AIR TRACK
DETERMINATION OF g
and
NEWTON'S SECOND LAW

Part One. DETERMINATION OF g.

Make sure the track is level. Then tilt the track by placing first one, and then two, blocks under that end of the track which has only one foot. Perform the following experiment for each tilt angle θ:

After a few practice runs, make two ink-jet records of the cart accelerating down the track. Analyze your ink-jet records to determine the acceleration and error for each run. Now find g for each run ($g = a/\sin(\theta)$). Sin(θ) should be determined by direct measurement of the right triangle created by tilting the track, not by measurement of the angle with a protractor. Be careful to propagate errors correctly. Compare your value of g and its error with the accepted value of g.

Part Two. NEWTON'S SECOND LAW

Remove all blocks. Again check the track to make sure it is level. Using a nylon string, connect the air track cart over a pulley to a hanger. Let the mass of the hanger plus any masses attached to the hanger be represented by m. Let the mass of the cart plus any masses attached to the cart be represented by M. Now make five runs in which the hanging mass m accelerates the total mass $M + m$. Keep the total mass $M + m$ constant by beginning with five 50 gm masses on the cart and then each time moving one 50 gm mass to the hanger. **At all times keep the 50 gm masses arranged symmetrically on the cart.** Analyze your ink-jet records to determine the acceleration for each of the five runs. Then plot mg vs. a for the five runs and determine the line of best fit. What is the significance of the slope and y-intercept (if non-zero) of this line? Is Newton's Second Law verified to within your experimental error?

THING TO WATCH OUT FOR:

1. Don't slide cart on track with the blower off.
2. Be careful not to drop the carts. Any defects in the cart surface can create excess friction. If you drop one of the carts please alert your TA.
3. Timer voltage is 30,000 volts - although not lethal, it is uncomfortable.

ANALYSIS OF INK-JET RECORDS

Select a dot (not too close to the starting point) as position zero. Successive dots will be numbered 1, 2, 3, etc. For some runs, you may prefer to select every other dot. Measure the position of at least 7 dots, including dot 0. Calculate the average velocity in each interval (there will be at least 5 intervals). If the acceleration is truly constant, at what time in the interval does this average velocity actually occur, *i.e.* at what time in the interval is this average velocity for the interval equal to the instantaneous velocity? Calculate the change in velocity between each interval and each succeeding interval. Calculate the average acceleration $\overline{a}$ between each interval and each succeeding interval. All of these calculations should be arranged neatly in a single table.

Is your calculated acceleration constant to within your experimental error? If not, make a graph of $\overline{v}$ vs. t and determine the acceleration from the slope of the best fit line. How does this value of a compare with the average of your (at least five) $\overline{a}$ values? (NOTE: For very good runs, *i.e.* if your calculated acceleration is truly constant within your error, making the graph may be superfluous. But you should make a graph of $\overline{v}$ vs. t for at least one case.)