

MOMENTUM: A CRASH LESSON

LAB MECH 7.COMP

From *Physical Science with Computers*, Vernier Software & Technology, 2000.

INTRODUCTION

An object's momentum depends on both its mass and its velocity. Momentum can be expressed by the formula

$$p = mv$$

where p = momentum (in $\text{g}\cdot\text{m/s}$), m = mass (in g), and v = velocity (in m/s). Momentum is an important factor in analyzing collisions, especially those of automobiles. In this experiment, you will study the relationship between a car's momentum and the distance it pushes an object during a collision. You will use a balance or spring scale to measure the car's mass (m) and a computer-interfaced Motion Detector to measure its velocity (v). You will then calculate momentum (p) using the formula given above.

PURPOSE

The purpose of this experiment is to study the relationship between the mass, velocity, and momentum of a car as observed in collisions.

EQUIPMENT/MATERIALS

Power Macintosh or Windows PC
Vernier computer interface
Vernier Motion Detector
LoggerPro
1.5-m ramp
books to support a ramp

meter stick
balance or spring scale
ruler
masking tape
car with card attached
3-ring notebook

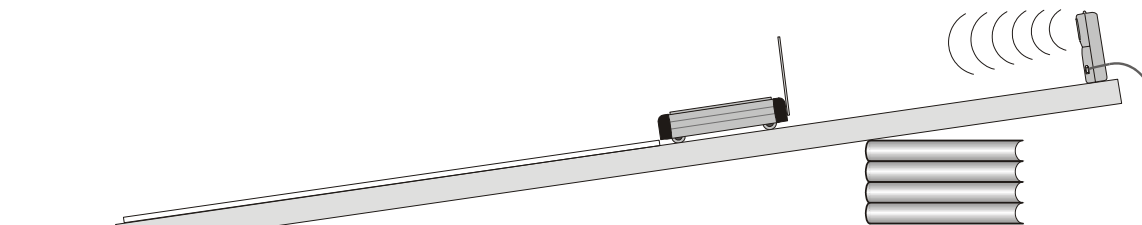




Figure 1

PROCEDURE

1. Set up a ramp using books as shown in Figure 1. The high end of the ramp should be 45 cm above the floor.
2. Tape a meter stick in the center of the ramp. Use two pieces of tape, one at each end of the meter stick. The 0-cm mark should be at the very bottom of the ramp. In this position, the meter stick will serve as a guide rail for your car.
3. Tape a card to the back of a car. The card serves as an ultrasound reflector.
4. Measure and record the mass of the car (in g) on the Data Sheet.
5. Measure a distance 30 cm from the bottom end of the ramp. Mark this distance with chalk or tape. Place the thick side of a 3-ring, hardback notebook on the 30-cm line, in a position where it will be struck in the center by the car rolling off the ramp.
6. Fasten the Motion Detector at the top and center of the ramp as shown in Figure 1. Connect the Motion Detector to DIG/SONIC 1 on LabPro.
7. Prepare the computer for data collection by opening the file in the Experiment 38 folder of *Physical Science with Computers*. The vertical axis has velocity scaled from -0.5 to 3 m/s. The horizontal axis has time scaled from 0 to 3 seconds.
8. Place your car on the ramp with its front at the 40-cm line. Click  and release the car after you hear a sound coming from the Motion Detector. The car should hit the notebook. Measure and record the distance the notebook is pushed (to the nearest cm).
9. Click the Statistics button, . Record the maximum velocity in the Data Table.
10. Return the notebook to its original position. Repeat Steps 8 and 9.
11. Repeat Step 10. You should now have three trials for the 40-cm distance.
12. Repeat Steps 8-11 at 60-cm and 80-cm distances.

DATA SHEET

Name _____

Name _____

Period _____ Class _____

Date _____

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DATA TABLES

Mass of the car (m) _____ g

	Distance Notebook Moved (cm)		
Release Position	Trial 1	Trial 2	Trial 3
40 cm			
60 cm			
80 cm			

	Velocity of Car (m/s)		
Release Position	Trial 1	Trial 2	Trial 3
40 cm			
60 cm			
80 cm			

	Average Values		
Release Position	Average Velocity (m/s)	Average Momentum (g·m/s)	Average Distance Moved (cm)
40 cm			
60 cm			
80 cm			

PROCESSING THE DATA

1. Calculate the average velocity for each release position. Show your work below. Record the values in the Average Values Table on the Data Sheet.

2. Calculate the average momentum of the car for each release position using the formula $p = mv$, where p = momentum (in $\text{g}\cdot\text{m/s}$), m = the car mass (in g), and v = velocity (in m/s). Use the average velocity values obtained in Step 1 above. Show your work below. Record the values in the Average Values Table on the Data Sheet.

3. Calculate the average distance moved by the notebook for each release position. Show your work. Record the values in the Average Values Table on the Data Sheet.

4. Graph your results. Graph MOMENTUM (from Step 2) on the horizontal axis and the AVERAGE DISTANCE THE NOTEBOOK MOVED (from Step 3) on the vertical axis.

5. How did increased car momentum affect the distance that the notebook moved?

