

LAB REPORT FOR EXPERIMENT 1

Date: 27-6-2016

Name: Rama Kamel aldrabee

Partner's Name: _____

Registration No: 0145006

Registration No: _____

Physics Section: 5

Instructor's Name: Dr. Munib

PHYSICS LAB EXPERIMENT 1: COLLECTION AND ANALYSIS OF DATA

I. PURPOSE :

calculate the relation ship between the time of the time and the diameter of a hole in the bottom of the container, and depth of the water in the container.

II. DATA :

Table (1.1)

h (cm)	t in seconds			
	d = 1.5 mm	d = 2.0 mm	d = 3.0 mm	d = 5.0 mm
30.0	73.0	41.2	18.4	6.8
10.0	43.5	23.7	10.5	3.9
4.0	26.7	15.0	6.8	2.2
1.0	13.5	7.2	3.7	1.5

Using data in Table (1.1) fill in Table (1.2) below:

Table (1.2)

d (mm)	t in seconds			
	h = 30.0 cm	h = 10.0 cm	h = 4.0 cm	h = 1.0 cm
5.0	6.8	3.9	2.2	1.5
3.0	18.4	10.5	6.8	3.7
2.0	41.2	23.7	15.0	7.2
1.5	73.0	43.5	26.7	13.5

for $h = 30 \text{ cm}$, fill in Table 1.3 below:

Table(1.3)

$t \text{ (s)}$	$d \text{ (mm)}$	$1/d^2 \text{ (mm}^{-2}\text{)}$
23.0	1.5	0.44
41.2	2.0	0.25
18.4	3.0	0.111
6.8	5.0	0.04

for $d = 2 \text{ mm}$ fill in Table 1.4 below:

Table(1.4)

$t \text{ (s)}$	$h \text{ (cm)}$	$\log t$	$\log h$
41.2	30.0	1.6148	1.477
23.7	10.0	1.374	1.0
15.0	4.0	1.176	0.6020
7.2	1.0	0.8573	0.00

III. ANALYSIS OF DATA :

Graph your results. **Independent** variables will be the diameter of hole and depth of water in the container. Time is the **dependent** variable and will depend on the previous two independent variables.

A. Plot the time (t) versus the depth (h) for each diameter (d) used. Do four graphs on one sheet, using the same set of axes, connecting points in a smooth curve for each and labeling them d_1 , d_2 , d_3 and d_4 .

B. On a second sheet of graph paper, plot the time (t) versus diameter (d) for each value of depth (h). Connect the points in a smooth curve and label the curves h_1 , h_2 , h_3 and h_4 .

C. Plot t versus $1/d^2$ for $h = 30 \text{ cm}$

D. plot $\log t$ versus $\log h$ for $d = 2 \text{ mm}$.

IV. CONCLUSIONS

1. From your graph (t) versus (h) for $d = 1.5 \text{ mm}$, extrapolate the curve toward the origin. Does it pass through it? Would you expect it to do so?

~~yes, the curve pass it through, when no height there~~
~~is no water, so there is time required to empty container~~
 equal zero

2. What type of relationship do you see between the **time** and **diameter**? Is it direct or inverse?

inverse & non linear

3. From t versus $1/d^2$ graph, find the empirical relationship between time (t) and hole diameter (d) for $h = 30 \text{ cm}$.

$$t = 166.66 \times \frac{1}{d^2} + 0$$

$P_1 (45, 0.22)$

$P_2 (20, 0.12)$

4. From the previous relation, can you predict the time needed to empty the container if the diameter of the opening was 4 mm, 8 mm?

$$t = 166.66 \times \frac{1}{d^2}$$

$$t \Big|_{d=4} \Rightarrow 166.66 \times \frac{1}{16} = 10.41$$

$$t \Big|_{d=8} \Rightarrow 166.66 \times \frac{1}{64} = 2.604$$

5. From the $\log t$ versus $\log h$ graph, find the empirical relationship between time (t) and depth (h) for $d = 2 \text{ mm}$.

$$t = h^{0.85} \times 10$$

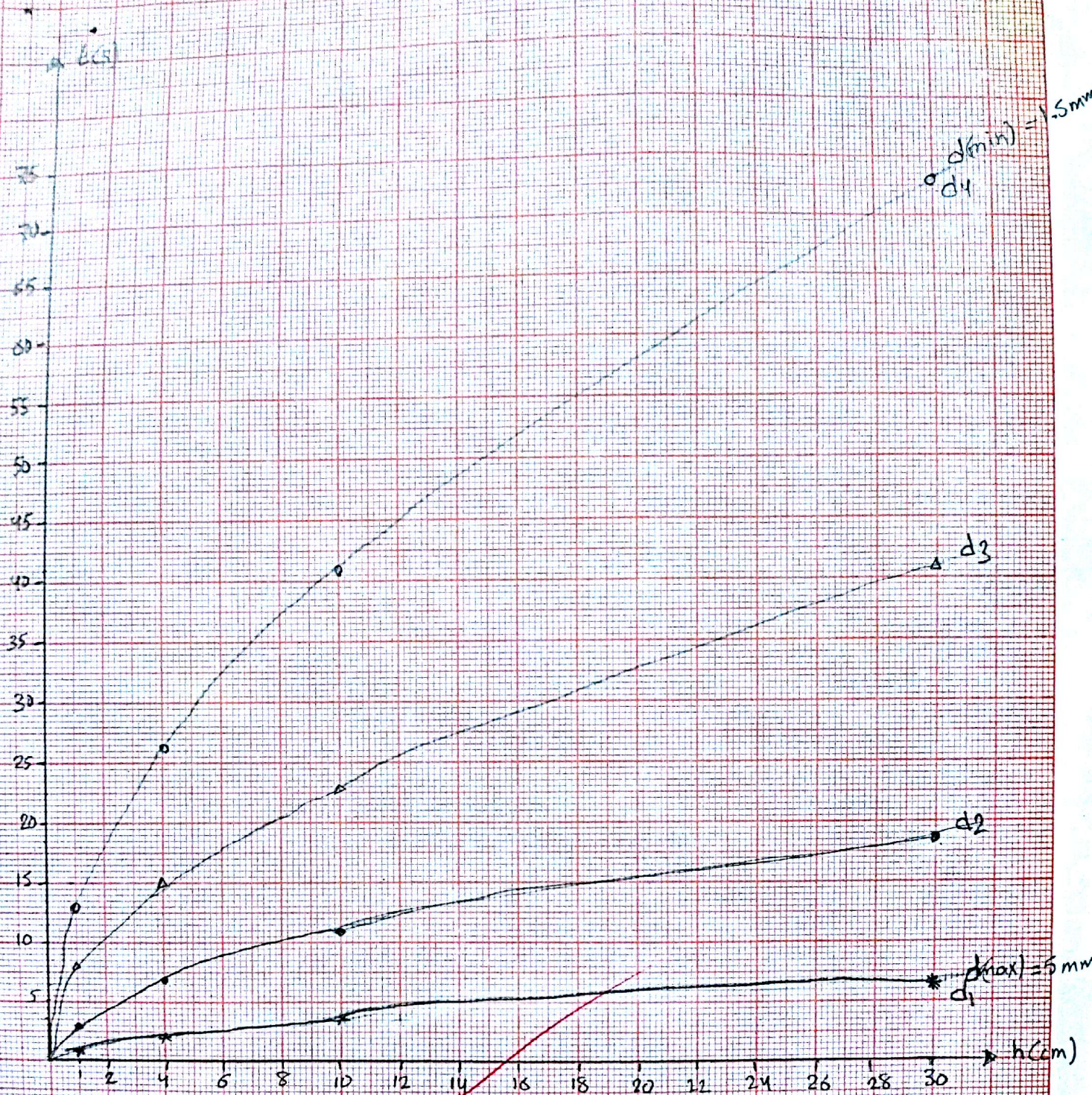
$$m = \frac{0.1}{0.2} = 0.5$$

6. Can you predict the time needed to empty the container if the depth of water was 25 cm, 80 cm?

$$t = h^{1/2} + 10^{(0.85)} \Rightarrow t = (h)^{1/2} + 7.079$$

$$t \Big|_{h=25} = 25^{1/2} + 10^{0.85} \Rightarrow 35.395$$

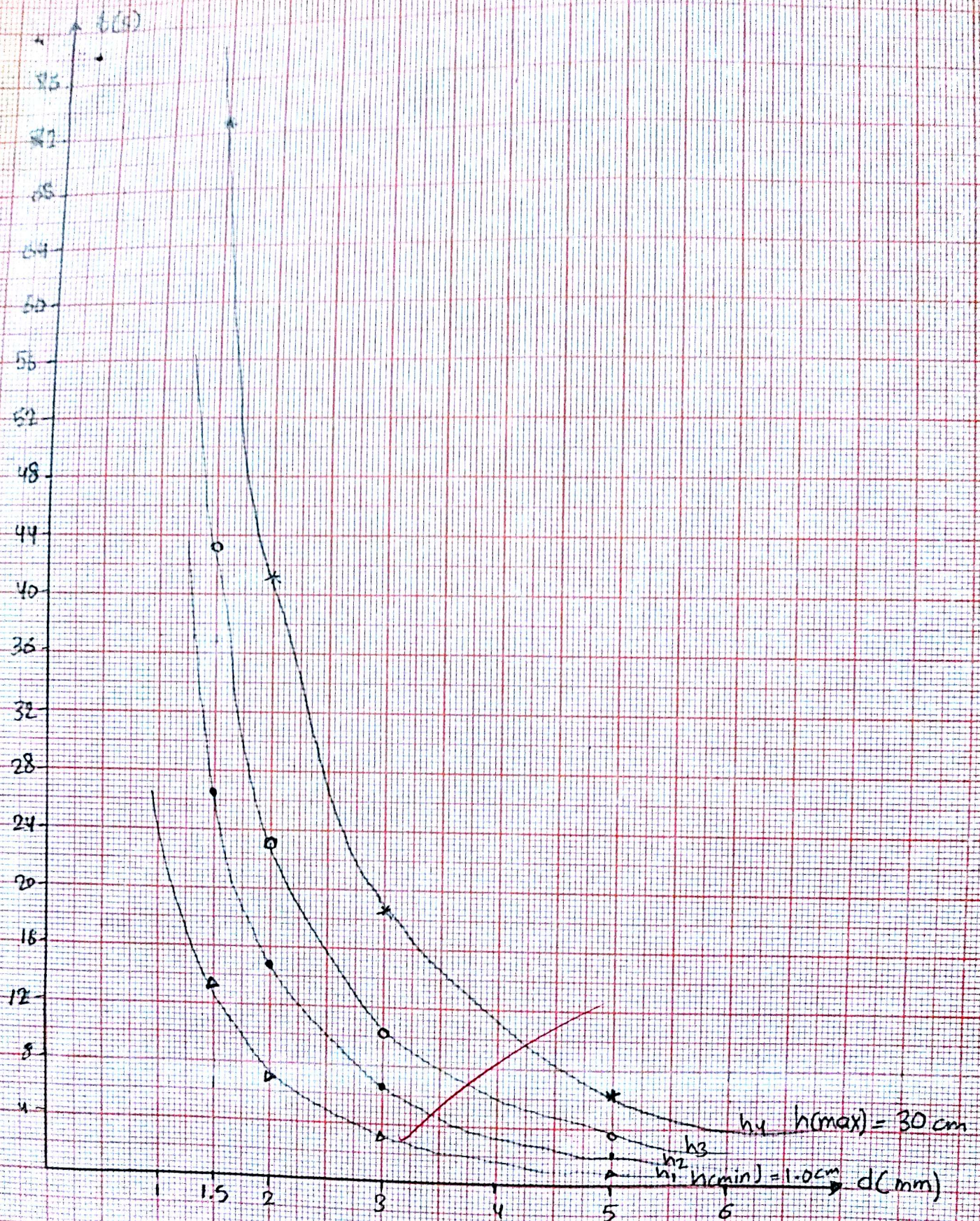
$$t \Big|_{h=80} = \sqrt{80} + 7.079 \rightarrow t = 63.325$$



* The relationship between h & $\delta(t)$ is direct.

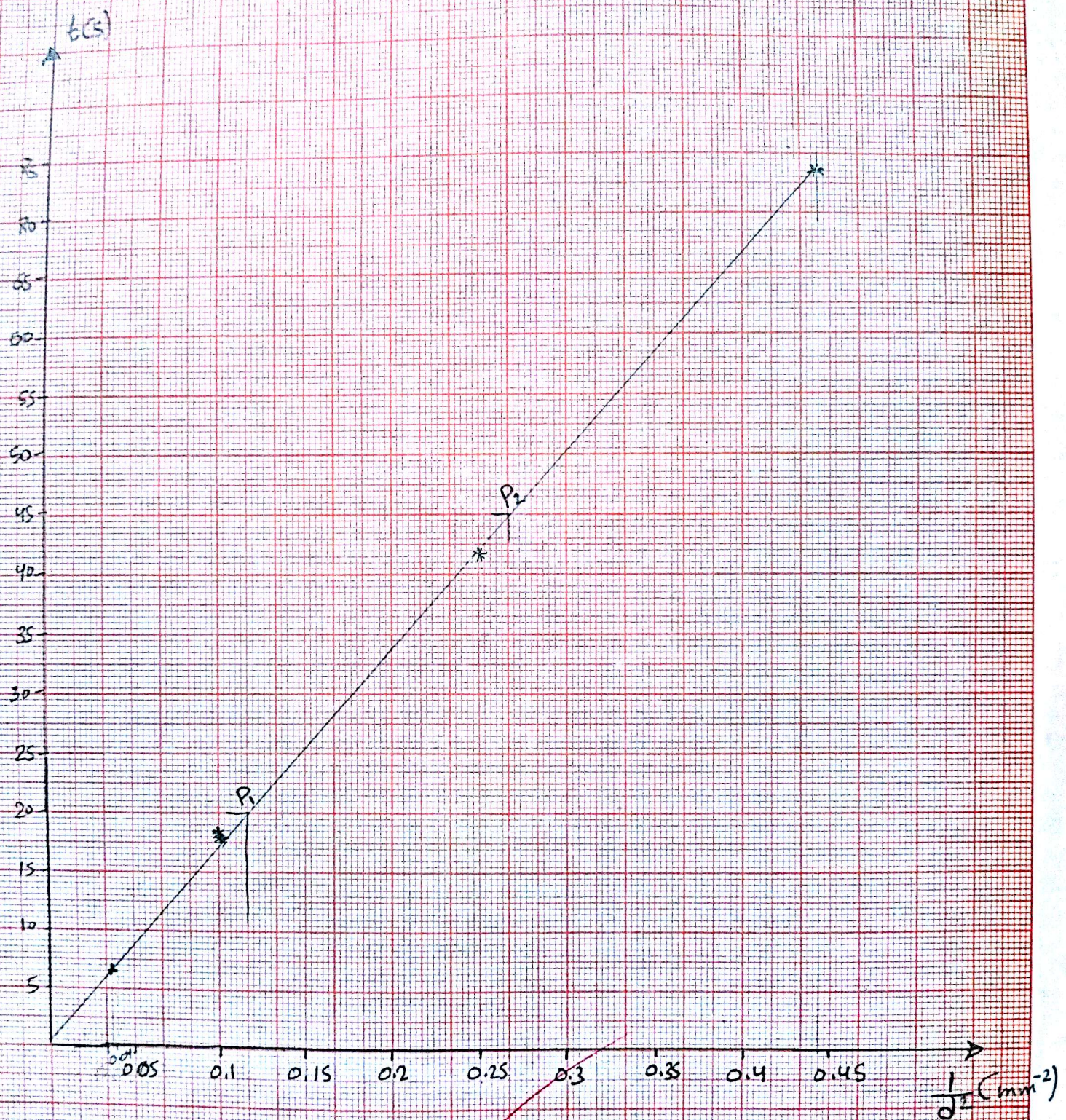
* The graph is non linear.

$d_4 = 5.0 \text{ mm}$
 $d_3 = 3.0 \text{ mm}$
 $d_2 = 2.0 \text{ mm}$
 $d_1 = 1.5 \text{ mm}$



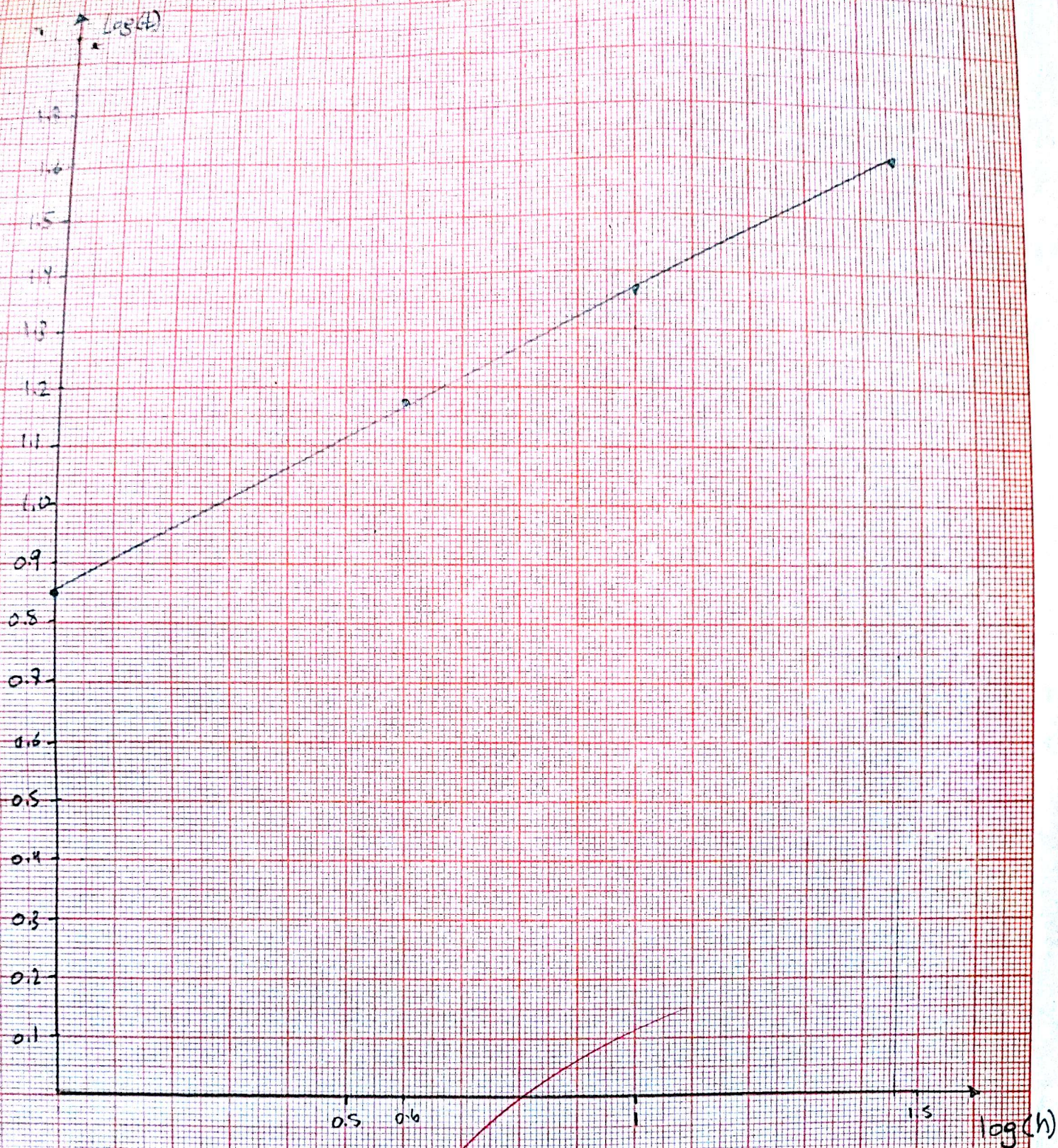
$h_1 = 1.0\text{ cm}$
 $h_2 = 4.0\text{ cm}$
 $h_3 = 10.0\text{ cm}$
 $h_4 = 30.0\text{ cm}$

* The relation ship between (d) & (t) is Inverse (the graph is non linear).



$$m = \text{slope} = \frac{45 - 20}{0.27 - 0.12} = 166.666$$

$$t = m \left(\frac{1}{d^2} \right) \Rightarrow t = 166.6 * \frac{1}{d^2} ; h = 30 \text{ cm}$$



$$m = \text{slope} = \frac{dy}{dx}$$

$$\Rightarrow \frac{1.05 - 0.95}{0.4 - 0.2} = \frac{0.1}{0.2} = 0.5$$

$P_1(0.4, 1.05)$

$P_2(0.2, 0.95)$

$$b = 0.85$$

$$t = 10^{0.85} \cdot (h)^{0.5}$$

LAB REPORT FOR EXPERIMENT 2

Date: 29/6/2016

Name: محمد بن عبد الله

Partner's Name: وفاء بن عبد الله

Registration No: 0145006

Registration No: 0155845

Physics Section: 5

Instructor's Name: د. فتيحي شطابي

PHYSICS LAB EXPERIMENT 2 : MEASUREMENTS AND UNCERTAINTIES

I. PURPOSE :

We need to learn how to use the vernier caliper & the
microscopic to measured diameter, length and derived other
quantity such as volume & density.

II. DATA AND DATA ANALYSIS :

A. Measurement of π

Record your data in Table (2.1) below:

Table (2.1)

Trial No	d (cm)	d - $\bar{d}$ (cm)	c (cm)	c - $\bar{c}$ (cm)
1	3.95 cm	0.01 cm	12.50 cm	0.00 cm
2	3.93 cm	- 0.01 cm		
3	3.93 cm	- 0.01 cm		
4	3.94 cm	0.00 cm		
5				
Average	$\bar{d} = 3.94$ cm		$\bar{c} = 12.50$ cm	
Error	$\Delta \bar{d} = \pm 5 \times 10^{-3}$ cm		$\Delta \bar{c} = \pm 0.05$ cm	

1. Calculate the error, $\Delta \bar{d}$, in measuring the diameter of the disk, and, $\Delta \bar{c}$, in measuring the circumference and enter the values calculated in Table 2.1
Example for one calculation ($\Delta \bar{d}$) or ($\Delta \bar{c}$):

$$\Delta \bar{d} = \pm \frac{1}{\sqrt{N(N-1)}} \sqrt{\sum (d_i - \bar{d})^2} \quad N=4$$

$$\Rightarrow \frac{1}{\sqrt{12}} \sqrt{3 \times 10^{-4}} = \pm 5 \times 10^{-3} \text{ cm}$$

$$\Delta \bar{c} = \pm \frac{1}{2} (1 \text{ mm}) \Rightarrow \pm \frac{1}{2} \times 0.1 \text{ cm} = \pm 0.05 \text{ cm}$$

2. Using your average measured values of $\bar{d}$ and $\bar{c}$, calculate $\bar{\pi}$.

$$\bar{\pi} = \frac{\bar{c}}{\bar{d}} \Rightarrow \frac{12.5 \text{ cm}}{3.94 \text{ cm}} \Rightarrow 3.17$$

3. Calculate the error, $\Delta \bar{\pi}$, in the measured value, $\bar{\pi}$.

Note: $\Delta \bar{\pi} = \bar{\pi} [(\Delta \bar{d} / \bar{d})^2 + (\Delta \bar{c} / \bar{c})^2]^{1/2}$ (2.1)

$$\Delta \bar{\pi} = 3.17 \times \sqrt{\left(\frac{5 \times 10^{-3}}{3.94}\right)^2 + \left(\frac{0.05}{12.50}\right)^2}$$

$$\boxed{\Delta \bar{\pi} \Rightarrow \pm 0.013}$$

$$\boxed{\bar{\pi} = 3.17 \pm 0.013}$$

4. Which error contributes most to $\bar{\pi}$? (give a quantitative answer)

$\frac{\Delta \bar{c}}{\bar{c}}$ contributes most of $\bar{\pi}$ because:

$$\left(\frac{\Delta \bar{c}}{\bar{c}}\right)^2 = (1.60 \times 10^{-5}) > \left(\frac{\Delta \bar{d}}{\bar{d}}\right)^2 = (1.61 \times 10^{-6})$$

5. Does the measured average value of $\bar{\pi}$ agree with the accepted value of $\bar{\pi}$ (3.14159) within the calculated experimental error.

$$\text{percent error} = \frac{|3.14 - 3.17|}{3.14} \times 100\%$$

$$\Rightarrow 0.04 \%$$

B. Determination of Density

Record your data in Table (2.2) below:

Table (2.2)

Trial No	h (cm)	h - $\bar{h}$ (cm)	d (cm)	d - $\bar{d}$ (cm)
1	9.93 cm	0.01	0.394 cm	0.000
2	9.92 cm	0.00	0.395 cm	0.001
3	9.92 cm	0.00	0.395 cm	0.001
4	9.92 cm	0.00	0.394 cm	0.000
5				
Average	$\bar{h} = 9.92$ cm		$\bar{d} = 0.394$ cm	
Error	$\Delta \bar{h} = \pm 2.88 \times 10^{-3}$ cm		$\Delta \bar{d} = \pm 4.08 \times 10^{-4}$ cm	
mass	m = 10.19 g		$\Delta m = \pm 5 \times 10^{-3}$ g	

1. Calculate the error, $\Delta \bar{h}$, in the average measured length and enter the result in Table (2.2).

$$\Delta \bar{h} = \sqrt{\frac{1}{N(N-1)} \sum_{i=1}^N h_i^2} \Rightarrow \sqrt{\frac{1}{12} \times 1 \times 10^{-4}} = 2.88 \times 10^{-3} \text{ cm}$$

2. Calculate the error, $\Delta \bar{d}$, in the average measured diameter and enter the result in Table (2.2).

$$\Delta \bar{d} = \sqrt{\frac{1}{N(N-1)} \sum_{i=1}^N d_i^2} \Rightarrow \sqrt{\frac{1}{12} + ((0.001)^2 + (0.001)^2)} = 4.08 \times 10^{-4} \text{ cm}$$

3. Take Δm to be half the smallest division of the balance used. $\Rightarrow 0.005$ g

4. Using your average measured values of $\bar{h}$, $\bar{d}$, π determined in part A, and the measured value of mass m, calculate $\bar{\rho}$.

$$\bar{\rho} = \frac{4m}{\pi (\bar{d})^2 \bar{h}} = \frac{4 \times 10.19}{3.14 \times (0.394)^2 \times 9.92} \Rightarrow 8.34 \text{ g/cm}^3$$

5. Calculate the error, $\Delta \bar{\rho}$, in the average value for the measured density, $\bar{\rho}$.

Note:
$$\Delta \bar{\rho} = \bar{\rho} \left[\left(\frac{\Delta m}{m} \right)^2 + \left(\frac{\Delta h}{h} \right)^2 + \left(\frac{2\Delta d}{d} \right)^2 + \left(\frac{\Delta \pi}{\pi} \right)^2 \right]^{\frac{1}{2}} \quad (2.2)$$

and use for $\bar{\pi}$ and $\Delta \pi$, the values determined in part A.

$$\Delta \bar{\rho} = 8.34 \times \left[\left(\frac{5 \times 10^{-3}}{10.19} \right)^2 + \left(\frac{2.88 \times 10^{-3}}{9.92} \right)^2 + \left(\frac{2 \times 4.08 \times 10^{-4}}{0.394} \right)^2 + \left(\frac{0.013}{3.14} \right)^2 \right]^{\frac{1}{2}}$$

$$\Rightarrow 0.038 \text{ g/cm}^3$$

6. Which error in m , $\bar{h}$, $\bar{d}$, or $\bar{\pi}$ contributes most to $\bar{\rho}$?
(give a quantitative answer)

$(\bar{\pi})$ contributes most to $\bar{\rho}$;

$$\left(\frac{\Delta \bar{\pi}}{\bar{\pi}} \right)^2 = 1.6 \times 10^{-5} > \text{than all other quantities.}$$

7. Using your calculations in (6), which error in m , $\bar{h}$, $\bar{d}$, or $\bar{\pi}$ contributes the least to $\bar{\rho}$?

$(\bar{h})$ contributes the least to $\bar{\rho}$ because

$$\left(\frac{\Delta \bar{h}}{\bar{h}} \right) = 8.4 \times 10^{-8} < \text{than other quantities.}$$

8. Compare the measured value of $\bar{\rho} \pm \Delta \bar{\rho}$ with the accepted value of ρ .

$$\bar{\rho} \pm \Delta \bar{\rho} \Rightarrow 8.34 \pm 0.038 \text{ g/cm}^3$$

$$\Rightarrow 8.34 + 0.038 = 8.378 \text{ g/cm}^3$$

$$8.34 - 0.038 = 8.302 \text{ g/cm}^3$$

The accepted value of $\rho = 8.3 \text{ g/cm}^3$.

~~Percent error~~

LAB REPORT FOR EXPERIMENT 3

Date: -----

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Registration No: 0145006

Registration No: 0155845

Physics Section: 5

Instructor's Name: Dr. Mohamed Elmaghrabi

PHYSICS LAB EXPERIMENT 3: VECTORS (FORCE TABLE)

I. PURPOSE :

perform addition of vector quantities by three methods:-
① component method ② graphically ③ experimentally.

II. DATA AND DATA ANALYSIS :

- 1- Record the **experimentally** measured value of the resultant of the two forces in step one of the procedure (magnitude and direction) .

$$\begin{aligned} F_b &= 125 \text{ gwt} & \phi_b &= 255^\circ \\ R &= 125 \text{ gwt} & \phi_R &= 255^\circ - 180^\circ = 75^\circ \end{aligned}$$

- 2- Determine the resultant of the two forces in step one of the procedure **graphically**. How does it compare with the measured value?

$$\begin{aligned} F_1 &= 125 \text{ gwt} \quad 35^\circ \\ F_2 &= 80 \text{ gwt} \quad 125^\circ \end{aligned}$$

- 3- Again determine the resultant of the two forces in step one by the **method of components**. How does it compare with the measured value?

$\begin{aligned} F_1 &= 100 \text{ gwt} \quad \phi_1 = 35^\circ \\ F_2 &= 80 \text{ gwt} \quad \phi_2 = 125^\circ \end{aligned}$	$\begin{aligned} \Sigma F_x &= F_1 \cos(\phi_1) + F_2 \cos(\phi_2) \\ &= 100 \cos(35^\circ) + 80 \cos(125^\circ) \\ &\Rightarrow +81.91 + -45.88 \\ &= 36.02 \end{aligned}$
$\begin{aligned} \vec{F} &= 36.02 \hat{i} + 122.88 \hat{j} \\ \vec{F} &= \sqrt{(36.02)^2 + (122.88)^2} \\ &= 128.05 \text{ gwt} \\ \tan \phi &= \frac{F_y}{F_x} = 3.41 \\ \phi &= \tan^{-1}(3.41) = 73.65^\circ \end{aligned}$	$\begin{aligned} \Sigma F_y &= F_1 \sin(\phi_1) + F_2 \sin(\phi_2) \\ &= 100 \sin(35^\circ) + 80 \sin(125^\circ) \\ &= 57.35 + 65.53 \\ &= 122.88 \end{aligned}$

4. Record the experimentally measured value of the resultant of the three forces in step two of the procedure (magnitude and direction) .

$$\vec{F}_1 = 200 \text{ gwt}, 30^\circ \quad \vec{F}_2 = 150 \text{ gwt}, 240^\circ, \quad \vec{F}_3 = 100 \text{ gwt}, 315^\circ$$

$$\vec{F}_R = 220 \text{ gwt}, 155^\circ$$

5. Determine the resultant of the three forces in step two of the procedure graphically using the polygon method . Compare it with the measured value.

6. Again, use the method of components to determine the resultant for the three forces in step two of the procedure. Compare with experimental findings.

$F_1 = 200 \text{ gwt}, 30^\circ$	$\begin{aligned} \Sigma F_x &= 200 \cos(30^\circ) + 150 \cos(240^\circ) \\ &+ 100 \cos(315^\circ) \\ &= 173.20 + -75 + 70.71 \\ &= 168.91 \text{ gwt} \end{aligned}$
$F_2 = 150 \text{ gwt}, 240^\circ$	
$F_3 = 100 \text{ gwt}, 315^\circ$	
$\vec{F} = 168.91 \hat{i} + -100.61 \hat{j}$	
$ \vec{F} = \sqrt{(168.91)^2 + (-100.61)^2}$	$\begin{aligned} \Sigma F_y &= 200 \sin(30^\circ) + 150 \sin(240^\circ) \\ &+ 100 \sin(315^\circ) \\ &\Rightarrow 100 + -129.90 + -70.71 \\ &= -100.61 \text{ gwt} \end{aligned}$
$\Rightarrow 196.60 \text{ gwt}$	
$\tan \phi = \frac{-100.61}{168.91} \Rightarrow -0.595$	$\phi = \tan^{-1}(-0.595)$ $\phi = -30.75^\circ = 330^\circ$

7. State the major source(s) of inaccuracy in the experimental results?

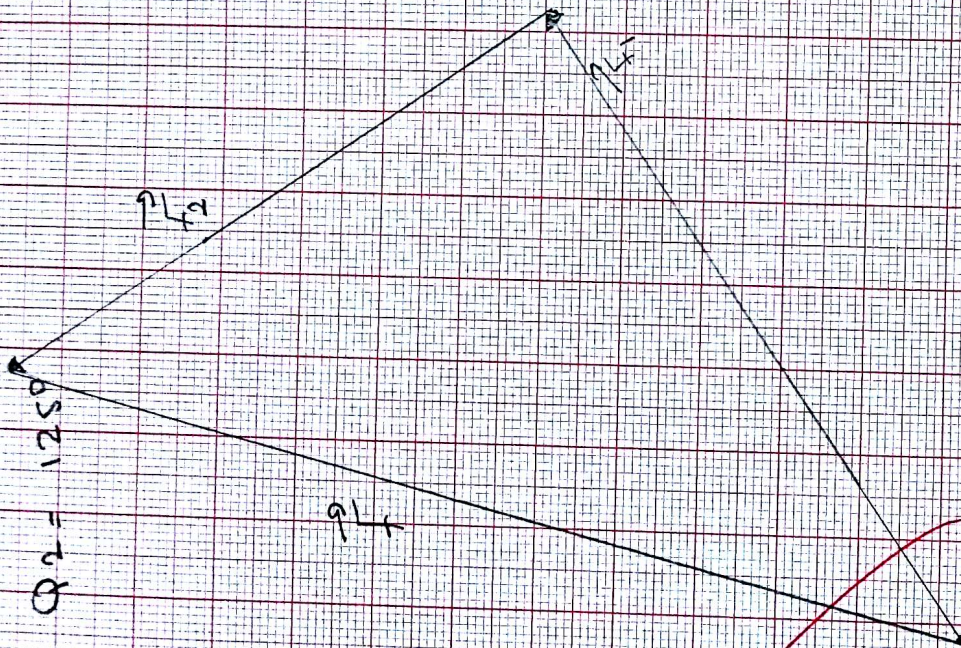
① Friction between string (rope) & pulley .

② while take the reads of angle .

2))

$$F_1 = 100 \text{ gwt}, \theta_1 = 36^\circ$$

$$F_2 = 80 \text{ gwt}, \theta_2 = 125^\circ$$



$$F = 124 \text{ gwt}$$

$$\theta = 76^\circ$$

$$100 \text{ gwt} = 1 \text{ cm}$$

$$100 \text{ gwt} = 10.0 \text{ cm}$$

5))

$$F_1 = 200 \text{ gwt}$$

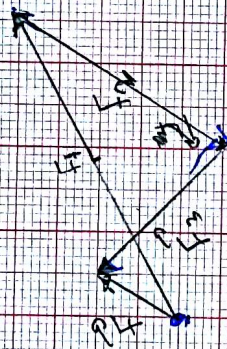
$$\varphi = 30^\circ$$

$$F_2 = 150 \text{ gwt}$$

$$\varphi_2 = 240^\circ$$

$$F_3 = 100 \text{ gwt}$$

$$\varphi_3 = 315^\circ$$



$$F = 200 \text{ gwt}$$

$$\varphi = 60^\circ$$

$$100 \text{ gwt} = 2 \text{ cm}$$

LAB REPORT FOR EXPERIMENT 4

Date: -----

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Partner's Name: رونق ابو حمان

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Physics Section: 5

Instructor's Name: د. منيرة فلاح

PHYSICS LAB EXPERIMENT 4: KINEMATICS OF RECTILINEAR MOTION

I. PURPOSE :

to study the kinematics of motion of an object
required a record of the position at different
times to study irregular motion

II. MEASUREMENTS :

1. Measure the distances x_1 , x_2 , x_3 etc. and record your measurements taken directly from the ticker timer tape in the second column of Table 4.1, and then complete entering the rest of the required derived quantities in Table 4.1 below:

Table (4.1)

Time t_i (s)	Displacement x_i (cm)	Displacement differences (cm) $\Delta x_i = (x_{i+1} - x_i)$	Average Speed (cm/s) $\bar{v}_i = \Delta x_i / \Delta t$	Velocity differences (cm /s) $\Delta v_i = v_{i+1} - v_i$	Average Acceleration (cm /s ²) $\bar{a}_i = \Delta v_i / \Delta t$
0	0.0				
0.05		2.9	29		
0.1	2.9			16	160
0.15		4.5	45		
0.2	7.4			22	220
0.25		6.7	67		
0.3	14.1			12	120
0.35		7.9	79		
0.4	22.1			11	110
0.45		9.0	90		
0.5	31.1			-6	-60
0.55		9.6	96		
0.6	40.6			-16	-160
0.65		11.2	112		
0.7	51.8			11	110
0.75		12.3	123		
0.8	64.1			2	20
0.85		13	130		
0.9	77.1			12	120
0.95		14.2	142		
1.0	91.3				

2. Complete entering the rest of the required derived quantities in Table 4.2 below:

Table (4.2)

Total Time t_j (s)	Distance on Tape x_j (cm)	Average Speed $\bar{v}$ (cm/s)
$t_2 = 0.2$	$x_2 = 7.4 \text{ cm}$	$\bar{v}_{2-10} = \frac{v_{10} - v_2}{t_{10} - t_2} = 104.875$
$t_3 = 0.3$	$x_3 = 14.1 \text{ cm}$	
$t_4 = 0.4$	$x_4 = 22 \text{ cm}$	$\bar{v}_{3-9} = 105$
$t_5 = 0.5$	$x_5 = 31 \text{ cm}$	
$t_6 = 0.6 = t_m$ (mid point)	$x_6 = 40.6 \text{ cm}$	$\bar{v}_{4-8} = 105.25$
$t_7 = 0.7$	$x_7 = 51.8 \text{ cm}$	
$t_8 = 0.8$	$x_8 = 64.1 \text{ cm}$	$\bar{v}_{5-7} = 104$
$t_9 = 0.9$	$x_9 = 72.1 \text{ cm}$	
$t_{10} = 1.0$	$x_{10} = 91.3 \text{ cm}$	

III. DATA AND DATA ANALYSIS :

- A. From an inspection of **your tape**, can you find where your speed was highest? Where it was lowest? Can you find where the acceleration was (a) greatest (b) smallest?

Speed was highest from $t = 0.95$ / lowest at $t = 0.15$

Acceleration greatest at $t = 0.95$ / smallest at $t = 0.15$

B. Now using Tables (4.1) and (4.2) continue the following analysis:

1. Plot on a linear graph paper x against t . Connect your plotted points with a **smooth curve**. From your graph can you tell where the speed was constant? Increasing? Decreasing?

From $t = 0.05$ to $t = 1.05$ the velocity increase

2. Plot a ^{histogram} **histogram** of average speed $\bar{v}$ against time t . Fig.4.2 shows a histogram of the data in the sample table.

Can you see regions where v is increasing? Decreasing? Constant?

the v increase from 0.05 to 0.95

3. Calculate the average speed during some long and shorter time interval all with the same midpoint $t_m = t_6 = 0.6$ s. Record your results in Table (4.2). Do your computed value of $\bar{v}$ appear to be approaching a limiting value? (yes.) Can you tell what is the instantaneous speed at the midpoint $t_6 = 0.6$ s?

at mid point $v = 104 \text{ cm/s}$

4. On your histogram of $\bar{v}$ against t draw a graph of instantaneous speed v against the time t by joining with **straight lines** the midpoints of the horizontal bars of the histogram; By joining the mid-points by **straight lines**, what assumption are you making about the way the instantaneous speed varies during each time interval?

the velocity has change with constant acceleration.

5. From your ^{histograph} (v, t) graph read off the instantaneous speed at $t = t_m = 0.6$ s. How does it agree with the value obtained in part B-3.?

$v_{\text{inst}} = 104 \text{ cm/s}$ it is nearest

6. Calculate the instantaneous speed at t_m by measuring the slope of the (x, t) graph. Does the value obtained for the instantaneous speed at $t = t_m = 0.6$ s agree with your previous two values obtained in B-3 and B-5?

$P_1 (0.4, 20)$ slope $\frac{\Delta x}{\Delta t} = \frac{52.5}{0.503} = 104.37 \text{ cm/s}$

$P_2 (0.903, 72.5)$

7. Measure the area under your (v, t) graph between two times t_i and t_f of your choice, what does this area represent?

between 0.35 & 0.45

the area = $29 \times 0.1 = 2.9 \text{ cm}$

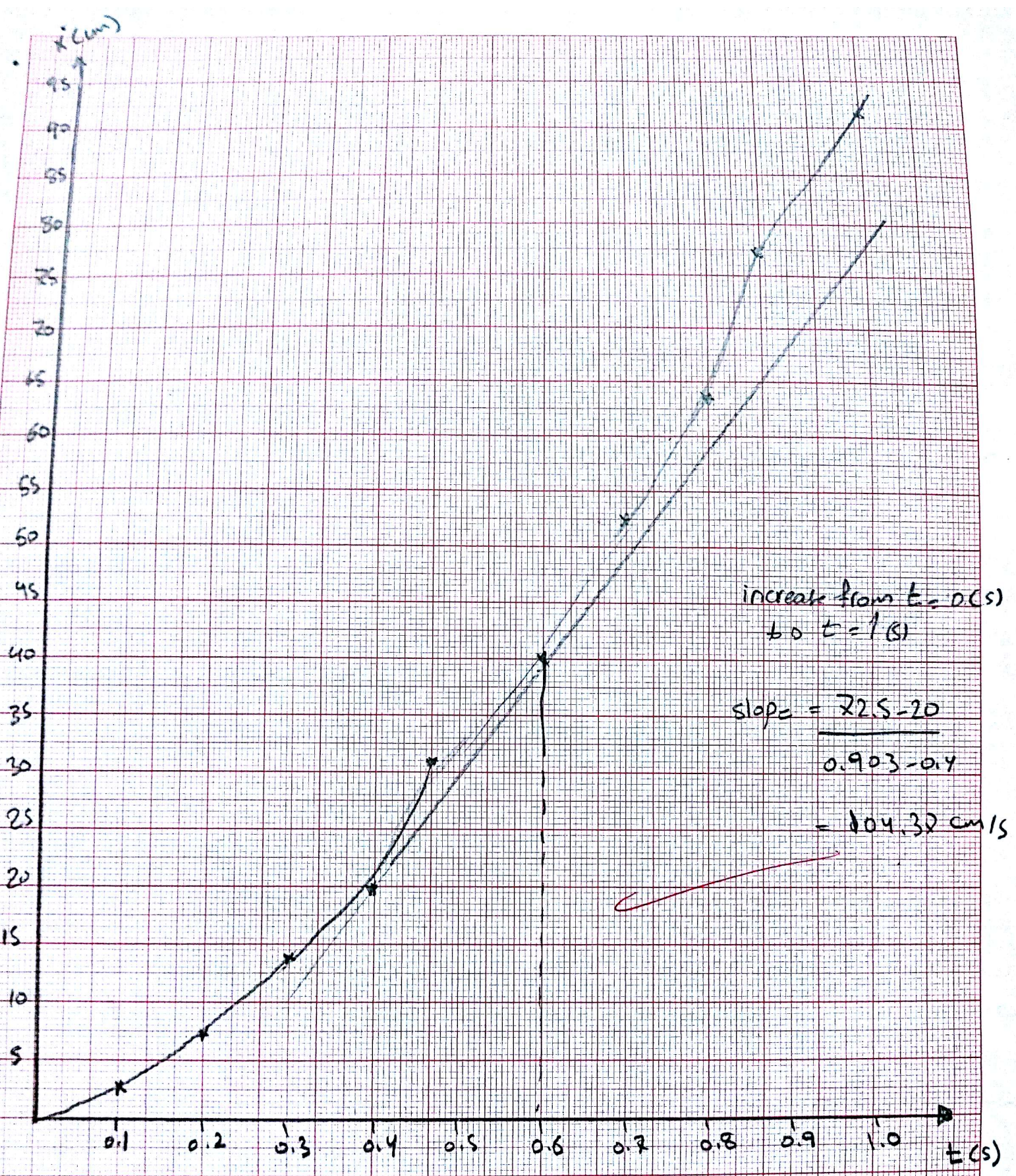
8. Now measure directly on the paper strip the distance actually moved during the time interval from t_i to t_f . Compare with the answer you got in B-7.

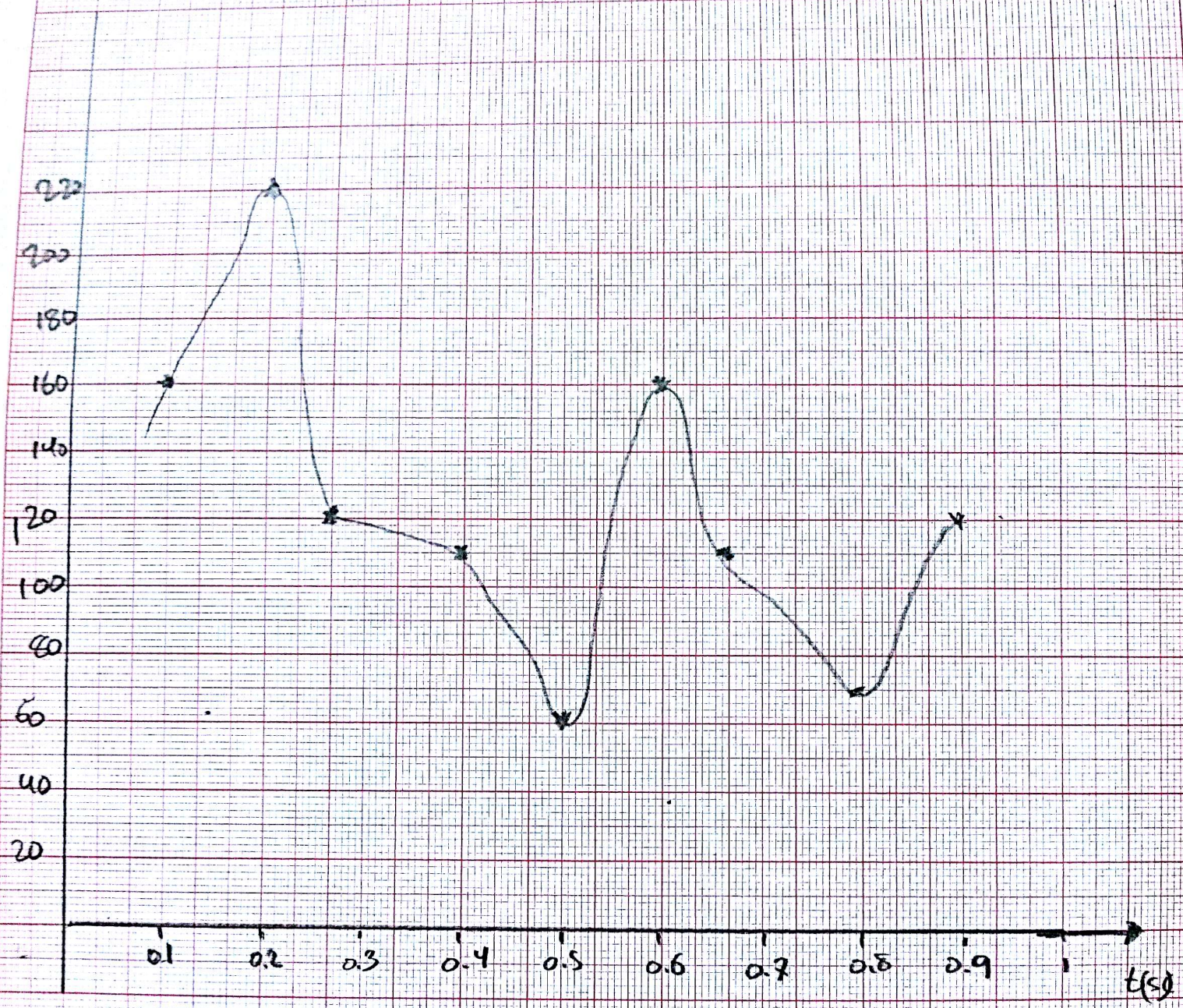
distance = 2.9 cm nearly the same

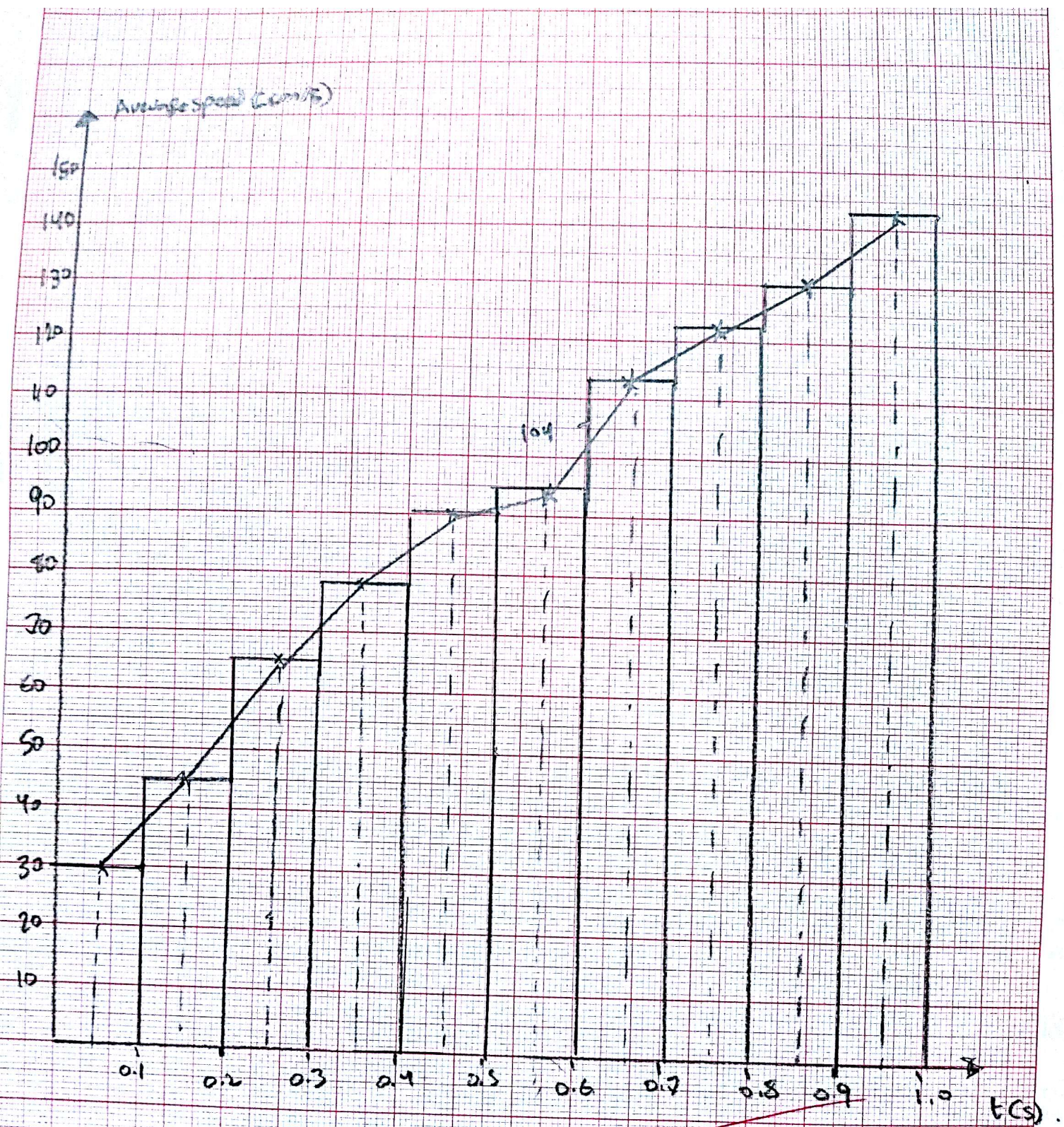
9. Using your computed data of the average acceleration $\bar{a}$ in Table (4.1) plot a smooth graph of ^{average} instantaneous acceleration (a) against the time t . How good was your early guess as to the times of the greatest and the smallest accelerations?

greatest at $t = 0.2$

smallest at $t = 0.5$







histogram

LAB REPORT FOR EXPERIMENT 5

Date: ... 18/7/2016

Name: 2/3/2016

Partner's Name: ...

Registration No: ... 0145006

Registration No: ... 0152523

Physics Section: ... 5

Physics Section: ... 5

Force and Motion

Purpose

Part 1: To study the relationship between the acceleration and added mass, while the net force is kept constant.

Part 2: To study the relationship between the acceleration, and the net force, while the mass is kept constant.

Theory

Newton's Second Law of Motion gives the relationship between the mass of an object m and the net force (resultant force) F_{net} required to produce a certain acceleration a , stated mathematically:

$$F_{net} = m a$$

If a net force F_{net} acts on a body of mass m , it will give that body an acceleration a . The acceleration is directly proportional to the net force and inversely proportional to the mass of the body. It is understood that the force F_{net} in the equation is the resultant external force acting on a body. Thus, if there is more than one force acting on a body, it is the resultant unbalanced force that causes the body to accelerate.

In this experiment, we will use an air track as an essentially frictionless surface. (An air track is an aluminum surface with many tiny holes punched regularly on it, such that when sufficient amount of air is blown through the holes continuously by means of an electric air blower, an object sliding on this cushion of air is considered to be moving without friction). An air track glider (M_g) will be accelerated along a level air track by means of a mass hanging (m_h) on a string over a pulley at the end of the track.

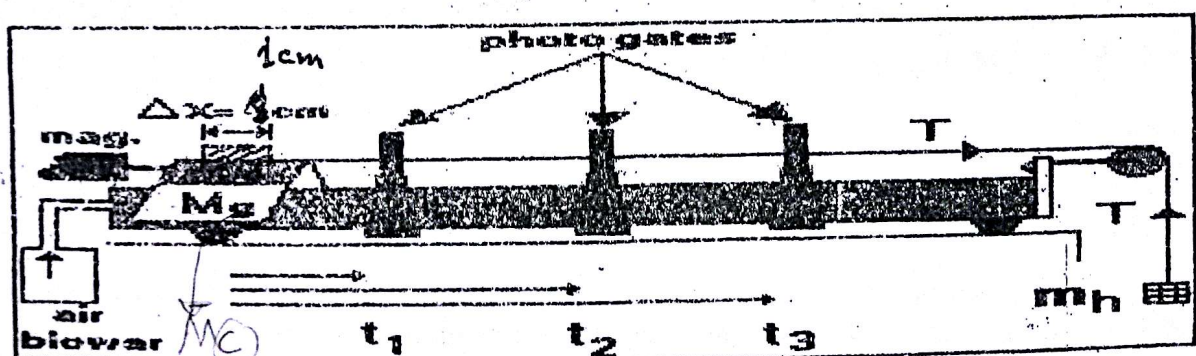


Figure 1

The mass of the glider M_g plus additional weights ma that may be attached to it is m_1 , and the hanging mass is m_h .

$$m_1 = M_g + m_a$$

The Newton's second law equations for m_1 and m_h , respectively are:

$$T = m_1 a$$

$$m_h g - T = m_h a$$

where T is the tension in the string

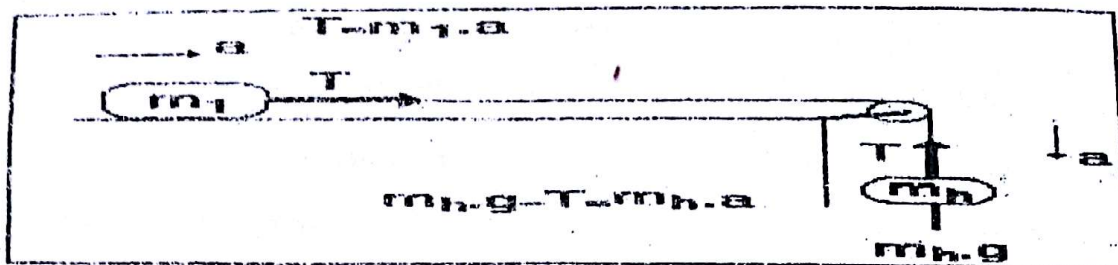


Figure 2

When we add up these two equations, the tension T cancels out, such that

$$m_h \cdot g = (m_1 + m_h) a$$

This equation can be considered as the Newton's second law equation for a system in which the string, and the masses m_1 and m_h , are thought of as one single object with a mass that is equivalent to the total mass of the system, $(m_1 + m_h)$. The only external force in the direction of motion is the weight of m_h ; thus $F_{\text{net}} = m_h \cdot g$. In this consideration, the tension T exerted by the string serves as an internal force within the system, and consequently does not appear in the equation.

Since the acceleration is constant with time, its instantaneous value is equivalent to its average value, and will be determined as

$$a = \frac{\Delta v}{\Delta t} = \frac{(v_2 - v_1)}{\Delta t}$$

where v_1 and v_2 are the instantaneous velocities at two different positions along the path of the motion, and Δt is a finite elapsed time between the two positions. The instantaneous velocities v_1 and v_2 are, in principle, supposed to be determined (by means of a photo gate at each position) as

$$v = \frac{\Delta x}{\Delta t}$$

where Δx is the width of a small flag mounted vertically at the top of the glider, and Δt is the time interval during which the flag blocks the photo gate as the glider slide along the track

Procedure

1. The air track will be assembled and leveled by the laboratory technician. Please do not attempt any adjustments of the air track. If you have trouble, ask the instructor for assistance.

Place the glider in motion by applying a very small force on the glider in a direction parallel to the air track. Do not attempt to move the glider if the air supply is not turned on.

2. Description of the buttons on the timer

- START: it starts the timer manually
- STOP: it stops the timer manually
- RESET: it resets the timer before starting a new count
- SELECT: it allows to see the partial times Δt

A. Acceleration and added mass with constant net force :

- 1- Set up the track as shown in Figure 1 where the distances between the photo gates are 30cm, the mass of holder $m_h = 20g$, $\Delta x = 4cm$ and the added mass $m_a = 0$ on the glider mass M_g . Press the start button and record the times t_1, t_2 and t_3 also press Δt to record the instantaneous time $\Delta t_1, \Delta t_2$ and Δt_3 as in Table 1

- 2- Repeat again for added masses as 25, 50 and 75g.
 3- Calculate the instantaneous velocity (v), where $v = \Delta x / \Delta t$ in cm/s.

$$\Delta x = 1 \text{ cm}$$

$$m_h = 20 \text{ g}$$

$m_a = 0$			$m_a = 25 \text{ g}$			$m_a = 50 \text{ g}$			$m_a = 75 \text{ g}$		
t (s)	Δt (s)	v (cm/s)	t (s)	Δt (s)	v (cm/s)	t (s)	Δt (s)	v (cm/s)	t (s)	Δt (s)	v (cm/s)
0	0	0	0	0	0	0	0	0	0	0	0
0.8	0.01	100	0.9	0.010	100	0.9	0.012	83.3	1.1	0.013	77
1.1	0.007	142.9	1.3	0.008	125	1.2	0.009	111.1	1.4	0.018	125
1.3	0.005	200	1.6	0.006	166.6	1.5	0.006	166.6	1.7	0.007	142.9

Table 1

- 4- For each value of the added mass, plot a graph of v against t . Plot them all on the same sheet of graph paper. Label each graph with the corresponding value of the added mass m_a for identification.
 5- Calculate the slope of each graph and determine the acceleration (a) in each case, and enter your calculated values in table 2 below:

m_a (g)	a (cm/s ²)	$1/a$ (s ² /cm)
0	200	5×10^{-3}
25	133.3	7.5×10^{-3}
50	100	0.01
75	68	0.124

Table 2

- 6- Plot a graph of added mass m_a against $1/a$. From the graph, what conclusion can you make about the way the acceleration of the glider depends on its total mass?

The relationship between $\frac{1}{a}$ & m_a is direct.

- 7- From your graph, find the mass M_g of the glider alone. cart

$$(m_a h + m_g) = 150$$

$$20 + m_g = 150$$

$$m_g = 130 \text{ g}$$

B. Acceleration and net force with constant mass:

- Set up the track as shown in Figure 1 (using two photo gates)
- Put 30g (m_a) on the glider and 10g on holder (m_h). Press the start button and record the times t_1 and t_2 also press Δt to record instantaneous time Δt_1 and Δt_2 as in Table 3
- Now remove 10g mass from the glider and place it on the hanger.
- Repeat this step 2 times, each time, removing 10g mass from the glider and placing it on the hanger.
- Calculate the instantaneous velocity (v), where $v = \Delta x / \Delta t$ in cm/s.
- Calculate the average acceleration (a), where $a = (v_2 - v_1) / (t_2 - t_1)$

$$\Delta x = 1 \text{ cm}$$

$m_a = 30\text{g}$ $m_h = 10\text{g}$	t (s)	Δt (s)	v (cm/s)	$v_2 - v_1$ (cm/s)	a (cm/s ²)
	1.2	0.015	66.7		
				44.4	55.5
$m_a = 20\text{g}$ $m_h = 20\text{g}$	2.0	0.009	111.1		
				75.8	126.3
$m_a = 10\text{g}$ $m_h = 30\text{g}$	11.5	0.006	166.7		
$m_a = 0\text{g}$ $m_h = 40\text{g}$	t (s)	Δt (s)	v (cm/s)	$v_2 - v_1$ (cm/s)	a (cm/s ²)
	0.7	0.009	111.1		
				88.9	177.8
$m_a = 0\text{g}$ $m_h = 40\text{g}$	1.2	0.005	200		
$m_a = 0\text{g}$ $m_h = 40\text{g}$	10.6	0.007	142.9		
				107.1	267.2
$m_a = 0\text{g}$ $m_h = 40\text{g}$	1.0	0.004	250		

Table 3

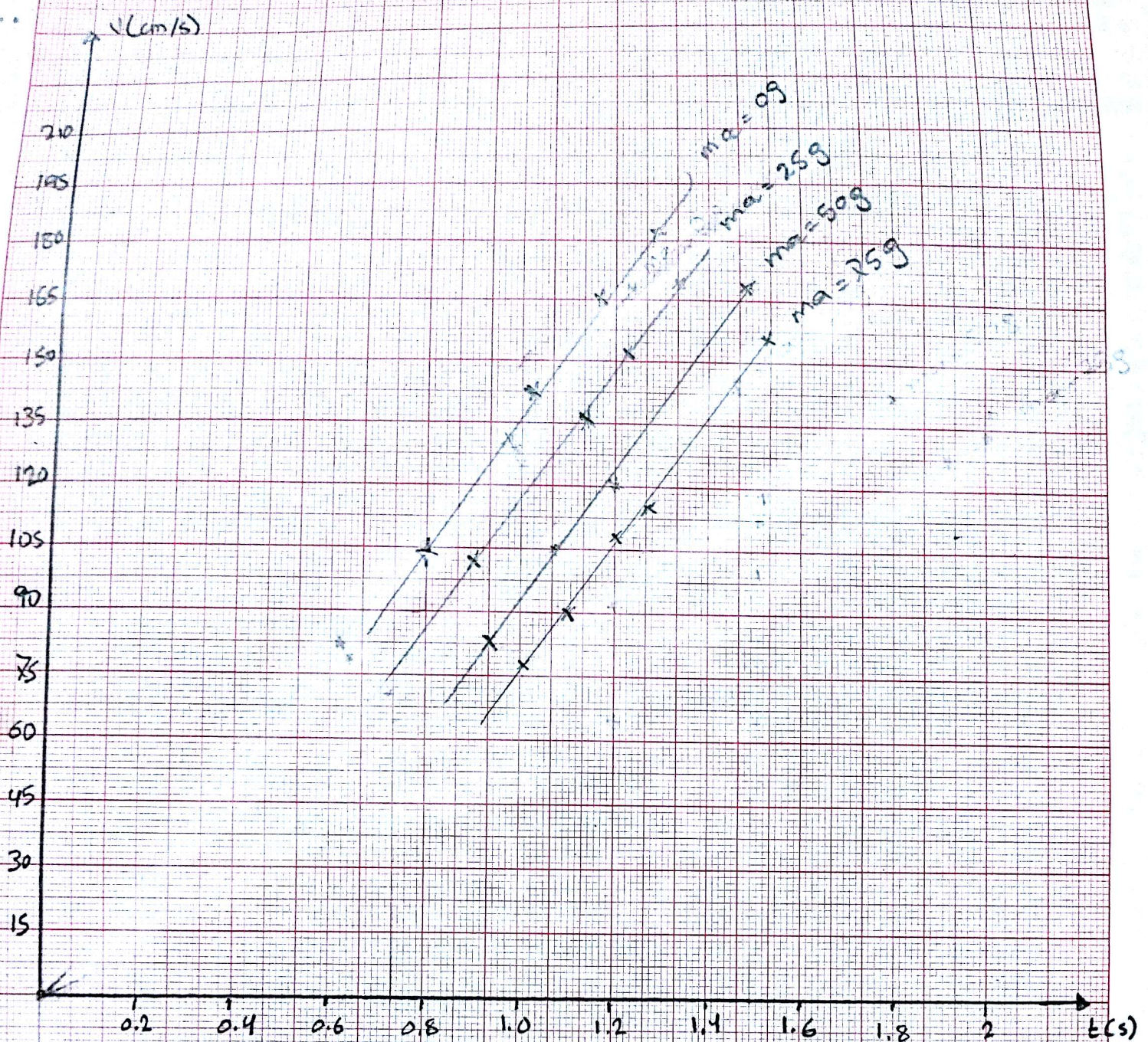
7- Enter your data for hanging weight ($m_h \cdot g$) where g , the acceleration due to gravity, is 980 cm/s^2 and corresponding acceleration (a) in Table 4.

Hanging weight $m_h \cdot g$ (dyne)	Acceleration a (cm/s ²)
9800 dyne	55.5
19600	126.3
29400	177.8
39200	267.2

Table 4

- 8- Plot a graph of the hanging weight ($m_h \cdot g$) against the acceleration (a)
 9- Calculate the slope of your graph. What does the slope of your graph represent?

$$\text{slope} = \frac{\Delta m_h g}{\Delta a} = \frac{22500 - 10000}{180 - 60} = 145.83 \text{ g} \text{ the mass of the whole system!}$$

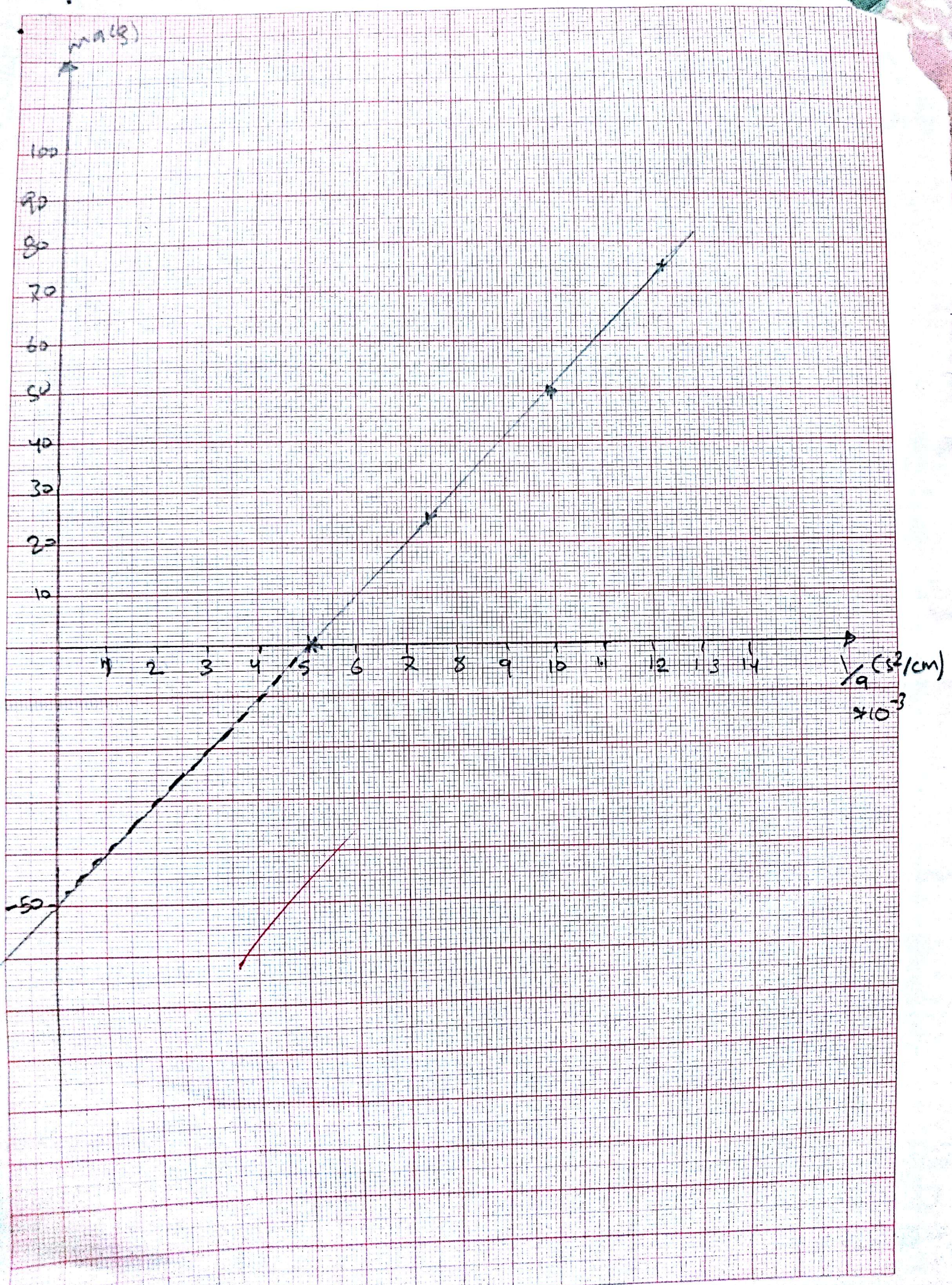


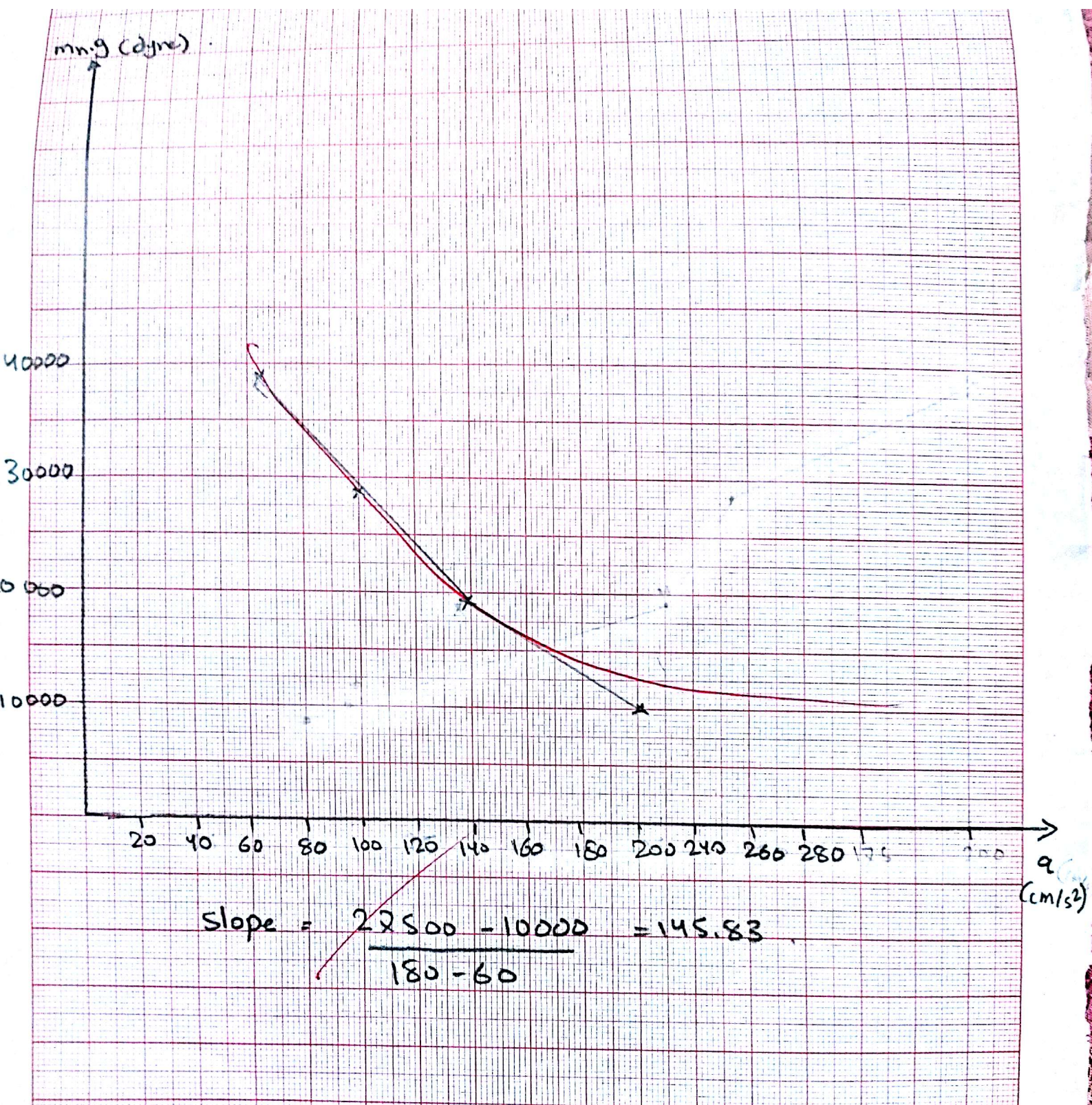
$$\text{slope of } (ma = 0) = \frac{v_2 - v_1}{t_2 - t_1} = \frac{185 - 165}{1.25 - 1.15} = 200 \text{ cm/s}^2$$

$$\text{slope of } (ma = 25g) = \frac{v_2 - v_1}{t_2 - t_1} = \frac{155 - 135}{1.30 - 1.15} = 133.3 \text{ cm/s}^2$$

$$\text{slope of } (ma = 50g) = \frac{v_2 - v_1}{t_2 - t_1} = \frac{125 - 105}{1.25 - 1.05} = 100 \text{ cm/s}^2$$

$$\text{slope of } (ma = 75g) = \frac{v_2 - v_1}{t_2 - t_1} = \frac{107 - 90}{1.35 - 1.1} = 68 \text{ cm/s}^2$$





LAB REPORT FOR EXPERIMENT 6

Date:.....

Name:.....

Partner's Name:.....

Registration No:.....

Registration No:.....

Physics Section:.....

Physics Section:.....

(Collisions)

(Conservation of Momentum)

Purpose

To analyse the change in momentum of a system by three methods: elastic collision against a fixed barrier, elastic collision between two trolleys and inelastic collision.

Theory

When two objects collide and there is no external force acts upon them, the vector sum of their momentum, $p = m v$, is always conserved. This means the total momentum after the collision ($p'_1 + p'_2$) is the same as that before the collision ($p_1 + p_2$):

[sum of p] before = [sum of p] after

[momentum] $\leftarrow$ $p_1 + p_2 = p'_1 + p'_2$

! كمية الحركة !

does not depend on the type of $m_1 v_1 + m_2 v_2 = m_1 v'_1 + m_2 v'_2$ (1)

Where v_1 and v_2 are the trolley's speeds before collision, v'_1 and v'_2 are the speeds after the collision, m_1 and m_2 are the trolley's masses.

If the forces acting during the collision are conserved, then the energy is conserved as well. If the objects moves along horizontal, only the kinetic energy, $KE = \frac{1}{2} m v^2$ plays a role. Therefore

$$[\text{sum of KE}] \text{ before} = [\text{sum of KE}] \text{ after}$$

$$\frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2 = \frac{1}{2} m_1 v_1'^2 + \frac{1}{2} m_2 v_2'^2 \quad (2)$$

In the other words, the ratio of the total kinetic energies after collision to that before collision is equal to one: $[\text{sum of KE}] \text{ before} / [\text{sum of KE}] \text{ after} = 1$. The conservation of mechanical energy is satisfied only by perfectly elastic collisions.

Procedure

1. The air track will be assembled and leveled by the laboratory technician. Please do not attempt any adjustments of the air track. If you have trouble, ask the instructor for assistance.

Place the glider in motion by applying a very small force on the glider in a direction parallel to the air track. Do not attempt to move the glider if the air supply is not turned on.

2. Description of the buttons on the timer

- START: it starts the timer manually
- STOP: it stops the timer manually
- RESET: it resets the timer before starting a new count
- SELECT: it allows to see the partial times Δt

2

$$v_1 = \frac{1 \text{ cm}}{(\Delta t)_1}$$

$$v_1' = v_f = \frac{1 \text{ cm}}{(\Delta t)_2}$$

A. Elastic collision against a fixed barrier.

When one of the collisions (the second one) is a fixed barrier, we may consider the mass of the first body negligible when compared to that of the second. In such case we have that:

$$v_1' = -v_1$$

$$v_1' = -v_1$$

that is, the first body will bounce back with the same speed.

- 1- Place a sensor, connected to the S2 socket, about 75cm away from the end of the track. Place another sensor at a distance of 125cm, connected to the S1 socket (Figure 1)

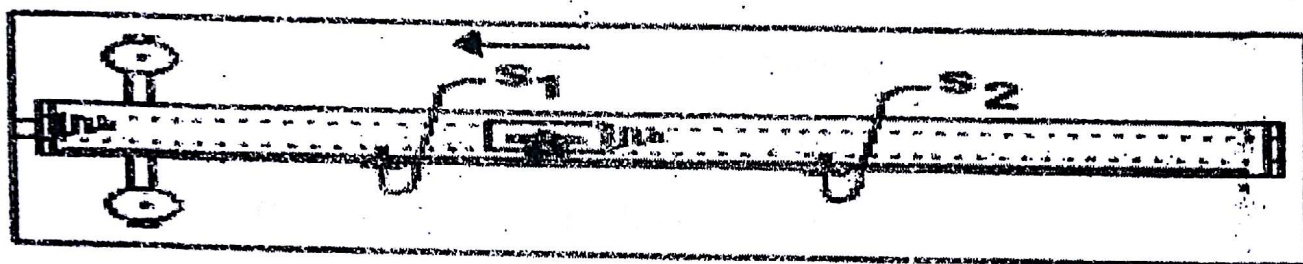


Figure 1

- 2- Activate the compressor and place the trolley on it along with a 40mm foil between the sensors. Give a slight pulse to the trolley towards the end track.

- 3- After the trolley has passed both sensors, push STOP button. Record the instantaneous time Δt_1 and Δt_2 . Calculate the instantaneous velocity (v) and the rebound coefficient (r). Where $v = \Delta x / \Delta t$ in cm/s and $r = |v_1'| / |v_1|$. change in mass of trolley and record your data in table 1.

Mass of trolley (g)	Δt_1 (s)	Δt_2 (s)	v_1 (cm/s)	v_1' (cm/s)	r
100	0.017	0.019	58.82	52.63	0.89
125	0.022	0.024	45.45	41.66	0.91
150	0.028	0.032	35.71	31.25	0.87

rebound coefficient

$$v_1 = -v_1'$$

$$r = \frac{|v_1'|}{|v_1|}$$

this means

Table 1

- 4- If $r = 1$ that's mean....the collision is elastic.....

- 5- If $r < 1$ that's mean....the collision is inelastic.....

B. Elastic collision between two trolleys.

3

1- Set up the equipment as shown in figure 2.

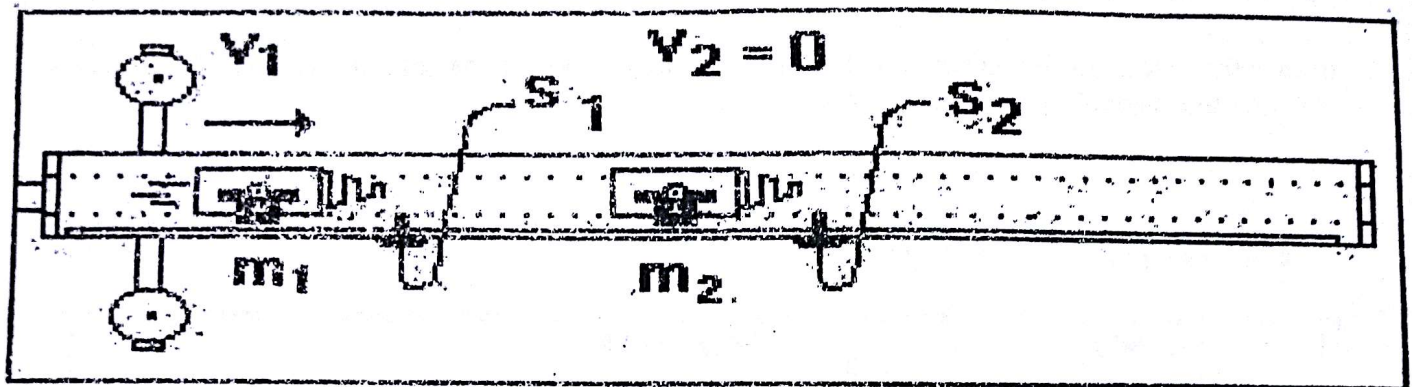


Figure 2

- 2- Activate the compressor and place the trolley (m_2) on it along with a 40mm foil between the sensors. Give a slight pulse to the trolley towards the end track.
- 3- Turn the air on in the linear air track. Hold trolley (m_2) at rest in a designated spot between the sensors until the trolley (m_1) is in motion.
- 4- Push the trolley (m_1) against the trolley (m_2). Record the instantaneous time Δt_1 and Δt_2 . Calculate the instantaneous velocity (v_1 and v'_2) where $v = \Delta x / \Delta t$.
- 5- Calculate the velocity (v'_1) by using equation (1) and change in the masses of trolleys and record your data in table 2.

$$v_1 = v_{1i} = \frac{1 \text{ cm}}{(\Delta t)_1}$$

$$v_2' = v_{2f} = \frac{1 \text{ cm}}{(\Delta t)_2}$$

$$v_1' = \frac{m_1 v_1 - m_2 v_2'}{m_1}$$

$K_{\text{total initial}}$	$K_{\text{total final}}$	m_1 (g)	m_2 (g)	Δt_1 (s)	v_1 (cm/s)	Δt_2 (s)	v_2' (cm/s)	v_1' (cm/s)
11130.32	11539.65	100	100	0.062	14.92	0.061	16.39	-1.47
83733.7	87637.6	125	100	0.027	37.032	0.024	41.66	3.709
30000	30454	150	100	0.050	20	0.041	24.39	3.74
45904.5	46233.8	100	125	0.033	30.3	0.032	27.02	-3.475
40812.24	41024.8	100	150	0.035	28.52	0.042	23.80	-2.13

Table 2

6- Is the collision elastic?

.....yes, because..... $K_{\text{total (initial)}} \approx K_{\text{total (final)}}$

$$K_{\text{total initial}} = \frac{1}{2} m_1 v_{1i}^2 \quad (\text{ergs})$$

$$K_{\text{total final}} = \frac{1}{2} m_1 v_{1f}^2 + \frac{1}{2} m_2 v_{2f}^2$$

C. Inelastic collision.

If the trolleys do not separate after the collision, the latter is called inelastic. In such type of collision only the momentum is maintained.

In case the second trolley is still, the system's momentum before the collision is $m_1 v_1$. After the collision the system's momentum is $(m_1 + m_2) v_f$.

$$m_1 v_1 = (m_1 + m_2) v_f \quad (3)$$

1- Set up the equipment as shown in figure 3.

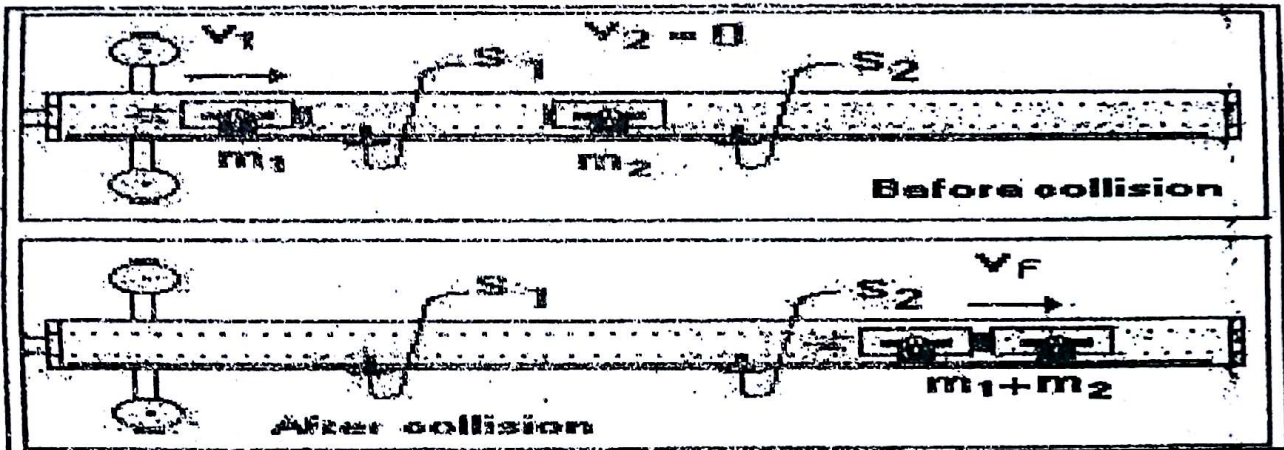


Figure 3

- 2- Turn the air on in the linear air track. Hold trolley (m_2) at rest in a designated spot between the sensors until the trolley (m_1) is in motion.
- 3- Push the trolley (m_1) against the trolley (m_2). Record the instantaneous time Δt_1 and Δt_2 . Calculate the instantaneous velocity (v_1 and v_f) where $v = \Delta x / \Delta t$.
- 4- Change in masses of trolleys and record your data in table 3.

		Before the collision				After the collision			
m_1 (g)	m_2 (g)	Δt_1 (s)	v_1 (cm/s)	momentum (g.cm/s)	the kinetic energy (J)	Δt_2 (s)	v_f (cm/s)	momentum (g.cm/s)	the kinetic energy (J)
100	100	0.029	34.48	3448	59443	0.053	18.86	3772	35569.08
125	100	0.038	26.31	3289	43263	0.060	16.66	3748.5	31225.005
100	150	0.040	25.00	2500	31250	0.080	12.5	3125	19531.25

Table 3

5- Is the collision elastic? Why?

no, because $k_{final} < k_{initial}$ (Before)

$$k_{initial} = \frac{1}{2} m_1 v_1^2$$

$$(P_{total})_i = m_1 v_1 + 0$$

$$k_{final} = \frac{1}{2} (m_1 + m_2) v_f^2$$

$$(P_{total})_f = (m_1 + m_2) v_f$$

$$v_f = \frac{1 \text{ cm}}{(\Delta t)_f} \quad \left(v_1 = \frac{1 \text{ cm}}{(\Delta t)_i} \right)$$

LAB REPORT FOR EXPERIMENT 7

Name: راما كمال الربيع

Date: 1/8/2016

Partner's Name: روقة العزبان

Registration No: 0145206

Registration No: 0155845

Physics Section: 5

Instructor's Name: د. منير عطية

PHYSICS LAB EXPERIMENT 7: ROTATIONAL MOTION

I. PURPOSE :

we measured of inertia of a body to translational acceleration & known as its mass the relation torque / angular acceleration --) is a measure of the reluctance of a body to rotational motion

II. DATA AND DATA ANALYSIS :

A. Acceleration and Moment of Inertia with Constant Applied Torque.

1. Enter your computed data of v versus t in Table 7.1 shown below:

Table 7.1

	Added mass to the turntable					
	M = 0 g		M = 100 g		M = 200 g	
Time (s)	v cm/s	$\omega = v/R$ rad/s	v cm/s	$\omega = v/R$ rad/s	v cm/s	$\omega = v/R$ rad/s
0.05	20	1.66	23	1.92	17	1.42
0.15	33	2.75	33	2.75	32	2.67
0.25	44	3.66	43	3.58	37	3.08
0.35	57	4.75	54	4.5	45	3.75
0.45	67	5.6	63	5.25	56	4.67
0.55	80	6.66	75	6.25	63	5.25
0.65	93	7.75	83	6.91	71	5.92
Radius of the turntable (R) = <u>12</u> cm						

$$\frac{\Delta x_1}{0.1}$$

$$\frac{\Delta x_2}{0.1}$$

$$\frac{\Delta x_3}{0.1}$$

2. For each value of the added mass, plot a graph of ω versus t . Plot them all on the same sheet of graph paper. Label each graph with the corresponding value of the added mass for identification.
3. What conclusions can you draw from your graphs about the angular acceleration of the empty and loaded turntable under a constant applied torque?
 I and α are inversely proportional to
each other when τ is constant
4. From your graphs determine the angular acceleration (α) of the turntable in each case, and enter your data in Table 7.2 below:

Table 7.2

Added mass M (g)	Angular Acceleration α (rad/s ²)	Moment of Inertia I (g . cm ²)
0	10	51600
100	8.75	60000
200	8	66300

5. Calculate the moment of inertia (I) of the turntable with and without the added masses using the following equation:

$$I = m R \left(\frac{g}{\alpha} - R \right)$$

^{mass (50)} ⁹⁸⁰
 $\uparrow$ $\uparrow$
 m R $\left(\frac{g}{\alpha} - R \right)^{12}$
 $\uparrow$
 α

where m is the mass of the falling weight and R is the radius of the turning wheel

6. From your table, how does the moment of inertia of the turntable (I) changes with the added mass?

yes it does, I increase with the increase
of M

B. Acceleration and Torque with Constant Moment of Inertia :

1. Compute the translational and angular velocities v and ω , for each recorded tape, and enter your data in Table 7.3 below:

Table 7.3

	Total Hanging Mass					
	m = 50 g		m = 100 g		m = 150 g	
Time (s)	v cm/s	$\omega = v/R$ rad/s	v cm/s	$\omega = v/R$ rad/s	v cm/s	$\omega = v/R$ rad/s
0.05	20	1.66	29	2.42	41	3.42
0.15	33	2.75	49	4.08	91	7.58
0.25	44	3.66	70	5.83	111	9.25
0.35	57	4.75	102	8.5	142	11.83
0.45	67	5.6	115	9.58	170	14.17
0.55	80	6.66	140	11.67	230	19.17
0.65	93	7.75	175	14.58	350	29.16

2. Use Table 7.3 to plot, on the same sheet of paper, the graphs of ω versus t .
3. What do you conclude from your graphs?

$\tau \propto \alpha$ is direct when I is constant

4. Determine the angular acceleration (α) in each case.

on the graph !

5. Enter your results in Table 7.4 below:

Table (7.4)

Total Hanging Mass (m) (g)	Angular Acceleration α (rad/s ²)	Torque (τ) = $Rm(g - \alpha R)$ (dyne.cm)
50	9.25	517800
100	18.66	907296
150	27.6	1167840

homework

6. Plot a graph of (τ) the **applied torque** against **angular acceleration** (α).

7. What do you conclude from your graph?

From table (7.4) $\uparrow$
it will pass through origin.

the relation ship between τ & α

is linear & direct when (I is constant)

8. Determine the moment of inertia of the empty turntable.

the moment of inertia of the empty turntable

$$= \text{slope} = 48.94 \times 10^3 \left(\frac{\text{dyne.cm}}{\text{rad/s}^2} \right)$$

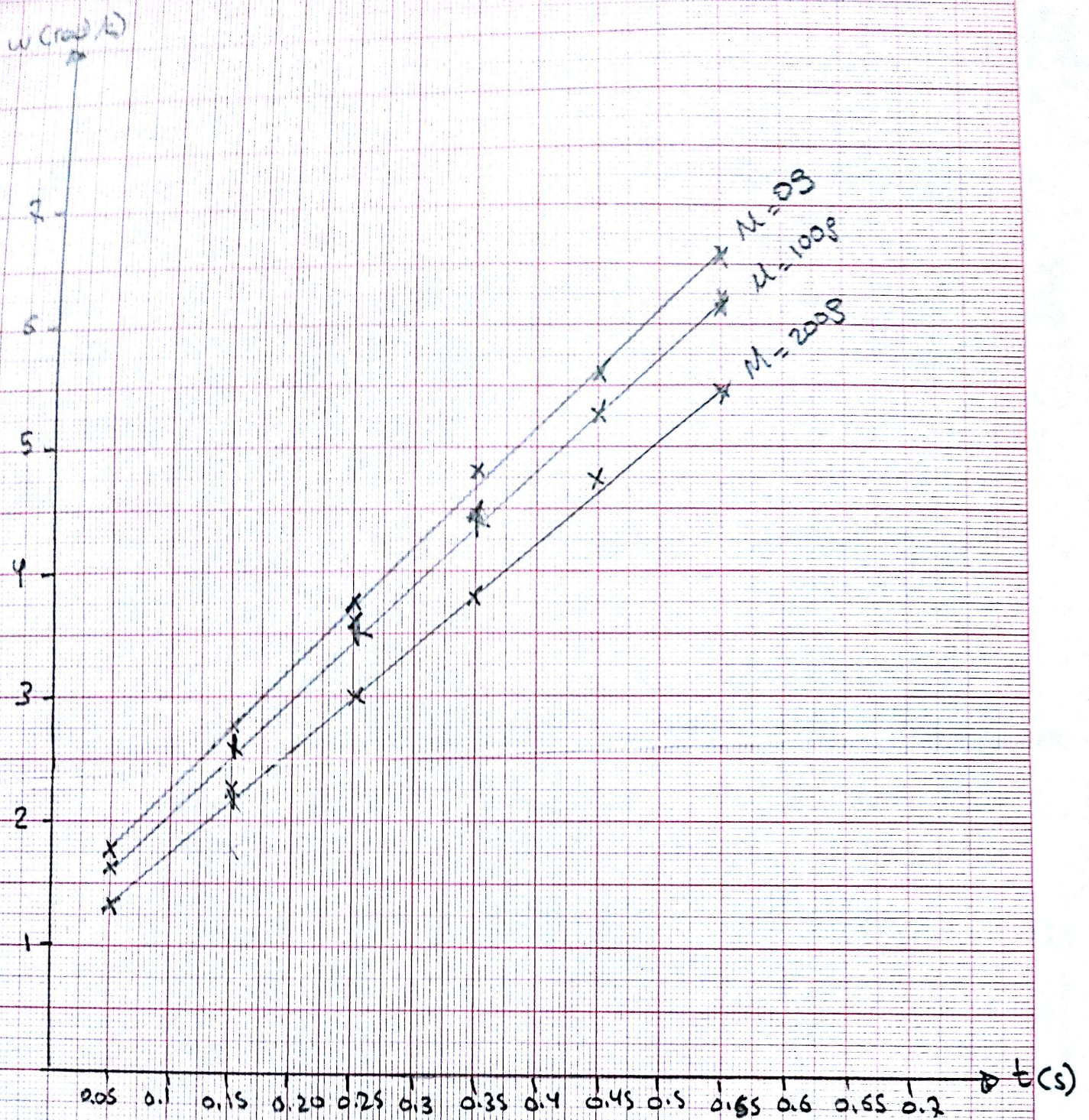
9. Do the values obtained in part A & part B for the moment of inertia of the empty turntable (I_0) agree? (percent difference)

$$I_0(B) = 48940$$

$$I_0(A) = 51600 \rightarrow \text{percent difference:-}$$

$$\Rightarrow \frac{|(51600 - 48940)|}{(48940 + 51600)/2} \times 100\%$$

$$= 5.29\%$$

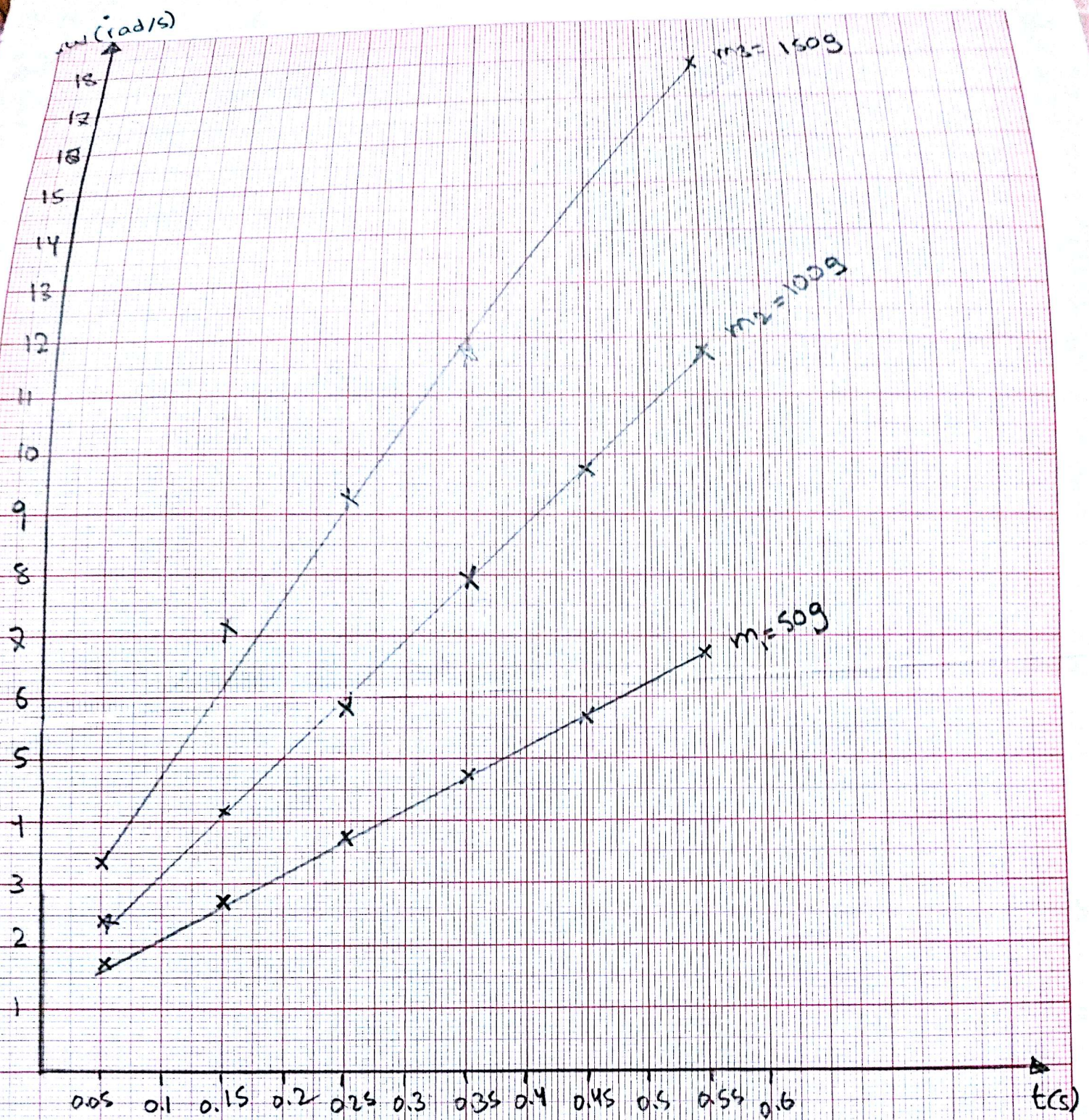


$$\text{slope} = \frac{\Delta \omega}{\Delta t} = \alpha$$

$$m = 0g \quad \alpha_1 = \frac{6.2 - 3.2}{0.5 - 0.2} = 10 \text{ rad/s}^2 \quad P_1(0.5, 6.2) \quad P_2(0.2, 3.2)$$

$$m = 100g \quad \alpha_2 = \frac{5.25 - 2.25}{0.5 - 0.1} = 8.25 \text{ rad/s}^2 \quad P_1(0.5, 5.25) \quad P_2(0.1, 2.25)$$

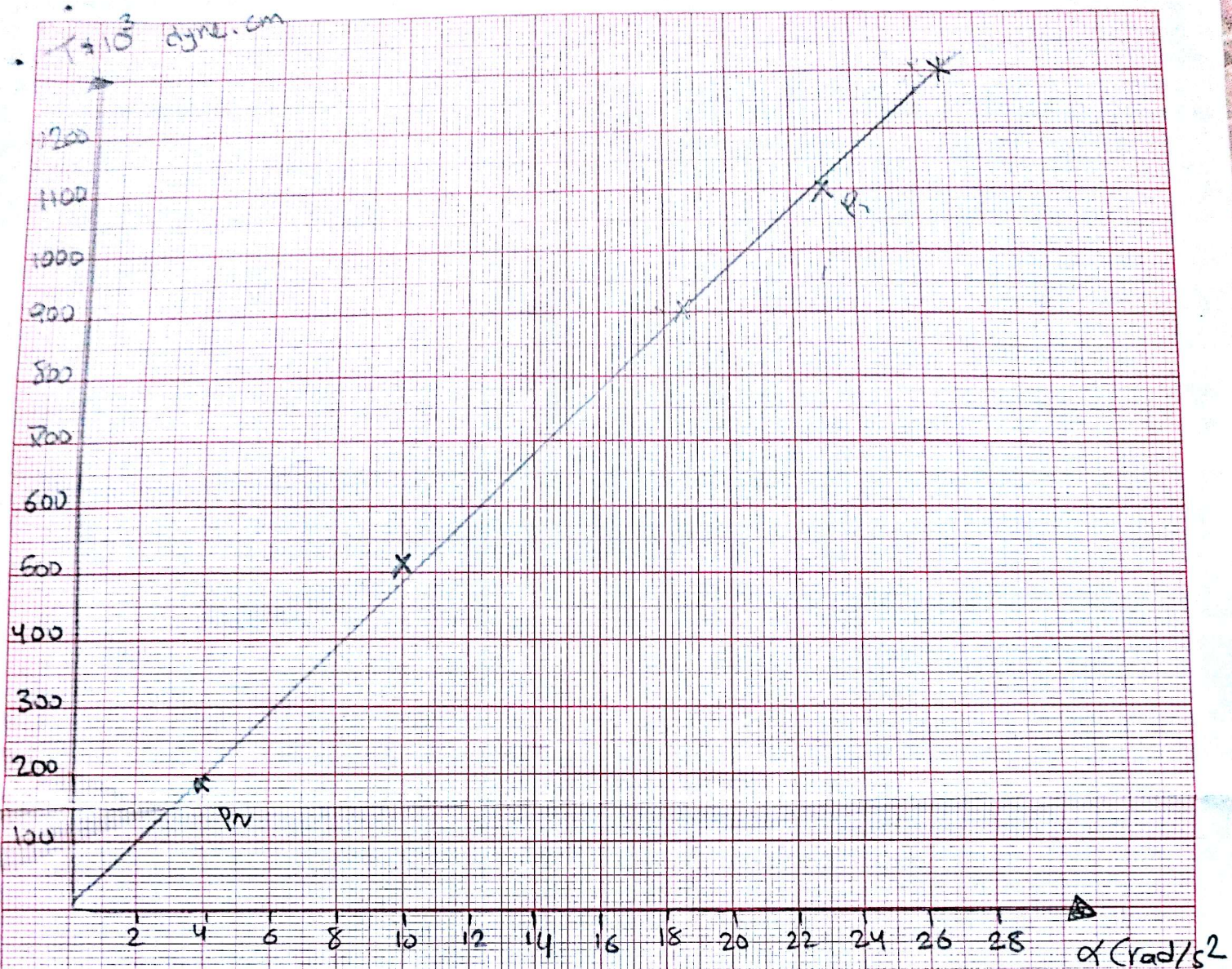
$$m = 200g \quad \alpha_3 = \frac{5 - 2.6}{0.5 - 0.2} = 8 \text{ rad/s}^2 \quad P_1(0.5, 5) \quad P_2(0.2, 2.6)$$



$$\alpha_1 = \left(\frac{6.1 - 2.2}{0.5 - 0.1} \right) = 9.75 \text{ rad/s}^2 / p_1 (0.5, 6.1) \quad p_2 (0.1, 2.2)$$

$$\alpha_2 = \frac{10.6 - 5}{0.5 - 0.2} = 18.66 \text{ rad/s}^2 / p_1 (0.5, 10.6) \quad p_2 (0.2, 5)$$

$$\alpha_3 = \frac{15.9 - 9}{0.5 - 0.25} = 27.6 \text{ rad/s}^2 / p_1 (0.5, 15.9) \quad p_2 (0.25, 9)$$



$$\text{slope} = \frac{936 \times 10^{-3}}{19} = 48.94 \times 10^3 \frac{\text{dyne.cm}}{\text{rad/s}^2}$$

$$P_1 (23, 1100)$$

$$P_2 (4, 180)$$

LAB REPORT FOR EXPERIMENT 8

Date: 27/7/2016

Name: راما كامل الرابع

Partner's Name: فرح عماد ابو حنون

Registration No: 0145006

Registration No: 2130599

Physics Section: 5

Instructor's Name: د. منير طاهر

PHYSICS LAB EXPERIMENT 8: SIMPLE HARMONIC MOTION : THE SIMPLE PENDULUM

I. PURPOSE :

to what is mean by simple harmonic motion and the
relation between T & L .

II. DATA AND DATA ANALYSIS :

1. Compute the average of the period for each length of the pendulum and record them in Table 8.1.
2. Fill in the average periods $\bar{T}$ and the lengths L in table 8.2.

Table 8.1

	$L_1 = 80 \text{ cm}$	$L_2 = 60 \text{ cm}$	$L_3 = 50 \text{ cm}$	$L_4 = 40 \text{ cm}$	$L_5 = 30 \text{ cm}$	$L_6 = 20 \text{ cm}$
Trial No.	$t/10 \text{ (s)}$	$t/10 \text{ (s)}$	$t/10 \text{ (s)}$	$t/10 \text{ (s)}$	$t/10 \text{ (s)}$	$t/10 \text{ (s)}$
1	1.80	1.59	1.44	1.22	1.15	0.96
2	1.75	1.58	1.45	1.28	1.16	0.94
3	1.77	1.56	1.42	1.31	1.13	0.97
4						
5						
	$\bar{T}_1 = 1.78 \text{ s}$	$\bar{T}_2 = 1.57 \text{ s}$	$\bar{T}_3 = 1.43 \text{ s}$	$\bar{T}_4 = 1.28 \text{ s}$	$\bar{T}_5 = 1.14 \text{ s}$	$\bar{T}_6 = 0.96 \text{ s}$

Table 8.2

$L \text{ (cm)}$	$\bar{T} \text{ (s)}$	$\bar{T}^2 \text{ (s}^2\text{)}$
80 cm	1.78	3.17
60 cm	1.57	2.46
50 cm	1.43	2.04
40 cm	1.28	1.64
30 cm	1.14	1.29
20 cm	0.96	0.92

3. Compute the square of the average period for each length and record it in Table 8.2.
4. Use your data in Table 8.1 to plot $\bar{T}$ versus L. What conclusion can you obtain from your graph?

The experiment does agree with theory, T increase with L

5. Now plot $\bar{T}^2$ versus L using Table 8.2. What kind of relationship do you obtain?

= linear direct relationship.

6. Compute the slope of your graph plotted in 4 above.

$$\text{Slope} = \frac{1.2 - 0.9}{30 - 20} = 0.04 \text{ (s}^2/\text{cm)}$$

7. Using the value of the slope you obtained calculate g, the acceleration due to gravity.

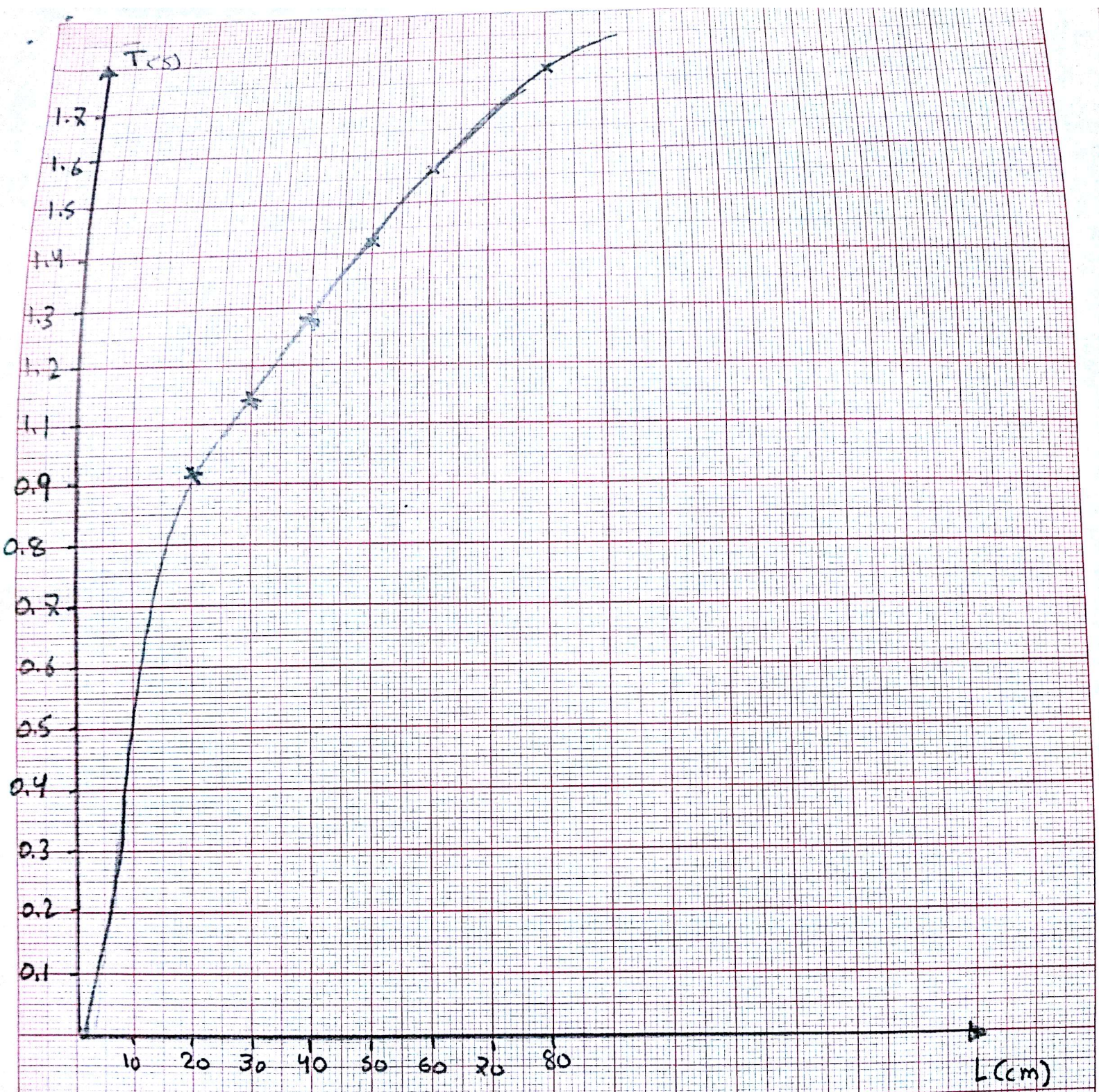
$$\text{Slope} = \frac{4\pi^2}{g} \Rightarrow g = \frac{4\pi^2}{\text{slope}} = \frac{4 \times (3.14)^2}{0.04}$$

$$g = 985.96 \text{ cm/s}^2$$

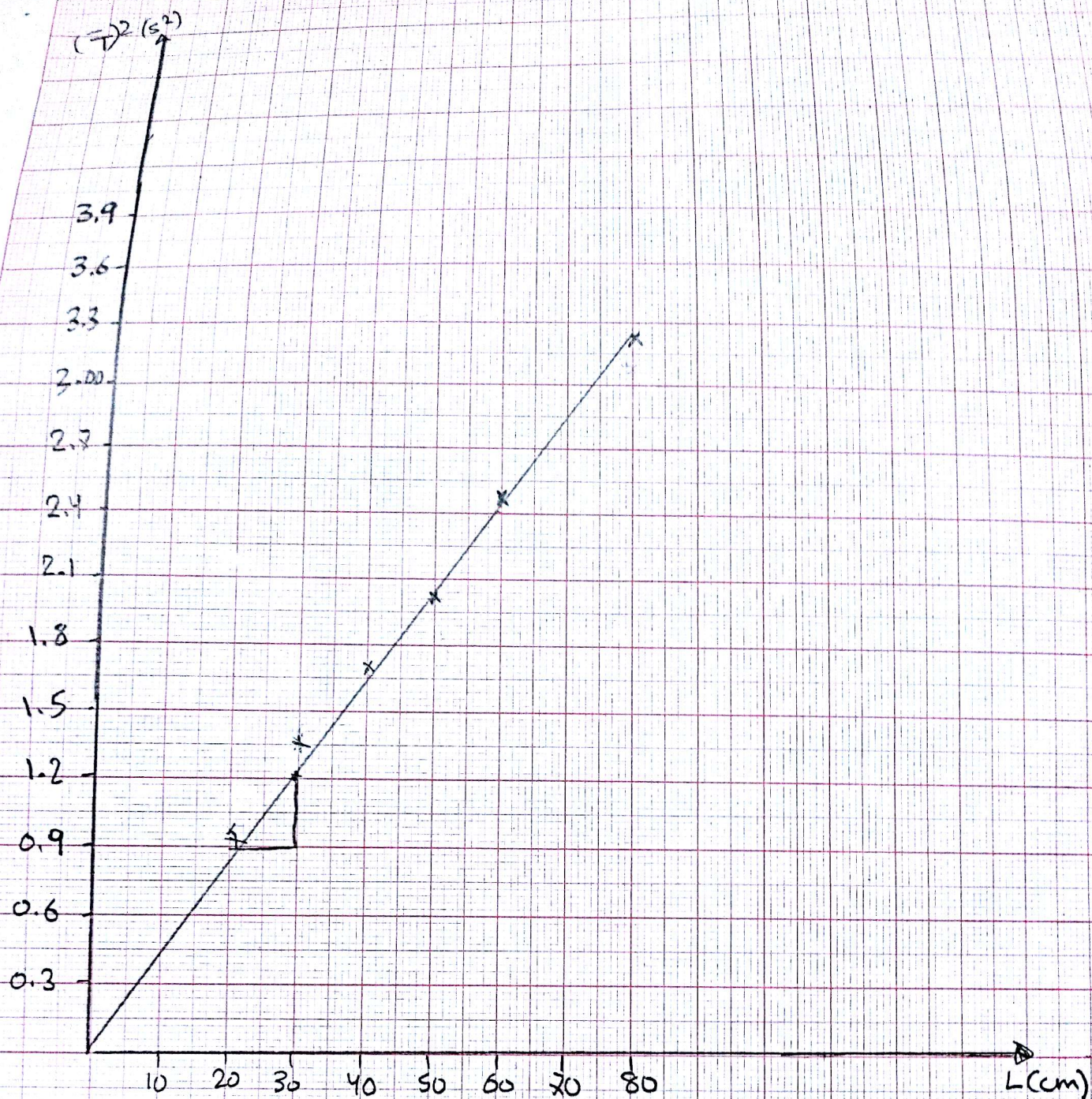
8. Estimate the error in g. $g_A = 980 \text{ cm/s}^2$

$$\text{percent error} = \left| \frac{g_E - g_A}{g_A} \right| \times 100\%$$

$$\text{percent error} = \left| \frac{985.96 - 980}{980} \right| \times 100\% = 0.60\%$$



T increase with L



$$\text{Slope} = \frac{\bar{T}_2^2 - \bar{T}_1^2}{L_2 - L_1} = \frac{1.2 - 0.9}{30 - 20} = 0.03 \text{ s}^2/\text{cm}$$

the relationship between $\bar{T}^2$ & L is direct linear.

LAB REPORT FOR EXPERIMENT 9

Name: Rama Kamil aldrab Date: 20/7/2016
 Registration No: 2145006 Partner's Name: Ali aldrab
 Physics Section: 5 Registration No: 215
 Instructor's Name: Abd alhadi

PHYSICS LAB EXPERIMENT 9: THE LAWS OF GASES

I. PURPOSE :

to investigate the behavior of simple gases, such as air under changes in the temperature or pressure of a certain amount of enclosed gas.

II. DATA AND DATA ANALYSIS :

A. Boyle's Law

1. Enter the data in Table (9.1) below:

Table (9.1)

Scale Readings (mm)		L = B-X (mm)	h = Y-X (mm)	1/L (mm ⁻¹)
X	Y			
277	840	113	563	8.81×10^{-3}
275	793	115	518	8.7×10^{-3}
272	750	118	478	8.47×10^{-3}
270	720	120	450	8.3×10^{-3}
265	685	125	420	8×10^{-3}
263	651	127	388	7.87×10^{-3}
259	620	131	361	7.63×10^{-3}
255	593	135	338	7.4×10^{-3}
B = 39.00 mm				
Average Room Temp. = 30 °C				

2. Plot $1/L$ as independent variable against h . Use the graph to find the value of the atmospheric pressure $P_a \pm \Delta P_a$.

$$P_a = 760 \text{ mm Hg}$$

3. Calculate the pressure of the entrapped gas P in each case, using the relation: $P = (P_a + h)$ and also calculate the quantity PL and enter their values in Table (9.2) below :

Table (9.2)

L (mm)	$P = P_a + h$ (mm Hg)	$P L$ (mmHg . mm)
113	1313	148369
115	1268	145820
118	1228	144904
120	1200	144000
125	1171	146375
127	1138	144526
131	1111	145541
135	1088	146880

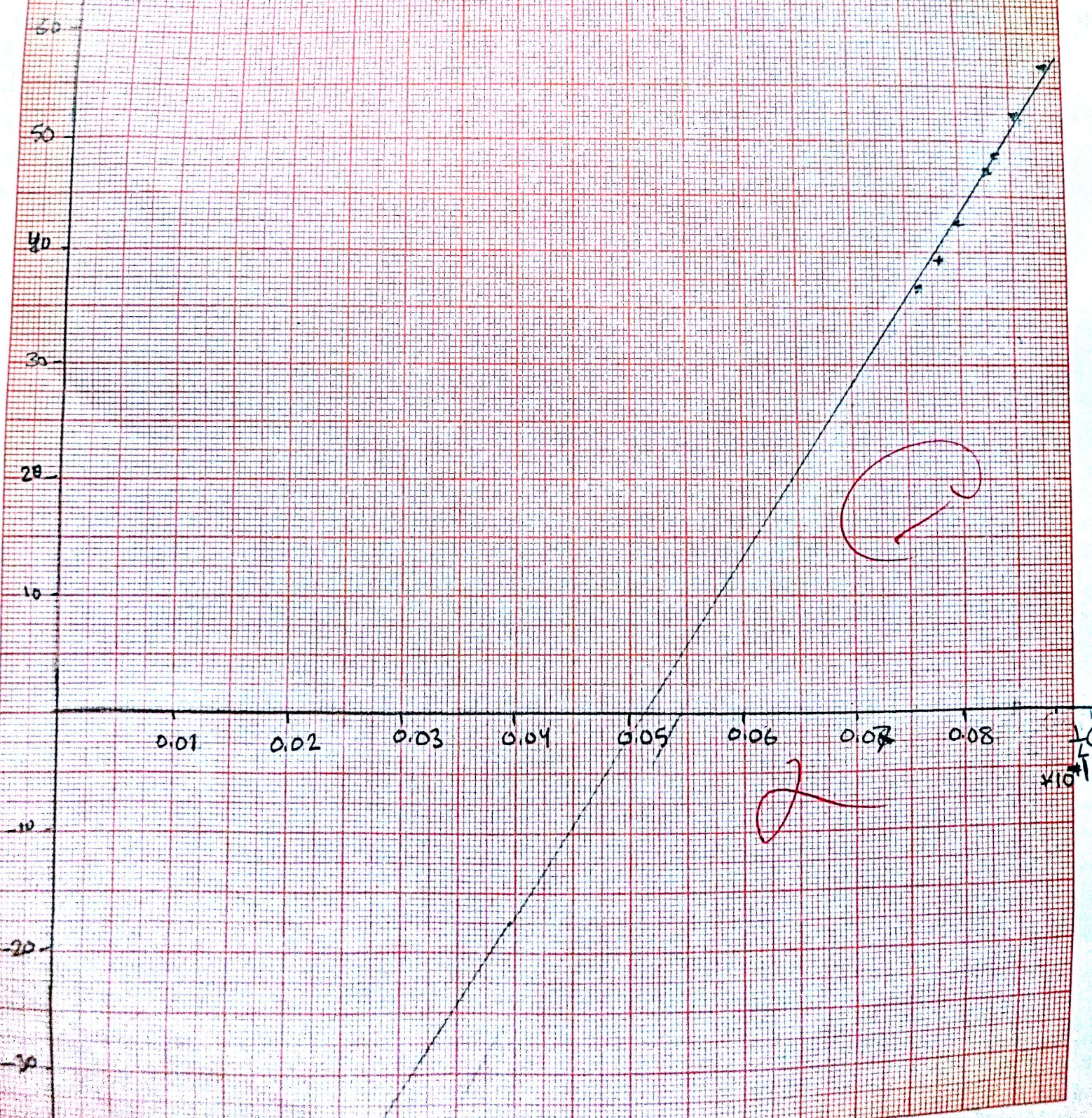
4. Plot a second graph between L as independent variable and $P = (P_a + h)$. What do you conclude from such a curve?

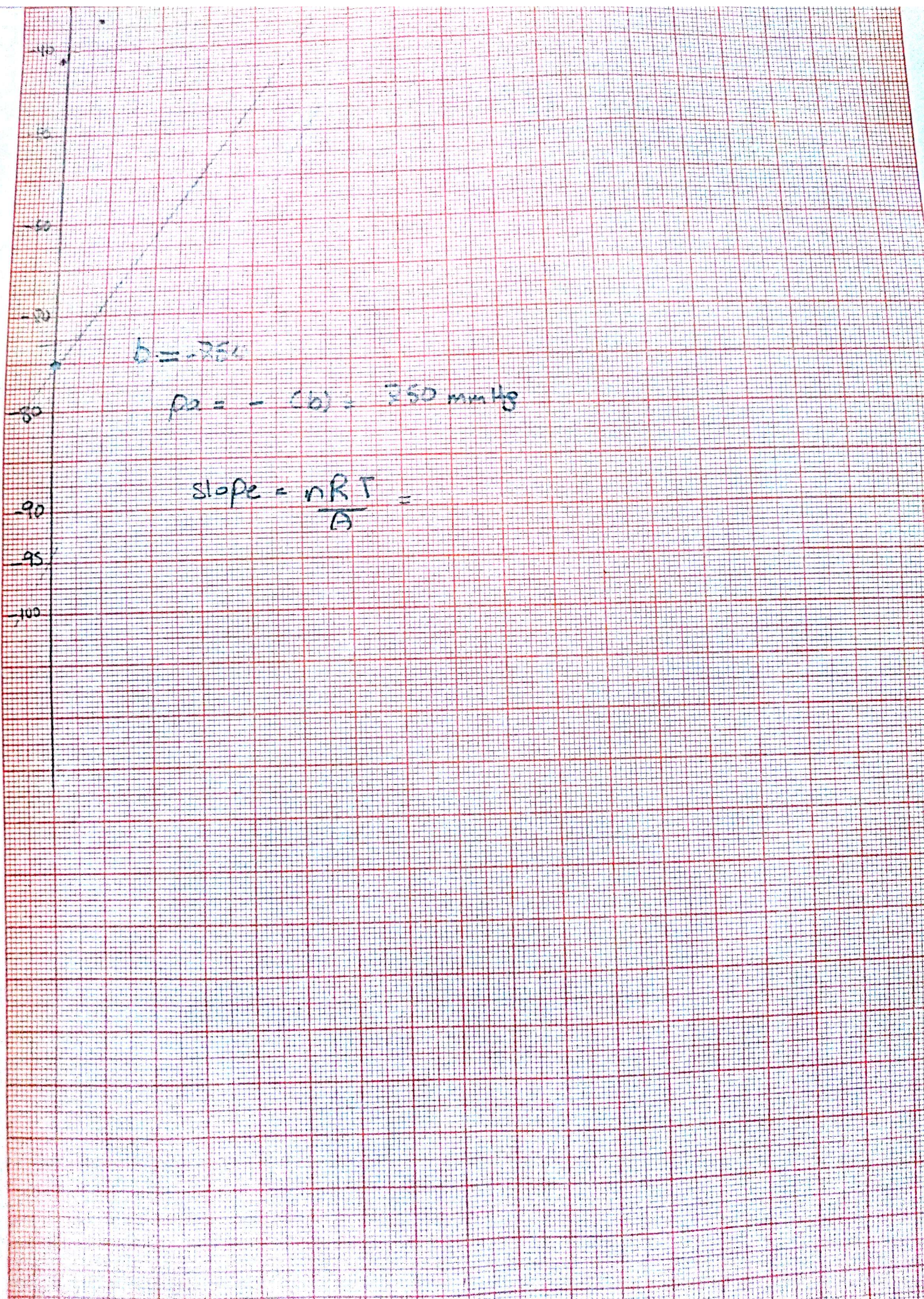
that P (pressure) decreases as L increases (inverse relation)

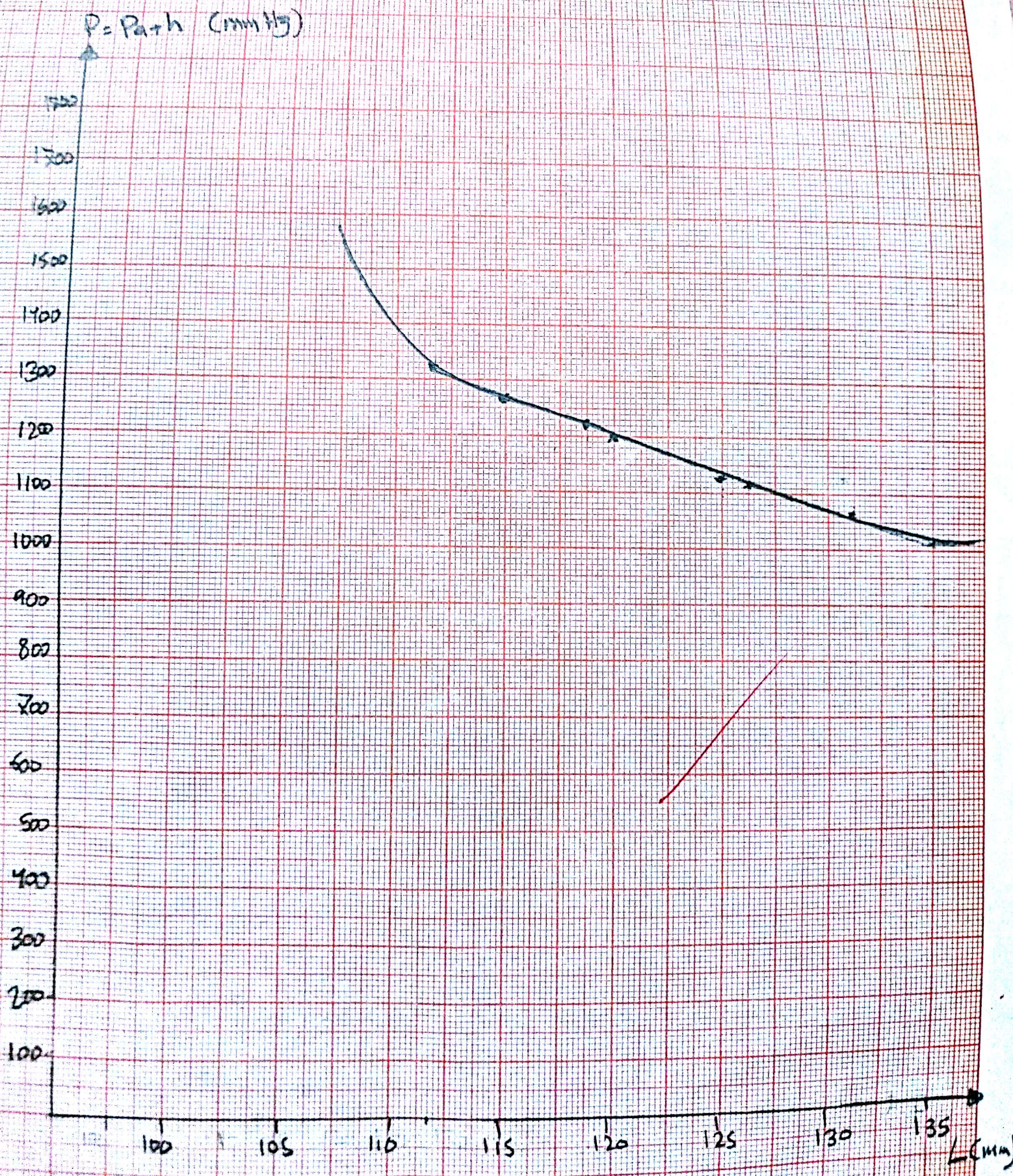
5. Plot a third graph between L as independent variable against PL . What do you conclude from this graph?

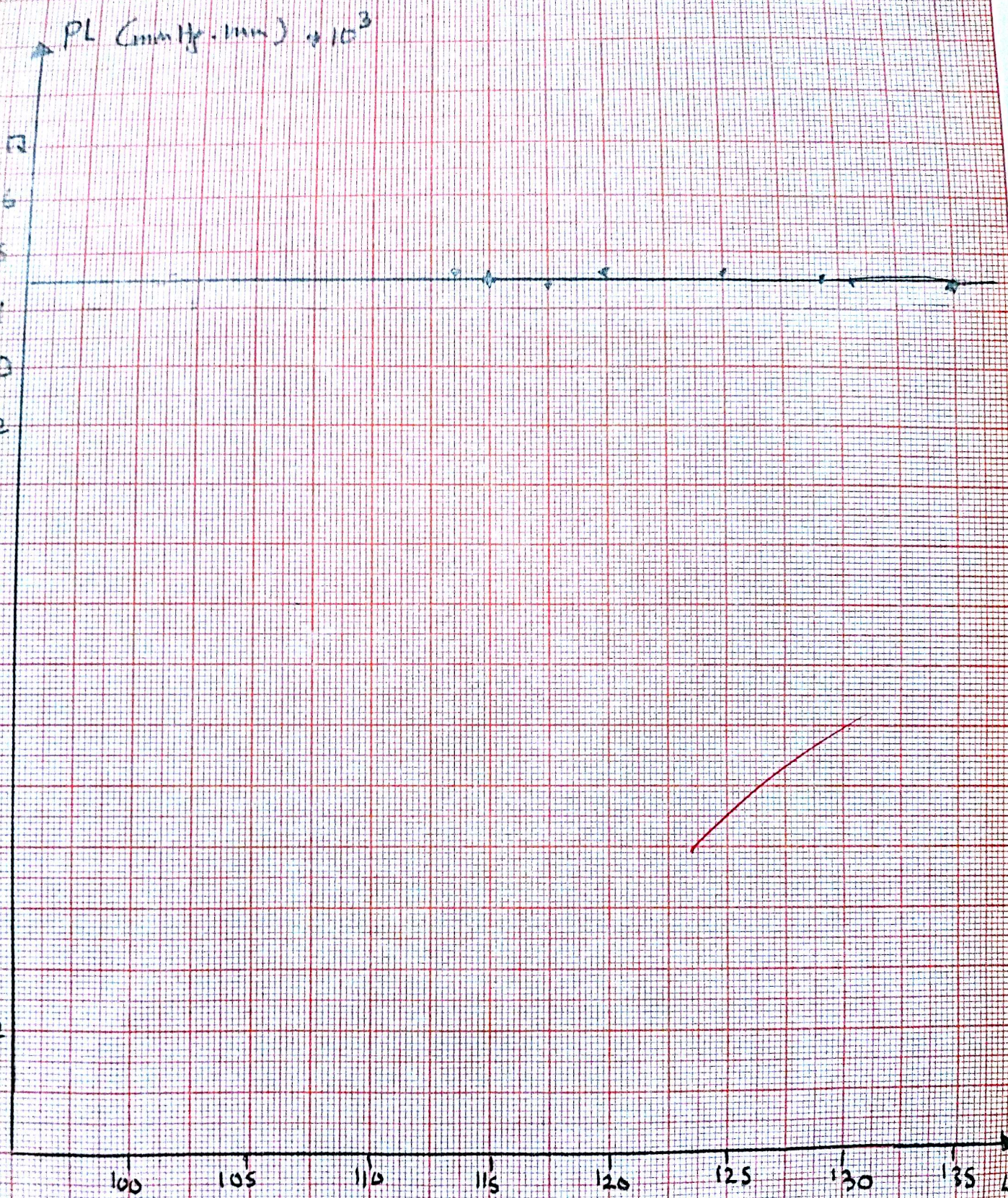
PL is constant

Temperature









LAB REPORT FOR EXPERIMENT 11

Date: -----

Name: -----

Partner's Name: -----

Registration No: -----

Registration No: -----

Physics Section: -----

Instructor's Name: -----

PHYSICS LAB EXPERIMENT 11: SPECIFIC HEAT CAPACITY OF METALS

I. PURPOSE :

Determination the specific heat capacity of a substance which based on the principles of calorimeter.

II. DATA AND DATA ANALYSIS :

1. Enter the data in Table (11.1) below:

Table (11.1)

Specific heat capacity of calorimeter C_1	= 0.22	cal/g°C
Specific heat capacity of water C_w	= 1	cal/g°C
Mass of calorimeter M_1	= 48.33	g
Mass of calorimeter + water	= 115.53	g
Mass of water M_w	= 67.2	g
Temp. of calorimeter. +water T_1	= 28°	°C
Temp. of metal T_2	= 94	°C
Final Equilibrium Temp. T_f	= 34.5	°C
Mass of metal M_2	= 88.55	g

2. What are the possible sources of error in this experiment?

error at take the reads of masses & temperatures (personal error)
loss some of heat from the calorimeter to surrounding &
the weight of the metal

3. Calculate the specific heat capacity (C_2) of the metal using the following equation:

Heat gained (by calorimeter + water) = Heat lost (by metal)

$$(M_1 C_1 + M_w C_w) (T_f - T_i) = M_2 C_2 (T_2 - T_1)$$

$$C_2 = \frac{(48.33 \times 1 + 67.2 \times 0.22) (34.5 - 28)}{88.55 \times (94 - 28)} = 0.096 \text{ cal/g}^\circ\text{C}$$

4. Calculate ΔC_2 and express your final result as : $C_2 \pm \Delta C_2$.

$$\frac{\Delta C_2}{C_2} = \pm \left[\left(\frac{\Delta x}{x} \right)^2 + \left(\frac{\Delta y}{y} \right)^2 + \left(\frac{\Delta z}{z} \right)^2 + \left(\frac{\Delta M_2}{M_2} \right)^2 \right]^{1/2}$$

$$x = 63.114, \Delta x = [5.12 \times 10^{-3}] \quad \Delta M_2 = 5 \times 10^{-3}$$

$$y = 6.5, \Delta y = 0.35 \quad M_2 = 88.55$$

$$z = 59.5, \Delta z = 0.35$$

$$\frac{\Delta C_2}{C_2} = 0.05 \Rightarrow \Delta C_2 = 4.87 \times 10^{-3} \text{ cal/g}^\circ\text{C}$$

$$C_2 \pm \Delta C_2 = 0.09 \pm 4.87 \times 10^{-3} \text{ cal/g}^\circ\text{C}$$

$$C_2 + \Delta C_2 = 0.09487 \text{ cal/g}^\circ\text{C}$$

$$C_2 - \Delta C_2 = 0.08513$$

5. What is the heat capacity of the metal sample?

$$\text{heat capacity} = C_2 \times m$$

$$\Rightarrow 0.09 \times 88.55$$

$$\Rightarrow 7.96 \text{ cal/g}^\circ\text{C}$$

6. How much heat is required to raise the temperature of 120g of Aluminum from 25°C to 140°F .

$$F = \frac{9}{5}C + 32 = 60^{\circ}\text{C}$$

$$Q = m C (T_2 - T_1)$$

$$= 120 \times 0.09 \times (60 - 25) \Rightarrow 378 \text{ cal}$$

LAB REPORT FOR EXPERIMENT 12

Name: ...

Registration No: ...

Physics Section: ...

Date: ...

Partner's Name: ...

Registration No: ...

Physics Section: ...

Ballistic Pendulum

Purpose

The objective of this experiment is to measure the speed of a rapidly moving object using the conservation of mechanical energy and momentum concepts. From the initial speed of the ball the acceleration due to gravity g can be determined.

Theory

We will use the mechanical energy in part one of this experiment to measure the speed of the ball. The ballistic pendulum apparatus is shown in figure 1. A steel ball is placed at the end of a compressed spring gun. When the spring gun is fired, the ball is projected horizontally leaving the gun with a velocity v . This means that the elastic potential energy stored in the spring (E_s) is transferred to the ball in the form of kinetic energy (E_k).

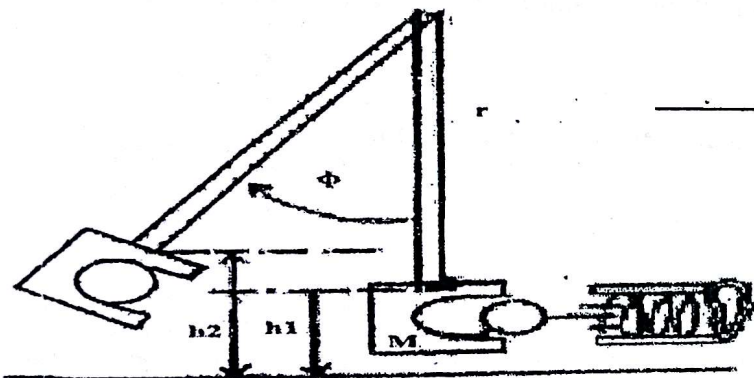
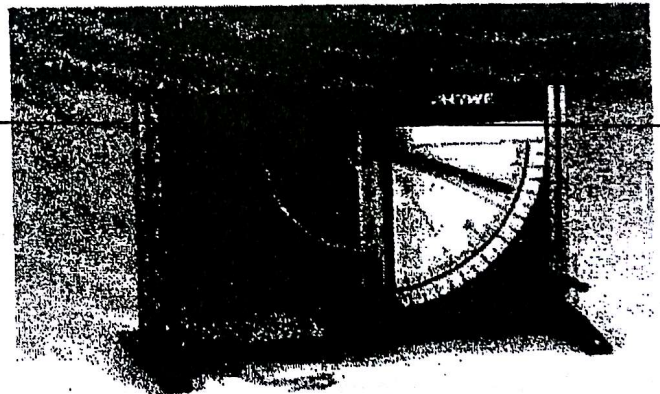


Figure 1



Applying the conservation of mechanical energy principle

$$\Rightarrow E_s = E_k$$

$$\Rightarrow \frac{1}{2} kx^2 = \frac{1}{2} mv^2 \quad (1)$$

Where x is the displacement of the spring from its unstretched ($x=0$) position, k is a constant called the force constant of spring, and m is the mass of the steel ball.

Then the initial velocity of the steel ball is:

$$v = \sqrt{\frac{kx^2}{m}} \quad (2)$$

In the second part the ball leaves the spring gun and then is caught by the catcher mechanism causing the pendulum with ball to swing upward. The velocity of the pendulum with captured ball can be calculated using the conservation of momentum and mechanical energy. Applying the conservation of momentum, we get

$$mv = (M_{\text{tot}} + m)V \quad (3)$$

Where $M_{tot} = M + m_a$

Therefore ,

$$V = \left(\frac{m}{M_{tot} + m} \right) v \quad (4)$$

Where v is the velocity of the projectile before collision, m is the mass of steel ball, M_{tot} is the total mass of pendulum ($M + m_a$), M is the mass of pendulum, m_a is the mass add and V is the velocity of the pendulum with the captured ball after collision.

If we then set the potential energy of the pendulum in its resting position to zero, the following is valid for the potential energy at the highest point of the oscillation (the velocity is zero):

$$U = (m + M_{tot}) \cdot g \cdot \Delta h \quad (5)$$

Where Δh is the height by which the center of gravity was raised.

$$\cos(\Phi) = \frac{r - \Delta h}{r} \quad (6)$$

$$\Delta h = r (1 - \cos(\Phi)) \quad (7)$$

Where r is the distance between the axis of rotation and the center of gravity of the pendulum with the captured ball and Φ is the angle at the maximum deflection of the pendulum. The equation (5) becomes

$$U = (m + M_{tot}) \cdot g \cdot r (1 - \cos(\Phi)) \quad (8)$$

The potential energy is equal to the kinetic energy E_{kin} immediately after the collision:

$$\frac{1}{2} (m + M_{tot}) V^2 = (m + M_{tot}) \cdot g \cdot r (1 - \cos(\Phi)) \quad (9)$$

From this equality we get:

$$V = \sqrt{2gr(1 - \cos(\Phi))} \quad (10)$$

For eq. (4) we get

$$\Rightarrow v = \frac{m + M_{tot}}{m} \sqrt{2gr(1 - \cos(\Phi))} \quad (11)$$

Information for an exact evaluation of the experiment

Similar result can be deduced by considering conservation of angular momentum and collision is very useful for practical purposes. At this time, we only wish to briefly show how things can achieve an exact evaluation. To begin with, Equation (9) for the kinetic energy is to be replaced by the equation for the rotational energy of a physical pendulum: $E_{kin} = \frac{1}{2} I \omega^2$

where I is the moment of inertia of the pendulum with captured ball and ω is the angular velocity. If one substitutes the angular momentum $L = I \omega$, the following is obtained:

$$E_{kin} = L^2 / (2I) \text{ or } L = (2 \cdot I \cdot E_{kin})^{1/2}$$

This angular momentum must be equal to the angular momentum L_0 of the ball before the collision with reference to the pivot point of the pendulum. If r is the distance of the ball from the pivot point at the instant of capture, then

$$L_0 = m \cdot r^2 \cdot \omega = m \cdot r \cdot v$$

By setting the two angular momentums equal to each other, one obtains

(3)

Procedure

Part 1: calculation of the initial speeds of a steel ball for three possible tension energies by using the conservation of energy principle.

1. Attach the steel ball to the holding magnet of the bolt.
2. Pull the bolt back until the desired lock-in position has been reached.
3. Measure the displacement x from unstretched position to the first tension position.
4. Repeat step 2 and 3 for the second and the third tension energy.
5. Record x_1 , x_2 and x_3 in table 12.1.
6. Calculate the initial speed for each case by using the equation 2.

Part 2: calculation of the constant acceleration g due to gravity.

1. Attach the steel ball to the holding magnet of the bolt.
2. Pull the bolt back until the desired lock-in the second position has been reached.
3. Without touching the pendulum's pulling pin, ensure that the pendulum is at rest and that the trailing pointer indicates nearly zero.
4. Trigger the shot by pulling the release lever. The amplitude of the pendulum's oscillation can be read from the trailing pointer.
5. To minimize the friction involved in the functioning of the trailing pointer shoot the resting pendulum using the same spring tension for a second and a third time without resetting the trailing pointer. When the trailing pointer is not moved any further, one can assume that the angle indicated has not been falsified by friction.
6. Now add 10g mass to the pendulum. Shoot the pendulum using the second position of spring and record the maximum deflection of the pendulum Φ . Repeat again for other added masses to the pendulum up to 40g in steps of 10g. Record your data in table 12.2.
7. Plot the relation between $1-\cos\Phi$ versus $(m/(M_{tot}+m))^2$. By using equation 11 calculate the constant acceleration g .

Analysis of Data

In this experiment, m (mass of the steel ball) = $35 \pm 0.01g$, M (mass of the pendulum) = $86 \pm 0.01g$ and $r = 24.00 \pm 0.05cm$, k (the force constant of spring) = $750N/m$. The throwing device of this experiment has three possible tension energies

Part 1: calculation of initial speeds of a steel ball for the three possible tension energies by using the equation 2. Measure the distances x_1 , x_2 and x_3 . Record it in Table 12.1 below.

$$\frac{1}{2} k x^2 = \frac{1}{2} m v^2$$

Table 12.1

x (m)	x^2 (m ²)	$k x^2$ (Nm)	v (m/s)
2.1×10^{-2}	4.41×10^{-4}	0.33	4.45 3.07
3.5×10^{-2}	1.225×10^{-3}	0.91	5.1
5×10^{-2}	2.5×10^{-3}	1.875	7.3
$k = 750N/m$		$m = 0.035kg$	

(4)

Part 2: calculation of the constant acceleration g due to gravity. Add 10g mass to the pendulum. Shoot the pendulum using the **second position** of spring and record the maximum deflection of the pendulum Φ , Record it in Table 12.2 below.

$(mv)_{\text{ball}} = (m + m_{\text{tot}}) V$ Table 12.2 $V = \left(\frac{m}{m + m_0} \right) V_{\text{ball}}$

$m_a(\text{kg})$	$M_{\text{tot}} = (M + m_a)$	$(m/(M_{\text{tot}} + m))^2$	Φ	$1 - \cos\Phi$
0	0.086	0.166	48°	0.271
0.01	0.096	0.132 0.132	43°	0.219
0.02	0.106	0.109	39°	0.181
0.03	0.116	0.091	35°	0.147
0.04	0.126	0.077	31°	0.116
$m = 0.035\text{kg}$		$M = 0.086\text{kg}$		

1. Use your data in table 12.2 to plot $(1 - \cos\Phi)$ versus $(m/(M_{\text{tot}} + m))^2$.

2. What conclusion can you obtain from your graph?

the relationship between m and $1 - \cos\Phi$ is linear
and increase and the slope represent $\frac{v^2}{2gr}$

3. Compute the slope of your graph plotted in 1 above.

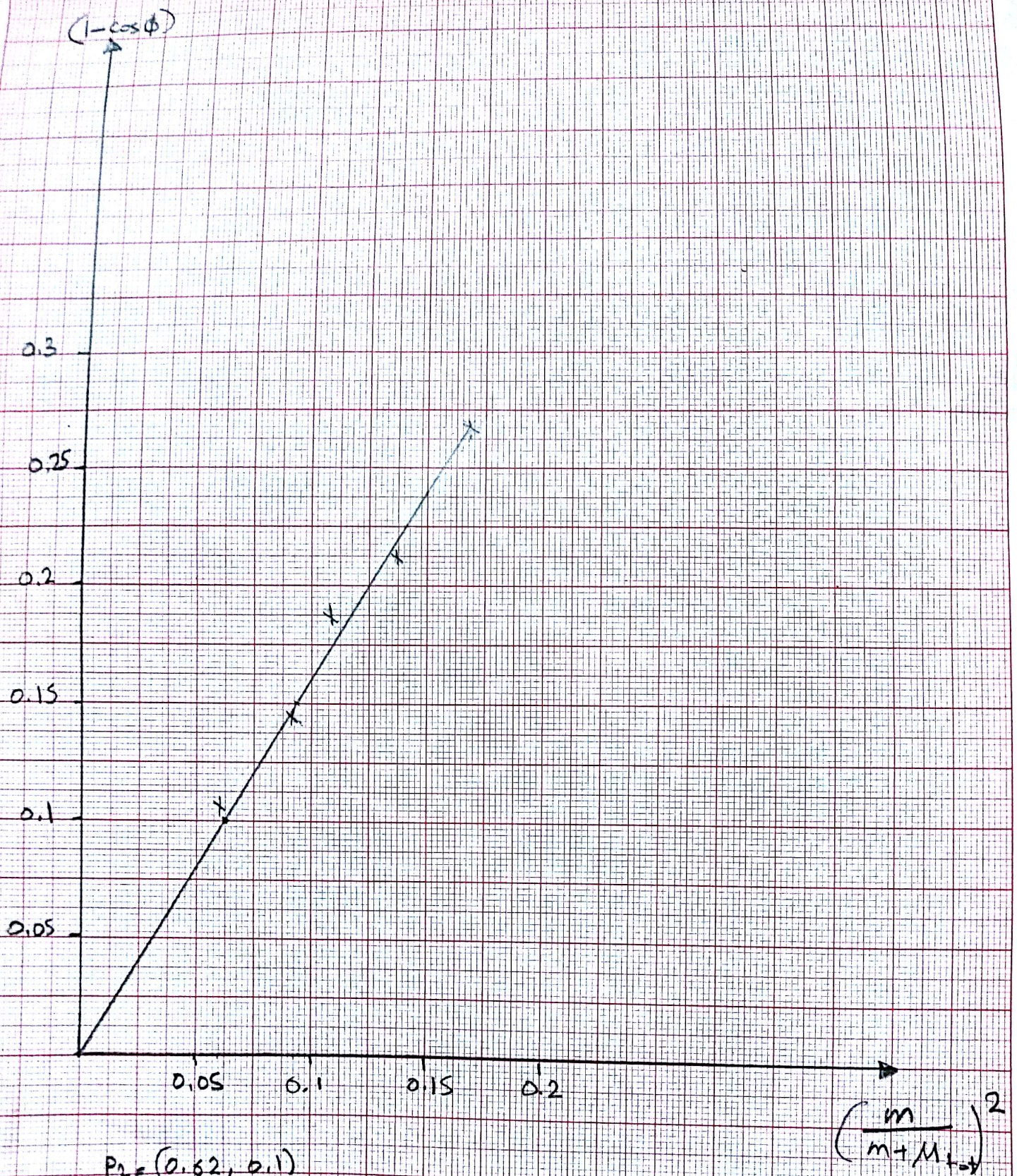
from the graph slope = $\frac{\Delta y}{\Delta x} = 5.6$

4. Calculate g , the acceleration due to gravity by using the value of the slope.

$$g = \frac{(5.1)^2}{2 \times 0.24 \times \text{slope}} = \frac{(5.1)^2}{(2 \times 0.24 \times 5.6)} = 9.67$$

5. Estimate the error in g .

$$\text{percent error} = \left| \frac{9.67 - 9.8}{9.8} \right| \times 100\% = 1.26\%$$



$$P_2 = (0.62, 0.1)$$

$$P_1 = (0.9, 0.15)$$

$$\text{Slope} = \frac{(0.9 - 0.62)}{(0.15 - 0.1)} = 5.6$$