Name _____ Date _____ Period _____

The Coefficient of Restitution

Find the Lab

- In your web browser, go to **www.gigaphysics.com**, then go to **Virtual Labs**, and then click **Conservation of Momentum**.
- If someone else used the computer for this lab before you, click **New Experiment**. This will ensure that you have your own unique cart data when you do the experiment.

Part I: Measure the Carts

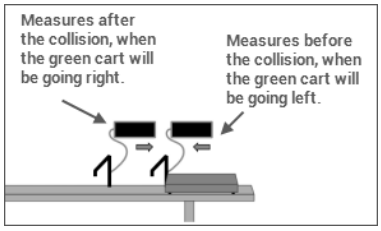
- To find the length of the purple cart, use your mouse to drag the cart over the caliper in the upper left corner of the lab. Convert the length to the SI unit of meters, then record your result in the table below. Repeat the procedure for the green cart.

Length of purple cart	Length of green cart

- *These measurements will stay the same as long as you don't refresh the screen or click the button to start a new experiment. If you don't complete the lab if one sitting and have to load the lab page again, the lengths will change. If this happens, you will need to measure them again and use the new values for the remainder of the lab.*

Part II: Determine the Carts' Velocities (Elastic Case)

- Set the **Carts' Direction** to opposite and the **Collision Behavior** to elastic.
- Click **Start Carts** to put the carts in motion. The red numbers you will soon see tell you how many seconds it took each cart to pass through that photogate. Record the times in the data table on the next page. (If you lose track of which photogate is measuring which condition, notice the purple and green arrows labelling each; a half purple/half green arrow is used when both carts were stuck together as they passed through. You can also click **Start Carts** if you want to watch the collision again.)
- Calculate the velocities of the carts using the times you just measured and the lengths of the carts, and enter them in the table. When you calculate velocities, make sure you watch the signs. Carts that move to the right have positive velocities, but carts that are moving to the left must have negative velocities.



	Elapsed time	Length	Velocity (watch signs!)
Purple cart before collision			
Green cart before collision			
Purple cart after collision			
Green cart after collision			

Part III: Calculating Momentum

- The formula for coefficient of restitution is as shown below, where v_2 and v_1 are the velocities of the two objects after collision, and u_2 and u_1 are their velocities before the collision:

$$C_R = \left| \frac{v_2 - v_1}{u_2 - u_1} \right|$$

- Calculate the coefficient of restitution, using the space below to show your work. *Caution: don't be tempted to ignore the velocities' signs just because there is an absolute value in the formula. Is it really true, for example, that |8 + (-3)| = 11?*

Coefficient of restitution (elastic case)	

Part IV: Compare the Partially Elastic Case

- This time, set the **Collision Behavior** to partially elastic. Repeat the steps from parts II and III.

	Elapsed time	Length	Velocity (with sign!)
Purple cart before collision			
Green cart before collision			
Purple cart after collision			
Purple cart before collision			

Coefficient of restitution (partially elastic case)	

Part V: The Inelastic Case

- Now set the **Collision Behavior** to inelastic.
- The remainder of the steps will be similar, except that this time the carts will stick together on impact. This means that for the post-collision velocity, you will add the carts' lengths together to obtain the total length. Calculate the appropriate velocities below.

	Elapsed time	Length	Velocity (with sign!)
Purple cart before collision			
Green cart before collision			
Carts stuck together after collision			

- Once again, calculate the coefficient of restitution. Note that after the collision, both the purple and the green carts will have the same velocity—the velocity of the stuck carts.

Coefficient of restitution (in elastic case)	

Part VI: Draw Conclusions

- Complete the chart below with the correct type of collision (elastic, inelastic, or partially elastic) for each coefficient of restitution.

Type of collision	Coefficient of restitution
	0
	between 0 and 1
	1

If a garbage bag full of pudding fell to the earth, what coefficient of restitution would you expect? Explain your response.

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A regulation racquetball must have a coefficient of restitution between 0.82 and 0.85 when the ball bounces off the floor. Describe the possible consequences of using a racquetball in which the coefficient of restitution is too low. What if it were too high? (Hints: In racquetball, players stand in an enclosed court with hard walls, and hitting the ball off the walls is allowed. Players often get hit by the ball, so players need to wear goggles to prevent eye injuries.)

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