Newton's Second Law Lab

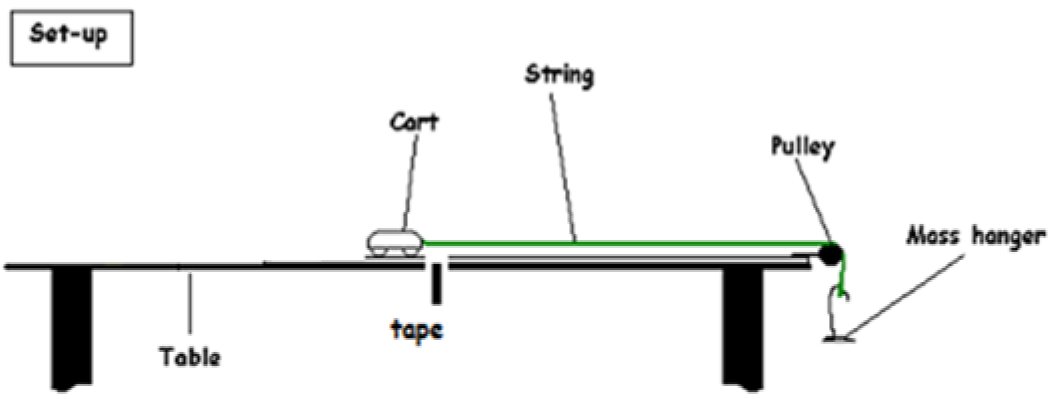
Purpose

To investigate the relationship between force, mass, and acceleration as provided in Newton's Second Law of Motion.

Newton's Second Law of Motion deals with the acceleration of an object due to a net force. In this activity you will use a dynamics cart to measure the acceleration as **(A)** you change the mass of the cart and as **(B)** you change the net force on the cart. A falling mass will be used to pull the cart along the table. The pulley will reduce the friction at the edge of the table. Keep in mind that the entire mass, both of the cart and the falling mass, must be used since both parts are moving together. Finally you will graph each part's data and verify the relationships presented in Newton's Second Law of Motion.

Materials

Spring scale	PASCO Smart cart	9 masses (m = 20 g, each)	mass hanger (m = 50 g)
Foam pad	tablet	pulley w/ table mount	1 piece of masking tape (1 inch long)
~1.5 m string			



Procedure

Part A: Constant net force, changing system mass: The pulling force on the cart will remain constant. You will only increase the mass of the cart.

1. Set up your lab table as shown in the picture above. The tape should be placed on the table at the front of the cart when set-up as shown.
2. Place a foam pad on the floor where the mass hanger will hit. Sketch you setup below you data tables.
3. The mass of the cart should be written on the cart. Add the mass of the hanger to the cart mass and record this total mass as the first mass in your Data Table.
4. Use the SparkVue app on the tablet to record the data from the Smart cart.

Have your teacher approve your setup at this point

5. Place the cart just behind the tape, start the data collection on the Sparkvue app, then let go of the cart. **Please have one person stop the cart before it hits the pulley.** Stop the data collection after the cart has stopped.

6. There should be an upward sloping line on your graph that represents the acceleration of the cart. You may need to adjust the scale of the graph in order to see it clearly.

Ask your teacher to verify your graph properly shows the acceleration.

7. To find the acceleration you will need to use the “Analyzing your data on a SparkVue graph” reference sheet. Record the acceleration in your data table.

8. Add three masses to the cart. Record the new total mass of the cart in your Data Table.
9. Repeat steps #5-7 (teacher verification not required)
10. Add three more masses to the cart. Record the new total mass of the cart in your Data Table.
11. Repeat step #5-7 (teacher verification not required)
12. Add three more masses to the cart. Record the new total mass of the cart in your Data Table.
13. Repeat step #5-7 (teacher verification not required)

Have your teacher approve your data.

Part B: Constant system mass, changing net force: The mass of the system will be kept constant. All you will do is move masses from the cart to the hanger, one at a time, thereby increasing the pulling force on the cart.

1. Use a spring scale to determine the weight (newtons) of the mass hanger. Record this as the first net force in your Data Table.

2. ***Place all nine masses on the cart. No…really…all nine of the shiny metal thingies on the cart now! Seriously, if you don't you'll have to do this part of the lab all over again.***

Have your set-up approved before you continue

3. Place the cart just behind the tape, start the data collection on the Sparkvue app, then let go of the cart. **Please have one person stop the cart before it hits the pulley.** Stop the data collection after the cart has stopped.

4. There should be an upward sloping line on your graph that represents the acceleration of the cart. You may need to adjust the scale of the graph in order to see it clearly.

5. To find the acceleration you will need to use the "Analyzing your data on a SparkVue graph" reference sheet. Record the acceleration in your data table.
6. Move three of the masses from the cart to the hanger. Use a spring scale to determine the weight (newtons) of the hanger with the masses added. Record this as the second net force in your Data Table.
7. Repeat steps #3-5
8. Move three more masses from the cart to the hanger. Use a spring scale to determine the weight (newtons) of the hanger with the masses added. Record this as the third net force in your Data Table.
9. Repeat steps #3-5
10. Move three more masses from the cart to the hanger. Use a spring scale to determine the weight (newtons) of the hanger with the masses added. Record this as the fourth net force in your Data Table.
11. Repeat steps #3-5

Have your teacher approve your data.

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Data Table **Part A**

Cart mass (g)	Acceleration (m/s^2)

Data Table **Part B**

Net force (N)	Acceleration (m/s^2)

Sketch the setup below:

Set-up Approval:

Part A Analysis

1. What physical quantity was held constant?

2. Identify the independent variable and explain why.

3. Identify the dependent variable and explain why.

4. Did the car accelerate as it was pulled by the hanging mass? How could you tell just by watching the cart?

5. Construct an **acceleration v. mass graph** from your data. Draw a best fit curve/line for your data.

6. Based on your graph, state how acceleration is affected by mass. Does this agree with Newton's 2nd law of motion?

Part B Analysis

1. What physical quantity was held constant?

2. Identify the independent variable and explain why.

3. Identify the dependent variable and explain why.

4. Did the car accelerate as it was pulled by the hanging mass? How could you tell just by watching the cart?

5. Construct an **acceleration v. net force graph** from your data. Draw a best fit curve/line for your data.

6. Based on your graph, state how acceleration is affected by net force. Does this agree with Newton's 2nd law of motion?

Newton's Second Law Lab: Sample Data

Data Table Part A

Cart mass (g)	Acceleration (m/s^2)
500.0	2.0
560.0	1.8
620.0	1.6
680.0	1.5

Data Table Part B

Net force (N)	Acceleration (m/s^2)
1.0	1.5
1.5	2.2
2.0	2.9
2.5	3.7