

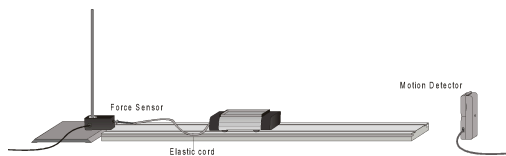
Momentum and Impulse [NOTEBOOK LAB]

The impulse-momentum theorem relates impulse, the average force applied to an object times the length of time the force is applied, and the change in momentum of the object:

$$\overline{F}\Delta t = mv_f - mv_i$$

Here we will only consider motion and forces along a single line. The average force, \overline{F} , is the *net* force on the object, but in the case where one force dominates all others it is sufficient to use only the large force in calculations and analysis.

For this experiment, a dynamics cart will roll along a level track. Its momentum will change as it reaches the end of an initially slack elastic tether cord, much like a horizontal bungee jump. The tether will stretch and apply an increasing force until the cart stops. The cart then changes direction and the tether will soon go slack. The force applied by the cord is measured by a Force Sensor. The cart velocity throughout the motion is measured with a Motion Detector. Using Logger *Pro* to find the average force during a time interval, you can test the impulse-momentum theorem.



OBJECTIVES

- Measure a cart's momentum change and compare to the impulse it receives.
- Compare average and peak forces in impulses.

MATERIALS

Computer	Air Track and Glider
Interfaces	Glider Sail
Force Sensor	Elastic cord
Motion Sensor	Mass Sets
Utility Clamp	Ring Stand Rod.

PROCEDURE

1. Setup the air track with a motion sensor on the end without the hose and a force sensor on the end with the air hose.
2. Attach a glider to the force sensor with an elastic cord approximately 1 meter long.
3. Open up the file Lab 06-1 Momentum Impulse Theorem.cap in the Capstone Folder in the pub drive.
4. Connect a motion sensor to the computer through the interface
5. Connect a force sensor to the computer through the interface.
6. Make sure that there are 2 graphs in the program. 1 for force and the other in 1 for displacement.
7. In capstone click record
8. Tare the force sensor with the button on the device.
9. Stop recording.
10. Turn the air on to full.
11. Click record again.
12. Using the side peg of the glider, push the glider down the track towards the motion sensor.
13. Once the glider has bounced back stop recording.
14. Using the slope tool determine the velocity before and after the string pulls on the glider.
15. Measure the mass of the glider with the balance.
16. Calculate the momentum and the change in momentum.
17. Using the coordinate tool measure the change in time between the start of the impulse force and the end of the force.
18. Using the coordinate tool measure the distance between the initial force and the maximum force.
19. Using $1/2 * b * h$ calculate the area of the force triangle. (Note the average force is $1/2 h$ and b is change in time)
20. How does this compare to the change in momentum?
21. Double check your answer using the area tool to measure the area between the x-axis and the curve created by the force vs time graph.
22. Complete all calculations and questions.
23. Repeat steps 11 through 22 with an additional 100 grams onto the glider.

DATA TABLE

Mass of cart	kg
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Trial	Final Velocity v_f	Initial Velocity v_i	Change of Velocity Δv	Average Force F	Duration of Impulse Δt	Impulse Ft	% difference between Impulse and Change in momentum (Ns)
Elastic 1	(m/s)	(m/s)	(m/s)	(N)	(s)	(Ns)	
1							
2							

Trial	Impulse Ft	Change in momentum	% difference between Impulse and Change in momentum
Elastic 1	(Ns)	(kgm /s) or (Ns)	(Ns)
1			
2			

Questions/Things you need to do individually:

Purpose (5pt)

Include

Hypothesis (5pt)

Include

Data (10pt)

Print and attach the data tables and graphs into your notebook.

Calculations (10 pt)

Show an example of how to calculate The impulse based on change in velocity. Also show the calculation based on the area under the curve. Finally show percent error between the two where the first calculation is the theoretical.

Error Analysis (10pt)

Write a strong error analysis section.

Results (10pt)

Explain the result. Make sure you include how they relate to the purpose of this lab. Compare the area under the curve vs the calculated change in momentum

