Newton's 2nd Law Lab (Modeling-friendly lab)

- Go to the PhET simulation Forces & Motion. https://phet.colorado.edu/sims/html/forces-and-motion-basics/latest/forces-and-motion-basics_en.html
- Select "Acceleration"
- Click to show Forces, Sum of Forces, Values, Mass, and Acceleration.

Experiment #1: Acceleration vs. Force

In this lab you will determine the relationship between acceleration and net force.

- Choose a mass at the beginning, and keep it constant for this entire experiment.
- Set the friction to zero. This will make your Applied Force equal to the net force.
- Record data for five different values of Applied Force.
- Graph Acceleration vs. Net Force.
    - If it is linear, write the equation of the line.
    - If it is not linear, Linearize the graph, and find the equation of the linearized graph.

Mass (kg)	Applied Force (N)	Acceleration (m/s^2)	

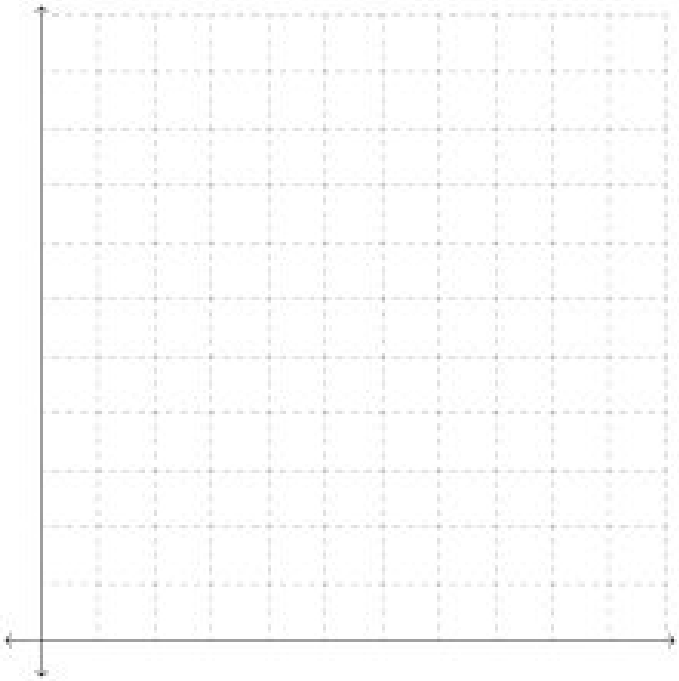
Experiment #2: Acceleration vs. Mass

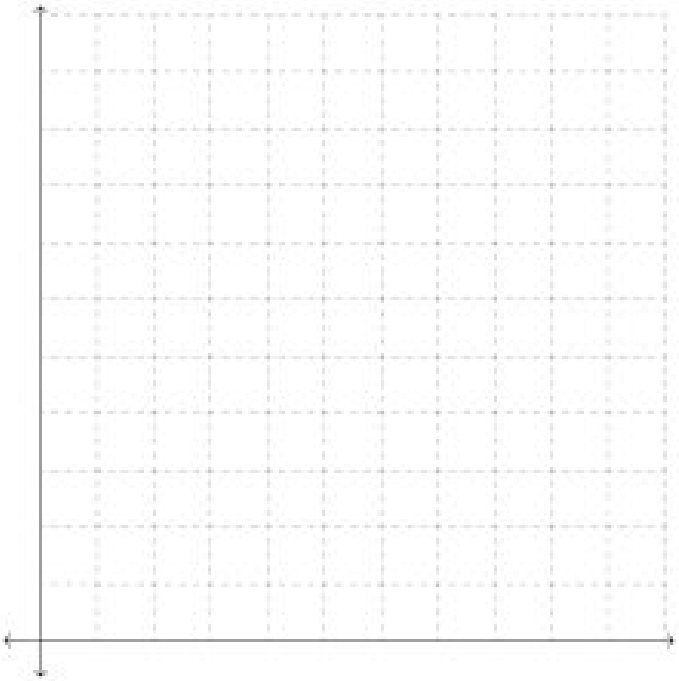
In this lab you will determine the relationship between acceleration and mass.

- Choose an Applied Force at the beginning, and keep it constant for this entire experiment.
- Set the friction to zero. This will make your Applied Force equal to the net force.
- Record data for five different values of Mass.
- Graph Acceleration vs. Mass.
    - If it is linear, write the equation of the line.
    - If it is not linear, Linearize the graph, and find the equation of the linearized graph.

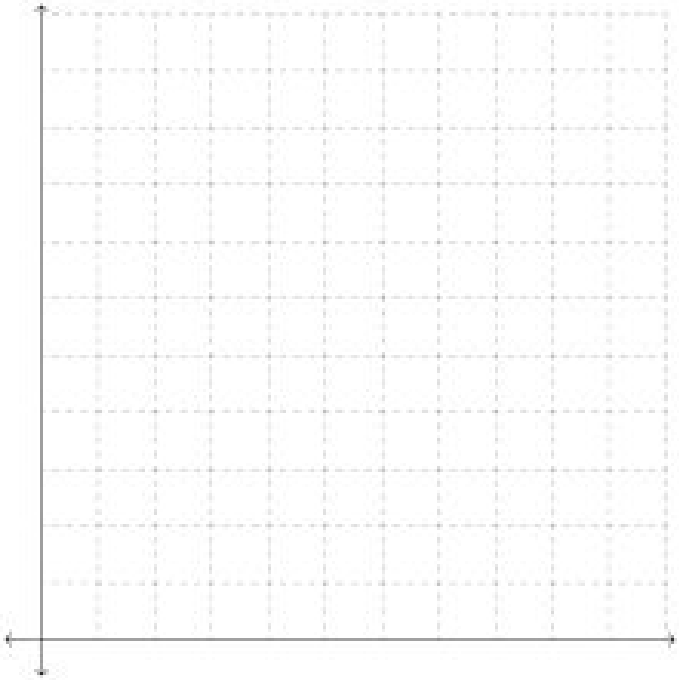
Applied Force (N)	Mass (kg)	Acceleration (m/s^2)	

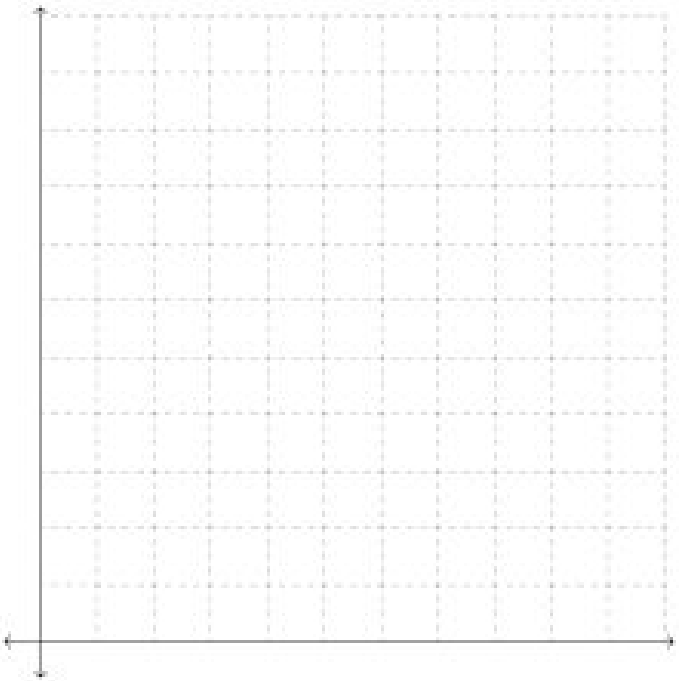
Experiment #1:





Experiment #2:





Post Lab Analysis: (Teacher Notes)

Reflection:

Students should be able to intuitively gain a sense of Newton's 1st Law using the simulations.

Note: Before doing this simulation, I was afraid the PhET data would be too perfect to simulate the real world. However, because the acceleration was rounded to the nearest tenth in the simulation, the data produced real-looking, slightly imperfect data. I really liked that. This was an efficient way to gather data to determine these relationships.

After graphing the data, discuss as a class that because acceleration is proportional to both force and 1/mass, it must be proportional to the product of F*1/m. Show how a α F*1/m could be turned into an equation if you knew the slope of the a vs. F*1/m graph. Take the data, and find **F*1/m** for both sets of data (in the extra column; round to one decimal.). You will discover that it equals the acceleration, so the slope is 1, giving us **a = F/m**, which is Newton's 2nd Law.

Using this equation, students could see that the slope of their A vs. F graph should be 1/m, and the slope of their A vs. 1/m graph should be F. You may have to remind students how to linearize an inverse graph, or as an alternative, you could have them curve fit the graphs instead.

Students should then be able to write up a lab report with all of their findings from the two experiments.