Name _____ Date _____ Period _____

Coefficient of Restitution

Part I: Introduction

In this simulation you will calculate the coefficient of restitution between two moving carts. To begin, go to www.gigaphysics.com in your web browser, then to the **Conservation of Momentum** lab. If you are using a computer that another student has just used for this lab, be sure to click the **New Experiment** button to get your own individual data.

Part II: Measure the Carts

You will need the length of each cart to perform the calculations for the rest of the lab. To find the length of each cart, click the **Green Car to Calipers** and **Purple Car to Calipers** buttons and read the values displayed on the balance. Convert the lengths to SI units, and record them below.

Length of green cart: _____ Length of purple cart: _____

Part III: Velocities for Elastic Collision

Set the **Carts' Direction** to **Opposite direction** and the **Collision Type** to **Elastic**. Then click the **Start Carts** button and watch what happens. You will see the carts pass through the various photogates, and when they do, the photogate displays will show the time it takes the cart to pass through the photogates. Notice the purple and green arrows to help you keep track of which cart (and in some cases which direction of travel) was being measured. The arrow that is half green and half purple means that the carts are stuck together as they pass that point. If you want, you may click the **Start Carts** button a couple of times to get used to what the simulation is showing you. Use the **Reset Carts** button to reset the carts to their starting position between trials.

When you're ready, click **Start Carts** one last time and record the photogate data in the chart below. Also add the length data from part II into the chart to help organize your work. Now that you know both how long the carts are, and how much time passed as they passed through each photogate, you can calculate the carts' velocities and add them to the table as well. Be sure to consider the sign of the velocity; most people assign carts moving to the right positive velocities and carts moving to the left negative velocities.

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

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Part IV: The Coefficient of Restitution

The coefficient of restitution is the ratio of the carts' relative velocities before and after the collision. In other words, where v_2 and v_1 are the velocites of the carts before the collision, and u_2 and u_1 are the velocities before the collision, then the coefficient of restitution C_R can be calculated using the formula:

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

The coefficient of resitution is dimensionless (i.e., has no units), because both the numerator and denominator have velocity units.

Note: When you perform the calculations, don't be tempted to ignore the signs of your velocities just because you see absolute value in the formula. To see why, consider the expression $|8 + (-3)|$. Is it equal to $|8 + 3|$?

Calculate the coefficient of restitution for the eleastic case in part III, showing your work in the space provided.

C_R = _____

You and your instructor may wish to review your results at this point, so that you can correct any errors before repeating them in the next set of calculations.

Part V: A Partially Elastic Collision

This time, set the **Collison Type** to **Partially Elastic**, then repeat the same steps you did for part III and IV.

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

C_R = _____

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Part VI: An Inelastic Collision

Now set the **Collison Type** to **Inelastic**. This time the procedure will be almost identical, but the carts will stick together after the collision. Therefore, calculate the velocity using the combined lengths of the green and purple carts; both the green and the purple cart will have that velocity.

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

C_R = _____

Part VII: Conclusions

In what type of collision will C_R always be 0? _____

In what type of collision will C_R always be 1? _____

In what type of collision will C_R be between 0 and 1? _____

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

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_____

The rules of racquetball require the racquetball to have a coefficient of restitution between 0.82 and 0.85 when the ball bounces off the floor. How would it affect the game if the ball were to "break" and had a lower coefficient of restitution?

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