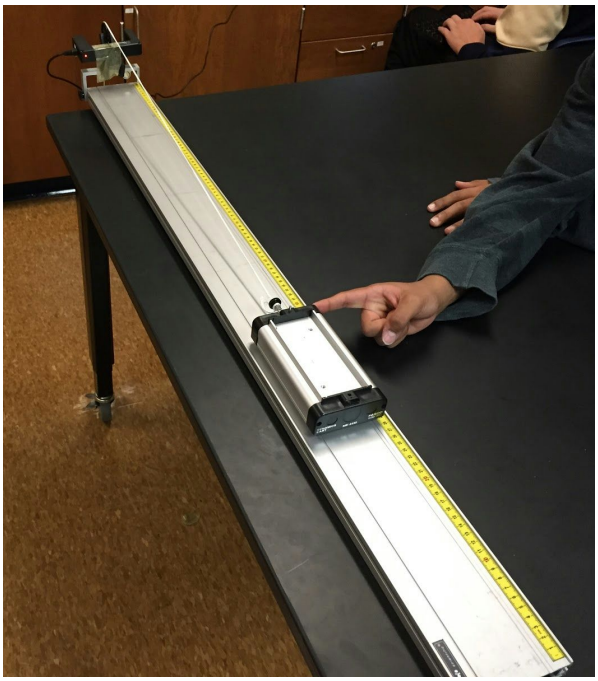
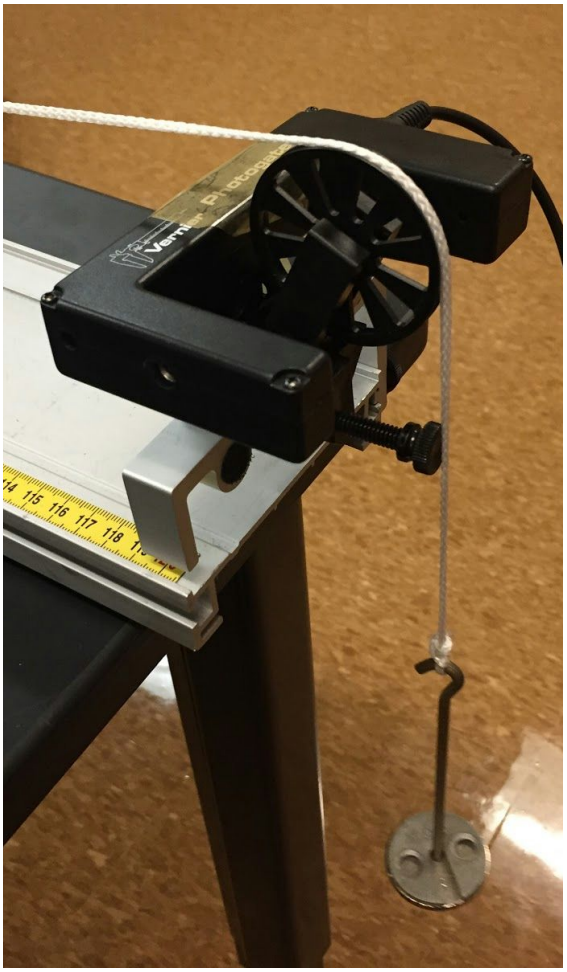
Observation and Analysis of Newton's Second Law

Materials:

- 120 cm cart track
- Pasco Dynamics Cart
- 100 cm string (depending on height above ground of track)
- Vernier Photogate
- 10 spoke wheel pulley
- 10 spoke wheel pulley mount
- Vernier Lab Pro
- Vernier Logger Pro
- 50 g weight stand (may vary)
- 5, 20, 50, and 200 g weights (may vary)
- Triple Beam Balance Scale





Procedure:

1. Find the mass of your cart. Record.
2. Place the track on a table approximately 1 meter tall. Make sure the track is level on all axes within one degree.
3. Tie one end of the string to the cart and the other end to the weight stand. Place the cart on the track making sure the string is placed on the track of the wheel pulley.
4. Attach the mount to the end of the track. Attach the 10 spoke wheel to the mount.
5. Attach the Photogate to the mount. If necessary, use tape to hold the Photogate far enough away from the wheel so that they don't rub each other.
6. Set up the Lab Pro so it is connected to the Photogate, the computer, and to a power supply.
7. Open Logger Pro, and go into Experiment>Set Up Sensors>Lab Pro:1 and then click the photogate picture under the DIG/SONIC headers.
8. Click "Set Distance or Length" and go into the drop down menu, hitting "10 spoke in groove Ultra Pulley" and hit okay.
9. Once you are ready to collect data, click the green button in the upper right that says collect data. Wait for a second after hitting the button to release the car. After the trial is complete, record the acceleration.
10. Select the acceleration where it is constant, then hit the button labeled Analyze, next pressing the linear fit button. Record the acceleration.
11. During the first set of trials, start with only the 50 g weight stand and have no weight on the cart. Add a different weight each trial to the weight stand until all weights have been on. Record each trial.
12. During the second set of trials, use the 50 g weight stand each time, this time adding weights to the cart each trial until all weights are on the cart. Record each trial.

Questions and Calculations:

1) Name and describe every force acting on the cart while it is in motion. Then, using the observed accelerations and known masses, calculate the magnitude of each force.
2) How does increasing the descending mass affect the amount of force pulling the cart? How does increasing the mass on the cart affect the amount of force pulling the cart?
3) How might the shapes of the cart and cart's weights affect your data? Why?
4) When more mass is placed on the cart, does the cart accelerate at a significantly different rate? Aside from gravity, friction, and air resistance, what property of matter is demonstrated here? Explain.
5) Examine the properties of the wheel pulley. How does the friction from its axis affect the cart's acceleration? Are there any other properties of motion relative to the wheel that might affect the acceleration?
6) If the descending weight pulling the cart was lowered on an inclined plane instead of dropped straight down, how would this affect the cart's acceleration? What angle, relative to the ground, of an inclined plane would provide the greatest acceleration?
7) How does the string's mass affect your data and calculations? Is it really negligible? How does the string's effective mass change as the descending weight moves toward the ground?
8) Analyze the net force acting on the cart, in comparison to its acceleration, in each trial. Citing Newton's Second Law of Motion, explain your findings.
9) Based on Newton's Second Law of Motion and ignoring friction and air resistance, calculate the:
    a) net force acting on the cart if it has positive acceleration 5 m/s^2 and mass 250 g
    b) acceleration of the cart if it has positive net force 12 N and mass 2.00 kg
    c) mass of the cart if it has positive acceleration 0.1 m/s^2 and positive net force 20 N
10) Extra Credit: Based on *strictly your observations* and Newton's Second Law of Motion, predict the:
    a) acceleration or *your* cart, with no additional mass on it, if the descending mass was 10 kg in total
    b) total descending mass, if the forward acceleration of *your* cart was 10 m/s^2 and your cart had an additional 15 kg on it

Your lab report should include at least:

- a cover page (title, author, date, partners)
- the lab's purpose
- a sketch or photo of your setup, or several if necessary
- the list of materials
- the procedure, in your own words
- a clean, thorough, and understandable display (probably a table) with all of your data and observations
- thoughtful and correct answers to the questions and calculations, with quantitative work shown when appropriate
- a conclusion paragraph(s) addressing and explaining at least:
    - the purpose of the lab
    - your data and observations
    - sources of uncertainty and error
    - Newton's Second Law of Motion and how it is substantiated by your observations