NEWTONS SECOND LAW VIRTUAL LAB

http://www.walter-fendt.de/ph11e/n2law.htm

PURPOSE: In this virtual laboratory activity, you will investigate the changes in the motion of a dynamics cart that occur when differing amounts of net force, total mass, and friction acting on the cart.

THEORY: Isaac Newton described the relationship of the net force applied to an object and the acceleration it experiences in the following way: the acceleration (a) of an object is directly proportional to and in the same direction as the net force (Fnet), and inversely proportional to the mass (m) of the object.

Procedure

1. Place about 1.0-gram of mass (0.001 kg) for the initial hanging mass.
2. Set the cart mass to 399-g (0.399 kg).
3. Calculate the applied net force (F_{net}) by multiplying the hanging mass (m) by acceleration due to gravity (9.8 m/s^2).
4. Calculate the total mass of the system by adding the mass of the cart (M) to the hanging mass (m).
6. Calculate the acceleration you expect to see in this scenario by taking the net force and dividing by the total mass of the system.
7. When you are ready to collect data, press the "start" button.
8. Record the measured acceleration (a) from the screen display in the data table and notice the plotted data on the graph.
9. Repeat the above steps for each of the other 4 scenarios in the table below. *Record all measurements in the data table.*

DATA TABLES:

Acceleration of a Cart - "Changing Net Force on Same Total System Mass"

Trial	Mass of Cart (kg) M	Mass Hanging (kg) m	Applied F_{net} (N) F_{net} = mxa	Total Mass (kg) (M+m)	Expected/Calculated Acceleration (m/s^2) a= F_{net}/(M+m)	Measured Acceleration (m/s^2) (from computer screen)
1	0.399	0.001				
2	0.398	0.002				
3	0.397	0.003				
4	0.396	0.004				
5	0.395	0.005				

PART 2: Investigate the mass-acceleration relationship - "Same Applied Force on different total system mass." Repeat the procedure instructions above with the values in the table below. In this situation, you are varying the total mass on the system, while keeping the applied net force the same.

Trial	Mass of Cart (kg) M	Mass Hanging (kg) M	Applied F_{net} (N) F_{net} = mg	Total Mass (kg) (M+m)	Acceleration Calculated (m/s^2) a= F_{net}/(M+m)	Measured Acceleration (m/s^2) (from computer screen)
1	0.195	0.005				
2	0.395	0.005				
3	0.795	0.005				

PART 2: Change friction: Set the coefficient of friction to 0.01 and repeat part 2.

Trial	Mass of Cart (kg) M	Mass Hanging (kg) M	Applied F_{net} (N) F_{net} = mg	Total Mass (kg) (M+m)	Acceleration Calculated (m/s^2) a= F_{net}/(M+m)	Measured Acceleration (m/s^2) (from computer screen)
1	0.195	0.005				
2	0.395	0.005				
3	0.795	0.005				

QUESTIONS

1. What relationships exist between these variables as indicated by your data? (Hint: Read the "Theory" section of this lab and see if your data supports it.)

a. Force changes and acceleration

b. Mass changes and acceleration:

2. Identify the manipulated, responding, and controlled variables in Part 1 and Part 2 of this lab:

Lab	Manipulated	Responding	Controlled
Part 1			
Part 2			

3. How does the "measured" acceleration compare to the "calculated" acceleration for part three?

4. What are some factors that could account for this difference?

5. Look at part one of this lab. If the applied net force on a system is doubled, what happens to the acceleration?

6. Look at part two of this lab. If the total mass on the system is doubled, what happens to the acceleration?

7. Why was the cart mass (M) and the hanging mass (m) added to determine the amount of mass accelerated by the net force?

8. State Newton's Second Law in terms of Force, Mass and Acceleration without the use of a mathematical formula.

9. What did frictional forces do to the acceleration obtained by the "cart-weight" system in part three?

10. What consequence would frictional forces have on the net Force (Fnet)?

11. Given that Newton's second law did not hold true for part 3 of this lab, how valid do you feel Newton's second law is in explain the relationships between force, mass, and acceleration in real-life situations? Justify your answer in a complete paragraph.