Name: Student Id: Date:

# Measurements, Errors, and Straight Line Motion with Constant Velocity	ME-1

PURPOSE

This experiment consists of two parts. In the first part, it teaches how to report experimental measurements along with the corresponding errors and the correct number of significant figures. In addition, it teaches students the manipulation of errors through arithmetic operations, and reporting the results with the correct number of significant figures. Lastly, it teaches how experimental results are presented in a graph. In the second part, an object moving under the influence of no net force is investigated. Such an object moves with a constant velocity along a straight line. The students are going to calculate this velocity.

PROCEDURE

In part A, you are going to measure the dimensions of your textbook to find its perimeter and volume. In part B, you are going to use air table. On a leveled-off air table, a puck with an initial velocity keeps moving with constant velocity along a straight line.

PART A: MEASUREMENTS AND ERRORS

1. Using a ruler with a millimetric division find the perimeter of your textbook. Measure the length and width of the textbook, and then multiply their sum by 2 to find the perimeter. Report each of the measurements as well as the results with their correct number of significant figures and accompanying errors. Report the result in centimeters, then transform this into meters.
2. Measure also the height (h) of the textbook, and find its volume. This measurement and the volume result are to be reported with the correct number of significant figures and accompanying errors.

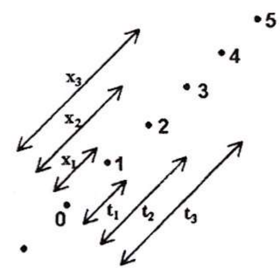
PART B: PUCK MOVING ON A LEVELED-OFF AIR TABLE

Before carrying out the experiment, make sure that you understand the instruction given by your lecturer. If some points are still not clear to you, you can ask your lecturer for assistance.

1. Level off the air table as your instructor demonstrated.
2. First place the conductive carbon paper and then place the data sheet on the glass place of the air table.
3. Keep one of the pucks stationary by placing it at one corner of the air table and putting a folded piece of paper under it. In this experiment, only one puck will be used.
4. Set the sparktimer frequency to 20 Hz.
5. Activate the footswitch (P) and push the puck **diagonally** across the surface of the air table. At the moment you release the puck, activate the footswitch (S) to start the sparktimer. Let the puck travel

the whole diagonal distance across the air table, and then remove your feet off both the (S) and (P) switches.

6. Remove the data sheet from the air table. Number the dots as 0,1, 2, … etc. The first dot can be (but not necessarily) taken as dot 0. Measure the distances of five dots from dot 0, (see the Figure below), and find the time corresponding to each dot. Fill in Table 1- 1 below. The *x* and *t* measurements in this table should be filled in along with their corresponding errors, i.e. as $x \pm \Delta x$ and $t \pm \Delta t$.



7. Using the data points in Table 1- 1, plot the graph of the position *x* versus the time *t* on linear graph paper. Plot the position (which is the dependent variable) in centimeters along the vertical axis, and the time (the independent variable) in seconds along the horizontal axis. Label the axes, and write down the corresponding unit on each axis. Plot the data points along with the error bars. Note that the distribution of the data points suggests a straight-line fitting. Is this an expected result? Draw the best and worst straight lines for your data.
8. Find the slopes of the best line, m_b, and the worst line m_w. Calculate the error (uncertainty) in the slope $\Delta m = |m_b - m_w|$. From these slopes find $v \pm \Delta v$.

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DATA AND RESULTS

PART A: MEASUREMENTS AND ERRORS

1. The circumference of the laboratory manual:

   The length $l \pm \Delta l$ = ...

   The width $w \pm \Delta w$ = ...

   The perimeter $C \pm \Delta C$ = ...

Show explicitly the details of the calculation of C ± ΔC in the space below:

. . . .
. . . .

2. The volume of the parallel-piped wooden block:

   $l \pm \Delta l$ = ...

   $w \pm \Delta w$ = ...

   $h \pm \Delta h$ =. . . . .

   The volume $V \pm \Delta V$ = ...

Explicitly show the details of calculation of ΔV below,

. . . .
. . . .

PART B: GRAPH AND INSTANTANEOUS VELOCITY

Record the frequency of the sparktimer, f=. . . . . Hz.

1. Fill in your x and t measurements with the corresponding errors in Table 1-1 below.

Dot Number	Position x ± Δx (cm)	Time t ± Δt (sec.)
0	0	0
1		
2		
3		
4		
5		

Table 1- 1.

2. Are the data points on the data sheet evenly spaced? Is this an expected result? Why?

. . . .
. . . .
. . . .

3. Show how to find the error Δt for some of your measurements.

. . . .
. . . .
. . . .

4. m_b= . . . . cm/sec.

   m_w=. . . . . cm/sec.

   $\Delta m = |m_b - m_w|$ = ... cm/sec

5. In the space provided below, report the value of v found from the slope of the graph with the correct number of significant figures.

   $v \pm \Delta v$ =. . . . . ± . . . . cm/sec.

Comments and Discussion:

Write down any comments related to the experiment, and/or elaborate on and discuss any points (if there are any) in the space below:

. . . .
. . . .
. . . .