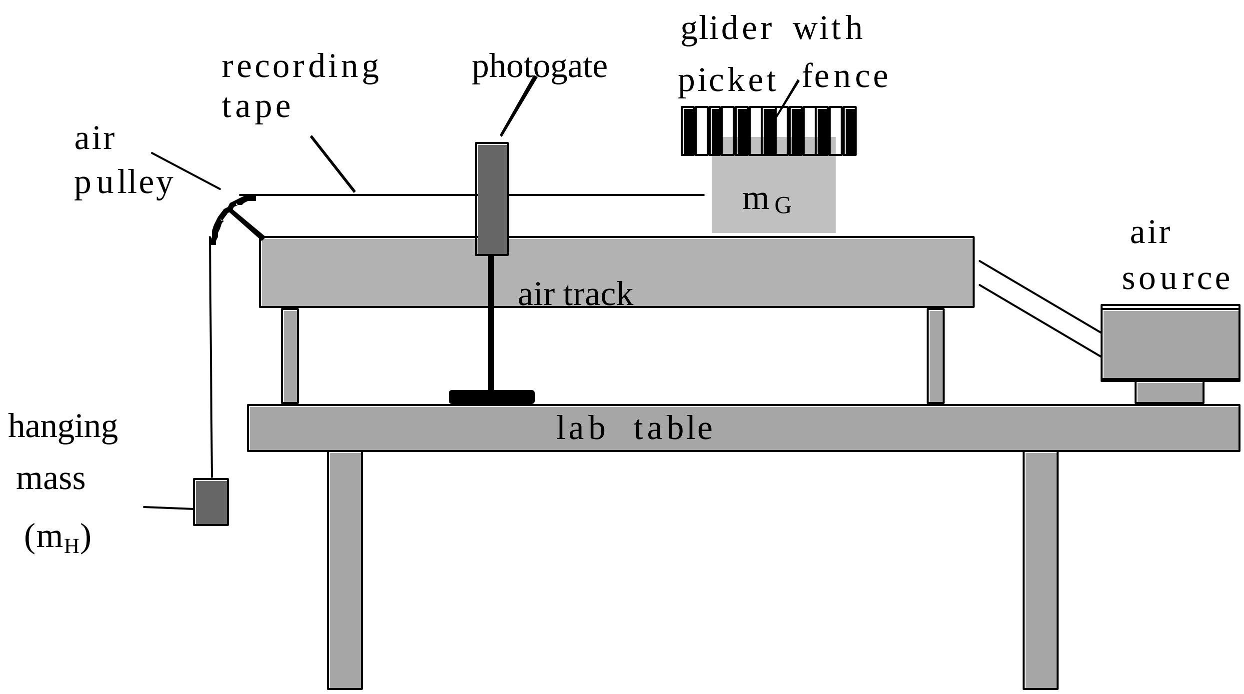
Lab M06 Newton's Second Law

10/21/03

GOAL: To investigate the relationship between net force, acceleration, and mass.

INTRODUCTION: A glider of mass m_G on a level air track is attached (via recording tape) to a mass m_H that hangs over the end of the air track. When the air is turned on, the tape slides with minimal friction over the air pulley; the hanging weight therefore accelerates the entire system (hanging mass + glider mass). The acceleration of the system will be measured using the picket fence method used in lab M05. The picket fence is taped to the top of the glider, and a photogate is positioned along the path of the fence.



You will vary the amount of force which is accelerating the entire system. You will keep the **total mass of the system constant**. You will plot the amount of force applied to the system on the y-axis and the acceleration of the system on the x-axis. You will to determine the type of relationship between these variables.

PRELAB: On separate paper, neatly and completely answer the following before coming to lab. (show your work)

1) What mathematical relationship (e.g., direct, inverse, quadratic, ...) should there be between the acceleration of the system and the net accelerating force ($m_H g$)?

2) What mathematical relationship (e.g., direct, inverse, quadratic, ...) should there be between the acceleration of the system and the total mass ($m_H + m_G$) of the system?

3) Write a formula for the acceleration of the system in terms of m_H, m_G, and g. Explain why you think your formula is correct.

METHOD:

1) Have your instruction sheet from lab M05 on hand as a reference.

2) Measure the mass of your glider, including just the picket fence, and record it on your lab data sheet.

3) The air track should be level throughout this experiment. Check this. If there is one part of your airtrack that is more flat than the rest of it, try to position the photogate in that region.

4) Initially, tie/tape five 0.020 kg masses (or some combination of 0.020kg and 0.010kg masses or metal washers) onto the hanging end of the recording tape (this will be the hanging mass) for a total of 0.100kg of hanging mass. Place a box containing styrofoam on the floor below it to gently catch the falling mass.

5) Position the photogate so that all the pickets will pass unobstructed through the gate before the hanging mass strikes the box—this is VERY important. Why? For each run, be sure to stop the glider before it crashes into the end of the air track.

6) Make 3 separate measurements of the acceleration with this amount of hanging mass. The software and the instructions for its use are the same as for lab M5. Record the value of the acceleration for each trial. Appropriate SI units should be used for all quantities.

7) Now reduce the amount of hanging mass by 20grams **while keeping the TOTAL mass of the system constant.** To accomplish this, remove 0.020 kg from the hanging mass and tape it to the glider.

8) Again make 3 measurement of the acceleration. Repeat this process (moving 0.020 kg from the hanging mass to the glider and measuring the acceleration 3 times) three more times (i.e., you will make a total of 15 measurements). Be sure to distribute the taped masses uniformly along the sides of the glider (so that the glider remains balanced—why is this important?) during each new run.

Report for lab M06

Name_________________________ blk _____
Partner(s) _____________________________

Raw Data:

Mass of glider including picket fence = m_G = _______________ kg
Measured system mass = (m_H + m_G) = _______________ kg

Total hanging mass= m_H (kg)	Net force = m_H *9.8N/kg (N)	Trial #	Acceleration—Δv/Δt = slope of v-t graph (m/s^2)
0.100		1	
		2	
		3	
0.080		1	
		2	
		3	
0.060		1	
		2	
		3	
0.040		1	
		2	
		3	
0.020		1	
		2	
		3	

ANALYSIS:
Using Graphical Analysis or your calculator, graph your data with acceleration on the horizontal axis and net Force (= Hanging Mass times 9.8 newtons/kilogram) on the vertical axis. Carefully sketch the graph below with labels, units, and scaling.

a) Explain why there should be a linear relationship between the acceleration and the net force.

b) Carry out the appropriate fit to your data, choosing the appropriate function in Graphical Analysis. Record the slope and y-intercept of the straight line that best fits your data.

c) Write down the symbolic math equation (y's and x's) describing the fit and also the appropriate symbolic physics equation. Write a translation table between the variables in the two equations and the numerical values with units.

d) Based on the equation that you wrote down in the prelab, calculate the total mass of your system. Compare this value with the directly measured total mass. Find the % difference between the two values (measured and calculated) of total mass.