Lab 2 - Constant Acceleration

Name ____

Partner's Name ____

I. Introduction/Theory

The purpose of this lab is to study how the acceleration of an object down an incline depends on the angle of the incline assuming constant acceleration and to obtain the constant acceleration due to gravity.

A cart on an incline will roll down the incline as it is pulled by gravity. The acceleration due to gravity is CONSTANT and straight down as shown in Figure 1. The component of gravity, which is parallel to the inclined surface, is **g sinθ**, so this is the net constant acceleration of the cart, neglecting friction. The sine of the angle (sin θ) will be calculated from the height of the air track and the length of the air track.

$$\sin\theta = \frac{\text{opposite side}}{\text{hypotenuse}} = \frac{\text{height}}{\text{length of track}}$$

To measure the acceleration, the cart will be started from rest and the time (t) it takes for it to travel a certain distance (d) will be measured. Then since $d = (\frac{1}{2})at^2$, the acceleration can be calculated using

$$a = 2d/t^2$$

Then a plot of acceleration versus sinθ should give a straight line with a slope equal to the acceleration due to gravity, g. Your text list the value of gravity at the surface of the earth to be 9.81 m/s^2.

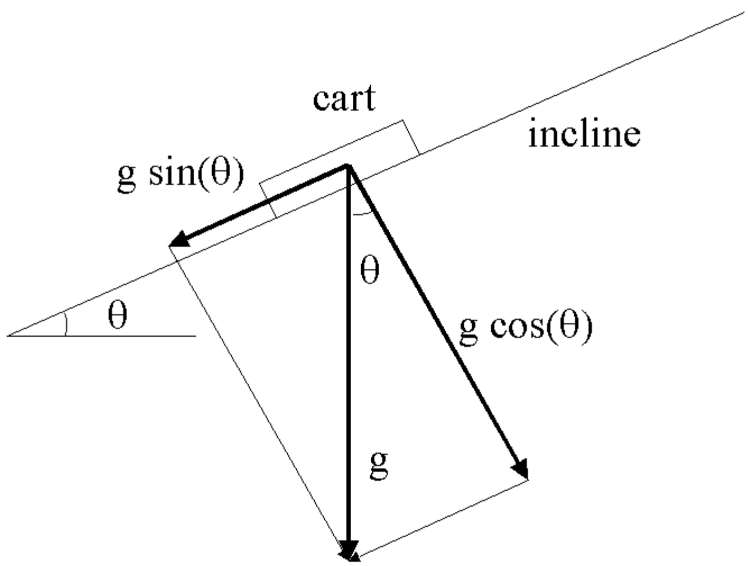

Figure 1

II.   Equipment

Air Track Cart
Stopwatch
Air Track with accessories
Meter Stick
Height Spacer Blocks

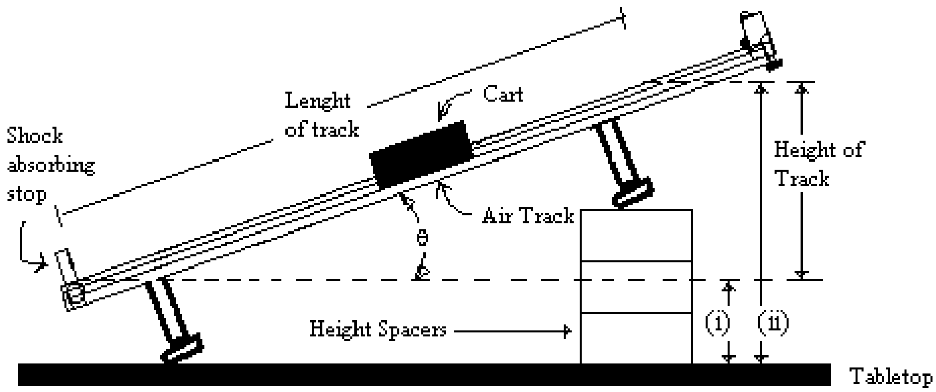

Figure 2. Equipment Setup

III. Procedure

Note: For analysis simplification, measurements made to determine sinθ will not require uncertainties.

A. Set up the air track as shown in Figure 2, raising the single foot end of the air track approximately 6 to 7 cm above the tabletop. Verify the shock absorbing stop is at the bottom of the air track!
B. Set the cart on the air track against the bottom end stop and record this final position of the cart in Table 1. Measure the vertical height of the front end of the cart (i), record in Table 1.
C. Pull the cart up to the top of the air track and record the initial position where the cart will be released from rest. Measure the vertical height of the front end of the cart (ii), record in Table 1. Verify that the change in the carts height is between 5.5 and 7.5 cm, adjust as required and record any changes.
D. Release the cart from rest and use the stopwatch to time how long it takes the cart to hit the end stop. The person who releases the cart should also operate the stopwatch. Repeat this measurement until 5 times are recorded in Table 1 (With different group members doing the timing).
E. Lower the end of the air track by ~2 cm and repeat steps b through d, excluding the length of track measurement only. Verify that the change in the carts height is between 3.0 and 5.5 cm, adjust as required and record any changes.
F. Lower the end of the air track by ~2 cm and repeat steps b through d, excluding the length of track measurement only. Verify that the change in the carts height is between 0.5 and 3.5 cm, adjust as required and record any changes.

IV. Data (include units!)

Initial Position of Cart = ____________________

Final Position of Cart = ____________________

Net distance of Cart (d) = ____________________

height at top (ii)			
height at bottom (i)			
Δh			
Trial 1 (sec)			
Trial 2 (sec)			
Trial 3 (sec)			
Trial 4 (sec)			
Trial 5 (sec)			
Average			
Std. Dev.			
Std. Error			
Accel. ($2d/t^2$) with Uncert. S_a			

Table 1

V. Analysis

A. Calculate the average, standard deviation, and standard error of the times recorded. Hint: use a spreadsheet. Record in Table 1.

B. Calculate and record above Table 1, the total distance without uncertainty traveled by the cart (d).

C. Calculate the accelerations using the distance and times ($a = 2d/t^2$). Record accelerations in Table 2 with uncertainties. Show work below or on an attached sheet.

D. Calculate sinθ and record values in Table 2 without uncertainties.

Height (Δh)	sinθ (=Δh/d)	Acceleration (a)	Uncert ($S_a = \lvert da/dt\ S_t \rvert$ or $2d/\underline{t}^2 - 2d/(\underline{t}+S_t)^2$)

Table 2

E. Plot acceleration including uncertainties versus sinθ. Draw the best-fit straight line and calculate its slope with uncertainty. Hint: in this example you should be able to add in another data point with a very small uncertainty (i.e. sinθ = 0). This slope is an experimental measurement of gravity (g).

Slope = ________________ ± ________________

NOTE: Don't forget to use the whole space provided and label your axes

F. How does this slope compare with the value of g given earlier, i.e. statistically compare them?

V. Conclusions (include physical concepts and principles investigated in this lab, independent of your experiments success, and summarize without going into the details of the procedure.)

Addition comments for clarifying the lab procedures are always welcome.