THE AIR TRACK AS AN INCLINED PLANE

Equipment List:

- One air track, blower, blower hose and power cord
- One digital photogate and one accessory photogate
- One glider
- Five different riser blocks
- One flat plastic accessory box
- Two meter stick
- Vernier calipers

Introduction:

You will calculate the acceleration of the glider down the inclined track (Call this the "experimental" acceleration). Then, from finding the angle of inclination of your track (using trigonometry), you will find a "theoretical" acceleration using the well known result from Newton's second law:
a = g sin(theta). Then you will compare the two accelerations for agreement using two methods: a "most probable range" overlap test and a discrepancy test.

Theory:

From Newton's second law, show that the theoretical acceleration of a body down a frictionless inclined plane is a = g sin(theata).

From kinematics, derive an equation that yields the acceleration of a body in terms of the distance it travels and the time it takes, assume a zero initial velocity.

Procedure:

1. Set up your air track equipment following the procedures in the INTRODUCTION TO THE AIR TRACK. Remember, you need not worry about leveling your air track since this experiment uses the air track as an inclined plane.

2. Using some combination of the small riser blocks provided, raise the end of the air track that has one foot only (the other end has two feet) about one or two centimeters.

3. Experiment to determine good placement of the photogates when one end of the track is elevated. Place the two photogates as far apart as possible. Measure the distance between the two photogates. One way to do this is to use the leading edge of the glider and record the position of the glider as it triggers each photogate. To see if the photogate has been triggered, check the red LED on the top of the photogate arm. Subtract the position of the glider at each photogate and you will have the distance between the two photogates.

4. The timer should be set to **PULSE** mode, and have the resolution switch set to 1 mS (use the 0.1 mS setting only if the time the glider is between the photogates is less than two seconds). The memory switch should be turned on so that the small red LED next to the switch is lit. The number on the LCD display is always the time measured *in seconds*.

5. Release your glider from rest so that its velocity through the first gate is zero. Find the time the glider is between the two photogates.

6. Repeat the same procedure for a total of **five** trials. This will allow you to calculate five accelerations. Apply the statistical method to calculate an average experimental accereration with an absolute uncertainty.

7. Calculate the angle of the plane using trigonometry. One method is to measure the distance between the two feet (it should be very close to one meter) and measure the height of the riser block (use the vernier calipers). The ratio of these two distances (both in the same units!) is equal to what trig function? Since you know the gravity field's value, you can calculate the "theoretical" acceleration: a = g sin(thetat). Treat this acceleration as an exact value with no uncertainty.

Analysis:

Compare your two accelerations using a discrepancy test. Less than ten percent is good. Less than five, very good. More than fifteen percent discrepancy and you are almost certainly making a mistake somewhere. Did the theoretical acceleration fall within the most probable range of the experimental?

Optional Graphical Analysis:

Repeat steps 3-7 for four more angles (four more risers or combinations of them) for a total of five different angles and 25 timing runs. Calculate *g* from the slope of the straight line graph that relates the sine of the angle to your calculated acceleration. Your graph will have at least ten data points. Use one of the computers to draw it. Use the "trendline" feature to have the best slope line (the computer will use "linear regression") printed on your graph. Also have the computer print the "correlation coefficient", r, on your graph. The closer r is to1, the more linear your data is. A correlation coeefficient of exactly 1 means your data is exactly linear. Do you have to re-measure the distance between the photogates as you change the elevation of the track? What does it mean physically if your y-intercept is not zero?

Conclusion:

Discuss methods that would minimize the discrepancy calculated above. Which angle would you expect to be larger most of the time due to systematic errors? See if you can discover any systematic errors and suggest ways in which they could be eliminated or at least minimized. At the discretion of your instructor, hand in an **abstract** written by you and your partner. The structure of an abstract is discussed in your lab skills manual.