

Newton's Second Law Demonstration

Equipment:

Smart Cart
Accessory Hook

Learning Outcome:

Forces and Accelerations of objects have a linear relationship that relates the mass of an object being accelerated to an unbalanced force acting on it.

Experimental Setup:

1. Take your Smart Cart out of the box.
2. Attach the hook accessory (included with Smart Cart) to the force sensor on the Smart Cart.
3. Press the power button on the side of the Smart Cart to turn it on.
4. In SPARKvue or Capstone, pair the Smart Cart to your computer or device. Here are a couple short videos to help you pair in either software:
 - a. SPARKvue: <https://www.youtube.com/watch?v=tsdHWu4quNo>
 - b. Capstone: <https://www.youtube.com/watch?v=JGy-UG245IY>
5. In the software, you will need to create a graph of Force vs. Acceleration.
 - a. SPARKvue: Under "Quick Start Experiments" choose: Newton's Second Law
 - b. Capstone:
 - i. Create a Graph Display
 - ii. Select measurement of [Force] for the y-axis
 - iii. Select measurement of [Acceleration - x] for the x-axis
 - iv. In the sampling control panel, press the "Zero Sensor" button

Before you collect data, practice rolling the cart in a forwards and backwards motion by only holding on to the hook. You want to apply a force along the cart's x-axis, and have the cart roll only along this direction. This is made easier using a PASCO track to keep the cart moving in one direction, but not necessary for the demonstration. (Hint: Try not to wiggle or knock the Smart Cart hook as this will result in extraneous data points.)

Data Collection:

1. Press the record data button
2. Holding only the hook, roll the Smart Cart forwards and backwards in the x-direction.
3. Repeat this motion a few times to generate enough data points to see the graphical relationship.
4. Stop data collection

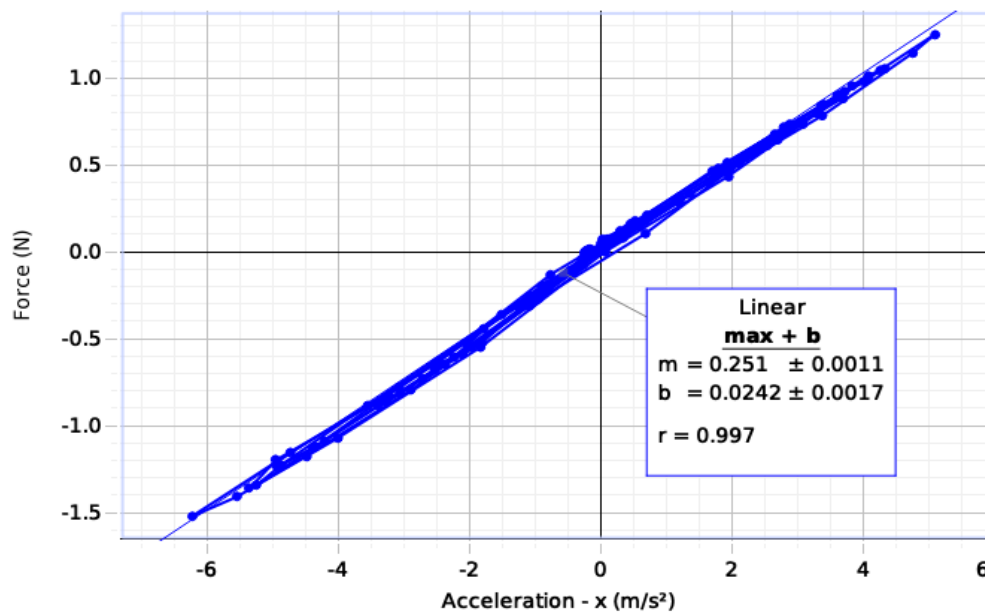
Data Analysis:

1. Turn on the 'Linear Fit' tool
2. This relationship shows that there is a proportionality constant between the unbalanced force, and the Smart Cart's resulting acceleration.
3. The proportionality constant is the mass of the cart.

Add mass to the Smart Cart and repeat data collection for the new system mass.

Sample Data:

This data was created with a Smart Cart that measured .246 kg, for an error around 2%.



Newton's Second Law - Smart Cart