exp-1-

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Collection and Analysis of Data

*Data

h(cm)	t(sec)			
	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

Table (1)

Using data in table (1) to fill table (2) below:

d(mm)	t(sec)			
	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	~~28~~ 26.7	13.5

Table (2)

For h = 30.0 cm, fill table (3) below:

ضيف منازل بعد الفاصلة.

t (sec)	d (mm)	$1/d^2$ (mm^{-2})
6.8	5.0	0.04
18.4	3.0	0.11
41.2	2.0	0.25
73.0	1.5	0.44

Table (3)

For d = 2.0 mm, fill table (4) below:

t (sec)	h (cm)	Log t	Log h
41.2	30.0	1.61	1.48
23.7	10.0	1.37	1
15.0	4.0	1.18	0.60
7.2	1.0	0.86	0

Table (4)

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*Analysis of Data:

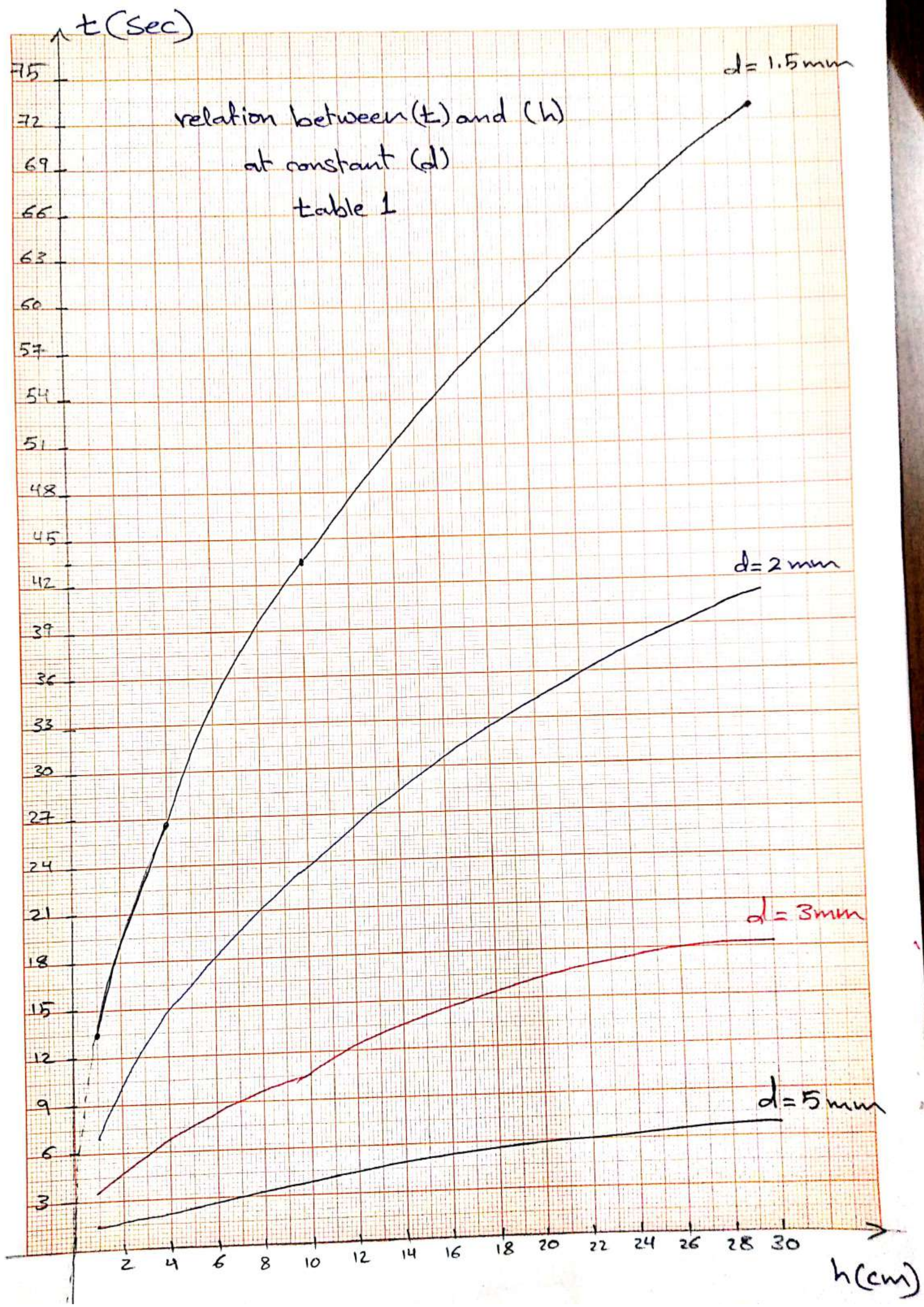
Graph your results. **Independent** variables will be the diameter of the hole and depth of water in the container. Time is the **dependent** variable and will depend on the previous two independent variables.

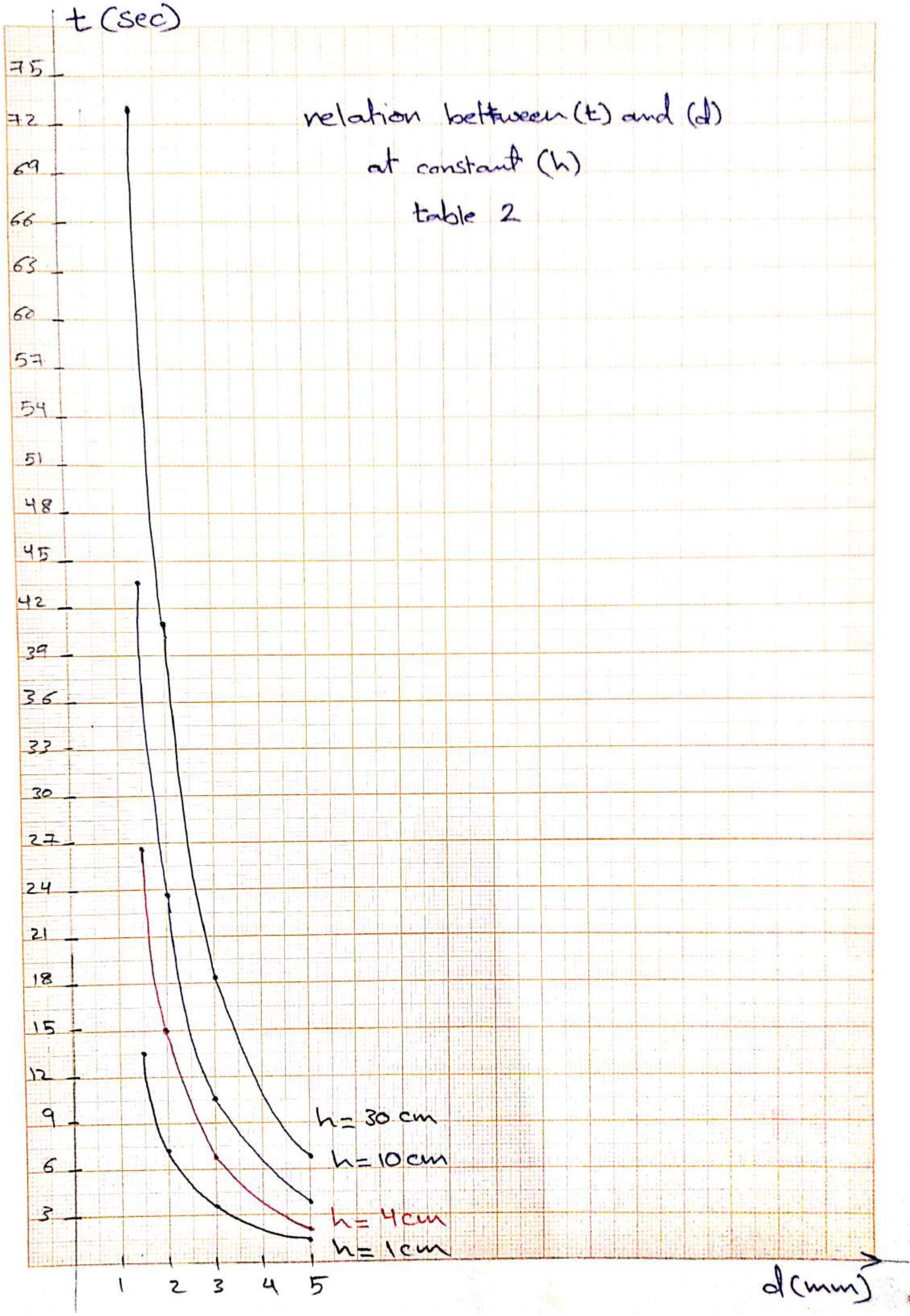
A. Plot the time (**t**) versus the depth (**h**) for each diameter (**d**) used. Do four graphs on one sheet, using the same set of axes, connecting points in a smooth curve for each and labeling them d_1, d_2, d_3 and d_4.

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.

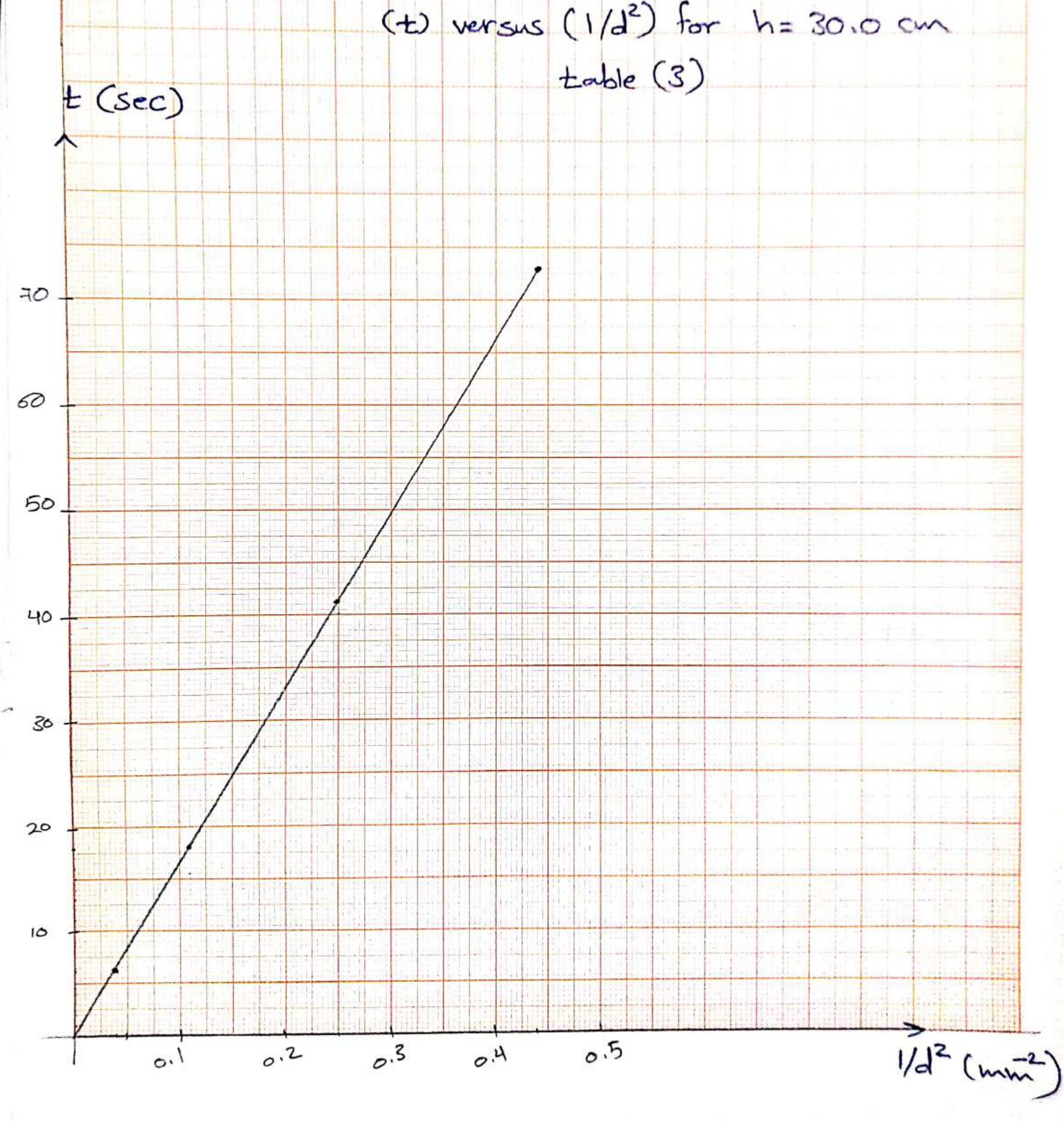
C. Plot **t** versus **$1/d^2$** for h = 30.0 cm.

D. Plot **log t** versus **log h** for d = 2 mm.


t (Sec)
relation between (t) and (h)
at constant (d)
table 1
d = 1.5 mm
d = 2 mm
d = 3mm
d = 5 mm
75
72
69
66
63
60
57
54
51
48
45
42
39
36
33
30
27
24
21
18
15
12
9
6
3
2
4
6
8
10
12
14
16
18
20
22
24
26
28
30
h (cm)

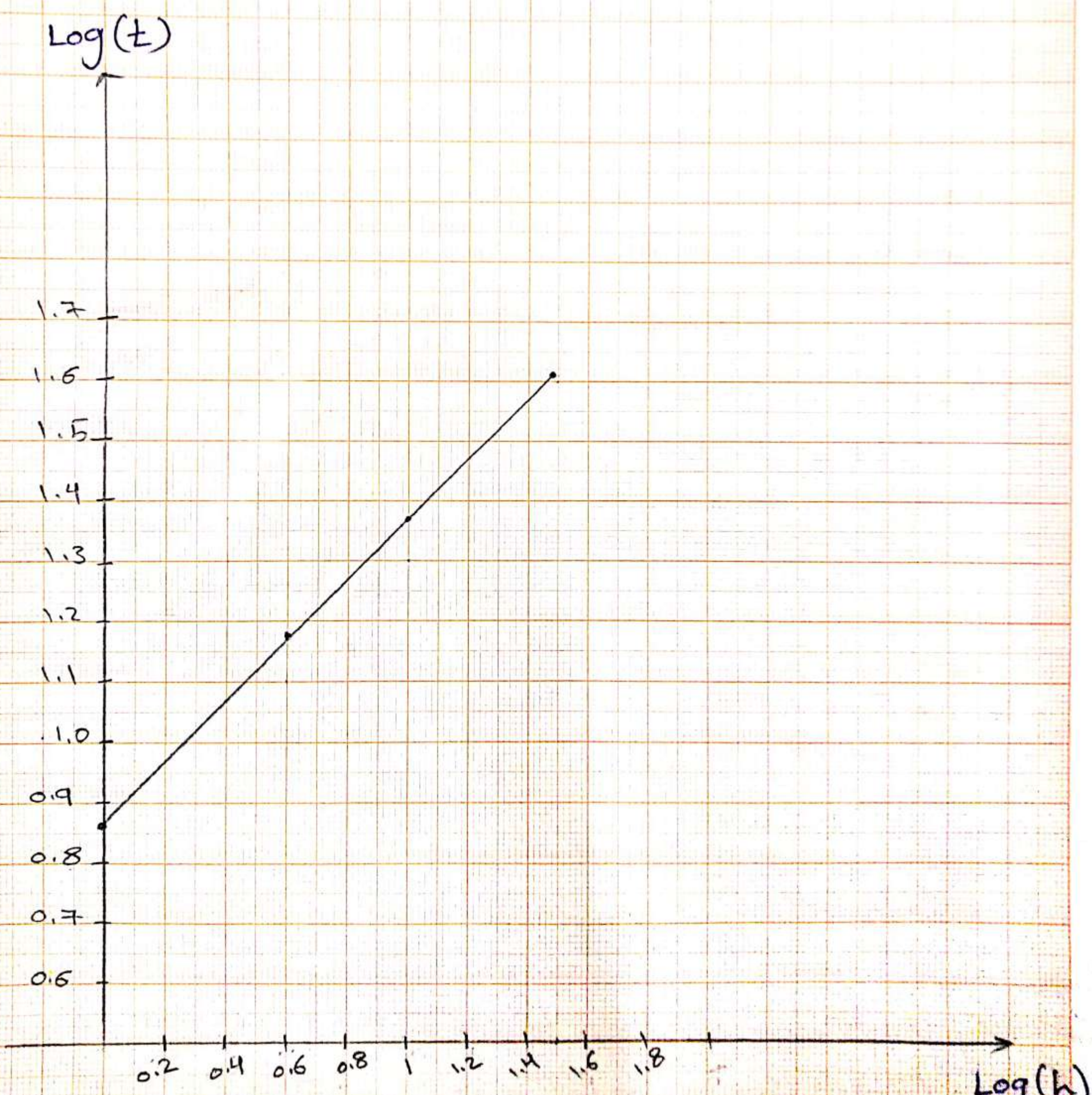


t (sec)
75
72
69
66
63
60
57
54
51
48
45
42
39
36
33
30
27
24
21
18
15
12
9
6
3
relation between (t) and (d)
at constant (h)
table 2
h= 30 cm
h= 10 cm
h= 4 cm
h= 1 cm
1
2
3
4
5
d (mm)


(t) versus (1/d²) for h= 30.0 cm
table (3)
t (sec)
70
60
50
40
30
20
10
0.1
0.2
0.3
0.4
0.5
1/d² (mm⁻²)

Log(t) versus Log(h) for d = 2.0 mm

table (4)



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Measurement and Uncertainties

A. Measurment of π

Record your data in the following table

Trial No.	d(cm)	$(d_i - d)^2$ (cm^2)	c (cm)	$(c_i - c)^2$ (cm^2)
1	3.75	8.1×10^{-5}	11.69	7.84×10^{-4}
2	3.72	4.41×10^{-4}	11.8	6.724×10^{-3}
3	3.735	3.6×10^{-5}	11.72	4×10^{-6}
4	3.77	8.41×10^{-4}	11.7	3.24×10^{-4}
5	3.73	1.21×10^{-4}	11.68	1.444×10^{-3}
Average	$\bar{d} = 3.741$ cm		$\bar{c} = 11.718$ cm	
Error	$\Delta d = 8.71 \times 10^{-3}$ cm		$\Delta c = 0.021$ cm	

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

$$\bar{\pi} = \frac{\bar{c}}{\bar{d}} = \frac{11.718}{3.741} = 3.1323$$

2. Calculate $\Delta\bar{\pi}$.

$$\Delta\bar{\pi} = \bar{\pi}\sqrt{\left(\frac{\Delta c}{\bar{c}}\right)^2 + \left(\frac{\Delta d}{\bar{d}}\right)^2} = 3.1323\sqrt{3.2 \times 10^{-6} + 5.42 \times 10^{-6}} = 0.0092$$

3. Which quantity contributes more to the error in the $\bar{\pi}$? ($\Delta\bar{d}/\bar{d}$. $\Delta\bar{c}/\bar{c}$)

$$\frac{\Delta\bar{d}}{\bar{d}} = \frac{8.71 \times 10^{-3}}{3.741} = 0.0023 \qquad \frac{\Delta\bar{c}}{\bar{c}} = \frac{0.021}{11.718} = 0.00179$$

it is more error in the $\bar{\pi}$

4. Find percent error of π, where the accepted value of $\pi = 3.14159$.

$$\text{Precent error of } \pi = \left|\frac{\pi - \bar{\pi}}{\pi}\right| \times 100\%$$

$$= \left|\frac{3.14159 - 3.1323}{3.14159}\right| \times 100\% = 0.29\%$$

B. Determination of the density:

Record your data in the following table

Trial No.	h(cm)	$(h-\bar{h})^2\,(cm^2)$	d (cm)	$(d-\bar{d})^2\,(cm^2)$
1	11.315	4.84×10^{-4}	0.653	7.056×10^{-5}
2	11.37	1.089×10^{-3}	0.655	4.096×10^{-5}
3	11.325	1.44×10^{-4}	0.666	2.116×10^{-5}
4	11.325	1.44×10^{-4}	0.672	1.1236×10^{-4}
5	11.35	1.69×10^{-4}	0.661	1.6×10^{-7}
Average	$\bar{h}$ = 11.337	cm	$\bar{d}$ = 0.6614	cm
Error	Δh = 0.01	cm	Δd = 0.0035	cm
Mass	m = 45.63	g	Δm = 0.01	g

1. Find **the average value** of the calculated densities and compare it with the standard value of this material density (ρ=8.89 g/cm³)? And find the percent error.

$$\rho = \frac{m}{\pi\left(\frac{d}{2}\right)^2 \bar{h}} = \frac{45.63}{(3.1323)(0.11)(11.337)} = 11.75\ g/cm^3$$

$$\text{Percentag error} = \left|\frac{\rho - \rho_{acc}}{\rho_{acc}}\right| \times 100 = \left|\frac{11.75-8.89}{8.89}\right| \times 100\% = 32.17\%$$

2. Calculate the error in the density (Δρ).

$$\Delta\rho = \rho\sqrt{\left(\frac{\Delta m}{m}\right)^2 + \left(\frac{\Delta\pi}{\pi}\right)^2 + \left(\frac{\Delta h}{h}\right)^2 + \left(\frac{2\Delta d}{d}\right)^2}$$

$$= 11.75 \times \sqrt{4.8\times10^{-8} + 8.6\times10^{-6} + 7.78\times10^{-7} + 1.12\times10^{-4}} = 0.129$$

3. Which quantity contributes more to the error in the density; the mass, the diameter or the height? Why? (see part A 3)

$$\frac{\Delta m}{m} = 2.19\times10^{-4} = 0.000219$$

$$\frac{\Delta\pi}{\pi} = 2.9\times10^{-3} = 0.0029$$

$$\frac{\Delta h}{h} = 8.8\times10^{-4} = 0.00088$$

$$\frac{2\Delta d}{d} = 0.01 = 0.01$$ ← is more error in the density

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Vectors (Force Table)

The values we will be working on are in the following table

Mass (g)	Weight (N) = mass × 9.8	Direction (°)
85	0.833	35
155	1.519	240
105	1.029	330

F_1 = 0.833N, 35°

F_2 =1.519N, 240°

F_3 = 1.029N, 330°

Insert the calculated values in the following table

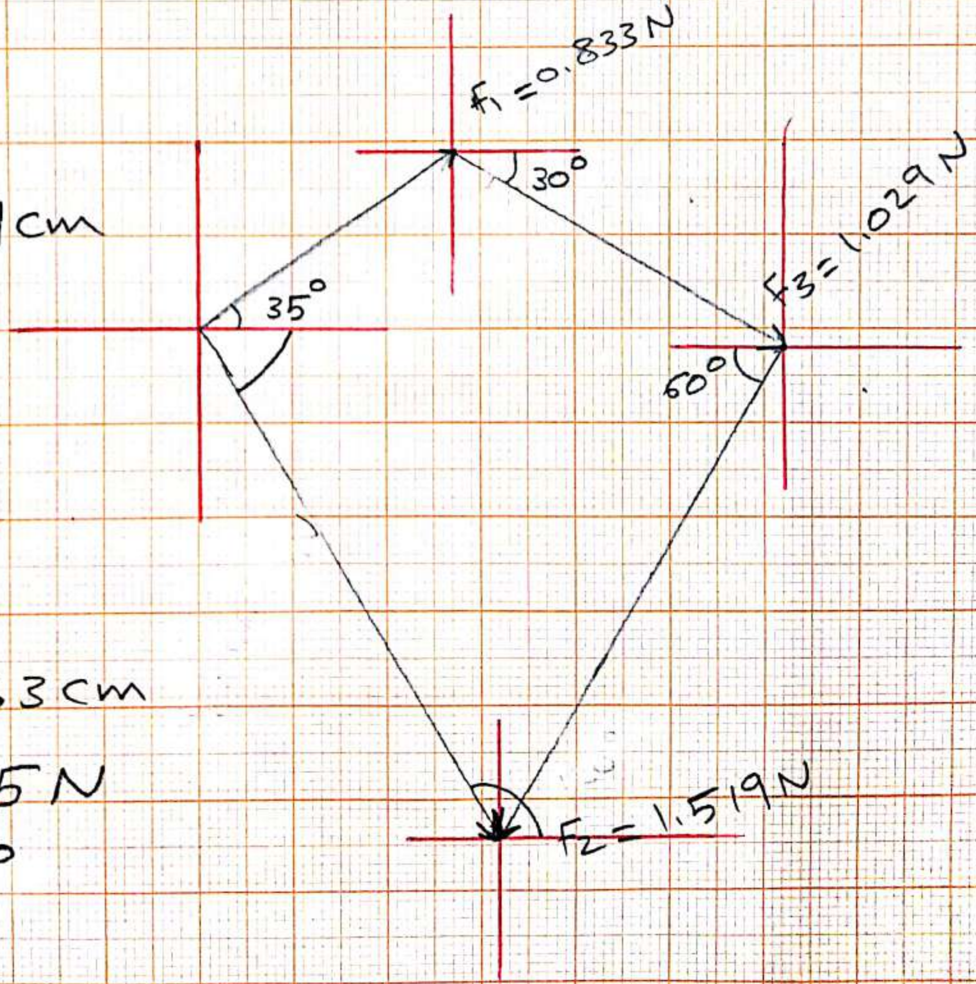
Resultant Force	Experimental Results	Graphical Results	Components Results
Magnitude (N)	1.5337 N	1.575 N	1.576
Direction (θ_R)	-60°	-60°	-59°
Percent Difference for Graphical results %	2.66%		
Percent Error for Components results %	2.68%		

*Graphical solution should be attached to the report.

Forces	Components Results	Equilibrant Results
Magnitude (N)	1.576	1.576
Direction (θ_R)	-59°	121°

*Note: The resultant and the equilibrant forces are same in magnitude and opposite in directions.

at scale 1N : 4cm



Length = 6.3cm

$F_R = 1.575N$

$\theta_R = -60°$

Use the given ticker tape for the data in your report

exp – 4 –
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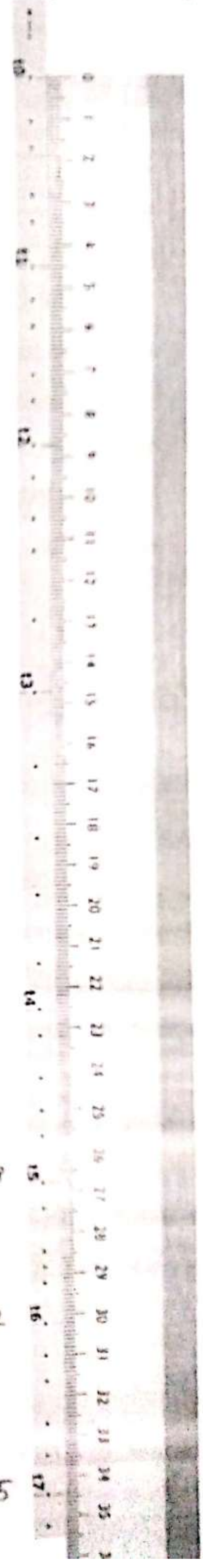
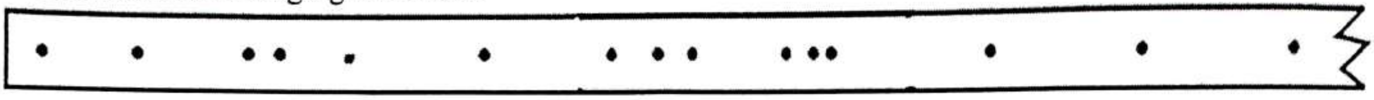
0
4.5
8.7
14.1
22.6
26.8
30.2
34.5



Purpose: To study irregular motion of your hand, by determining how the distance, velocity and acceleration are changing with time.



A. Fill in **table (1)** with data from **your tape**. Then, draw a graph of **x** versus **t**.

B. Use data from **table (1)** to fill **table (2)**. Then, draw a graph of $\bar{v}$ versus **t**. Then, draw the curve of the **instantaneous velocity**. {Assume that the instantaneous velocity at the interval's mid-point equals the average velocity in that interval, and that the acceleration is constant between each two intervals.}

C. Use data from **table (1)** to fill in **table (3)** .

Table(1)

Total time t (sec)	Total distance x (cm)
0.0	0.0
0.1	4.5
0.2	8.7
0.3	14.7
0.4	22.6
0.5	26.8
0.6	30.2
0.7	34.5

Table(2)

Time interval (s)	Average velocity $\bar{v} = \frac{\Delta x}{\Delta t}$ (cm/s)
0.0 – 0.1	45
0.1 – 0.2	42
0.2 – 0.3	60
0.3 – 0.4	79
0.4 – 0.5	42
0.5 – 0.6	34
0.6 – 0.7	43

Table (3)

t_{mid} (s)	$v_{mid} \cong \bar{v}$ (cm/s)	$\bar{a} = \frac{\Delta v}{\Delta t}$ (cm/s²)
0.05	45	
		-30
0.15	42	
		180
0.25	60	
		190
0.35	79	
		-370
0.45	42	
		-80
0.55	34	
		90
0.65	43	

Use **(x-t) graph** to answer the following questions:

a) Determine **one** interval in which:

1- The velocity is increasing: (0.2 , 0.3) s

2- The velocity is decreasing: (0.3 , 0.4) s

3- The velocity is constant: (0 , 0.2) s

b) Find the instantaneous velocity at **t = 0.4 s** from the **slope** of the tangent of the **(x-t)** graph. Slope = $\frac{\Delta x}{\Delta t} = \frac{26 - 17.8}{0.475 - 0.3} = \frac{8.2}{0.175} = 46.86$ cm/s

(0.3 , 17.8)

(0.475 , 26)

Fill in **table (4)** below using data from **table(1)**, and then answer the following questions:

Table (4)
Average velocity $\bar{v} = \frac{\Delta x}{\Delta t}$ (cm/s)
$\bar{v}_{7-1} = \frac{x_7 - x_1}{t_7 - t_1} =$ 50
$\bar{v}_{6-2} = \frac{x_6 - x_2}{t_6 - t_2} =$ 53.75
$\bar{v}_{5-3} = \frac{x_5 - x_3}{t_5 - t_3} =$ 60.5

c) The **midpoint** for the given intervals is t_{mid} = 0.4 s.

d) As the time interval is shortened, is there any relation between average velocities in **table (4)** and instantaneous velocity at the midpoint? when I near to point 0.4 so the $\bar{V}_{3-5} \approx \bar{V}$ at 0.4

e) Write down the approximate instantaneous velocity at t_{mid} from table (4).

60.5 cm/s

f) Compare this result with that you have found in **question (b)** above?

Percent error = $\left| \frac{46.86 - 60.5}{\frac{46.86+60.5}{2}} \right| \times 100\%$ = 25.4 %

Use **(v-t) graph** to answer the following questions:

g) Determine **one** interval in which the acceleration is **positive**: (0.15 − 0.35) s

h) Find the instantaneous velocity at **t = 0.4 sec** from the graph. 60 cm/s

i) And compare it with the result in **question (b)**.

Percent deffinent = $\left| \frac{60 - 46.86}{53.43} \right| \times 100\%$ = 24.6 %

j) Calculate the area under the **instantaneous velocity** in the interval **[0.2-0.4] sec**.

$(0.2 \times 50) + (0.15 \times 10) + (\frac{1}{2} \times 0.05 \times 10) + (\frac{1}{2} \times 0.15 \times 20) = 13.175$ cm

k) What does this area represent? Distance (cm)

l) Compare it with the distance moved in the interval **[0.2-0.4] sec** from **table (1)**.

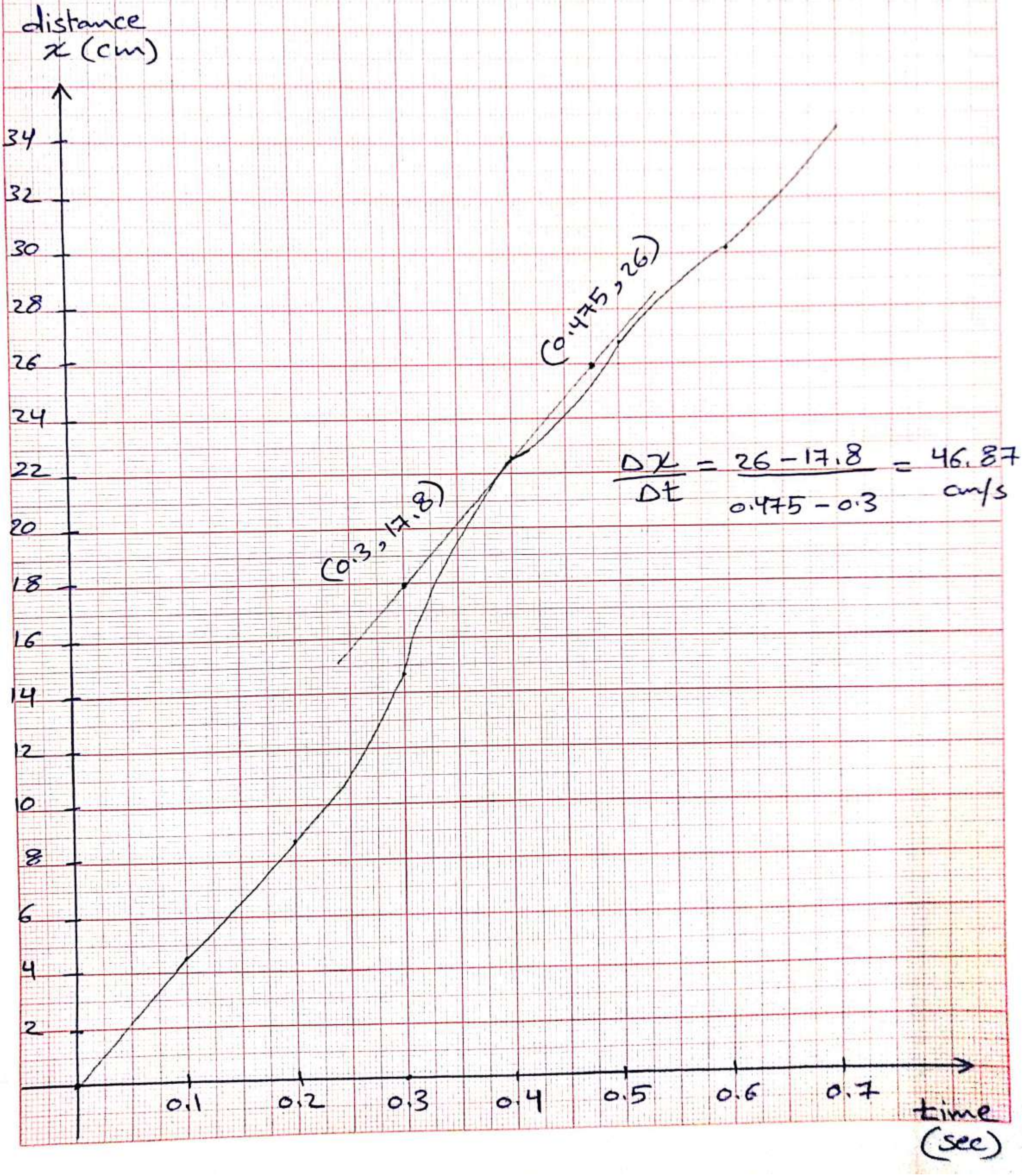
Percent defferent = $\left| \frac{13.175 - 13.9}{13.5375} \right| \times 100\%$ = 5.4 %

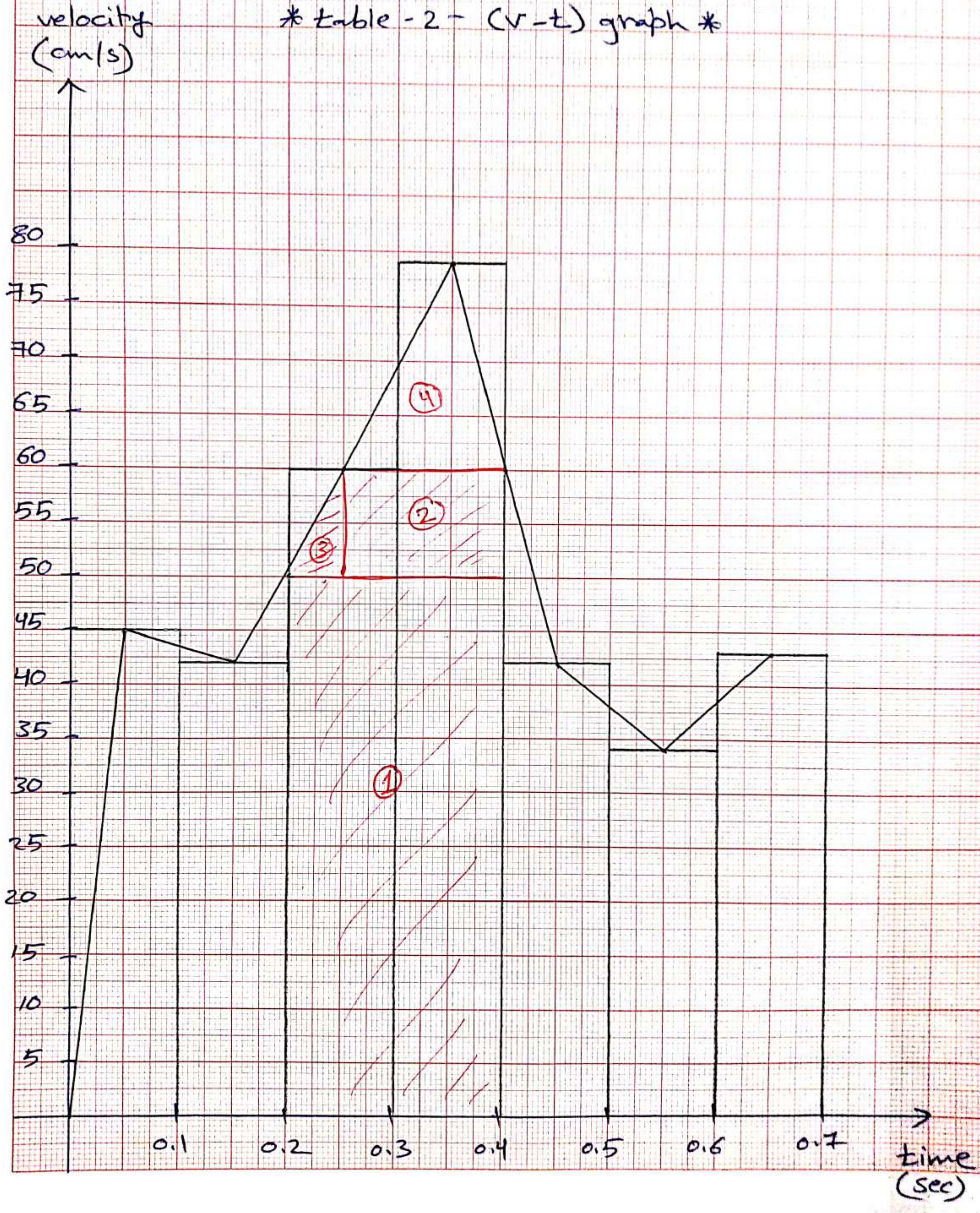
Use *Table (3)* to answer the following questions:

n) How does the acceleration change from one interval to the other (is it uniform or irregular)?

irregular

* table -1- → (x-t) graph *





velocity
(cm/s)
* table - 2 - (v-t) graph *
80
75
70
65
60
55
50
45
40
35
30
25
20
15
10
5
0.1
0.2
0.3
0.4
0.5
0.6
0.7
time
(sec)
4
2
3
1

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Simple Pendulum ex-6- [10/10]

1. Compute the average of the period for each length of the pendulum and record them in **table1**.
2. Fill in the average periods and the lengths **L** in **table 2**.
3. Compute the square of the average period for each length and record it in **table 2.**

Table.(1)			
Fill in the table with data from the experiment			
L (cm)	$T_1 = t_5/5$ (s) Trial 1	$T_2 = t_5/5$ (s) Trial 2	$\bar{T}$ (s)
95	1.9	1.95	1.925
70	1.66	1.67	1.665
60	1.5	1.54	1.52
50	1.4	1.4	1.4
25	0.98	0.99	0.985
15	0.77	0.77	0.77

Table (2)		
Use data from table 1 to fill table 2		
L (cm)	$\bar{T}$ (s)	$\bar{T}^2$ (s)
95	1.925	3.7
70	1.665	2.77
60	1.52	2.31
50	1.4	1.96
25	0.985	0.97
15	0.77	0.59

4. Use the data in **table 2** to plot $\bar{T}$ versus **L**. What conclusions can you obtain from your graph?

[Non-linear], and when L increasing the Time increase

5. Now plot $\bar{T}^2$ versus **L** using **table 2**. What kind of relationship do you obtain? Linear and directly

6. Compute the slope of your $\bar{T}^2$ versus **L** graph.

(0,0), (60, 2.31)

slope = $\frac{2.31-0}{60-0}$ = 0.0385

الفرع السابع → $0.0385 = \frac{4\pi^2}{g}$ → g = 1025.4 cm/s²

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

اكمل بالصفحة السابقة

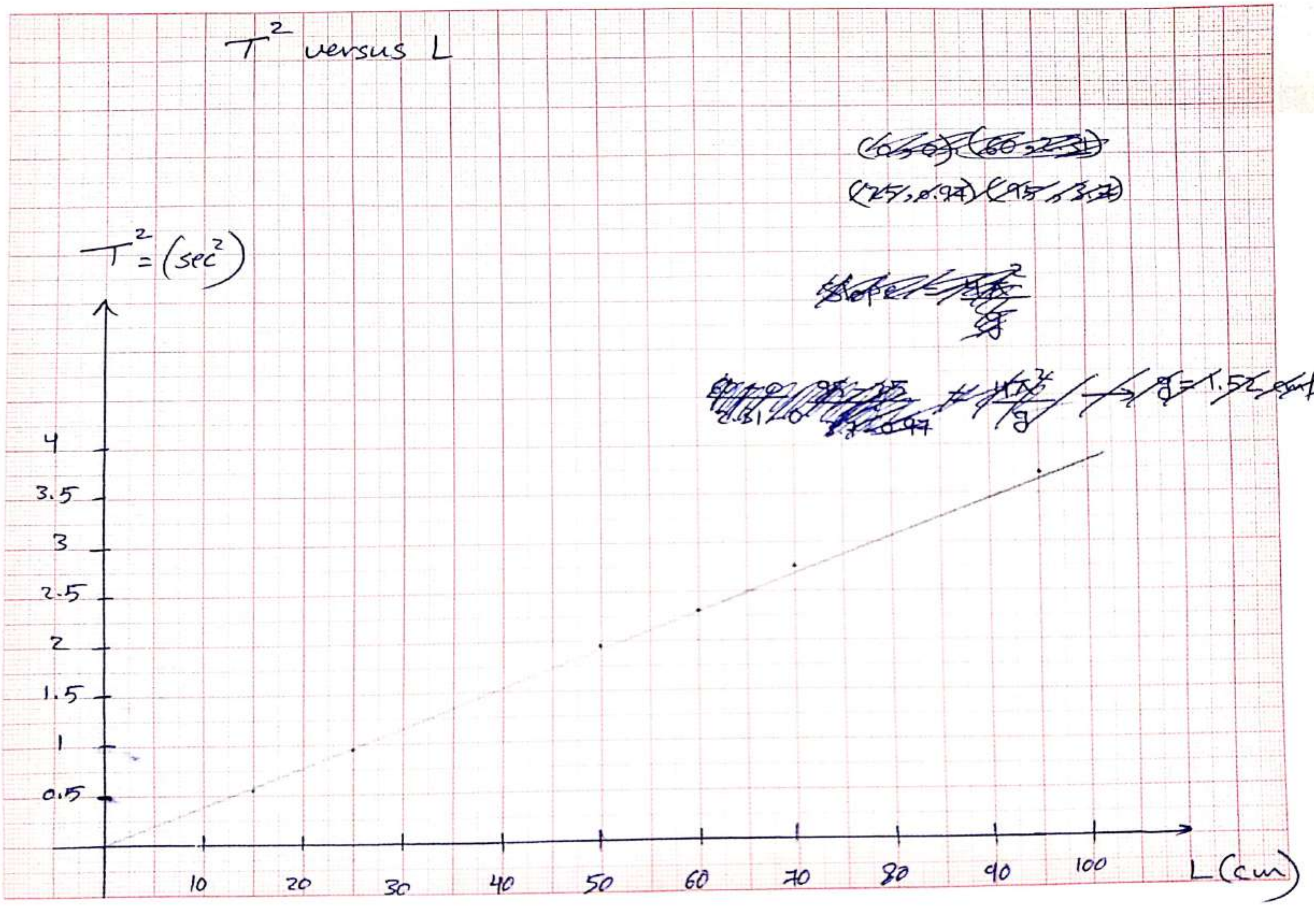
$g = 1025.4 \ cm/s^2$

8. Estimate the percent error in **g**.

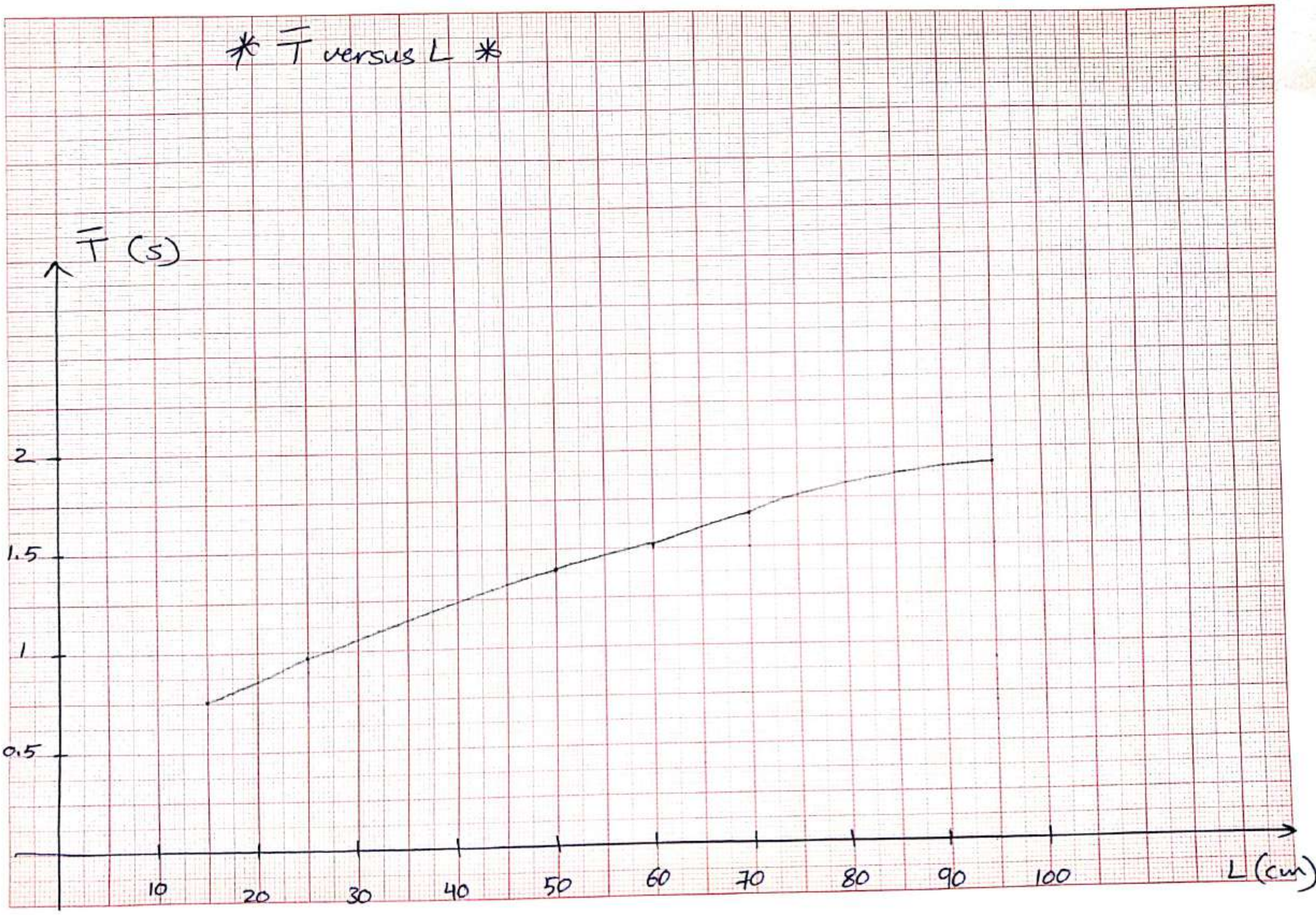
$$error\% = \left| \frac{E - A}{A} \right| \times 100\%$$

$$= \left| \frac{1025.4 - 980}{980} \right| \times 100\%$$

$$= 4.6\%$$



T² versus L
T² = (sec²)
4
3.5
3
2.5
2
1.5
1
0.5
10
20
30
40
50
60
70
80
90
100
L (cm)


* T̄ versus L *
T̄ (s)
2
1.5
1
0.5
10
20
30
40
50
60
70
80
90
100
L (cm)

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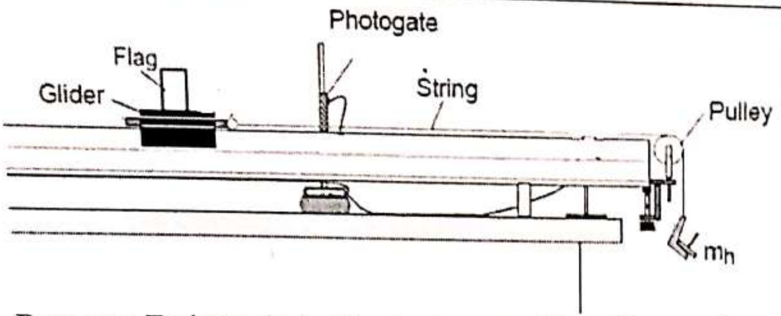
exp _ 8
(7/10)

Force and Motion: Newton's Second Law



In figure **M**: mass of glider
m_a: added mass on glider
m_h: hanging mass
The theoretical equation of motion for this system is:

$$m_h g = (M + m_a + m_h)a$$

Purpose: To investigate Newton's second law: How a given force accelerates different masses and how different forces accelerate a given mass.

Part (I): Acceleration and added mass with constant driving force.

Fill in **table (1)** with data from **your experiment**. Make a graph for m_a versus **1/a**. Then answer the following questions.

a) What is your conclusion about the way in which the acceleration depends on the magnitude of the added mass? when I increase magnitude of the adding accel. the (a) is decrease.

Glider's mass = 0.1 kg			
Air pressure #	Added mass m_a (kg)	Acceleration **a** (m/s^2)	**1/a** $(m/s^2)^{-1}$
4	0	0.317	3.15
5	0.020	0.291	3.44
6	0.050	0.245	4.1
7	0.100	0.192	5.2

b) Find the slope of your **(m_a-1/a)** graph.

$$slope = \frac{0.10 - 0}{5.2 - 3.15} = 0.0488$$

What does the slope represent? driving force ($m_h g$)

c) Determine the value of the **glider mass(M)** from the (m_a-1/a)graph. And compare it with the real value.

$M = |y_{int}| - (slope/g) = 0.151 - (0.0488/9.8) = 0.146$ N

percent error % $= \left|\frac{0.146 - 0.1}{0.1}\right| \times 100\% = 46\%$

Part (II): Acceleration and driving force with constant total mass.

Fill in **table (2)** with data from **your experiment**. Then, draw a graph for $m_h g$ versus **a**.

a) What is your conclusion about the way in which the acceleration depends on the magnitude of the hanging mass?

when I increase the magnitude of hanging mass the acceleration increase (linear and direct)

Air pressure	m_a (g)	m_h (g)	$m_h g$ (dyne)	a (cm/s^2)
7	100	50	49000	192
6	50	100	98000	~~392~~ 398.2
5	20	130	127400	501.6
4	0	150	147000	587.3

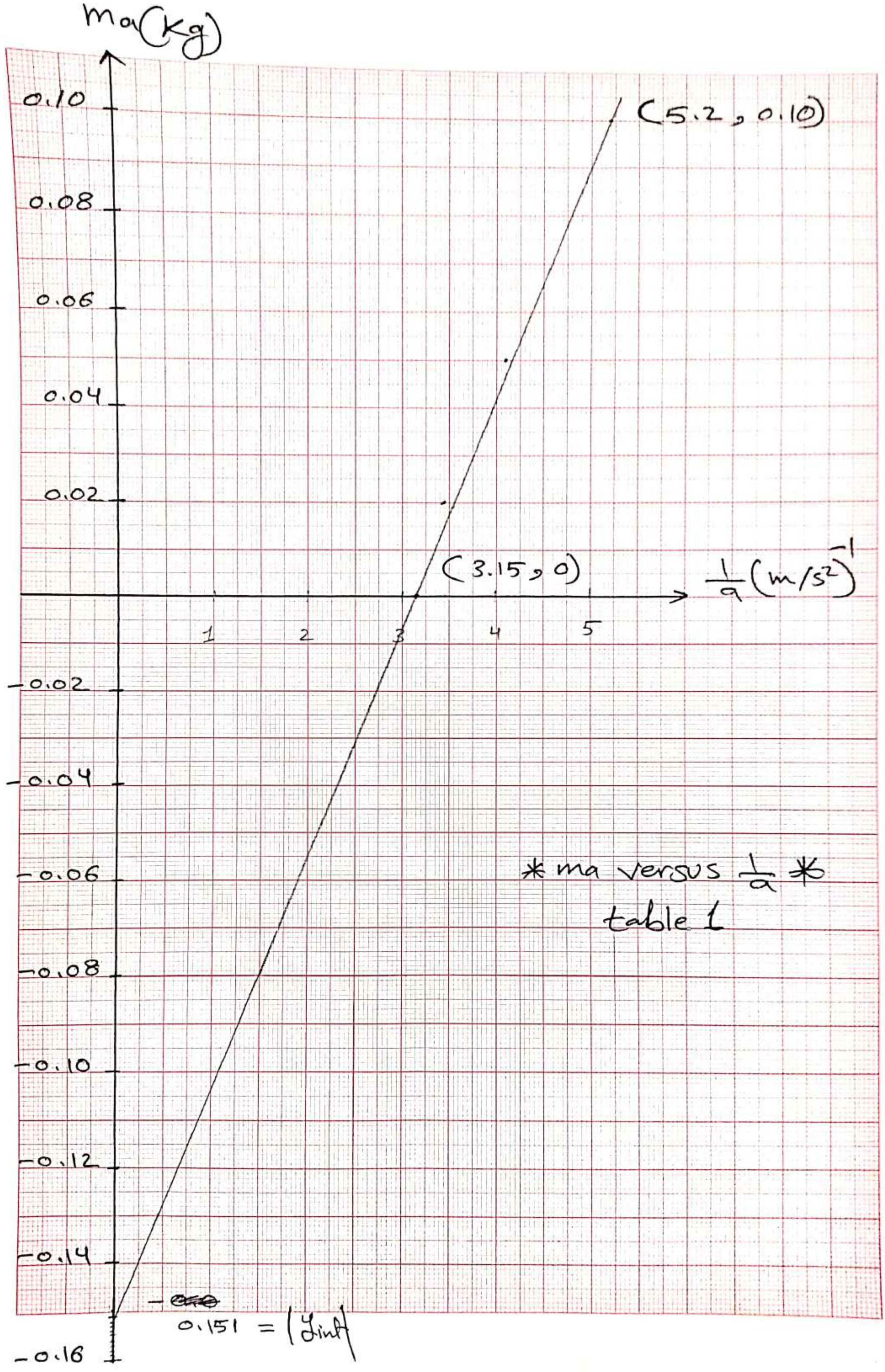
$m_a + m_h = 150$ g

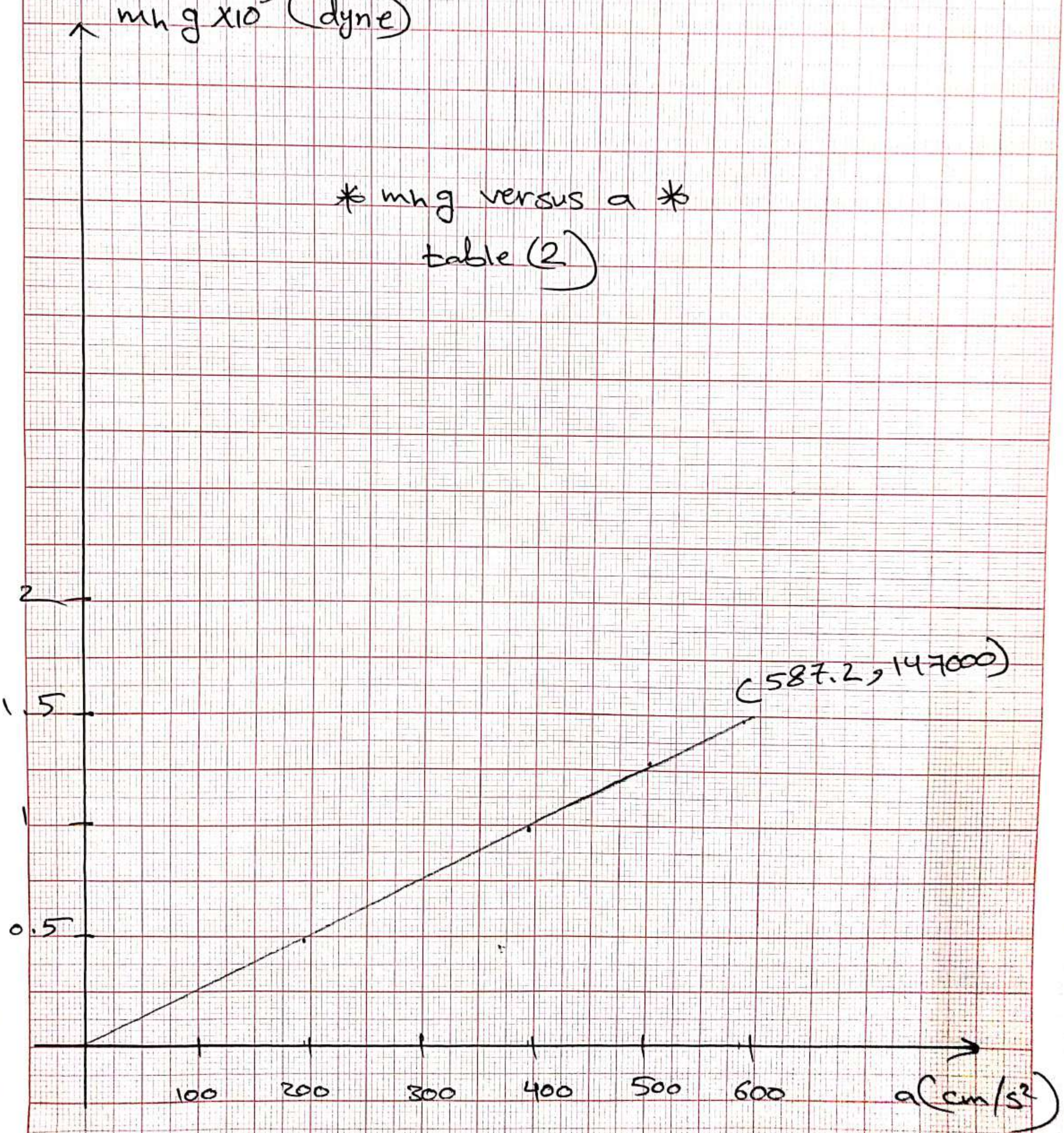
b) Find the **slope** of your $m_h g$ versus ***a*** graph. What does the slope represent?

$$slope = \frac{147000 - 0}{587.2 - 0} = 250.34$$

c) Do you expect that the $m_h g$ versus *a* curve should pass through the origin? **Explain** your answer.

yes, Becouse when no hanging mass the acceleration ~~~~ will be zero.


ma(kg)
0.10
0.08
0.06
0.04
0.02
-0.02
-0.04
-0.06
-0.08
-0.10
-0.12
-0.14
-0.16
1
2
3
4
5
(5.2, 0.10)
(3.15, 0)
$\frac{1}{a}(m/s^2)^{-1}$
* ma versus $\frac{1}{a}$ *
table 1
-0.151 = |y int|



mhg x10^5 (dyne)
* mhg versus a *
table (2)
2
1.5
1
0.5
(587.2, 147000)
100
200
300
400
500
600
a(cm/s²)