What's Cooking Lab

Teacher's Guide

Topic:

Momentum and Collisions

The following information is provided to the student:

Question:
What is the speed of a ball (in miles/hour) fired from a cannon?

Purpose:
To determine the speed (in miles/hour) of a tennis ball which is fired from a cannon.

A complete lab write-up includes a Title, a Purpose, a Data section, and a Conclusion. The Data section should include a diagram of the physical setup, with the specific variables being measured represented in the diagram. Actual data values should be organized in a table with a row-column format. One example calculation should be shown for each type of calculation. The Conclusion should answer the question posed in the Purpose.

Materials Required:

Homemade tennis ball cannon on wheels; wood board; photogate system; mass balance; tennis ball; lighter fuel; matches or lighter.

Description of Procedure:

A homemade tennis ball cannon is placed upon a wood board. The cannon is equipped with a photogate flag which extends from its side. The cannon is loaded with a tennis ball. Lighter fuel is added to the fuel chamber and allowed time to vaporize. A match is used to ignite the cannon. The tennis ball is projected forward at high speeds; a photogate is used to determine the recoil speed of the cannon. The momentum conservation principle is used to calculate the speed of the tennis ball.

Alternative Materials and Procedure:

Alternative materials and procedures are not recommended.

Safety Concern:

There is always a higher than usual level of risk associated with working in a science lab. Teachers should be aware of this and take the necessary precautions to insure that the working environment is as safe as possible. The tennis ball which is projected from the cannon will be traveling very fast upon exit. Students should stand back and away from where it is pointed. Student *horseplay* and off-task behaviors should not be tolerated.

Suggestions, Precautions, Notes:

1. This lab should probably not be done in the classroom. It should not be done near smoke detectors. It should not be done in a small space. (And depending what kind of cannon you build, it might be a lab that should not be done at all.) It should either be done in the hallway or in a safe outdoor location (away from traffic).

The Laboratory

2. After a few trials of this lab, the meaning of the title *What's Cooking* will be evident to your class. And after a few periods of doing this lab, the meaning of the title will be evident to the entire school. If doing the lab indoors, it might be wise to warn the Deans office, police liaison and maintenance staff in advance that you will be cooking up some physics in the hallway.
3. Extreme caution should be taken during this lab. This should be done as a demonstration lab. Students should not be allowed to fire the cannon. The various dangers associated with the lab should be discussed in advance. Keep students away from the cannon.
4. The successful firing of the cannon might be characterized as both an art and a science. As far as the science is concerned, the following seems to be important:
    a. Expect the first round or two to be unimpressive. The reaction becomes more impressive as the fuel chamber heats up.
    b. *Plunge* of cannon after each trial so as to remove exhaust gases from the fuel chamber and to replace it with oxygen-rich air.
    c. Don't use too much lighter fuel. Depending on the cannon, as little as a half of dropper is required. More fuel (as students will urge) is not necessarily better. The concept of chemical stoichiometry governs the most efficient combination of fuel and oxygen.
    d. Once the fuel is added to the fuel chamber, it needs time to vaporize. The amount of time varies from cannon to cannon; 30 seconds works for many cannons. It helps to gently rotate the cannon about its axis in an effort to distribute the unvaporized fuel about the entire fuel chamber.
    e. The type of lighter fuel seems to matter. Some teachers swear by ZIPPO brand fuel. Students who have *done this at home* will have some recommendations for fuel. They are probably great recommendations; but you may want to test them privately before using it with your classes.
    f. The ball definitely matters. A ball which snuggly fits the cannon muzzle is best. *Skinners* are not great balls for use in this lab; *fuzzies* are better.
    g. The placement of the ball in the cannon also seems to matter. Experiment with this.
5. Plans for building a tennis ball cannon are abundantly available on the internet. YouTube has many videos. Viewing a few of the videos will leave you wondering *is this legal*? It would definitely be wise to build one of the tamer-looking models in order to prevent representatives from the Homeland Security Office from visiting your school.

Auxiliary Materials:

None

Scoring Rubric:

M9.	**What's Cooking? Lab**	**Score**
___	Included, labeled and organized all parts of the lab report.	
___	Data section includes a diagram of the physical set up; specific variables being measured are shown and labeled in the diagram. Actual values for these variables for several trials are organized in a table using a row-column format; column headings are provided and units are stated. An example calculation is shown for v_{cannon}, p_{cannon} and v_{ball}; Work is shown and labeled; calculations are correct. Conversion of speed values to miles/hour is performed accurately.	____/____
___	Conclusion answers the *question* posed in the Purpose.	

Connections to The Physics Classroom Tutorial:

The following reading is a suitable accompaniment to this lab:

http://www.physicsclassroom.com/Class/momentum/u4l2e.cfm

Connections to Minds on Physics Internet Modules:

Sublevel 6 of the Momentum and Collisions module is a suitable accompaniment to this lab:

http://www.physicsclassroom.com/mop/module.cfm