Newton's 2nd Law

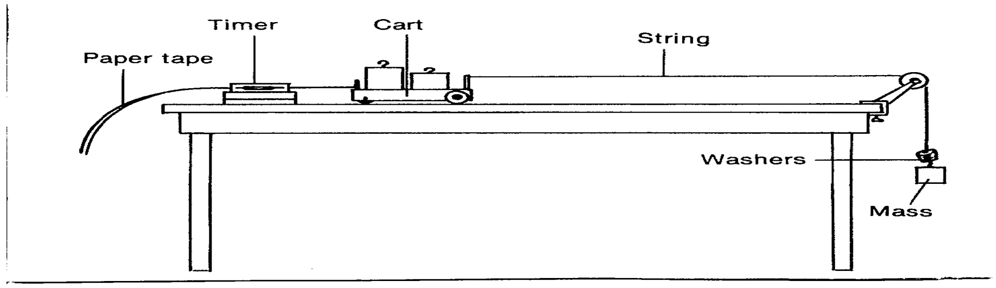
NAME______________ PERIOD______________ DATE___________

INTRODUCTION:

Newton's 2nd law of motion states that an unbalanced force applied to a mass produces an acceleration according to the equation ______. Because of friction, this law seems to contradict common experience. In driving a car, for example, a constant force is required to keep the car moving with a constant velocity. If the force is removed, the car comes to a stop. In the absence of friction, however, the car would continue to move with a constant velocity.

In this experiment, a) we will study Newton's 2nd law by first measuring the change in acceleration resulting when a constant mass is subjected to a changing force, b) and observe the change in acceleration when the force remains constant but the mass changes. Friction will be minimized by using a rolling cart and a counterweight.

DIAGRAM:



PROCEDURE:

a) CONSTANT MASS, BUT VARYING FORCE

1. Measure the mass of the cart on the digital balance. Many of the carts already have masses listed on them. Place two more kilograms on the cart and record the total mass in your table.

2. Set up the apparatus as shown with the timer tape attached to one end of the cart and the string tied to the other. Pass the string over the pulley and fasten an opened paperclip to the end. Add some washers to the paperclip so that with just a little push the cart travels at constant speed. You now have a counterweight to just offset the frictional force. DO NOT REMOVE THIS COUNTERWEIGHT AT ANY TIME THROUGHOUT THE LAB. Hold the cart while placing the tape in the timer.

3. Add a 200g mass to the paperclip. Start the timer and release the cart. Just before the 200g mass hits the floor stop the cart and turn off the timer. Remove the tape and label it "Trial 1". Repeat this procedure for **four more** different masses. <u>NOTE: Cushion the fall of the masses with something to avoid a CRASH!</u> **Number** and keep these **5 trials** separate from those in the next step.

4. Circle your <u>first</u> dot and number every dot after that from 1 until a distance of 1.00 meters was reached. Include this final time for the run (remembering that each interval is 1/60 of a second).

5. Record both the distance (in meters) and time (in seconds) **on the tape**.

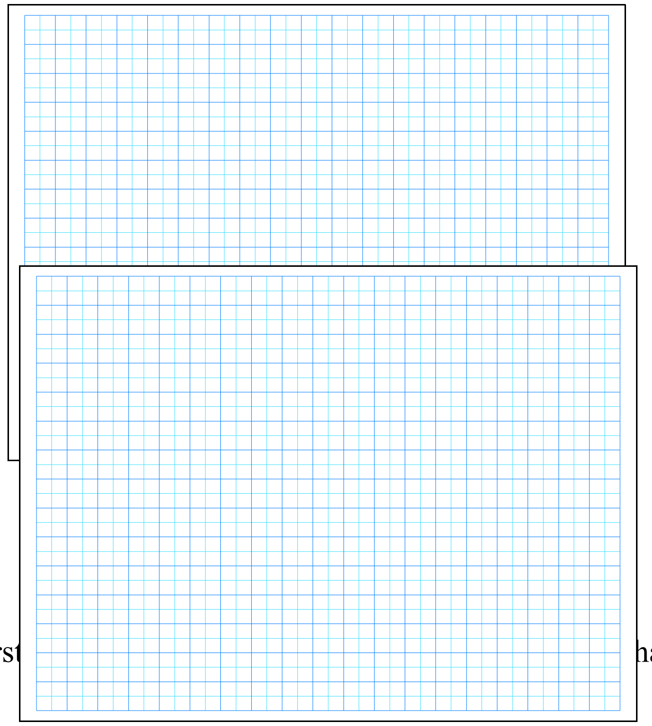
b) CONSTANT FORCE, BUT VARYING MASS

6. For the 5 trials in this section, keep a 500g mass on the paperclip in addition to the counterweight. Run the empty cart (plus 500g) and record the total mass of the cart, as well as the accelerating force. Add 500g more to the cart and run the cart again. Complete **a total of five trials** (trials 6-10) with varying cart masses. Record all data in results table.

Trial #	Mass of Cart (kg)	Hanging Mass (kg)	Acceleration (m/s^2)
1			
2			
3			
4			
5			
6			
7			
8			
9			
10			

INTERPRETATION:

1. Since each tape started at d=0 and t=0, you can use the equation $\mathbf{d=1/2at^2}$ to calculate the acceleration, **a**. Calculate the acceleration for all 10 trials and record these values in the table.
2. Using your data from trials 1-5, plot a graph with the forces (hanging masses) on the x-axis and the acceleration on the y-axis.
3. Using your data from trials 6-10, plot a graph with the cart mass on the x-axis and the acceleration on the y-axis.



4. Using your first hanging force; i.e. is it

inversely or linearly related?

5. Using your second graph, explain how acceleration varies with a changing total mass; i.e. is it inversely or linearly related?

NOTE: There will be no bonus offered for graphs. This is mandatory!