Inertia HT Lab

PSI Physics

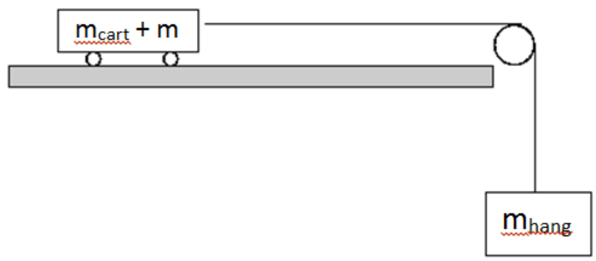
Name:______________________________

Problem: The goal of this lab is to:

- verify Newton's Second Law F=ma.
- measure acceleration due to gravity, g.

Materials:

- Cart
- Pulley
- String
- Masses 0.2 kg – 1.0 kg
- PASCO Interface
- PASCO Motion Sensor II
- PC with PASCO Capstone software



Preparing the PASCO Capstone Software:

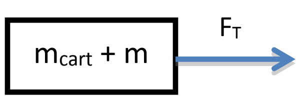
1. Connect the motion sensor to the PASCO interface (the yellow plug goes into digital input port 1, and the black plug goes into port 2). Turn on the interface.
2. Open the Capstone software on the computer. On the left sidebar, click "Hardware Setup." Then, click the yellow circle that represents the first digital port (where the yellow plug is), and select "Motion Sensor II."
3. On the right sidebar, double click the "Graph" icon. Make the x-axis measure time and the y-axis measure velocity.

Setup:

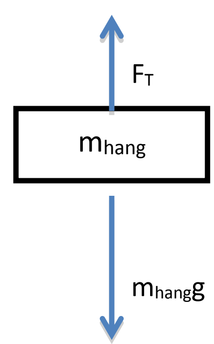
A cart of mass, m_{cart}, with an added mass, m, on a table is connected by a string to a mass, m_{hang}, hanging over a pulley that is fixed to the edge of the table. The length of the string, x, is just long enough for the hanging mass to touch the floor when the cart touches the pulley.

<u>Free Body Diagrams and Newton's Second Law Equations:</u>

<u>Cart</u>



<u>Hanging Mass</u>



$F_T = (m_{cart} + m)\, a$ (1)

$-F_T + m_{hang}\, g = m_{hang}\, a$ (2)

adding (1) and (2): $m_{hang} g = (m_{cart} + m)a + m_2 a$

$$\boxed{m_{hang}\, g = (m_{cart} + m + m_{hang})\, a} \quad (3)$$

Procedure:
In this experiment you will measure the acceleration for a cart as the mass that is added to the cart is changed.

<u>All data and calculations should be entered on the data table attached to the end of this handout</u>.

1. In preparation:
   - Weigh the cart, then determine its mass m_{cart} = ________ kg *(enter this in column 1)*
   - Hang a small mass (10 or 20 g) on the end of the string. Record the value of the hanging mass m_{hang} = _________ kg *(enter this in column 2)*

2. For each of the following 5 masses: m = 0.2 kg, 0.3 kg, 0.5 kg, 0.7 kg, and 1.0 kg:
   - Put the mass in the cart.
   - Pull the cart back until the hanging mass just touches the pulley.
   - Have the Capstone software start recording data, then let go of the cart.

Analysis:

1. Record the **initial v** and the **final v** for each of the total masses in the table by using the point tool in Capstone. Also record the time of the initial v and final v. *Record your answers in columns 5 and 6*.

2. Calculate **a** for each of the total masses by using the initial and final v and t values to calculate average slope. *Record your answer in column 7*.

3. What happens to the acceleration of the cart as more mass is added?

4. Explain what inertia (mass) has to do with the acceleration of the cart.

5. For each of the rows in the table, calculate F = Ma and *record your results in column 8*.

6. Then calculate the average value of F=Ma and record your answer in the bottom right cell of the table.

7. Notice that F is approximately the same for all the rows. This force is also just the weight of the hanging mass, $F = m_{hang}g$.

   a. Given your average F, find the value of g.

b. How does this compare with the accepted value of 9.8 m/s^2?

Application:

8. Another experiment is performed using the same apparatus. This time the cart with added mass is fixed, $m_{cart} + m = 1.2kg$ and the hanging mass, m_{hang} changes. Calculate the acceleration of the cart for the 3 values of m_{hang} by completing the table below.

$m_{cart} + m$ (kg)	m_{hang} (kg)	$M = m_{cart} + m + m_{hang}$ (kg)	m_{hang} g (N)	a (m/s_2)
	0.01			
	0.02			
	0.04			

Use g = 9.8 m/s^2. Equation (3) on page 1 of this hand out may be helpful to you.

9. A 20 kg mass is connected by a 100 meter cable to a 1000 kg car that is at rest, with its brakes off, about 100 meters from the edge of the cliff. The weight is then hung over a pulley at the edge of the cliff and released.
   a. What is the acceleration of the car toward the cliff?

   b. How long will it take the car to reach the cliff?

   c. How fast will the car be traveling the moment it goes over the cliff?

Inertia Lab Data and Analysis Table

(1) Mass of Cart	(2) Hanging Mass	(3) Added Mass	(4) Total Mass	(5) Initial v and time	(6) Final v and time	(7) Acceleration	(8) Force
m_{cart} (kg)	m_{hang} (kg)	m (kg)	$M=m_{cart}+m+m_{hang}$ (kg)	Use the point tool	Use the point tool	$a = \frac{v_{final}-v_{initial}}{t_{final}-t_{initial}}$	$F = M\times a$ (N)
						Average Force =	