TechLab: Such Sweet Sorrow

conservation of momentum in explosions

PERIOD	1.		
	2.		
GROUP	3.		
	4.		

• Purpose •

In this activity you will verify conservation of momentum in explosions.

• Initial Apparatus •

___ PASCO Introductory Dynamics System (dynamics carts, track, and accessories)

• Additional Apparatus for Procedures 4-8 •

___ computer (PhyzMac iBook or equivalent)
___ probeware (DataStudio or equivalent)
___ 2 motion sensors (PASport)
___ 2 interface devices (USB Link)
___ spreadsheet software (Microsoft Excel or equivalent)

• Initial Setup •

1. If you have been using a computer for a previous activity, set it aside (put it to sleep) for procedures 1-3.

2. Arrange the track so that it is level. When the track is level, a cart will roll equally easily either way on it.

3. Review the *PhyzLab Prep: Carts & Tracks* section describing how to set the plunger on the plunger cart.

• Procedure •

1. THE EVENT

a. Arrange the carts so that they will undergo an **explosion** on the track. When arranged correctly, a stationary **parent** will separate into two **daughters**. The explosion must be activated so that the parent is not pushed one way or the other along the track. Use a mass block or wood block to tap the plunger pin with just barely enough force to activate the explosion. This takes practice. Note: you will need to use the hands of alert lab group members to prevent the carts from running off the end the track.

i. Describe the preparations of the carts and draw a diagram showing how they are aligned before the explosion.

ii. Draw a labeled diagram of the apparatus before and after the event. (Use the terms "parent" and "daughter" appropriately in your diagrams.)

BEFORE AFTER

iii. Describe the motion of the daughters after the explosion.

b. The initial explosion produced daughters with approximately equal masses. Use the mass blocks to arrange explosions that produce daughters with unequal masses. Describe the differences that are apparent when one daughter is more massive than the other.

2. CONSERVATION OF MOMENTUM

The stationary parent has no momentum before it explodes. After the explosion, the daughters have momentum in opposite directions.

a. If momentum is conserved, what must be true about the momentum of the parent before the explosion and the total momentum of the two daughters after the explosion?

b. What, then, must be true of the magnitude (size) of the momenta of the daughters?

c. What two quantities must be known to calculate the momentum of a daughter after the explosion?

3. MASS MEASUREMENTS

Record the mass of each item. As with all laboratory work, observe correct use of significant figures.

Plunger Cart	m = _____ kg	Collision Cart	m = _____ kg
Mass Block 500 #1	m = _____ kg	Mass Block 500 #2	m = _____ kg
Mass Block 250 #1	m = _____ kg	Mass Block 250 #2	m = _____ kg

4. NOW FOR THE HARD PART (PART 1)

Arrange the apparatus so that you can measure the speed of **two** carts as they emerge from an explosion on the track.

a. Obtain the apparatus needed for this procedure (listed in the Apparatus section).

b. Turn the computer on. While the computer is starting...

c. Attach two motion sensors to the track. Make sure each gold disc is aimed horizontally along the track (facing the carts on the track).

d. Connect the motion sensors to the interface devices. Connect the interfaces device to the computer.

e. When asked what you would like to do with the sensors, Launch DataStudio.

f. Using the Setup panel, disable Position measurements and enable Velocity measurements for **both** sensors. (Note that you only have access to the controls of one sensor at a time.) After setting **both** sensors, close the Setup panel.

g. Close the empty graph of Position. Create a graph of Velocity vs. Time. Then drag the Velocity2 measurement onto that graph and release it in the middle of the graph window.

h. Click the on-screen Start button and move one of the daughters for a few seconds. Stop the data sampling and determine which cart's motion corresponds to "Velocity" and which corresponds to "Velocity2." Delete that data.

i. Run through an explosion with the sensors on. Alert lab partners must prevent the carts from crashing into the motion sensors without blocking the motion sensor "beam." Stop the sampling following the explosion.

j. Determine the launch speed of each daughter. Hints:
- You have two plots. Each plot has its own Smart Tool. Activate the Smart Tool for **each** plot.
- Look for a reliable speed value for each daughter after the explosion. Stay away from "spikes."
- **Disregard the sign of the speed value found on DataStudio; treat all values as positive.**

5. NOW FOR THE HARD PART (PART 2)

a. If the event does not produce a good result, delete it and try again. When you think you have recorded a good event, activate a Smart Tool for each velocity measurement and place them on their plots. Note: negative velocity indicates an object approaching the sensor. Record speed values as positive.

i. Record the speed of one daughter _____.

ii. Record the speed of the other daughter _____.

b. Create a data table spreadsheet. Open Excel and create a blank spreadsheet ("workbook"). Save it with an appropriate filename to the appropriate folder on the computer.

c. Set the view to "normal" (View: Normal).

d. Make a row of **labels** for the masses of the daughters (m1 and m2) and the launch speeds of the daughters (v1 and v2) after the explosion.

e. Record the **values** of the masses and speeds of the daughters on the data table.

f. Add columns to your spreadsheet in which the momenta of the daughters is calculated. Label them p1' and p2'. Program the cells to calculate the appropriate momenta. To multiply in Excel, use the asterisk (*) symbol.

g. The percent difference between any two numbers, a and b, is $[\, |a - b| / (a + b)\,] \times 200$.

Add a column for the percent difference between the final momenta ("%D p'") of the two daughters after the explosion (p1' and p2') calculation in the spreadsheet. To find the absolute value in Excel, use the "ABS()" function. Place the expression you wish to take the absolute value of inside the parentheses.

If the difference is less than 20%, consider the event a successful demonstration of conservation of momentum.

6. VARY THE CONFIGURATIONS

a. Return to DataStudio and delete the previous run. Repeat the procedure until you have good data for a light daughter (empty cart) exploding from a heavy daughter (loaded cart).

b. Enter the appropriate data into your Excel spreadsheet. Copy your equation cells down their columns so that the spreadsheet calculates p1', p2' and %D p'. Save the updated spreadsheet (File: Save).

c. Use the available mass blocks to create several more different mass ratio configurations. Repeat the procedure until you have good data for all of them.

d. When you have at least five distinct trials, save the updated spreadsheet (File: Save).

e. Time and talent permitting, clean up the formatting of your spreadsheet. Center the contents of the columns, correct the number of significant figures, add a row above the label row for column titles ("Mass 1," etc.), and add a row below the data labels for units (kg, m/s, etc.), add lines where appropriate, lightly shade the calculated cells.

f. Produce a print preview showing your spreadsheet in landscape format that fits to one page (you may have to use the Setup button and make appropriate adjustments to achieve this).

g. If you are printing wirelessly, make sure you are connected to the wireless network. (If you are not sure how to do this, ask your instructor.) Secure a PhyzBlessing, then print one copy for each member of the group.