Walk-in Lab 8
An Inelastic Collision
Physics 121

CID(s): ____________________

Description
This week we will study the conservation of momentum in class, and we’ll use the collision of two masses in
this lab to show how it works. To understand what you will see today requires a combination of conservation
of momentum and conservation of energy. The analysis is pretty simple as long as you remember that
inelastic collisions conserve momentum but not kinetic energy. Have fun, work in groups of up to three
people, and email me your ideas for making the lab better. See you in class, and have a great day.

Objective: To measure the influence of an inelastic collision on the motion of an object.

Equipment: triple beam balance, projectile launcher mounted on a vertical measuring stand, push rod to
load the launcher, brass ball, aluminum ball catcher with clay inside.

Part A – Energy and momentum analysis
You can analyze this whole thing using the conservation of energy and momentum. But you have to be
careful to use the right law at the right time. You will shoot a brass ball of mass \( m \) upward from a spring
into an aluminum cylinder with clay inside to which the ball sticks. (The cylinder+clay has mass \( M \).) The
ball+cylinder+clay then rises to a certain height after the collision. Your job is to predict the height to
which the combined masses rise and then to check your calculation against what actually happens. The
calculation proceeds in three steps.

(1) Imagine shooting the ball without the aluminum catcher present. Use conservation of energy to relate
the upward launch speed \( v \) of the ball to the maximum height \( h_1 \) to which it will rise. To measure \( h_1 \)
you will use the ruler on the vertical rod on which the launcher is mounted. (The \( y = 0 \) point of this ruler is
close enough to where the ball leaves the launcher to get good results in this lab. You will discover that you
can only measure heights of moving objects with this ruler to within a few centimeters anyway.)

(2) Now imagine shooting the ball into the cylinder so that the ball sticks to the clay inside, creating an
inelastic collision between the two masses. Use conservation of energy to relate the speed \( v \) from step (1) to
the final velocity \( v' \) of the combined masses after the inelastic collision.

(3) Finally, use the masses \( m \) and \( M \) as well as \( v' \) from (2) to calculate the height \( h_2 \) to which the
ball+catcher will rise upward after the collision. (Assume that the collision takes place at \( y = 0 \) on the
ruler.) Since the inelastic part of the process is complete after step (2) you can use conservation of energy
again for this part.

Take your results from (1)-(3) and use them to find a formula that relates \( h_1 \) and \( h_2 \). Your answer will
look like \( h_2 = (\ldots)h_1 \); your job is to find what \( (\ldots) \) is.

Write your answer here. \( h_2 = \ldots \ ) h_1
Part B – Comparing measurements to your analysis

Measure the masses and record your results: \( m = \) _________, and \( M = \) _________

Cock the spring gun, place the ball on the launcher, and shoot the ball upward without the catcher in place.

Unless you are really careful about how you cock and fire the gun you will get horrible results.

1. Make sure that you cock the launcher without the brass ball present and make sure that the spring is compressed all the way down, as far as it will go. Pushing it down hard and fast will probably put it all the way down.

2. When you push the trigger to fire it, push the trigger in with your hand and hold it in so that it doesn’t come back out. If you don’t do this the spring will drag against the trigger inside the mechanism and the full force of the spring won’t be used to launch the ball.

Measure \( h_1 \) by eye on the ruler and try to catch the ball so it doesn’t wreck the tile on the floor. Repeat the measurement 3 times and average your result.

\( h_1 = \) _________, _________, _________ Average \( h_1 = \) _________.

Use the measured masses and your average \( h_1 \) in the formula you found in Part A to predict \( h_2 \), the height to which the combined masses will rise when you launch the ball into the catcher.

\( h_2 \) (predicted) = _________

Part C – The moment of truth

Now put the aluminum ball catcher in place, launch the ball into the catcher, and measure how high the ball+catcher goes. CATCH THE BALL+CATCHER! Repeat 3 times and average your result:

\( h_2 = \) _________, _________, _________ Average \( h_2 = \) _________

Compare this to your prediction in part A and calculate your percent error. If you are careful, this ought to be within 10% or so.

\( \text{percent error} = \) _________