track closest to the wall and connected to the DAQ board.
- A Clamp should be attached about half-way down the track for the cart to collide with.
- The Force Sensor with the spring bumper attached should be mounted on the Cart. Measure the total mass of the Cart and Force Sensor.
- Place the Cart on the Track with the bumper facing the clamp. Connect the Force Sensor to the DAQ board. Press the *Tare* button on the Force Sensor to zero its readings.
- Run the Cart up and down the Track a few times to warm up the bearings in the wheels.
- Set the sample rate for the Motion Sensor to 50 samples per second. Set the sample rate for the Force Sensor to 100 samples per second.

Now the Activities:

A. You want the spring bumper on the Force Sensor to collide with the clamp. The Cart will drag the wire connecting the Force Sensor to the DAQ board; make sure it is as free to move as possible. You may need to adjust the position of the Track and/or clamp to get a nice "clean" collision.
B. Take data on the speed versus time using the Motion Sensor and force versus time using the Force Sensor from a second or so before the collision to a second or so after the collision.
C. From the speed versus time data, what is the momentum of the Cart plus Force Sensor just before the collision? What is the momentum just after the collision? Use the convention that the speed of the Cart before the collision is a positive number, and the speed after the collision is a negative number.
D. What is the change in the momentum from just before the collision to just after?

E. From the force-time data, visually estimate the total impulse exerted on the Cart during the collision: this is the area under the force-time graph. Compare your result to Part D.
F. Use the software to calculate the total impulse exerted on the Cart. Which result do you think is better, the software's calculation or your estimate in Part E? Explain.

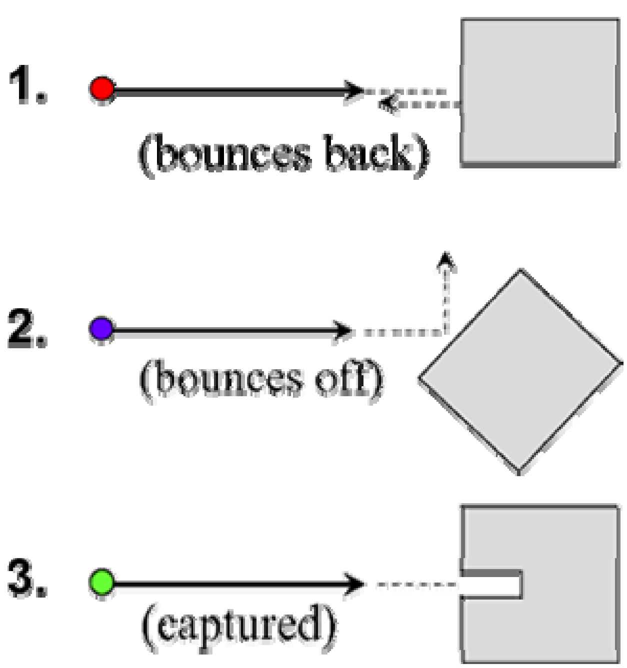
Course Concepts Mechanics Module 4, *Activity 3*

You are asleep in your room, but a fire has broken out in the hall and smoke is pouring in through the partially open door. You need to close the door as soon as possible. The room is so messy you cannot get to the door. You have a ball of clay and a super ball, each with the same mass. If you throw the clay at the door it will stick to it; if you throw the super ball at the door it will bounce off. You only have time to throw one thing at the door.

A. Which should your throw at the door, the clay or the super ball? Explain.
B. Which ball will experience the largest impulse during the collision?
C. From Newton's 3rd Law the impulse that the door exerts on the ball during the collision is equal in magnitude although opposite in direction to the impulse the ball exerts on the door. Which ball exerts the largest impulse on the door?

Course Concepts *If you have time: Mechanics Module 4, Activity 4*

Three identical balls slide on a table and hit a block that is fixed to the table. In the figures we are looking down from above. In each case the ball is going at the same speed before it hits the block.



Rank in order from the largest to the smallest the magnitude of the force exerted on the block by the ball.

Course Concepts *If you have time: Mechanics Module 4, Activity 5*

An *air track* is similar to the Track you have been using in the Practicals. The track has small holes drilled in it, and air blows out of the holes. Thus the carts for the air track float on the air and there is extremely low friction between the cart and the track. An animation of an air track is at:

http://faraday.physics.utoronto.ca/PVB/Harrison/Flash/ClassMechanics/AirTrack/AirTrack.html

There are six possible collisions that may be simulated: three different values for the mass of one of the carts, with elastic "bouncy" and inelastic "sticky" collisions for each value of the mass.

A. The *momentum* $\vec{p} = m\vec{v}$ is also called the *quantity of motion* and sometimes just the *inertia*. For Newton momentum was central to his thinking about dynamics. Use the animation to determine if the total momentum of the carts is conserved before and after each of the six possible collisions.
B. For Leibniz, a contemporary and rival of Newton, momentum was not central to his thinking. Instead he concentrated on the quantity mv^2, which he called the *vis viva* (literally "living force"). Use the animation to determine if the total *vis viva* of the carts is conserved before and after each of the six possible collisions.
C. Which concept, momentum or *vis viva*, appears to be the most fundamental?

Last revision to this write-up: May 24, 2009 by Jason Harlow.

The Mechanics Module 4 Guide was written in July 2007 by David M. Harrison, Dept. of Physics, Univ. of Toronto. Some parts are based on Priscilla W. Laws et al., **Workshop Physics Activity Guide** (John Wiley, 2004), Unit 8. Last revision: August 8, 2008.