EXPERIMENT M3
ANALYSIS OF STRAIGHT LINE MOTION WITH CONSTANT VELOCITY

1. PURPOSE

The purpose of this experiment is to observe that an object moving under the influence of no net force moves in a straight line and with constant velocity, and calculate this velocity.

2. EQUIPMENTS

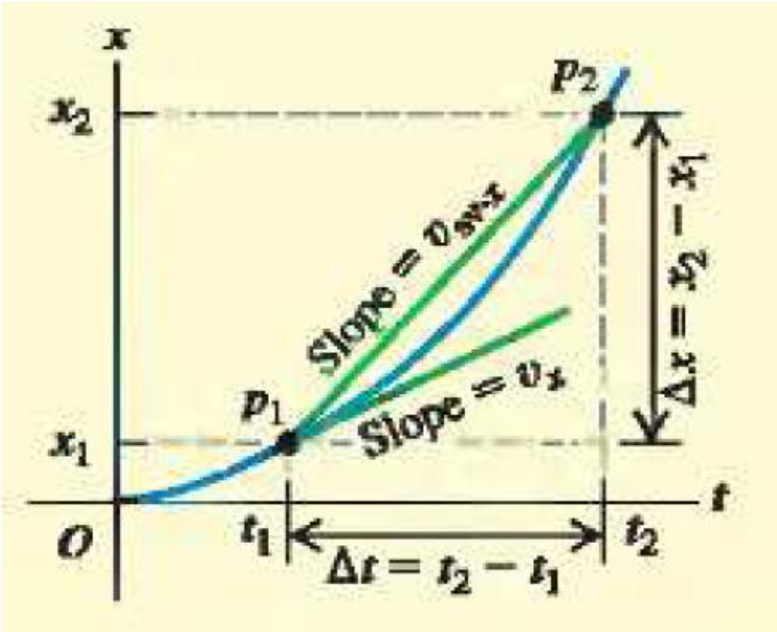
Air table setup, milimeter ruler, milimeter graph paper and calculator

3. THEORY

Motion is a continuous change of position in time. There are three types of motion; the simplest of these is the motion in a straight line with constant velocity. In this type of motion, the moving object travels equal distances in equal time intervals along a straight line. Recall that Newton's first law of motion states that an object at rest will remain at rest, and an object moving in a straight line with constant velocity will remain so unless a net force acts on the object. Therefore, an object that moves in a straight line with constant velocity experiences no net force. In other words, the resultant force acting on this object is zero. Straight-line motion, average and instantaneous x-velocity: When a particle moves along a straight line, we describe its position with respect to an origin O by means of a coordinate such as x. The particle's average x-velocity V_{av-x} during a time interval $\Delta t = t_2 - t_1$ is equal to its displacement $\Delta X = X_2 - X_1$ divided by Δt . The instantaneous x -velocity V_x at any time t is equal to the average x-velocity for the time interval from t to $t + \Delta t$ in the limit that Δt goes to zero. Equivalently, V_x is the derivative of the position function with respect to time.

$$V_{av-x} = \frac{x_2 - x_1}{t_2 - t_2} = \frac{\Delta_x}{\Delta_t} \quad (1.1)$$

$$V_x = \lim_{\Delta t \to 0} \frac{\Delta_x}{\Delta_t} = \frac{d_x}{d_t} \quad (1.2)$$



4. EXPERIMENT

In this experiment, you are going to work on motion with constant velocity using air table. Since it is the first time, you will learn how you use air table. Also, the graphical analysis is important for this experiment.

1- Set the air table parallel to the ground by using its support (be sure disc doesn't move to right or left and up or down when you decontrol it).

2- Place the data carbon sheet and the data sheet on the air table smoothly.

3- Keep the disc fixed in a corner by curling the corner of the data sheet.

4- Set the frequency of the arc chronometer **20, 30** and **60 Hz**.

5- Press the **P** pedal that run the air pump and push the disc with your fingers tenderly to pass the disc cornerwise of the air table. Repeat this procedure until you are sure motion of the disc is on the straight line.

6- Press the **A** pedal of the arc chronometer at time that given the first motion to disc while the air pump is ON. Stop to press the **A** pedal of the arc chronometer and **P** pedal of the air pump when the disc comes to other corner of the table.

7- Number the points starting with 0 (zero) (it is not important beginning from the first point). Choose 5 consecutive points among those points. Since the velocity of the disc constant any point can be chosen as the origin. Name the interval between the 0th and 1st points as X_1 coordinate and between the 0th and 2nd points X_2 coordinate and determine other coordinates accordingly. Frequency gives time elapse between two consecutive points. Since you know that time elapse between two consecutive points is one devided by frequency, you can determine how long it took for each point to be created. Fill the Table 3.1. below with the position (X) and time (t). You should consider error values corresponding to position ($X \mp \Delta X$) and time ($t \pm \Delta t$).

8- Place your data on a position-time table and plot it position as (dependent variable) horizontal axis and time (independent variable) as vertical axis. Show the units of axis absolutely. Plot the best and worst line with error values for two axis. Slope of the best line corresponds to velocity of the disc.

9- Determine the slope of the best line (m_{bl}) and slope of worst line (m_{wl}) and absolute error of slope ($\Delta m = |m_{bl} - m_{wl}|$) and velocity of the disc $V \pm \Delta V$.

10- Fill the Table 3.2. for $i = 0, 1, 2, 3, ...$

5. DATAS

1- Draw the similar table on your data sheet and write your datas on it.

Point Number	**Position $X \mp \Delta X$ (cm)**	**Time $t \pm \Delta t$ (s)**
0		
1		
2		
3		
4		
5		

Table 3.1: Position and time datas

2- Draw the similar table on your data sheet and write your datas on it by using the data on the Table 3.1.

Time Elapse	$X_i \mp \Delta X_i$ **(cm)**	$X_{i+1} \mp \Delta X_{i+1}$ **(cm)**	$X_{i+1} - X_i \mp \Delta(X_{i+1} - X_i)$ **(cm)**	$t_i \mp \Delta t_i$ **(s)**	$t_{i+1} \mp \Delta t_{i+1}$ **(s)**	$t_{i+1} - t_i \mp \Delta(t_{i+1} - t_i)$ **(s)**	$V_{ort} \mp \Delta V_o$ **(cm/s)**
0-1							
1-2							
2-3							
3-4							
4-5							

Table 3.2: Position and time datas

6. QUESTIONS

1- Are the intervals between the data points equal or not ? Is it a conclusion as you expect ? Explain it briefly.

2- Show how you calculate Δt for any time value that you determine ?

3- Determine the mean velocity for any time elapse via slope of line in graph.

4- Show how you calculate error value of mean velocity for any time elapse.