

## Lab # 4 Newton's 2<sup>nd</sup> Law-Part Two

**Purpose:** To investigate the dynamics of one-dimensional motion.

**Equipment:** Same as Newton's 2<sup>nd</sup> Law (Part One)

**Discussion:** This week, instead of having the total system mass remain constant while we vary the driving force on the glider, we will vary the total system mass and keep the driving force constant. (The method for measuring acceleration is exactly as in last week's lab.) Recall equation (4) from last week's lab:

$$F_d = m_d g = (M + m_d)a.$$

This equation is in  $y = mx + b$  form. Last week we plotted  $F_d$  on the vertical axis ( $y$ ) and  $a$  on the horizontal axis ( $x$ ), so the coefficient of  $a$ , the quantity in parentheses,  $M + m_d$ , represented the slope of the line.

Now consider the equation above in a slightly different, yet equivalent, form:

$$(M + m_d) = F_d (1/a)$$

If we plot total system mass vs. the reciprocal of acceleration, the slope of the line should be the **constant** driving force. (Notice that, again, the equation is in  $y = mx + b$  form.)

### **Procedure:**

1. Level the air track. Align the air track, string, & pulley such that everything is lined up properly as discussed last week. All **FIVE** of your trials will be run with 40 grams suspended from the paper clip.
2. Each trial will use different total system mass combinations, by methods such as taping two gliders of similar or different sizes together, attaching mass cylinder(s) from a weight set to the glider, etc. You should make an attempt to spread your 5 trials out fairly evenly over a total system mass range from about 0.2 kg to 0.6 or 0.7 kg. It is very **important** that you test each mass combination on the air track to ensure it does, in fact, move easily after a push from one end of the track to the other, and back again. If you test one of your mass combination and find that it slows to a stop on the air track, and increased friction will render your data useless.
3. Record the total system mass for each trial in kg. Don't forget to add in the mass of the horizontally moving paper clip and the 0.0405 kg suspended from the vertical end of the string.
4. Prepare the following table in Excel:

Trial No.	Acceleration (m/s <sup>2</sup> )	Reciprocal of Acceleration (s <sup>2</sup> /m)	Total System Mass (kg)
1	-----	-----	-----
2	-----	-----	-----
etc.	etc.	etc.	etc.

5. Plot total system mass versus the reciprocal of accelerations and find the slope of the trendline. Compare this experimental driving force value to the actual driving force, which is the weight of 40.5 grams, and compute percent error.