

## Sand Balloon Lab

### Teacher's Guide

**Topic:**

Momentum and Collisions

**The following information is provided to the student:**

**Question:**

How does the total momentum (vector sum) of two objects before a collision compare to the total momentum after the collision?

**Purpose:**

To compare the total momentum of two objects before a collision to the total momentum of the two objects after the collision.

A complete lab write-up includes a Title, a Purpose, a Data section, and a Conclusion/Discussion of Results. The Data section should include an organized table of pre- and post-collision velocity and mass values. Work should be shown for each type of calculation performed. The Conclusion/Discussion should involve a comparison of the pre- and the post-collision momentum of the *system* of two objects. An error analysis should be conducted and percent differences should be calculated for the various data trials.

**Materials Required:**

Small balloon; sand; cart; track; computer interfaced motion detector; mass balance.

**Description of Procedure:**

A small balloon is filled with sand and tied up. A motion detector is placed at one end of the track. The cart is placed in front of it. The cart is set in motion with a moderate push. Upon reaching the middle of the track, the sand balloon is released so as to gently fall on the cart and continue in motion on top of the cart. The motion detector is used to determine the pre-collision and post-collision speed of the cart (and the balloon). The mass balance is used to determine the mass of the sand balloon and the cart.

**Alternative Materials and Procedure:**

Pre- and post-collision speeds can be determined with motion detectors (as prescribed above), photogates (the cart will have to be equipped with a *flag*) and even ticker tape timers. If the older style and larger inertia carts are used, a brick could be dropped onto the cart in place of the sand balloon.

**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. Student *horseplay* and off-task behaviors should not be tolerated.

**Suggestions, Precautions, Notes:**

1. [Pasco Scientific](#) is one of several companies which sells low-friction carts equipped with magnets (for elastic collisions), Velcro strips (for inelastic collisions), plungers (for explosions), additional

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masses and a mass tray. These are ideal for collision studies and other mechanics labs. Their lowest cost model is ME-6950.

2. The procedure of dropping the sand balloon on the cart should be demonstrated. Students generally make three mistakes. First, they tend to drop the balloon from too high of a height. Second, students tend to give the balloon a forward push or throw, thus adding momentum to the system which is presumed to not be present. And third, students tend to hold their hand above the track after release of the balloon, thus interfering with the ability of the motion detector to detect the motion of the cart. Demonstrate how to hold the sand balloon just above the height of the cart, how to release the sand balloon from rest without adding momentum to the system, and how to pull your hand away afterwards so as to not interfere with the motion detector.
3. Before collecting data, students should take some time to practice dropping the sand balloon on the cart.

### Auxiliary Materials:

None

### Scoring Rubric:

<b>M6. Sand Balloon Lab</b>	<b>Score</b>
<ul style="list-style-type: none"><li>— Included, labeled and organized all parts of the lab report.</li><li>— Data section includes a table of pre- and post-collision mass and velocity values; column headings and units are included. Momentum values are calculated for the cart, the sand balloon, and the system; results of calculations are labeled (<math>p_{\text{cart}} = \dots</math>); work is shown; units are provided. Measurements are reasonably accurate.</li><li>— Conclusion/Discussion compares the total system for the before- and after-collision situations. An error analysis is conducted and a percent difference comparison is performed; work is clearly shown for the percent difference.</li></ul>	—/—

### Connections to The Physics Classroom Tutorial:

The following reading is a suitable accompaniment to this lab:

<http://www.physicsclassroom.com/Class/momentum/u4l2b.cfm>

<http://www.physicsclassroom.com/Class/momentum/u4l2d.cfm>

### Connections to Minds on Physics Internet Modules:

Sublevels 5 and 7 of the Momentum and Collisions module are a suitable accompaniment to this lab:

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