Appendix C

Sample Lab Report

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Lab 1- Uniformly accelerated motion

Objectives : To the determine acceleration and its uncertainty of a glider moving along a frictionless air track and to use it to calculate the gravitational acceleration g.

t_i(**s**)	x_i (**cm**)
0.2	0.5
0.4	1.3
0.6	2.4
0.8	3.8
1.0	5.6
1.2	7.7
1.4	10.2
1.6	13.0
1.8	16.2
2.0	19.6
2.2	23.5
2.4	27.6

$$\delta t = 0.005s \quad , \quad \delta x_i = 0.1cm$$

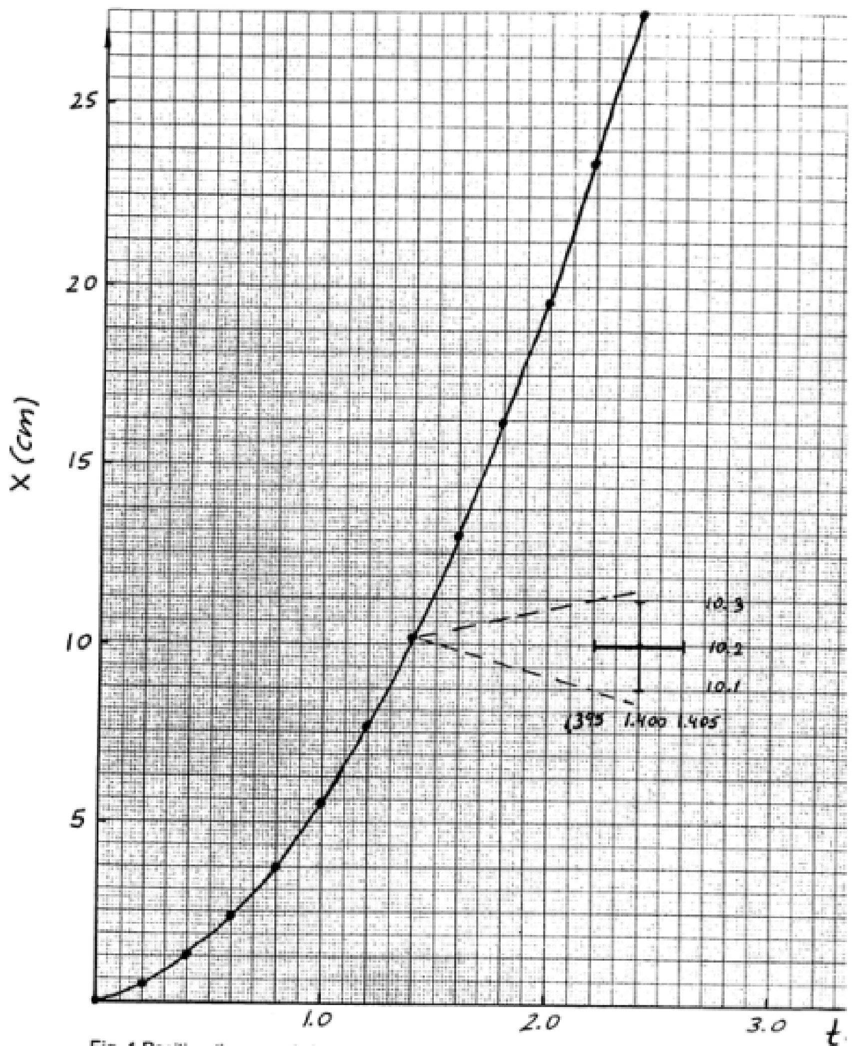

Fig. 1 Position-time graph for a glider moving on a frictionless air track.
Error bars are too small to be shown (smaller than the solid circles).
The equation representing this graph is $x = at^2/2$. Its graph is a parabola.

Figure C.1: Average velocity in consecutive time intervals for a glider moving along an air track. An instantaneous velocity is approximately equal to the average velocity at the median time for each time interval.

t_i (s)	x_i (cm)	$v = \frac{x_{i+1} - x_i}{t_{i+1} - t_i}$ (cm/s)	Median Time t_m(s)
0.2	0.5	$\frac{1.3 - 0.5}{0.4 - 0.2} = 4.0$	$\frac{0.2 + 0.4}{2} = 0.3$
0.4	1.3		
0.6	2.4	$\frac{3.8 - 2.4}{0.8 - 0.6} = 7.0$	$\frac{0.6 + 0.8}{2} = 0.7$
0.8	3.8		
1.0	5.6	$\frac{7.7 - 5.6}{1.2 - 1.0} = 10.5$	$\frac{1.0 + 1.2}{2} = 1.1$
1.2	7.7		
1.4	10.2	14	1.5
1.6	13.0		
1.8	16.2	17	1.9
2.0	19.6		
2.2	23.5	20.5	2.3
2.4	27.6		

Uncertainty Calculations

$$v = \frac{x}{t}\ , \text{ where } x = x_{i+1} - x_i, \quad t = t_{i+1} - t_i$$
$$\delta x = \delta x_{i+1} + \delta x_i = 1mm + 1mm = 2mm = 0.2cm$$
$$\delta t = \delta t_{i+1} + \delta t_i = 0.005s + 0.005s = 0.01s$$

$$\delta v_1 = (\frac{0.2cm}{0.8cm} + \frac{0.01s}{0.2s})4.0cm/s = 1.2cm/s$$
$$\delta v_6 = (\frac{0.2cm}{4.1cm} + \frac{0.01s}{0.2s})20.5cm/s = 2.0cm/s$$

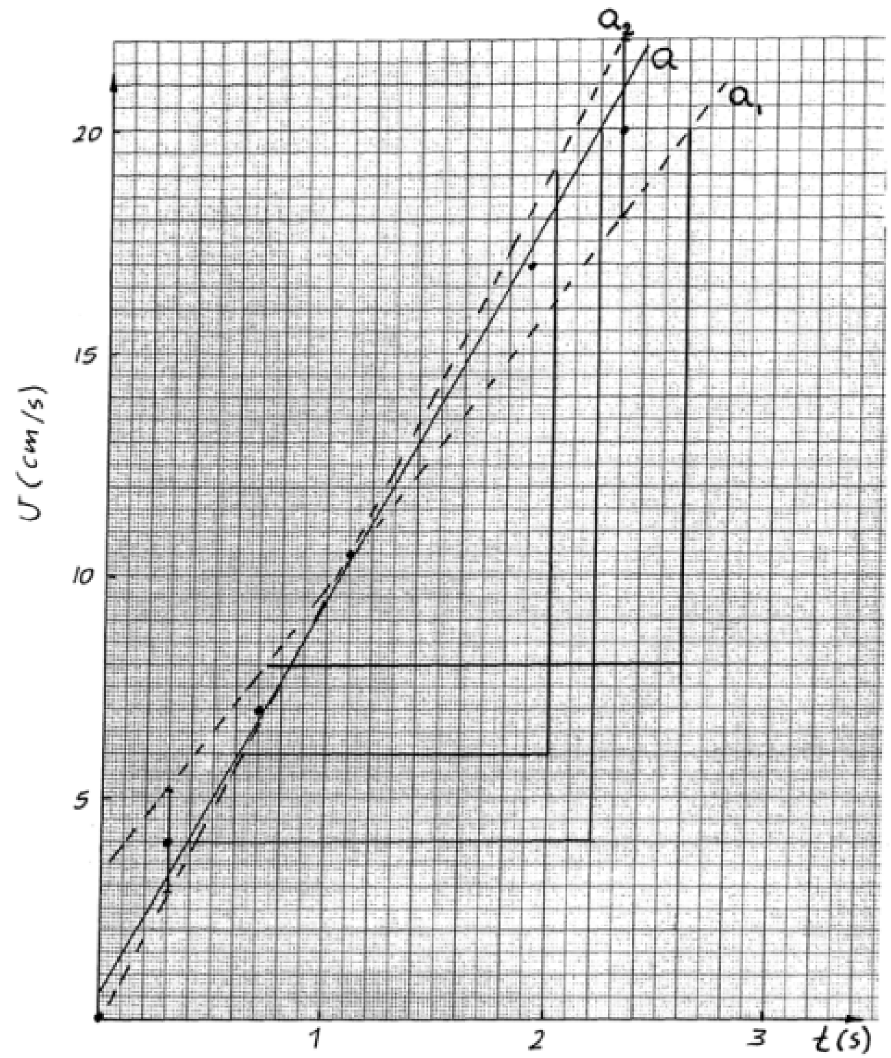

Fig. 2. Velocity versus time graph for a glider moving on the air track. Slopes of the two dotted lines are used to evaluate the error of acceleration.

Acceleration of the Glider

$$a = \frac{\Delta v}{\Delta t} = \frac{20.0cm/s - 4.0cm/s}{2.2s - 0.4s} = 8.9cm/s^2$$

Uncertainty of Acceleration

$$\Delta a = \frac{a_2 - a_1}{2}$$
$$a_1 = \frac{\Delta v}{\Delta t} = \frac{20.0cm/s - 8.0cm/s}{2.6s - 0.72s} = 6.4cm/s^2$$
$$a_2 = \frac{\Delta v}{\Delta t} = \frac{18.0cm/s - 6.0cm/s}{2.0s - 0.62s} = 10.1cm/s^2$$

$$\delta a = \frac{10.1cm/s^2 - 6.4cm/s^2}{2} = 1.8cm/s^2$$

$$\text{Therefore :} \quad a = (8.9 \pm 1.8)cm/s^2$$

Gravitational Acceleration

$$a = g \sin\theta$$
$$\theta = (0.6 \pm 0.1)degree$$
$$g = \frac{a}{\sin\theta} = \frac{0.089m/s^2}{\sin 0.6^\circ} = 8.5m/s^2$$

Conclusions: The motion of the glider on the air track is constant in time. This is evidenced by the parabolic dependence of the position versus time graph and a straight line dependence of the velocity versus time graph. The magnitude of the gravitational acceleration is slightly smaller than the standard value, which can be accounted for by the friction between the glider and the air track and inaccurate measurement of the angle of inclination of the air track. Within experimental uncertainty, the value of the gravitational acceleration agrees with the standard value of $g = 9.81m/s^2$.