Experiment No. 3
Acceleration on Inclined Plane

1. Objectives:

(1) Study the relation between covered distance x and elapsed time t for the glider on an air track moving under constant acceleration.
(2) Determine the acceleration of the glider on the incline and then the acceleration due to gravity

2. Apparatus:

Air track, glider, ruler, air pump, timer with two photogates, spirit level.

3. Theory:

To determine the acceleration due to gravity (g) in physics lab (1), one uses an inclined frictionless plane (مستوى مائل أملس عديم الاحتكاك) (air track) with two light gates, a timer, and a glider. (See Fig. 3.1)

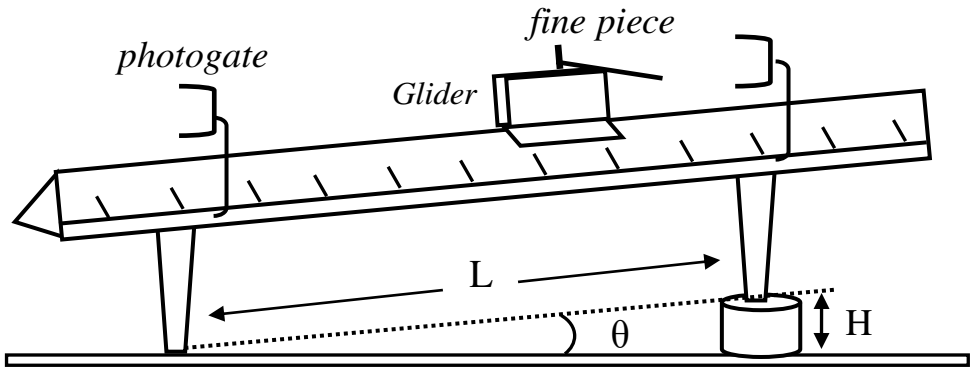

Fig.3.1 Air track inclined at angle θ

You will calculate the acceleration of a body on an inclined, near-frictionless plane (a glider on the air track) from measurements of distance and time, assuming the acceleration constant. This is the experimental acceleration. Then, from finding the angle of inclination of the track (using trigonometry), you will find the acceleration due to gravity g.

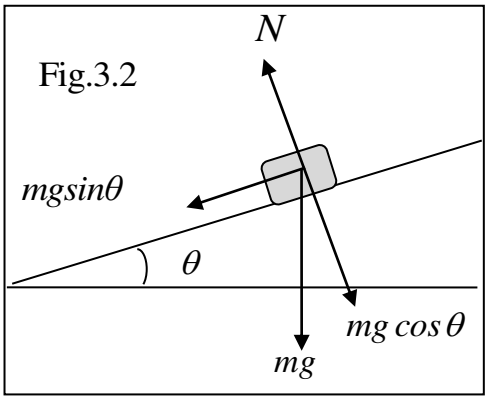

Fig.3.2

For the glider moving down the incline <u>from rest</u> is

$X = \frac{1}{2}at^2$, where X is the distance traveled, and t is the time needed by the glider to cover this distance.

From newton's 2nd law for the motion along the plane is (fig. 3.2)

$$ma = mgsin\theta$$

The acceleration of the glider is then

$$a = g\ sin\theta \qquad \Rightarrow g = \frac{a}{sin\theta}$$

If the distance traveled on the incline **x** is plotted vs. $\mathbf{t^2}$, the slope of the graph obtained is from (when the glider starts from rest)

$$X = \frac{1}{2}at^2 \qquad \Rightarrow slope = S = \frac{1}{2}a, \qquad a = 2S$$

Draw two best lines find the slopes as S_{max} and S_{min}

$$S = (S_{max} + S_{min})/2,$$
$$\Delta S = (S_{max} - S_{min})/2$$
$$slope = S = \frac{1}{2}a \qquad \Rightarrow a = 2S = g\ sin\theta$$

$$\Rightarrow \quad g = \frac{a}{sin\theta} = \frac{2S}{sin\theta}$$

$$\Rightarrow \quad \frac{\Delta g}{g} = \frac{\Delta S}{S} + \frac{\Delta sin\theta}{sin\theta}, \quad \text{and} \quad \frac{\Delta sin\theta}{sin\theta} = \frac{\Delta L}{L} + \frac{\Delta H}{H}$$

4. <u>Procedure:</u>

1) Level the air track horizontally with the leg screws by adjusting the screw until the glider does not accelerate in either direction along the track.
2) Make the air track inclined at an angle θ by putting a piece of wood at one end under the leg of the track.
3) Calculate $\sin\theta$ by measuring the hypotenuse and opposite. $\sin\theta = \frac{H}{L}$
4) Release the glider from the top end of the air track from rest and measure the time the glider needs to pass a specified distance x to the lower end.
5) Repeat 3 times measuring the time labeled t_1, t_2, and t_3 for the same distance.
6) Repeat the previous steps 5 times for different distances.
7) Tabulate your results in the table of the report.

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Name: …….…….. Grade: ….....

Student's No.: ……..... Day and Date: ……

Partners Names: …….……..…… Sec.: ……

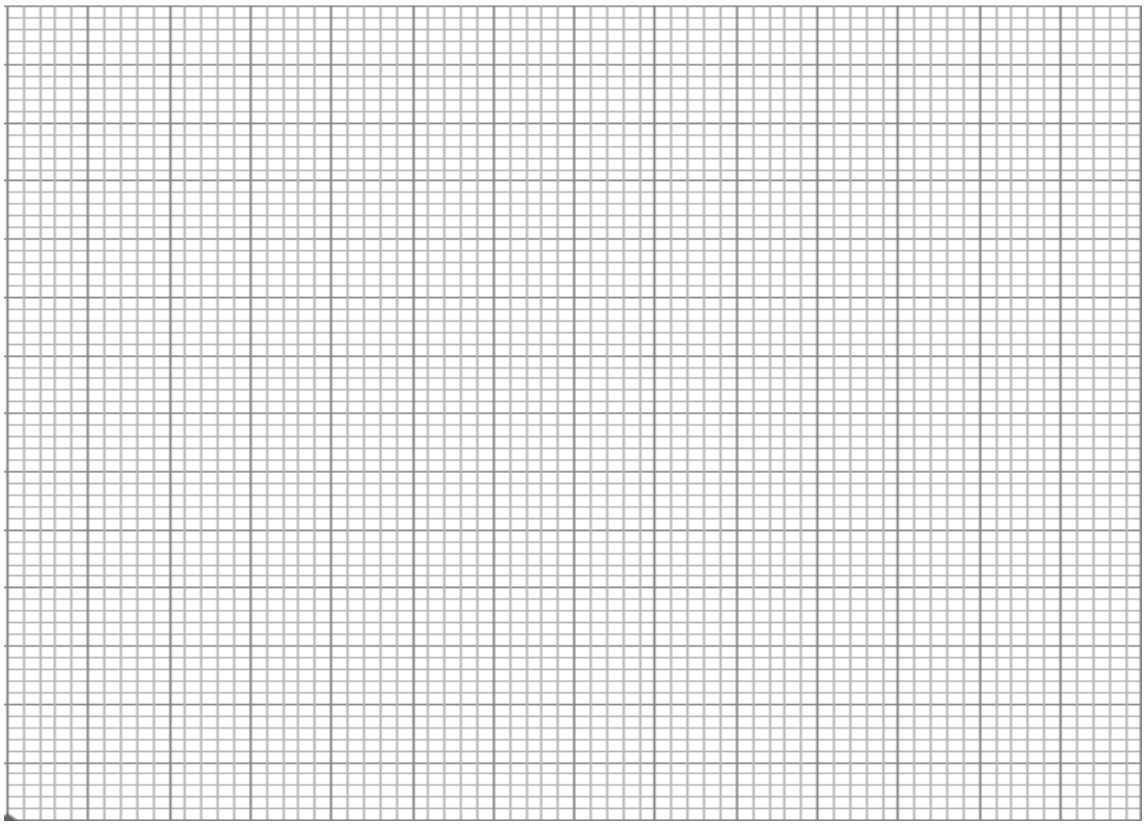
Data:

(1) Measure the sin of the inclination angle $sin\theta = H / L =$

Trial	X (cm)	t_1 sec	t_2 sec	t_3 sec	$\bar{t}$ sec	$\bar{t}^2$ sec^2
1						
2						
3						
4						
5						
6						

(1) For each value of X find the average time squared $\bar{t}^2$, and fill them in the table above.

(2) Plot the distance traveled **X versus** $\bar{t}^2$ and connect the points with the best two lines. **calculate the slope of each, call them** S_{max} **and** S_{min}



(4) Find S_{max} = ……

S_{min} = ……..

(5) Find the slope $S = (S_{max} + S_{min}) / 2$ =……

(6) Find the error in the slope $\Delta S = (S_{max} - S_{min}) / 2$

…….....

(7) Find the acceleration due to gravity $g = \frac{a}{sin\theta} = \frac{2S}{sin\theta}$ =

…….

(8) Find the error in g

Δg =……..……..…

(9) Questions:

(1) Find the velocity of the glider at the bottom of the inclined plane in terms **X, g,** and **sinθ.**

(2) Is g constant at all locations on earth? Why?

(3) Discuss your result for g.