Laboratory A
Newton's Second Law

Newton's Skateboard

Purpose: To investigate the relationship among mass, force, and acceleration.

Materials: Per group of 6-8 students – skateboard, bathroom scale, meter stick, 3 stopwatches, masking tape.

Guiding Question:
What happens to a person's speed if pushed with a constant force?

Procedure

1. With pieces of tape, mark positions on the floor at intervals of 0m, 5m, 10m, and 15m on a smooth, level floor in the gym or hallway. Select two students who will ride the skateboard, one who is "lighter" and one who is "heavier." Record their names in the data tables.

2. A student must sit, well balanced and tucked, on a skateboard at the 0m mark. A second student must stand behind the 0m mark pressing a bathroom scale on the upper back of the sitting student. Three other students can be positioned with a stopwatch at each of the measured intervals (5m, 10m, and 15m) in order to take times to the nearest .01s.

3. The second student must push on the scale and back of the sitting student with a constant pushing force when given the command to begin. The pushing student must maintain a small but constant force (see Data Table A) throughout the distance the skater is pushed, including through the 15m mark. Do NOT push harder to "get going." Time how long it takes to get to the 5m, 10m, and 15m marks, and record this data in Data Table A along with the readings on the bathroom scale. Designate someone in your group to record data.

SAFETY NOTE: Moving students (pushers and skaters) must be sure to be traveling as straight as possible on the course! Pushers should immediately stop pushing if a skater is veering off course. A "catcher" student should be positioned just beyond the end of the 15m course to catch and slow down the skater at the end of each run.

4. Repeat the activity twice using a different skater to vary the mass, but keeping the pushing force the same. If the results are inconsistent, the skater may be off-balance or turning the board from a straight line during the trial; if so, then repeat the trial.

5. Repeat with the pusher maintaining a different constant force (See Data Table B) throughout the distance the skater is pushed, but using the same two skaters as before. Record your results in Data Table B.

6. Create two separate distance vs. time graphs on the same sheet of graph paper (top half and bottom half) for each table's data. Entitle each graph, Plot the data points for each of two students on each graph. Be sure to differentiate the data points for each student by using different symbols or colors to mark points. Connect each student's data points and label them with the student's name and whether they were the lighter or heavier skater.

This lab is an adaptation of *Getting Pushy* from the Conceptual Physics Laboratory Manual.

Lab Reporting Sheet
Laboratory A

Name:_____

Date:_____

Newton's Skateboard

- Before you do the lab, write down what you think will happen to each person's speed when they're pushed with a constant force.

Data Table A: Smaller Constant Force

Name	Force (N or lb)	Distance (m)	Time (s)
		5 m	
		10 m	
		15 m	
		5 m	
		10 m	
		15 m	

Data Table B: Larger Constant Force

Name	Force (N or lb)	Distance (m)	Time (s)
		5 m	
		10 m	
		15 m	
		5 m	
		10 m	
		15 m	

- Until the time of Galileo and Newton, people believed that a constant force is required to produce a constant speed. Do your observations confirm or reject this idea? Explain.

- What happens to your speed as you go farther and farther along the measured distances?

- What happens to the rate of increase in speed – the acceleration – as you proceed farther and farther along the measured distances?

- When the force of pushing is the same, how does the acceleration depend on the mass of the skater?

- When the mass of the skater is the same, how does the acceleration depend on the force of pushing?

- Using your variables of force, mass, and acceleration, derive an equation that shows the relationships you found in this activity. (It should look familiar!)