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NEWTON'S 2ND LAW FORCE AND ACCELERATION LAB

PART I – CHANGING MASS

Purpose: *To investigate the effect of increases in mass on an accelerating system*

Procedure:

1. Set up the ramp on the Physics Stand so that it is horizontal.
2. Using a triple-beam balance, determine the mass of the car with no weights. Determine the individual mass of each of the 3 weights you will be using. Record all 4 individual **masses** in Data Table 1.
3. Attach a string to the car and suspend the string over the pulley on the ramp. There will be some friction involved with this experiment. To offset as much as we can, we will suspend a 10 g disc from the opposite end of the string. Add enough mass to the string so that when the empty car is pushed slightly it moves at a constant speed. *(Hint: use the photogates to help!)*
4. Add a 50-g hook mass hanger to the counterweight. This falling mass will remain the same at all times for this experiment to provide a constant applied force to the car.
5. Attach the two photogates to the ramp at least 10 cm from either end. Make sure that the photogate nearest the physics stand is placed before the wing of the car when the mass hanger is on the floor.
6. Measure and record **the displacement between the two photogates** and the **length of the "wing" on the car** below Table 1.
7. Release the mass hanger and let the falling mass accelerate the car. In a new table, record the **time through photogate A** and the **total time from photogate A to photogate B**.
8. Repeat for 5 trials, recording the times for each trial in Data Table 2.
9. Repeat the procedure 3 more times, each time adding an additional weight to the car.

Data Analysis:

1. Calculate and record the **total mass** for each situation (car + each weight) in a new table (Table 3).
2. Next, calculate **average time through A** and **average time from A to B** and record in Table 3.
3. Calculate the **initial velocity** of the system. Record this in Data Table 3 for each situation.
4. Next, calculate the **accelerations** of the system. *(Hint: you know displacement, initial velocity, and time)*. Record the acceleration in Data Table 3 for each situation.
5. Make a graph of showing the relationship between **mass and acceleration**. Include an appropriate best-fit trend line/curve that matches our understanding of physics. *(Hint: Newton's 2nd Law!)*

Conclusion Questions:

1. Qualitatively describe your graph. Is it a straight line or a curved line? What does the graph tell you about the relationship between mass and acceleration?
2. What did we ensure did not change in this experiment? What was the numerical value of this constant variable?
3. If you have a constant applied force, theoretically how does increasing the mass of an object affect its acceleration? Compare this theoretical result to your actual results.
4. Make a new graph and this time linearize the graph so you have a straight line **with an upward slope** that shows us a constant force is being applied. *(Hint: Newton's 2nd Law!)*