

**Straight Line Motion with Constant Acceleration
and Motion in A Plane****ME-2****PURPOSE**

The purpose of this experiment is to study and analyze the straight-line motion with constant acceleration, and to find this acceleration for a puck moving on an inclined air table. The motion of a horizontally projected puck on the inclined air table will also be studied and analyzed.

EQUIPMENT

An air table, a puck shooter, a cylinder to tilt the air table, an angle finder, an ordinary ruler with millimeter divisions, linear graph paper, a pencil, an eraser, a calculator

EXPERIMENTAL PROCEDURES

This experiment has two parts, both of which will be carried out using an inclined air table. One side of data sheet will be used at a time. First, level off the air table, and then tilt it to an inclined position by using the cylinder. Find the inclination of the air table with the angle finder. Keep one of the pucks at rest over the carbon paper at the lower right corner of the air table. In both experiments, only one puck will be used.

PART I: Straight Line Motion with Constant Acceleration

1. Put the puck at the top of the inclined plane of the air table. Activate only the (P) switch. Check that the puck falls freely down the plane.

Set the sparktimer frequency to 20 Hz. (If the dots you get with $f=20$ Hz turn out to be inconvenient for analysis, you can switch to 10 Hz.) Put the puck at the top of the inclined plane. Put the (P) and (S) switches on top of each other and activate them simultaneously. De-activate the switches when the puck reaches the bottom of the inclined plane.

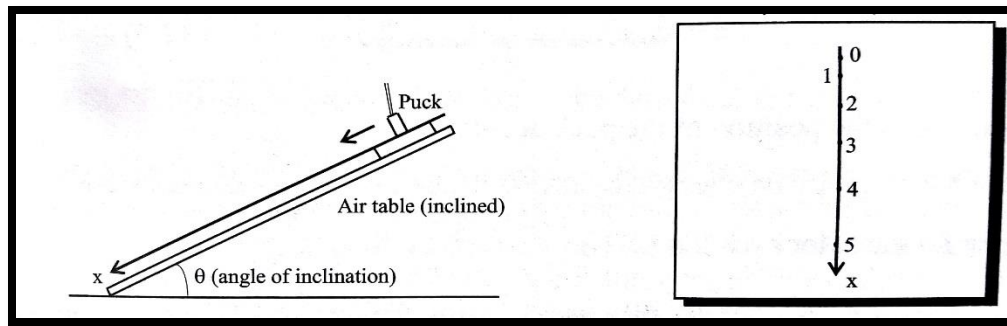


Figure 1. The set up for a puck moving down an inclined air table.

2. Remove the data sheet from the air table and examine the dots produced on it. Have your data approved by your instructor. Take the trajectory of the puck as the positive x -axis. Number the data points starting from the first dot as 0, 1, 2, ..., 5. Take $x=0$ and $t=0$ at the first dot, and measure the distance of the remaining four dots from the dot 0. Also, determine the time t for each of these dots. Fill in your data in Table 1 below along with their corresponding measurement errors.
3. Using the data in Table 1, plot x versus t^2 graph on a linear graph paper. Draw the best and worst lines, and find the acceleration $a \pm \Delta a$ of the puck.

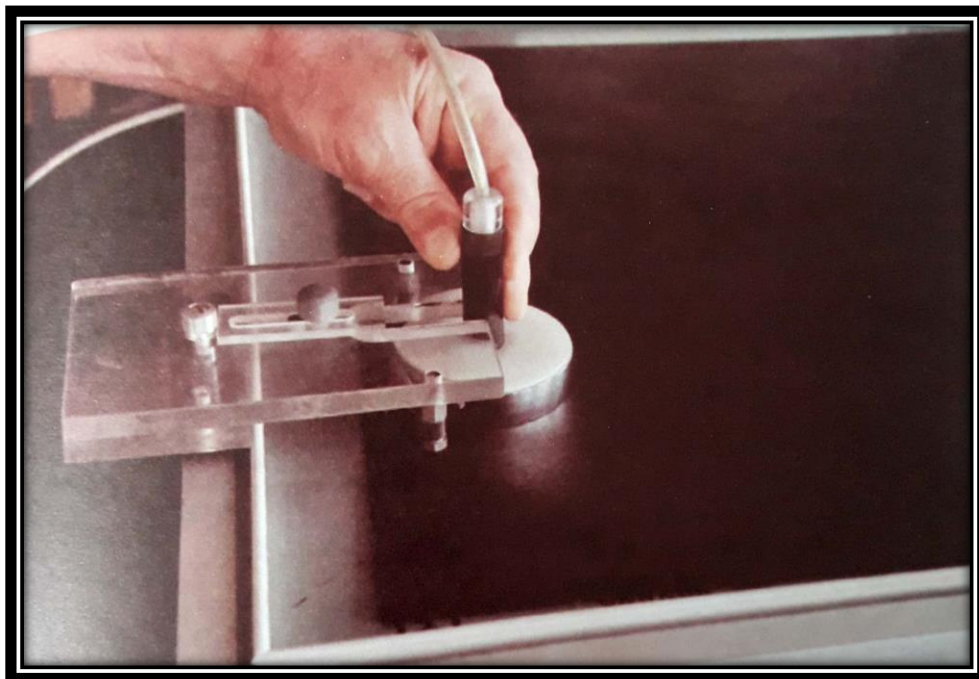


Figure 2. Adjusting the shooter on the edge of the inclined air table

PART II: Horizontal Projection

1. Use the other side of the data sheet in this part.
2. Keep one of the pucks stationary by placing it on a folded piece of paper at the lower right corner of the inclined air table.
3. Attach the shooter to the left side of the inclined plane of the air table about 10 cm from the upper edge, and adjust the shooting angle to zero degrees.

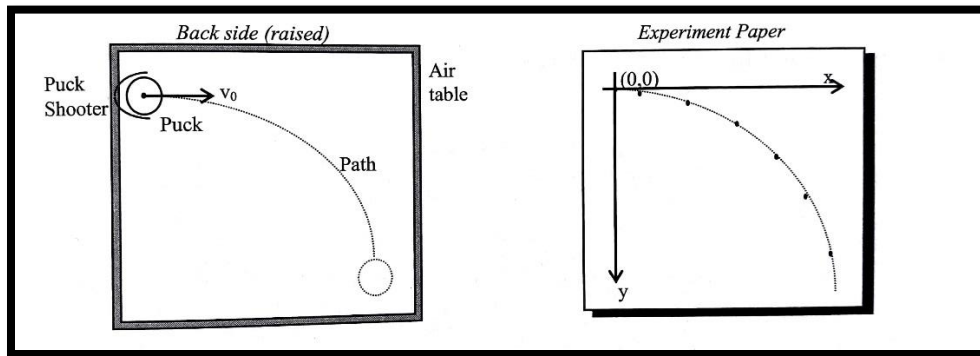


Figure 3. Horizontally projected puck on an inclined air table.

4. Activate only the P switch, place the puck into the shooter, and **make a few test shots to adjust the tension in the rubber** belt of the shooter to give a convenient trajectory.
5. Now activate the P switch and place the puck into the adjusted shooter, then release it while simultaneously activating the S switch to trigger the sparktimer. Keep the switches on until the puck comes to the bottom of the data sheet and then remove your hands off them.
6. Before removing the data sheet, place the puck opposite to, but outside, the shooter, and activating both the P and S switches simultaneously, make it slide freely down the inclined plane.
7. Now take the data sheet off the air table, and examine the trajectories you have got. You should get something like trajectories illustrated in Figure below. Denote the two trajectories by A and B as in the figure. If your data points are inconvenient for analysis, make another run and get new data.

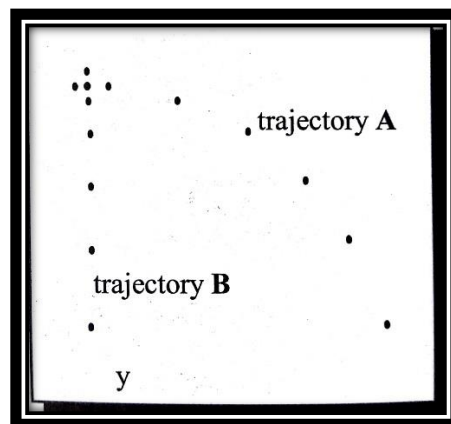


Figure 4. The dots on the data sheet

8. Circle the data of both trajectories, and **starting from the first dot**, number them as 0,1,2,... etc.
9. Draw the x and y -axes for trajectory A. This can be done by first drawing a line parallel to the trajectory B that passes through the first dot (dot 0) of trajectory A. This line will be the y -axis. Then draw a horizontal line perpendicular to it from dot 0 to have the x -axis. Take the positive y -direction to be downwards.

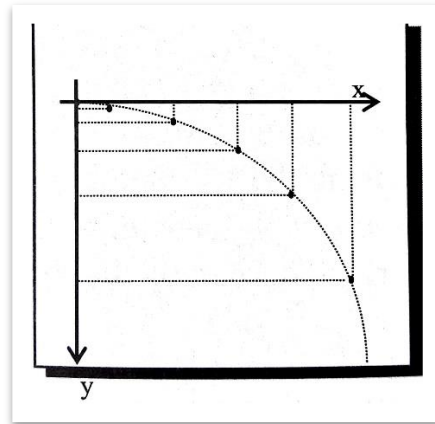


Figure 5. Projections of dots on the data sheet along the x and y -axes.

10. Draw from each dot in trajectory A normals to the x and y -axes to get the x and y -projections of these dots. You will get a result similar to the one shown in the above Figure. What type of motion does the puck have along the horizontal and vertical axes?
11. Measure and record the time of flight t_f (the total time that elapsed during the motion of the puck), and the range R of the projectile (the horizontal distance traveled during the motion). Using R and t_f , find the projection velocity v_{ox} .
12. Starting from dot 0 of trajectory A, measure the distances of the y -projections of 5 data points from this point. Determine also the time corresponding to each of these points. Record your results in the left margin of Table 2. Also measure and record the distances of the first 5 dots in trajectory B from dot 0 along with the corresponding times. Put these in the right margin of Table 2.
13. Taking y to be the distance of dot 5 from dot 0, use $y = (a t^2)/2$ to find the accelerations a_A and a_B for both trajectories A and B. Compare these with the acceleration you found in Part I of the present experiment.

PART I: Straight Line Motion with Constant Acceleration

1. How do the dots you got in the present experiment differ from those you got in Experiment ME-1? What type of motion did you have in each of these experiments?

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2. Fill in your data table in the table below. Report your measurements with the correct number of significant figures and include the errors.

Dot Number	$x \pm \Delta x$ (cm)	$t \pm \Delta t$ (sec)	$t^2 \pm \Delta t^2$ (sec ²)
0			
1			
2			
3			
4			
5			

Table 1

3. In the space provided below show how to find the error $\Delta(t^2)$ in t^2 for only one data point.

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4. In the space provided below report the slopes of the best and worst lines of the x - t^2 graph with the correct number of significant figures.

$$m_b = \text{..... cm/sec}^2$$

$$m_w = \text{..... cm/sec}^2$$

5. Find the acceleration of the puck along with its error from the slopes above and record it with the correct number of significant figures.

$$a \pm \Delta a = \text{ cm/sec}^2$$

PART II: Horizontal Projection

6. What kind of motion does the horizontally projected puck have along the x and y -axes? Explain your answers.

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7. Report t_f and R

$$t_f = \text{ sec.}$$

$$R = \text{ cm.}$$

8. Calculate the projection velocity $v_0 = v_{0x}$, and report it with the correct number of significant figures:

$$v_0 = \text{ cm/sec}$$

9. Record your measurements for the trajectories A and B in the table below. Report them with the correct number of significant figures and errors.

	Trajectory A (y-projections)		Trajectory B	
Dot Number	$y \pm \Delta y$ (cm)	$t \pm \Delta t$ (sec.)	$y \pm \Delta y$ (cm)	$t \pm \Delta t$ (sec.)
0	0	0	0	0
1				
2				
3				
4				
5				

Table 2

10. Using the equation given in procedure part, and taking y as the distance of the fifth point, find the accelerations a_A and a_B of both trajectories A and B , and report them with the correct number of significant figures. Compare these two accelerations, and compare them with the acceleration you found in Part I too.

$$a_A = \text{ cm/sec}^2$$

$$a_B = \text{ cm/sec}^2$$

Comments and Discussion:

Write down any comments related to the experiment, and/or elaborate on and discuss any points. Compare and contrast your results.

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