Conservation of momentum

Identification page

Instructions: Print this page and the following ones before your lab session to prepare your lab report. Staple them together with your graphs at the end. If you forgot to print it before your lab, you can reproduce it by hand but you have to follow the exact format (same number of pages, same items on each page, same space to answer question).

Complete all the identification fields below or 10% of the lab value will be deduced from your final mark for this lab.

For in-lab reports, hand in your report to your demonstrator at the end of the sessions or you will receive a zero for this lab.

For take-home reports, drop your report in the right box or 10% of the lab value will be deduced from your mark. Refer to the *General information* document for the details of the late report policy.

Experiment title: Conservation of momentum

Name: _____

Student number: _____

Lab group number: _____

Course code: PHY

Demonstrator: _____

Date of the lab session: _____

Partner's name: _____

Data sheet

Instructions: This lab report is due at the end of the lab session. We recommend completing the *Data sheet* before starting the *Questions* section.

Part 1 - Centre of mass

[1] Measure the mass of both gliders with their bumpers attached:

$M_1 = (\_\_\_\_\_ \pm \_\_\_\_\_)$ $M_2 = (\_\_\_\_\_ \pm \_\_\_\_\_)$

Part 2 - Elastic collisions

[4] **Table 1 - Elastic collisions data table**

Run		Glider 1 Mass, M_1 (kg)	Glider 1 Velocity before, v_1 (m/s)	Glider 1 Velocity after, v_1' (m/s)	Glider 2 Mass, M_2 (kg)	Glider 2 Velocity before, v_2 (m/s)	Glider 2 Velocity after, v_2' (m/s)
1	$v_1 > 0, v_2 = 0, M_1 \approx M_2$						
2	$\boldsymbol{v_1 > 0, v_2 = 0, M_1 < M_2}$						
3	$v_1 = 0, v_2 < 0, M_1 < M_2$						

Part 3 - Inelastic collisions

[4] **Table 2 - Inelastic collisions data table**

Run		Glider 1 Mass, M_1 (kg)	Glider 1 Velocity before, v_1 (m/s)	Glider 1 Velocity after, v_1' (m/s)	Glider 2 Mass, M_2 (kg)	Glider 2 Velocity before, v_2 (m/s)	Glider 2 Velocity after, v_2' (m/s)
4	$v_1 > 0, v_2 = 0, M_1 \approx M_2$						
5	$v_1 > 0, v_2 = 0, M_1 < M_2$						
6	$\boldsymbol{v_1 = 0, v_2 < 0, M_1 < M_2}$						

Graphs

Prepare Graph 1. Submit it online before the end of the lab session. [4 points]
Prepare Graph 2. Submit it online before the end of the lab session. [2 points]
Prepare Graph 3. Submit it online before the end of the lab session. [2 points]

Questions

Part 1 - Centre of mass

[1] Compare the velocities for glider 1 before the collision and glider 2 after the collision.

[2] Explain the shape of the curve obtained for the position of the centre of mass vs. time. What does the slope mean and how does it relate to the other two linear fits you performed?

Part 2 - Elastic collisions

[4] **Table 3 - Momentums before and after various elastic collisions**

	Before collision			After collision			
Run	**Momentum of glider 1, p_1 (kg×m/s)**	**Momentum of glider 2, p_2 (kg×m/s)**	**Total momentum, $p = p_1 + p_2$ (kg×m/s)**	**Momentum of glider 1, p_1' (kg×m/s)**	**Momentum of glider 2, p_2' (kg×m/s)**	**Total momentum, $p' = p_1' + p_2'$ (kg×m/s)**	**Ratio, p'/p (%)**
1							
2							
3							

[2] **Table 4 – Kinetic energies before and after various elastic collisions**

Run	Total kinetic energy before collision, $K = K_1 + K_2$ (10^{-3} J)	Total kinetic energy after collision, $K' = K_1' + K_2'$ (10^{-3} J)	Ratio, K'/K (%)
1			
2			
3			

[2] How does the total momentum of the system after the collision compare with the total momentum before the collision for each of your trials? Do your results agree with your expectations? Explain.

[2] How do the kinetic energies before and after the collision compare for each of your trials? Discuss.

[2] When two gliders that have the same mass and the same speed (in opposite directions) collide and bounce off each other elastically, what is trajectory of the center of mass?

Part 3 - Inelastic collisions

[4] **Table 5 - Momentums before and after various inelastic collisions**

	Before collision			After collision			
Run	**Momentum of glider 1, p_1 (kg×m/s)**	**Momentum of glider 2, p_2 (kg×m/s)**	**Total momentum, $p = p_1 + p_2$ (kg×m/s)**	**Momentum of glider 1, p_1' (kg×m/s)**	**Momentum of glider 2, p_2' (kg×m/s)**	**Total momentum, $p' = p_1' + p_2'$ (kg×m/s)**	**Ratio, p'/p (%)**
4							
5							
6							

[2] **Table 6 - Kinetic energies before and after various inelastic collisions**

Run	**Total kinetic energy before collision, $K = K_1 + K_2$ (10^{-3} J)**	**Total kinetic energy after collision, $K' = K_1' + K_2'$ (10^{-3} J)**	**Ratio, K'/K (%)**
4			
5			
6			

[2] How does the total momentum of the system after the collision compare with the total momentum before the collision for each of your trials? Do your results agree with your expectations? Explain.

[2] Is kinetic energy conserved your inelastic collisions for each of your trials? Discuss.

[2] When two gliders moving towards each other have the same mass and the same speed, they stop when they collide and stick together (completely inelastic collision). What happens to each glider's momentum? Is momentum conserved? Is kinetic energy conserved?

Total : _____ / 44

(36 points for report, 8 points for graphs)