9. FORCES AND INTERACTIONS

What can force do to an object's motion?

Objectives:

- Recognize that force is a push or a pull.
- Recognize that forces have magnitudes (strengths) and directions.
- Discover that a force applied to an object will change the object's direction.
- Describe the key idea of Newton's first law of motion.

Materials and Equipment

- Data collection system
- Force sensor with hook attached
- Motion sensor
- Toy cart with wheels
- Tape or rubber bands to connect motion sensor
- Measuring device

Safety

Follow these important safety precautions in addition to your regular classroom procedures:

- Do not apply a pushing or pulling force greater than 50 newtons to the force sensors (doing so will result in damage to the sensors).

Procedure

Part 1 – Investigating Position

1. Select Sensor Data in SPARKvue.
2. Connect the motion sensor to your device.
3. Select the line graph display. Display Position on the y-axis of a graph with Time on the x-axis.
4. Position the cart approximately 50 cm from the metal screen of the motion sensor.
5. Start recording data and push and pull the cart so it travels as follows:

   a. Quickly push the cart towards the motion sensor, stopping about 15 cm from the front of the metal screen.

   b. Pause for five seconds.

   c. Quickly pull the cart back to the beginning potion.

   d. Pause for five seconds.

   e. Quickly push the cart towards the motion sensor, stopping again about 15 cm in front of the metal screen.

6. Stop recording data and save the experiment as Position vs. Time or according to your teacher's directions. Using this data, recreate the graph on Graph 1 under Data Collection. Make sure to label the x and y axes, use proper units, and create a scale.

Part 2 – Measuring Force

1. Use tape or rubber bands to connect the force sensor to your cart as shown in Figure 1.

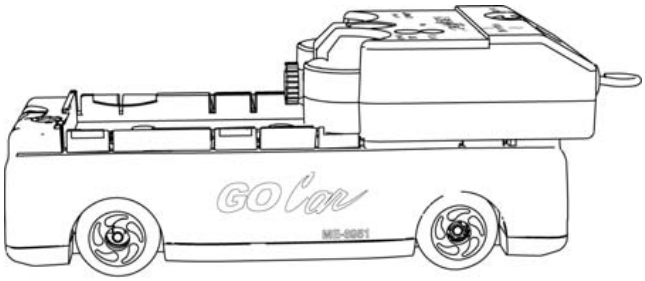


Figure 1. Force sensor attached to toy cart

2. Start a new experiment, connect the force sensor to your device and choose the line graph display. Display Force on the y-axis with Time on the x-axis.

3. Position the cart approximately 50 cm from the metal screen of the motion sensor.

4. Zero out the force sensor. Note: The force sensor always needs to be zeroed out in the position it will be used.

5. Begin recording data by firmly grasping the hook of the force sensor, and quickly push and pull the car as you did in the first trial—toward the motion sensor, stop for 5 seconds, away from the motion sensor, stop for 5 seconds, and then toward the motion sensor, stopping about 15 cm in front of the metal screen.

6. Stop recording data and save the experiment as Force vs. Time or according to your teacher's directions. Using this data, recreate the graph on Graph 2 under Data Collection. Make sure to label the x and y axes, use proper units, and create a scale.

Part 3 – Comparing Force and Position

1. Start a new experiment.

2. Select Sensor Data and connect both the motion and force sensors to your device. Select only Force and Position. Disable the Wireless Acceleration and Gyro Sensors.

3. Select the line graph display. You should now have two graphs. One for Force vs. Time and one for Position vs. Time.

4. Position the cart approximately 50 cm from the metal screen of the motion sensor and begin collecting data.

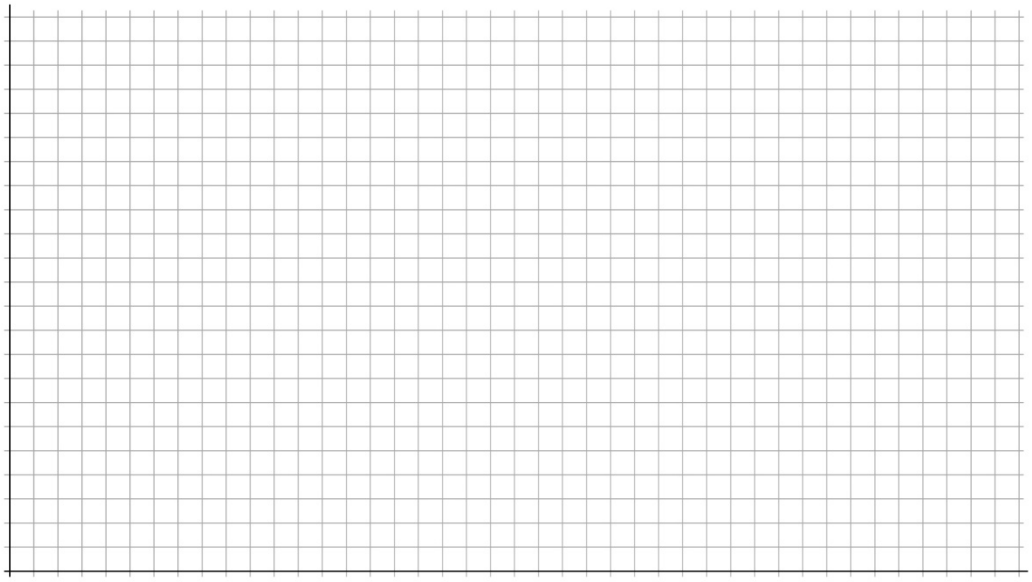
5. Firmly grasp the hook of the force sensor, and quickly push and pull the car as you did in the first trial—toward the motion sensor, stop for 5 seconds, away from the motion sensor, stop for 5 seconds, and then toward the motion sensor, stopping about 15 cm in front of the metal screen.

6. Stop recording data and save the experiment as Force and Position or according to your teacher's directions.

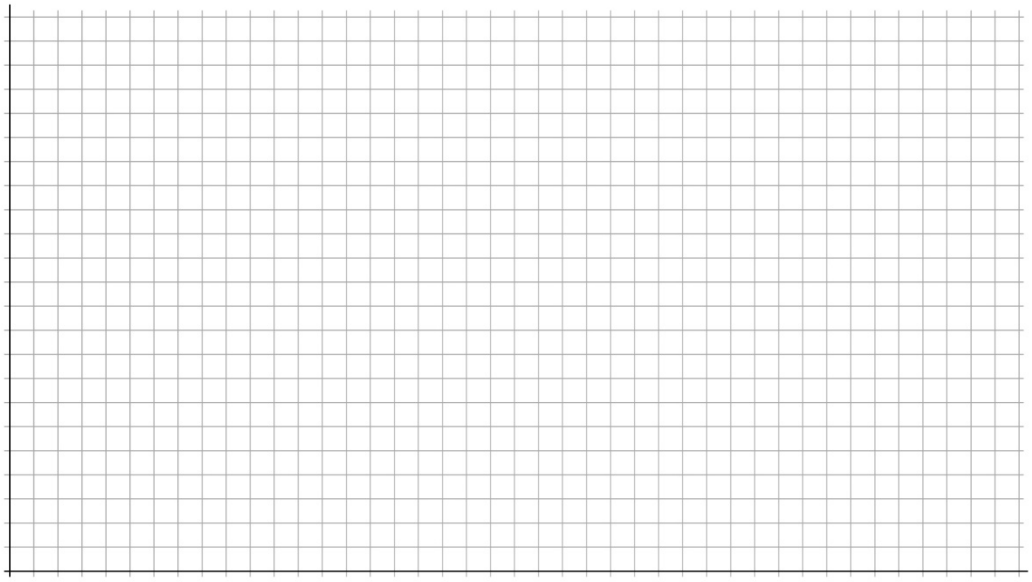
7. Review this data and your observations to answer questions in the Questions and Analysis portion of the lab.

Data Collection

Graph 1: Position vs. Time



Graph 2: Force vs. Time



Questions and Analysis

1. Using evidence from Graph 1, how can you describe the data as it relates to how position changed when you moved the cart?

2. Describe the cart's motion when no force is applied to it.

3. Using evidence from Graph 2, how can you describe the data as it relates to how force was measured when you moved the cart?

4. Sir Isaac Newton said, "Every body continues in a state of rest, or of motion in a straight line at constant speed, unless it is compelled to change that state by forces exerted upon it." By body he meant "any object", including the toy cart. What do you think Newton meant by "a state of rest"?

5. What evidence do you see in your graphs of Position and Force versus Time that support's Newton's idea?

6. Using the activity you just completed, re-state or paraphrase Newton's idea, also known as Newton's First Law of Motion, in your own words.