

**Regis College Physics 205A, Fall 2008**  
**Lab 5: Conservation of Momentum by Video Analysis**

In this lab, you will experimentally test the ideas that we have discussed about conservation of momentum and energy in collisions.

We will use a set of battery-operated “hover pucks” that direct a stream of air downward so that they can move with little friction on a smooth surface. (The effect is similar to an air hockey table, but the air source is in the puck rather than in the table.) Each group will also use a Canon PowerShot A560 digital camera, which has an excellent movie mode, offering a choice of 30 frames per second at  $640 \times 480$  resolution or 60 frames per second at  $320 \times 240$  resolution.

There are no prelab questions this week: your recent hard work with conservation of momentum in class should have prepared you for the analysis in this lab.

**Technical hints**

To set the camera for movie mode, turn the thumbwheel so that the picture of the movie camera is aligned with the line on the camera. Turn the camera on by pressing the ON/OFF button. To choose between the standard and fast frame rates, press the FUNC/SET button on the back of the camera (the center of the circular control ring), then press on the left or right sides of the control ring to select an option, then press FUNC/SET again. When you're ready to start filming, press the shutter release button; press it again to end the movie. To play back your movie on the LCD screen, first press the play/record button (an arrow pointing right and a red camera icon, above and left from the control ring), then press FUNC/SET twice to play. Press the play/record button again to go back to recording mode.

When you are ready to import the movies onto the computer, connect the USB cable to the port on the left side of the camera (as seen from the front, under a cover marked “DC IN DIGITAL A/V OUT”) and to the front of the computer. The computer should recognize the camera and offer to open a choice of programs: pick the Microsoft Scanner and Camera Wizard. Click “Next” a few times, then choose a name for your movie collection; a subfolder within your “My Pictures” folder will be created by this name to hold your movie files.

**Procedural notes**

1. Try to level your lab table(s) with appropriate shims so that a puck placed on it/them gains little momentum from gravitational interactions.
2. Determine the mass of each puck.
3. Film several collisions between pucks on the table. Include at least:
  - a collision between a moving puck and one that is at rest.
  - a nearly head-to-head collision between two pucks.
  - a glancing collision between two pucks moving in roughly opposite directions.

Hold the camera as steady as you can, with its sensor plane nearly parallel to the plane of the table. Include an object of known length (such as a ruler) in each clip. Check that your video looks reasonable when played back on the camera's display.

4. Start the *Logger Pro* application and open the file "12 Video Analysis.cmbl" in the Tutorials folder. Work through the tutorial on video analysis features.
5. Using the *Logger Pro* software package, select the coordinates of the centers of the pucks in each frame of one of your two-puck collision videos.
6. Determine the  $x$  and  $y$  components of the momentum vectors of each of the pucks before and after the collision. Based on the standard deviation across several frames, estimate the uncertainty of the measurement of each of these momentum components. Is each component of the total momentum of the system conserved (within your estimated experimental uncertainty)?
7. Compute the kinetic energies of each of the pucks, before and after the collision, including uncertainties. Does the total energy of the system appear to be conserved?
8. Repeat steps 5 through 8 for as many of your other two-puck videos as time allows.